Julimar Phase 2 Drilling and Subsea Installation Environment Plan

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1 INTRODUCTION

1.1 Overview

Woodside Energy Julimar Pty Ltd (Woodside), as Titleholder under the Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009 (Cth) (referred to as the Environment Regulations), proposes to undertake the following activities within Permit Area WA-49-L for the Julimar Development Phase 2:

- Drill and develop four production wells, connected to a six-slot manifold ('JULA').
- Construct an approximately 22 km production flowline and control umbilical extension between the JULA manifold and the existing Brunello Crossover Manifold (BRU-XOM).
- Install and pre-commission subsea hardware and flowline.

These activities will hereafter be referred to as the Petroleum Activities Program and form the scope of this Environment Plan (EP).

Hydrocarbons from the Julimar Phase 2 production wells will be produced through the existing Wheatstone Platform, and from there to the Wheatstone Project's onshore liquefied natural gas (LNG) trains and domestic gas plant at Ashburton North. Commissioning of the Julimar Development Phase 2 and hydrocarbon production through the Wheatstone Platform is subject to the existing Wheatstone Operations EP. It is outside the scope of this EP. Commissioning activities will be covered under the Wheatstone Operations EP as well as hydrocarbon production. The need to revise and resubmit the Wheatstone Operations EP as a result of the Julimar Development Phase 2 will be assessed prior to commissioning.

This EP has been prepared as part of the requirements under the Environment Regulations, as administered by the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA).

1.2 Defining the Petroleum Activity

The Petroleum Activities Program to be undertaken in Permit Area WA-49-L comprises development drilling and installation of related subsea infrastructure, which are petroleum activities as defined in Regulation 4 of the Environment Regulations. As such an EP is required.

1.3 Purpose of the Environment Plan

In accordance with the objectives of the Environment Regulations, the purpose of this EP is to demonstrate that:

- The potential environmental impacts (planned (routine and non-routine) and unplanned) and risks (unplanned events) that may result from the Petroleum Activities Program are identified.
- Appropriate management controls are implemented to reduce impacts and risks to a level that is 'as low as reasonably practicable' (ALARP) and acceptable.
- The Petroleum Activities Program is performed in a manner consistent with the principles of ecologically sustainable development (as defined in Section 3A of the *Environment Protection and Biodiversity Conservation Act 1999* (Cth) (EPBC Act).

This EP describes the process and resulting outputs of the risk assessment, whereby impacts and risks are managed accordingly.

The EP defines activity-specific environmental performance outcomes (EPOs), environmental performance standards (PSs) and measurement criteria (MCs). These form the basis for monitoring, auditing and management of the Petroleum Activities Program to be undertaken by Woodside and its contractors. The implementation strategy (derived from the decision support framework tools) specified within this EP provides Woodside and NOPSEMA with the required level of assurance that impacts and risks associated with the activity are reduced to ALARP and are acceptable.

1.4 Scope of the Environment Plan

The scope of this EP covers the activities that define the Petroleum Activities Program, as described in **Section 3**. The Operational Area defines the spatial boundary of the Petroleum Activities Program, and includes a 4 km radius around each well and a 1.5 km radius around subsea installation locations in which subsea installation, pipelay and pre-commissioning petroleum activities will occur.

This EP addresses potential environmental impacts from planned petroleum activities within the Operational Area and any potential unplanned events that originate from within the Operational Area.

Transit to and from the Operational Area by the Mobile Offshore Drilling Unit (MODU), pipelay vessel, installation vessels and support vessels are not within the scope of this EP. In addition, vessels supporting the Petroleum Activities Program operating outside the Operational Area (e.g. transiting to and from port) are subject to all applicable maritime regulations and other requirements and are not managed by this EP.

1.5 Environment Plan Summary

This Julimar Phase 2 Drilling, Subsea Installation and Pre-Commissioning EP summary has been prepared from material provided in this EP. This summarises the items listed in **Table 1-1**, as required by Regulation 11(4).

Table 1-1: EP summary table

EP Summary material requirement	Relevant section of EP containing EP Summary material
The location of the activity	**Section 3.3**, pages 38–39
A description of the receiving environment	**Section 4**, pages 60–160
A description of the activity	**Section 3**, pages 35–59
Details of the environmental impacts and risks	**Section 6**, pages 171–329
The control measures for the activity	**Section 6**, pages 171–329
The arrangements for ongoing monitoring of the titleholder's environmental performance	**Section 7.5**, pages 334–339
Response arrangements in the oil pollution emergency plan	**Section 7.9**, pages 344–353, **Appendix D**
Consultation already undertaken and plans for ongoing consultation	**Section 5**, pages 161–171
Details of the titleholder's nominated liaison person for the activity	**Section 1.8**, pages 16–17

1.6 Structure of the Environment Plan

The EP has been structured to reflect the process and requirements of the Environment Regulations as outlined in **Table 1-2**.

Table 1-2: EP requirements under the Environment Regulations and applicable elements and sections of the EP

Criteria for acceptance	Content Requirements/Relevant Regulations	Applicable Elements of the EP	Section of EP
Regulation 10A(a): *is appropriate for the nature and scale of the activity*	Regulation 13: *Environmental assessment* Regulation 14: *Implementation strategy for the environment plan* Regulation 16: *Other information in the environment plan*	The principle of 'nature and scale' is applicable throughout the EP	**Section 2** **Section 3** **Section 4** **Section 5** **Section 6** **Section 7**
Regulation 10A(b): *demonstrates that the environmental impacts and risks of the activity will be reduced to as low as reasonably practicable* Regulation 10A(c): *demonstrates that the environmental impacts and risks of the activity will be of an acceptable level*	Regulation 13(1) to 13(7): *13(1) Description of the activity* *13(2)(3) Description of the environment* *13(4) Requirements* *13(5)(6) Evaluation of environmental impacts and risks* *13(7) Environmental performance outcomes and standards* Regulation 16(a) to 16(c): *A statement of the titleholder's corporate environmental policy* *A report on all consultations between the titleholder and any relevant person*	Set the context (activity and existing environment) Define 'acceptable' (the requirements, the corporate policy, relevant persons) Detail the impacts and risks Evaluate the nature and scale Detail the control measures – ALARP and acceptable	**Section 1** **Section 2** **Section 3** **Section 4** **Section 5** **Section 6** **Section 7**
Regulation 10A(d): *provides for appropriate environmental performance outcomes, environmental performance standards and measurement criteria*	Regulation 13(7): *Environmental performance outcomes and standards*	Environmental performance outcomes Environmental performance standards Measurement criteria	**Section 6**
Regulation 10A(e): *includes an appropriate implementation strategy and monitoring, recording and reporting arrangements*	Regulation 14: *Implementation strategy for the environment plan*	Implementation strategy, including: Environmental Management System (EMS) Performance monitoring Oil Pollution Emergency Plan and scientific monitoring Ongoing consultation	**Section 7** **Appendix D**

Criteria for acceptance	Content Requirements/Relevant Regulations	Applicable Elements of the EP	Section of EP
Regulation 10A(f): *does not involve the activity or part of the activity, other than arrangements for environmental monitoring or for responding to an emergency, being undertaken in any part of a declared World Heritage property within the meaning of the EPBC Act*	Regulation 13(1) to 13(3): *13(1) Description of the activity* *13(2) Description of the environment* *13(3) Without limiting [Regulation 13(2)(b)], particular relevant values and sensitivities may include any of the following:* *(a) the world heritage values of a declared World Heritage property within the meaning of the EPBC Act;* *(b) the national heritage values of a National Heritage place within the meaning of that Act;* *(c) the ecological character of a declared Ramsar wetland within the meaning of that Act;* *(d) the presence of a listed threatened species or listed threatened ecological community within the meaning of that Act;* *(e) the presence of a listed migratory species within the meaning of that Act;* *(f) any values and sensitivities that exist in, or in relation to, part or all of:* *(i) a Commonwealth marine area within the meaning of that Act; or* *(ii) Commonwealth land within the meaning of that Act.*	No activity, or part of the activity, undertaken in any part of a declared World Heritage property	**Section 3** **Section 4**
Regulation 10A(g): *(i) the titleholder has carried out the consultations required by Division 2.2A* *(ii) the measures (if any) that the titleholder has adopted, or proposes to adopt, because of the consultations are appropriate*	Regulation 11A: *Consultation with relevant authorities, persons and organisations, etc.* Regulation 16(b): *A report on all consultations between the titleholder and any relevant person*	Consultation undertaken in the preparation of the EP	**Section 5**
Regulation 10A(h): *complies with the Act and the regulations*	Regulation 13(4)a: *Describe the requirements, including legislative requirements, that apply to activity and are relevant to the environmental management of the activity* Regulation 15: *Details of the titleholder and liaison person* Regulation 16(a): *A statement of the titleholder's corporate environmental policy* Regulation 16(c): *details of all reportable incidents in relation to the proposed activity.*	All contents of the EP must comply with the *Offshore Petroleum and Greenhouse Gas Storage Act 2006* and the Environment Regulations	**Section 1** **Section 5** **Section 6** **Appendix A** **Appendix B**

1.7 Description of the Titleholder

The nominated Titleholder for this activity is Woodside Energy Julimar Pty Ltd, on behalf of a Joint Venture comprising Woodside Energy Julimar Ltd and KUFPEC Australia (Julimar) Pty Ltd.

Woodside's mission is to deliver superior shareholder returns through realising its vision of becoming a global leader in upstream oil and gas. Wherever Woodside works, we are committed to living its values of integrity, respect, working sustainably, discipline, excellence and working together.

Woodside's operations are characterised by strong safety and environmental performance in remote and challenging locations.

Through collaboration, Woodside leverages its capabilities to progress its growth strategy. Since 1984, the company has been operating the landmark Australian project, the North West Shelf, and it remains one of the world's premier LNG facilities. In 2012, Woodside added the Pluto LNG Plant to its onshore operating facilities.

Woodside has an excellent track record of efficient and safe production. Woodside strives for excellence in safety and environmental performance and continues to strengthen relationships with customers, partners co-venturers, governments and communities to ensure they are a partner of choice. Further information about Woodside can be found at http://www.woodside.com.au.

1.8 Details of Titleholder, Liaison Person and Public Affairs Contact

In accordance with Regulation 15 of the Environment Regulation, details of the Titleholder, liaison person and arrangements for the notification of changes are described below.

1.8.1 Titleholder

Woodside Energy Julimar Pty Ltd
Mia Yellagonga, 11 Mount Street, Perth WA 6000
Telephone: 08 9348 4000
Fax: 08 9214 2777
ABN: 63 005 482 986

1.8.2 Activity Contact

Craig Gonsalves
Project Manager, Julimar Development Phase 2
Mia Yellagonga, 11 Mount Street, Perth WA 6000
Phone: 08 9348 4000
Fax Number: 08 9214 2777
craig.gonsalves@woodside.com.au

1.8.3 Nominated Liaison Person

Daniel Cleary
Corporate Affairs Manager
Mia Yellagonga, 11 Mount Street, Perth WA 6000
Phone: 08 9348 4000
Fax Number: 08 9214 2777
feedback@woodside.com.au

1.8.4 Arrangements for Notifying of Change

Should the Titleholder, nominated liaison person or the contact details for either change, then NOPSEMA is to be notified of the change in writing within two weeks or as soon as practicable.

1.9 Woodside Management System

The Woodside Management System (WMS) provides a structured framework of documentation to set common expectations governing how all employees and contractors at Woodside will work. Many of the standards presented in **Section 6** are drawn from the WMS documentation, which comprises of four elements: Compass & Policies; Expectations; Processes & Procedures; and Guidelines outlined below (and illustrated in **Figure 1-1**):

- **Compass & Policies:** Set the enterprise-wide direction for Woodside by governing our behaviours, actions and business decisions and ensuring we meet our legal and other external obligations.
- **Expectations:** Set essential activities or deliverables required to achieve the objectives of the Key Business Activities and provide the basis for developing processes and procedures.
- **Processes & Procedures:** Processes identify the set of interrelated or interacting activities which transforms inputs into outputs, to systematically achieve a purpose or specific objective. Procedures specify what steps, by whom and when required to perform an activity or a process.
- **Guidelines:** Provide recommended practice and advice on how to perform the steps defined in Procedures, together with supporting information and associated tools. Guidelines provide advice on: how activities or tasks may be performed; information that may be considered; or how to use tools and systems.

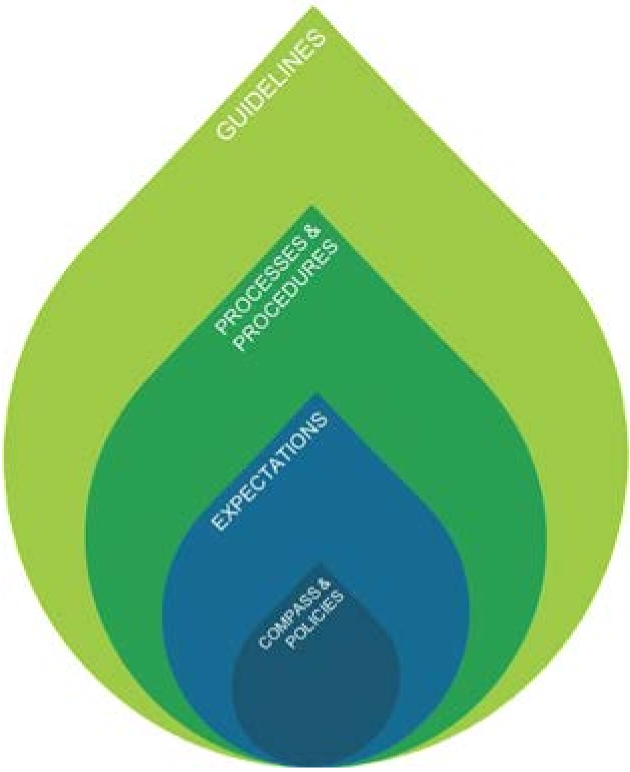


Figure 1-1: The four major elements of the WMS System

The WMS is organised within a Business Process Hierarchy based upon Key Business Activities to ensure the system remains independent of organisation structure, is globally applicable and scalable wherever required. These Business Activities are grouped into Management, Support and Value Stream activities as shown in **Figure 1-2**. The Value Stream activities capture, generate and deliver value through the exploration and production lifecycle. The Management activities influence all areas of the business, while Support activities may influence one or more Value Stream activities.

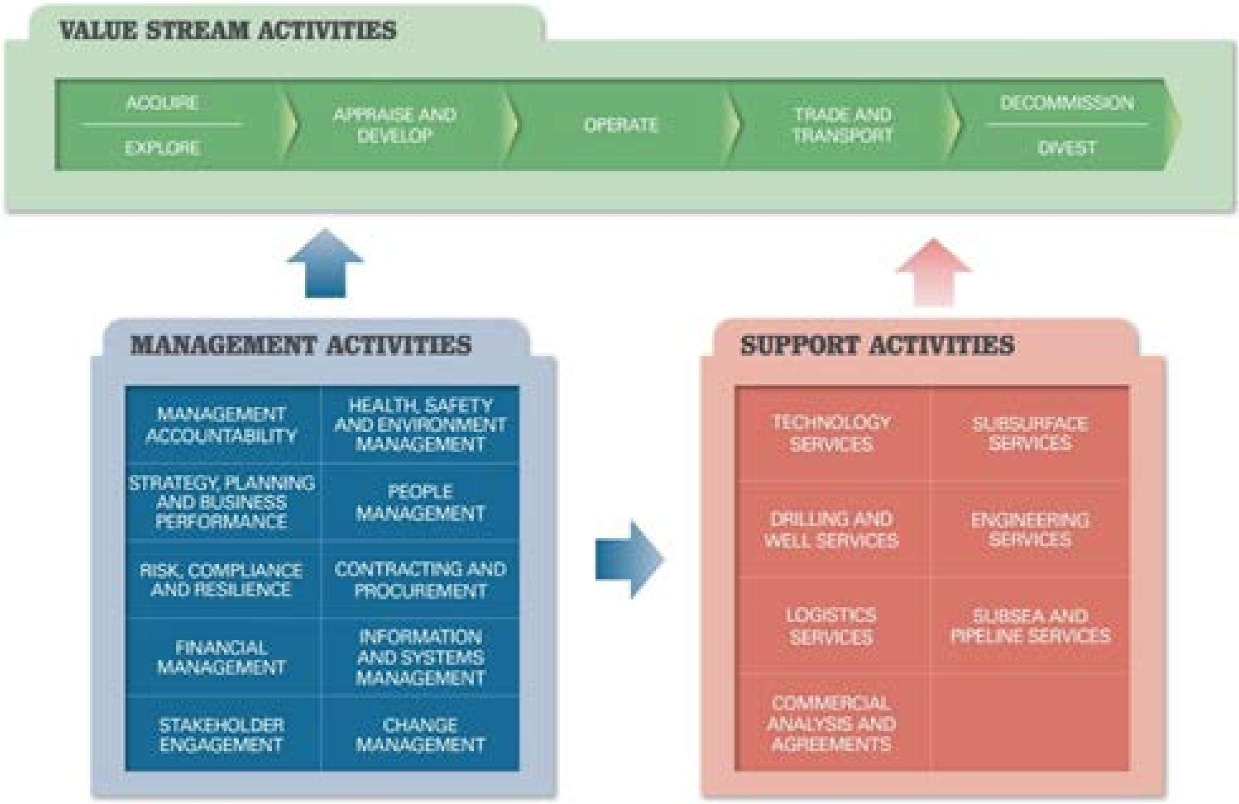


Figure 1-2: The WMS business process hierarchy

1.9.1 Health, Safety, Environment and Quality Policy

In accordance with Regulation 16(a) of the Environment Regulations, Woodside's corporate Health Safety, Environment and Quality Policy is provided in **Appendix A** of this EP.

1.10 Description of Relevant Requirements

In accordance with Regulation 13(4) of the Environment Regulations, a description of requirements, including legislative requirements, that apply to the activity and are relevant to managing risks and impacts of the Petroleum Activities Program is provided in **Appendix B**.

1.10.1 Applicable Environmental Legislation

The Commonwealth *Offshore Petroleum and Greenhouse Gas Storage Act 2006* (OPGGS Act) controls exploration and production activities beyond three nautical miles to the outer extent of the Australian Exclusive Economic Zone at 200 nautical miles, also known as Commonwealth waters.

The Environment Regulations apply to petroleum activities in Commonwealth waters. The Environment Regulations are administered by NOPSEMA.

The objectives of the Environment Regulations include provisions to ensure petroleum activities are performed in a manner:

- consistent with the principles of ecologically sustainable development
- by which the environmental impacts and risks of the activity will be reduced to ALARP
- by which the environmental impacts and risks of the activity will be of an acceptable level.

2. ENVIRONMENT PLAN PROCESS

2.1 Overview

This section outlines the process that Woodside follows to prepare the EP once an activity has been defined as a petroleum activity (refer **Section 1.2**). The process (**Section 2.3**) describes the environmental risk management methodology that is used to identify, analyse and evaluate risks to meet ALARP and acceptability requirements and develop environmental performance outcomes and standards. This section also describes Woodside's risk management methodologies applicable to implementation strategies applied during the activity.

Regulation 13(5) of the Environment Regulations requires environmental impacts and risks to be detailed, and evaluated appropriate to the nature and scale of each impact and risk associated with the Petroleum Activities Program. The objective of the risk assessment process described in this section is to identify risks and associated impacts of an activity, so they can be assessed and appropriate control measures applied to eliminate, control or mitigate the impact/risk to ALARP and to determine if the impact or risk level is acceptable.

Environmental impacts and risks include those directly and indirectly associated with the Petroleum Activities Program, and includes potential emergency and accidental events:

- Planned activities have the potential for inherent environmental impacts.
- An environmental risk is an unplanned event with the potential for impact (termed risk 'consequence').

Herein, potential impact from planned activities are termed 'impacts', and 'risks' are associated with unplanned events with the potential for impact (should the risk be realised), with such impact termed potential 'consequence'.

2.2 Environmental Risk Management Methodology

2.2.1 Woodside Risk Management Processes

Woodside recognises that risk is inherent to its business and effectively managing those risks is vital to delivering on company objectives, success and continued growth. Woodside is committed to managing all risks proactively and effectively. The objective of Woodside's risk management system is to provide a consistent process for recognising and managing risks across Woodside's business. Achieving this objective includes ensuring risks consider impacts across the following key areas of exposure: health and safety, environment, finance, reputation and brand, legal and compliance, and social and cultural. A copy of Woodside's Risk Management Policy is provided in **Appendix A**.

The environmental risk management methodology used in this EP is based on Woodside's Risk Management Procedure. This procedure aligns to industry standards such as international standard ISO 31000:2009. The WMS risk management procedures, guidelines and tools provide guidance on specific techniques for managing risk, these tailor the Risk Management Procedure for particular areas of risk within certain business processes. Three such procedures applied for managing environmental risk include Woodside's:

- Health Safety and Environment Management Procedure
- Impact Assessment Procedure
- Process Safety Management Procedure.

The risk management methodology provides a framework to demonstrate that the identified risks and impacts are continually identified, reduced to ALARP and assessed to be at an acceptable level, as required by the Environment Regulations. The key steps of Woodside's Risk Management

Process are shown in **Figure 2-1**. A description of each step and how it is applied to the scopes of this activity is provided in **Sections 2.1** to **Section 2.10**.

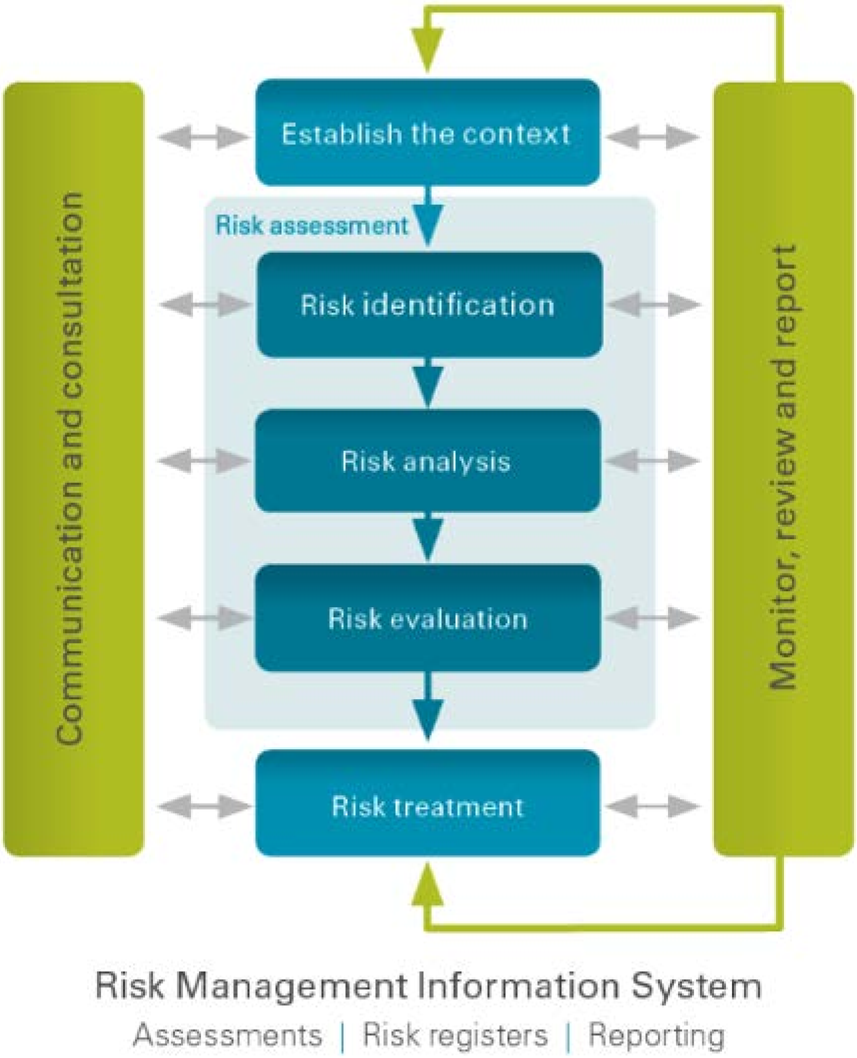


Figure 2-1: Woodside's risk management process

2.2.2 Health, Safety and Environment Management Procedure

Woodside's Health, Safety and Environment Management Procedure provides a structure for managing health, safety and environment (HSE) risks and impacts across Woodside and defines the decision authorities for company-wide HSE management activities and deliverables, and to support continuous improvement in HSE management.

2.2.3 Impact Assessment Procedure

To support effective environmental risk assessment, Woodside's Impact Assessment Procedure (**Figure 2-2**) provides the steps needed to meet required environment, health and social standards through ensuring impact assessments are undertaken appropriate to the nature and scale of the activity, the regulatory context, the receiving environment, interests, concerns and rights of stakeholders, and the applicable framework of standards and practices.

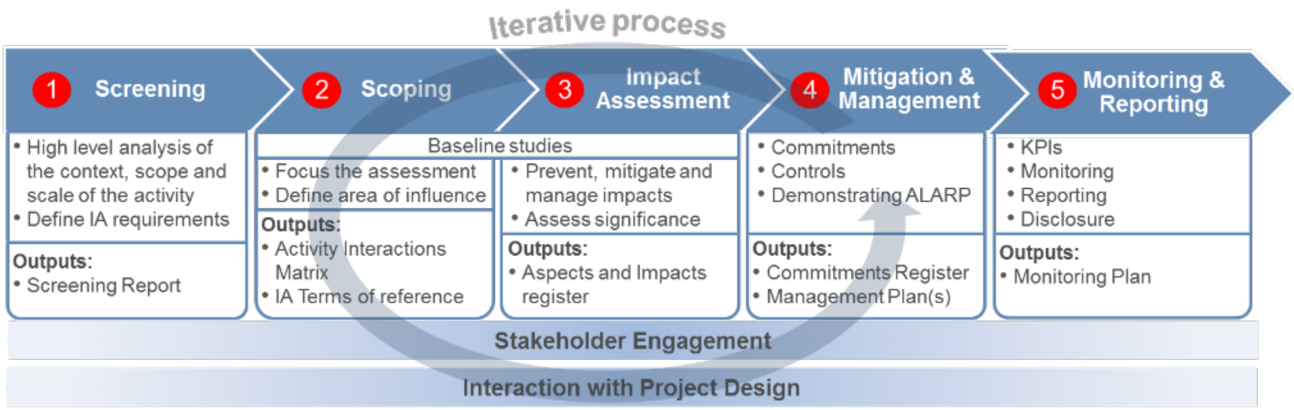


Figure 2-2: Woodside's impact assessment process

2.3 Environment Plan Process

Figure 2-3 illustrates the Environment Plan development process. Each element of this process is discussed in **Sections 2.4** to **Section 2.10**.

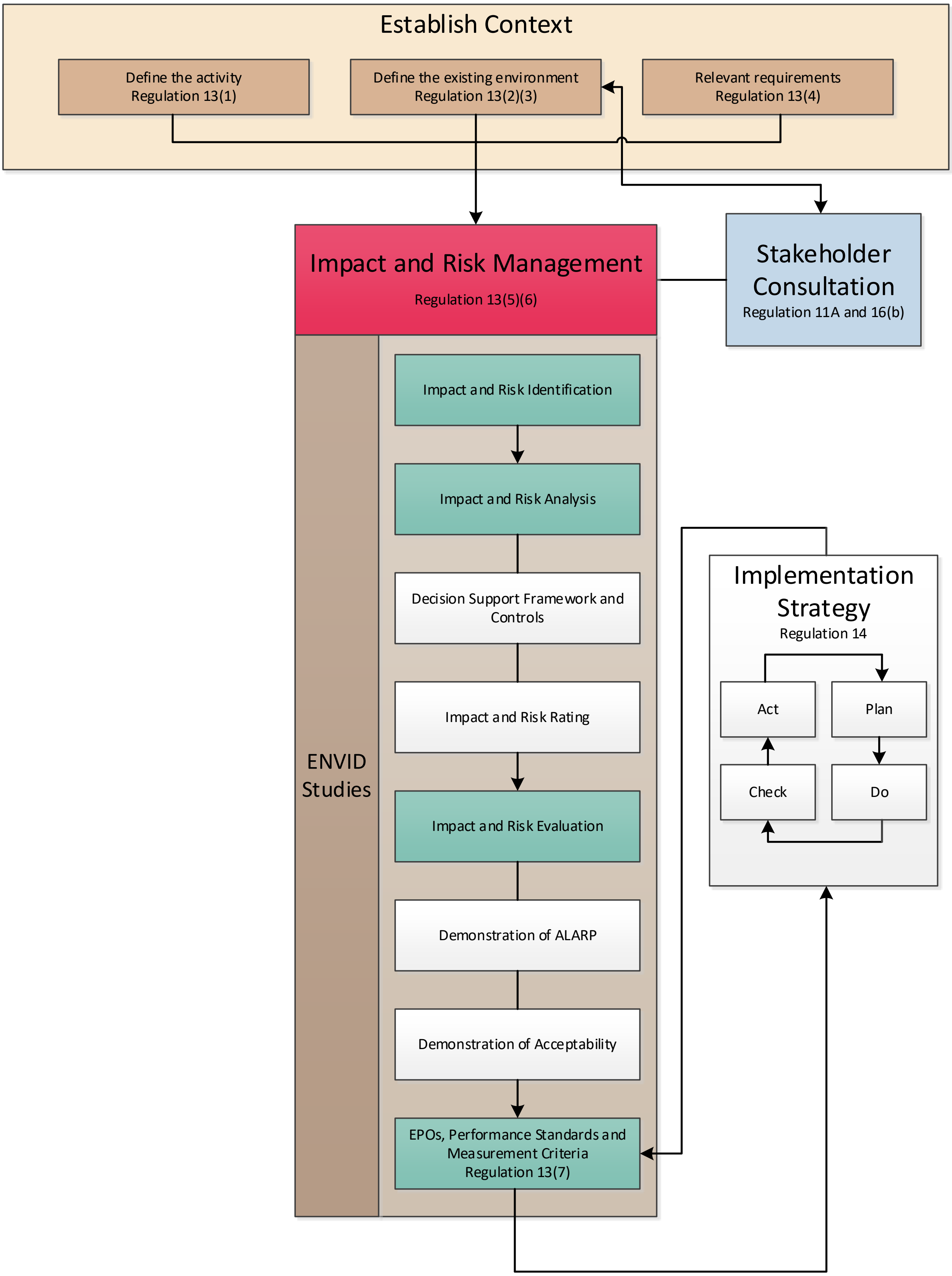


Figure 2-3: Environment plan development process

2.4 Establish the Context

2.4.1 Define the Activity

This first stage involves evaluating whether the activity meets the definition of a 'petroleum activity' as defined in the Environment Regulations.

The activity is then described in relation to:

- the location
- what is to be undertaken
- how it is planned to be undertaken, including outlining operational details of the activity and proposed timeframes.

The 'what' and 'how' are described in the context of 'environmental aspects'[1] to inform the risk and impact assessment for planned (routine and non-routine) and unplanned (accidents/incidents/emergency conditions) activities.

The activity is described in **Section 3** and referred to as the Petroleum Activities Program.

2.4.2 Define the Existing Environment

The existing environment that may be impacted by the Petroleum Activities Program (as described in **Section 4**) is defined by considering the nature and scale of the activities (i.e. size, type, timing, duration, complexity and intensity). The existing environment may potentially be impacted directly or indirectly by planned and unplanned[2] events. The existing environment (**Section 4**) is structured into sub-sections defining the physical, biological, socio-economic and cultural attributes of the area of interest in accordance with the definition of 'environment' in Regulation 4(a) of the Environment Regulations. These sub-sections make particular reference to the following:

- The environmental values potentially impacted by the Petroleum Activities Program, which include key physical and biological attributes of the existing environment (as defined by Woodside in **Table 2-1** and **Section 2.4.2**).
- EPBC Act matters of national environmental significance (MNES) including listed threatened species and ecological communities, and listed migratory species. Defining the spatial extent of the existing environment is guided by the nature and scale of the Petroleum Activities Program within the Operational Area (planned activities) and the environment that may be affected (EMBA) by unplanned events. Potential impacts to MNES as defined within the EPBC Act are addressed through Woodside's impact and risk assessment process (**Section 2.6**).
- Relevant values and sensitivities, which may include world or national heritage listed areas, Ramsar wetlands, listed threatened species or ecological communities, listed migratory species, sensitive values that exist in, or in relation to commonwealth marine area or land.

[1] An environmental aspect is an element of the activity that can interact with the environment.

[2] The worst-case unplanned event is considered to be an unplanned hydrocarbon release, further defined for each activity through the risk assessment process. Interpretation of stochastic oil spill modelling determines the EMBA for the release, which defines the spatial scale of the environment that may be potentially impacted by the Petroleum Activities Program, which provides context to the 'nature and scale' of the existing environment.

- In categorising the environmental values potentially impacted by the Petroleum Activities Program (as presented in **Table 2-1**), information is standardised relevant to the understanding of the receiving environment. Potential impacts to these environmental values are evaluated in the risk analysis (refer **Section 2.6**), and risk-rated for all planned and unplanned activities. This provides a robust approach to the overall environmental risk evaluation and its documentation in the EP.

Table 2-1: Example of the environment values potentially impacted which are assessed within the EP

Environmental Value Potentially Impacted *Regulations 13(2)(3)*						
Soil and Groundwater	Marine Sediment	Water Quality	Air Quality (incl odour)	Ecosystems/Habitats	Species	Socio-Economic

The existing environment is described in **Section 4**.

2.4.3 Relevant Requirements

The relevant requirements in the context of legislation, other environmental approval requirements, conditions and standards that apply to the Petroleum Activities Program are identified and reviewed.

Relevant requirements are presented in **Appendix B**.

Woodside's corporate Heath Safety, Environment and Quality Policy is presented in **Appendix A**.

2.5 Impact and Risk Identification

Relevant environmental aspects and hazards have been identified to support the process to define environmental impacts and risks associated with an activity.

The environmental impact and risk assessment presented in this EP has been informed by recent and historic hazard identification studies (e.g. HAZID/ENVID), process safety risk assessment processes, reviews and associated desktop studies associated with the Petroleum Activities Program. Risks are identified based on planned and potential interaction with the activity (based on the description in **Section 3**), the existing environment (**Section 4**) and the outcomes of Woodside's stakeholder engagement process (**Section 5**). The environmental outputs of applicable risk and impact workshops and associated studies are referred to as ENVID thereafter in this EP.

The ENVID has been undertaken by multidisciplinary teams consisting of relevant engineering and environmental personnel with sufficient breadth of knowledge, training and experience to reasonably assure that risks were identified and their potential environmental impacts assessed. Impacts and risks were identified during the ENVID for both planned (routine and non-routine) activities and unplanned (accidents/incidents/emergency conditions) events. During this process, risks that are identified as not applicable (not credible) are removed from the assessment. This is performed by defining the activity and identifying that an aspect is not applicable.

The impact and risk information is classified, evaluated and tabulated for each planned activity and unplanned event. Environmental impacts and risk are recorded in an environmental impacts and risk register. The output of the ENVID is used to present the risk assessment and forms the basis to develop performance outcomes, standards and measurement criteria. This information is presented in **Section 6**), using the format presented in **Table 2-2**.

Table 2-2: Example of layout of identification of risks and impacts in relation to risk sources

Impacts and Risks Evaluation Summary													
Source of Risk	***Environmental Value Potentially Impacted***							***Evaluation***					
	Soil and Groundwater	Marine Sediment	Water Quality	Air Quality (incl Odour)	Ecosystems/Habitat	Species	Socio-Economic	Decision Type	Consequence/Impact	Likelihood	Risk Rating	ALARP Tools	Acceptability
Summary of source of impact/risk													

2.6 Impact and Risk Analysis

Risk analysis further develops the understanding of a risk by defining the impacts and assessing appropriate controls. Risk analysis considered previous risk assessments for similar activities, reviews of relevant studies, reviews of past performance, external stakeholder consultation feedback and review of the existing environment.

The key steps undertaken for each risk identified during the risk analysis were:

- Identify the decision type in accordance with the decision support framework.
- Identify appropriate control measures (preventative and mitigative) aligned with the decision type.
- Assess the risk rating.

2.6.1 Decision Support Framework

To support the risk assessment process, and Woodside's determination of acceptability (**Section 2.7.2**), Woodside's HSE risk management procedures include using a decision support framework based on principles set out in the Guidance on Risk Related Decision Making (Oil and Gas UK, 2014). This concept has been applied during the ENVID, or equivalent preceding processes during historical design decisions, to determine the level of supporting evidence that may be required to draw sound conclusions about risk level and whether the risk is acceptable and ALARP (**Table 2-4**). This is to confirm:

- Activities do not pose an unacceptable environmental risk.
- Appropriate focus is placed on activities where the risk is anticipated to be acceptable and demonstrated to be ALARP.
- Appropriate effort is applied to managing risks based on the uncertainty of the risk, the complexity and risk rating (i.e. potential higher order environmental impacts are subject to further assessment).

The framework provides appropriate tools, commensurate to the level of uncertainty or novelty associated with the risk (referred to as Decision Type A, B or C). The decision type is selected based on an informed discussion around the uncertainty of the risk, and documented in ENVID output.

This framework enables Woodside to appropriately understand a risk, determine if the risk is acceptable and can be demonstrated to be ALARP.

2.6.1.1 Decision Type A

Risks classified as a Decision Type A are well understood and established practice. They generally consider recognised good industry practice, which is often embodied in legislation, codes and standards and use professional judgement.

2.6.1.2 Decision Type B

Risks classified as Decision Type B typically involve greater uncertainty and complexity (and can include potential higher order impacts/risks). These risks may deviate from established practice or have some lifecycle implications, and therefore require further engineering risk assessment to support the decision and ensure the risk is ALARP. Engineering risk assessment tools may include:

- risk-based tools such as cost based analysis or modelling
- consequence modelling
- reliability analysis
- company values.

2.6.1.3 Decision Type C

Risks classified as Decision Type C typically have significant risks related to environmental performance. Such risks typically involve greater complexity and uncertainty, therefore requiring a precautionary approach. The risks may result in significant environmental impact, significant project risk/exposure or may elicit negative stakeholder concerns. For these risks, in addition to Decision Type A and B tools, company and societal values need to be considered by undertaking broader internal and external stakeholder consultation as part of the risk assessment process.

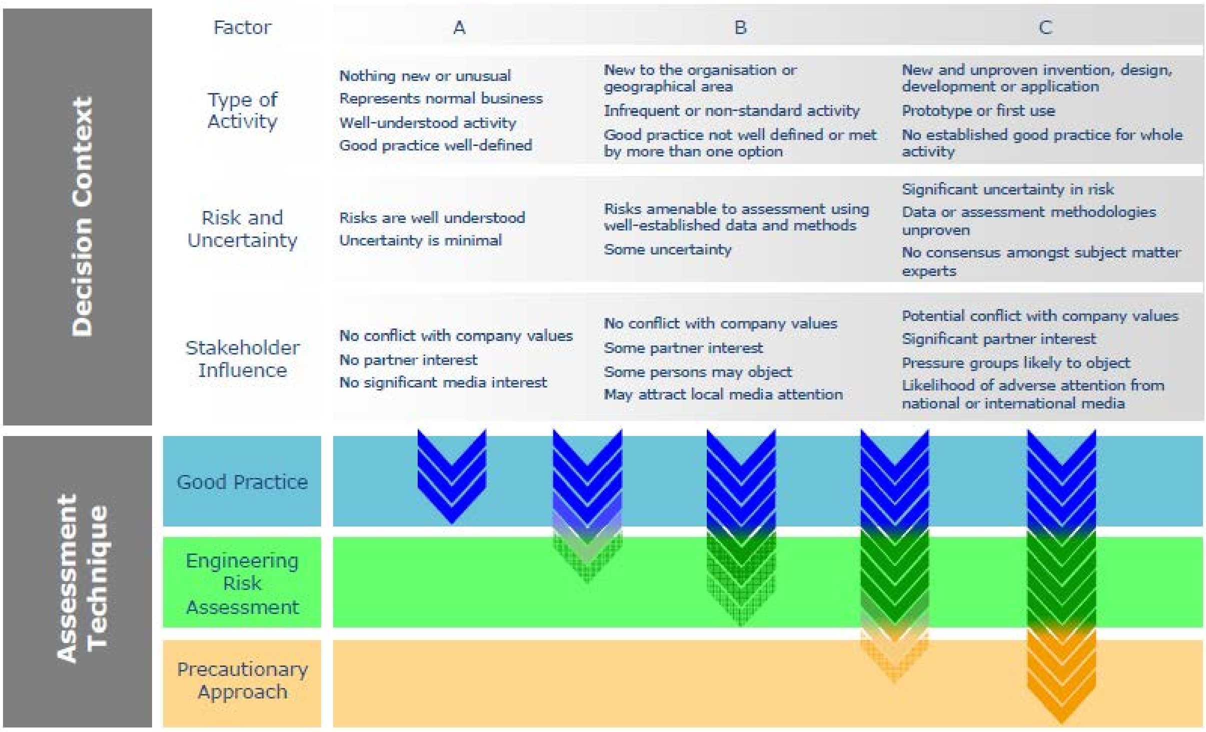


Figure 2-4: Risk related decision making framework (Oil and Gas UK, 2014)

2.6.1.4 Decision Support Framework Tools

The following framework tools are applied, as appropriate, to assist with identifying control measures based on the decision type described above:

- **Legislation, Codes and Standards (LCS)** identifies the requirements of legislation, codes and standards which are to be complied with for the activity.
- **Good Industry Practice (GP)** identifies further engineering control standards and guidelines which may be applied by Woodside above those required to meet the legislation, codes and standards.
- **Professional Judgement (PJ)** uses relevant personnel with the knowledge and experience to identify alternative controls. Woodside applies the hierarchy of control as part of the risk assessment to identify any alternative measures to control the risk.
- **Risk Based Analysis (RBA)** assesses the results of probabilistic analyses such as modelling, quantitative risk assessment and/or cost-benefit analysis to support the selection of control measures identified during the risk assessment process.
- **Company Values (CV)** identifies values detailed in Woodside's code of conduct, policies and the Woodside compass. Views, concerns and perceptions are to be considered from internal Woodside stakeholders directly affected by the planned impact or potential risk.
- **Societal Values (SV)** identifies the views, concerns and perceptions of relevant stakeholders and addresses relevant stakeholder views, concerns and perceptions.

2.6.1.5 Decision Calibration

To determine that the selected alternatives and control measures applied are suitable, the following tools may be used for calibration (i.e. checking) where required:

- **Legislation, Codes and Standards/Verification of Predictions –** Verification of compliance with applicable legislation, codes and standards and/or good industry practice.
- **Peer Review –** Independent peer review of professional judgements, supported by risk based analysis, where appropriate.
- **Benchmarking** – Where appropriate, benchmarking against a similar facility or activity type or situation which has been accepted to represent acceptable risk.
- **Internal Stakeholder Consultation** – Consultation undertaken within Woodside to inform the decision and verify company values are met.
- **External Stakeholder Consultation** – Consultation undertaken to inform the decision and verify societal values are considered.

Where appropriate, additional calibration tools may be selected specific to the decision type and the activity.

2.6.2 Control Measures (Hierarchy of Controls)

Risk reduction measures should be prioritised and categorised in accordance with the hierarchy of controls, where risk reduction measures at the top of the hierarchy take precedence over risk reduction measures further down:

- **Elimination** of the risk by removing the hazard.
- **Substitution** of a hazard with a less hazardous one.

- **Engineering Controls** which include design measures to prevent or reduce the frequency of the risk event, detect or control the risk event (limiting the magnitude, intensity and duration) such as:
  - prevention: design measures that reduce the likelihood of a hazardous event occurring
  - detection: design measures that facilitate early detection of a hazardous event
  - control: design measures that limit the extent/escalation potential of a hazardous event
  - mitigation: design measures that protect the environment should a hazardous event occur
  - response equipment: design measures or safeguards that enable clean-up/response after a hazardous event occurs.
- **Procedures and Administration** which include management systems and work instructions used to prevent or mitigate environmental exposure to hazards.
- **Emergency Response and Contingency Planning** which includes methods to enable recovery from the impact of an event (e.g. protection barriers deployed near the sensitive receptor).

2.6.3 Impact and Risk Classification

Environmental impacts and risks are assessed to determine the potential impact significance/consequence. The impact significance/consequence considers the magnitude of the impact or risk and the sensitivity of the potentially impacted receptor (represented by **Figure 2-5**).

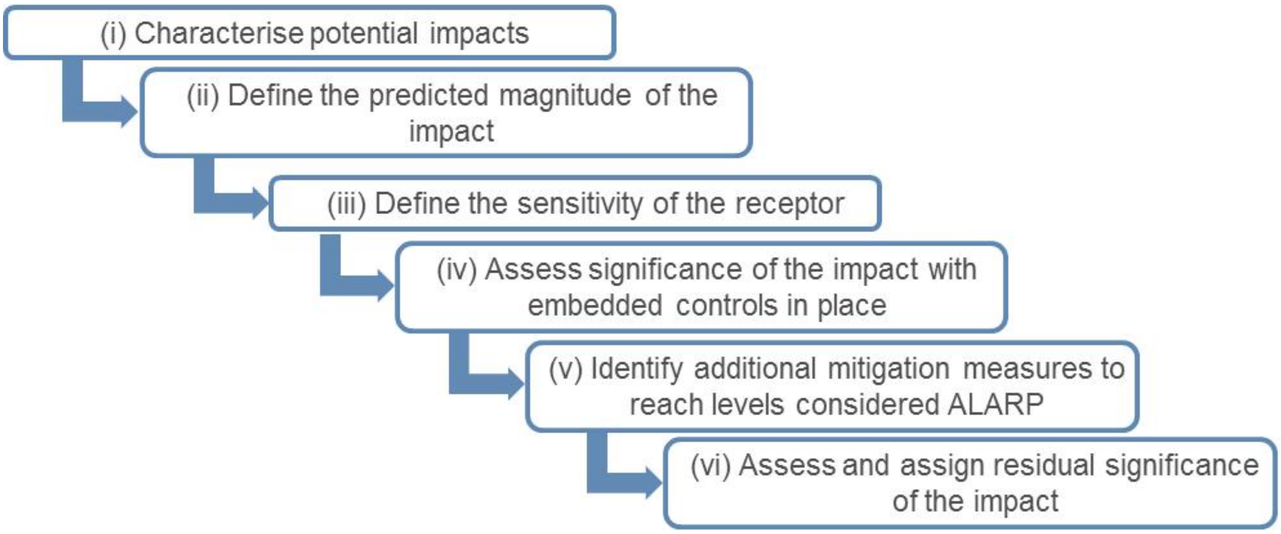


Figure 2-5: Environmental impact analysis

Impacts are classified in accordance with the consequence (**Section 2.6.3**) outlined in Woodside Risk Management Procedure and Risk Matrix.

Risks are assessed qualitatively and/or quantitatively in terms of both likelihood and consequence in accordance with the Woodside Risk Management Procedure and Risk Matrix.

The impact and risk information is summarised, including classification, and evaluation information as shown in the example (**Table 2-2**) for each planned activity and unplanned event evaluated.

Table 2-3: Woodside risk matrix (environment and social and cultural) consequence descriptions

Environment	Social & Cultural	Consequence Level
Catastrophic, long-term impact (>50 years) on highly valued ecosystems, species, habitat or physical or biological attributes	Catastrophic, long-term impact (>20 years) to a community, social infrastructure or highly valued areas/items of international cultural significance	*A*
Major, long term impact (10–50 years) on highly valued ecosystems, species, habitat or physical or biological attributes	Major, long-term impact (5–20 years) to a community, social infrastructure or highly valued areas/items of national cultural significance	*B*
Moderate, medium-term impact (2–10 years) on ecosystems, species, habitat or physical or biological attributes	Moderate, medium term Impact (2–5 years) to a community, social infrastructure or highly valued areas/items of national cultural significance	*C*
Minor, short-term impact (1–2 years) on species, habitat (but not affecting ecosystems function), physical or biological attributes	Minor, short-term impact (1–2 years) to a community or highly valued areas/items of cultural significance	*D*
Slight, short-term impact (<1 year) on species, habitat (but not affecting ecosystems function), physical or biological attributes	Slight, short-term impact (<1 year) to a community or areas/items of cultural significance	*E*
No lasting effect (<1 month). Localised impact not significant to environmental receptors	No lasting effect (<1 month). Localised impact not significant to areas/items of cultural significance	*F*

2.6.3.1 Risk Rating Process

The risk rating process is undertaken to assign a level of risk to each risk event, measured in terms of consequence and likelihood. The assigned risk level is therefore determined after identifying the decision type and appropriate control measures.

The risk rating process considers the potential environmental consequences and where applicable, the social and cultural consequences of the risk. The risk ratings are assigned using the Woodside Risk Matrix (refer to **Figure 2-6**).

The risk rating process is performed using the following steps.

2.6.3.2 Select the Consequence Level

Determine the worst case credible consequence associated with the selected event, assuming all controls (preventative and mitigative) are absent or have failed (**Table 2-3**). Where more than one potential consequence applies, the highest severity consequence level is selected.

2.6.3.3 Select the Likelihood Level

Determine the description that best fits the chance of the selected consequence occurring, assuming reasonable effectiveness of the prevention and mitigation controls (**Table 2-4**).

Table 2-4: Woodside risk matrix likelihood levels

Likelihood Description						
Frequency	1 in 100,000–1,000,000 years	1 in 10,000–100,000 years	1 in 1000–10,000 years	1 in 100–1000 years	1 in 10–100 years	>1 in 10 years
Experience	**Remote**: Unheard of in the industry	**Highly Unlikely**: Has occurred once or twice in the industry	**Unlikely**: Has occurred many times in the industry but not at Woodside	**Possible**: Has occurred once or twice in Woodside or may possibly occur	**Likely**: Has occurred frequently at Woodside or is likely to occur	**Highly Likely**: Has occurred frequently at the location or is expected to occur
Likelihood Level	**0**	**1**	**2**	**3**	**4**	**5**

2.6.3.4 Calculate the Risk Rating

The risk level is derived from the consequence and likelihood levels determined above in accordance with the risk matrix shown in **Figure 2-6**. A likelihood and risk rating is only applied to environmental risks using the Woodside Risk Matrix.

This risk level is used as an input into the risk evaluation process and ultimately for prioritising further risk reduction measures. Once each risk is treated to ALARP, the risk rating articulates the ALARP baseline risk as an output of the ENVID studies.

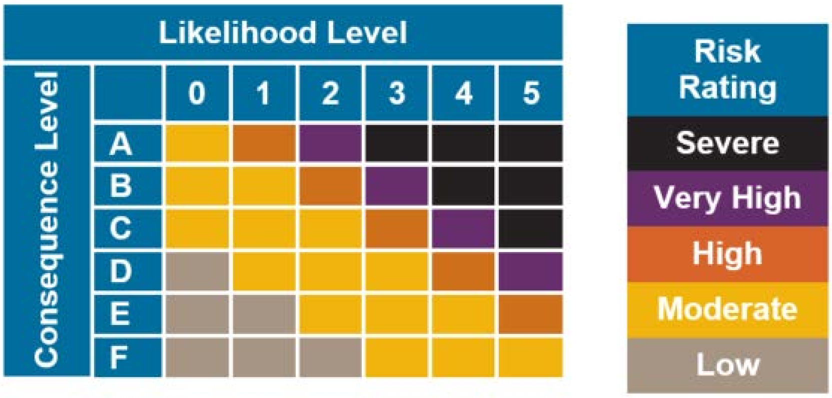


Figure 2-6: Woodside risk matrix: risk level

In support of ongoing risk management (as a key component of Woodside's Process Safety Management Framework – refer to Implementation Strategy (**Section 7**)), Woodside uses the concept of 'current risk' and applies a current risk rating to indicate the current or 'live' level of risk, considering controls that are currently in place and regularly effective. Current Risk Classification is effective in articulating potential divergence from baseline risk, such as if certain controls fail or could potentially be compromised. Current risk ratings aid in communication and visibility of the risk events, and ensures risk is continually managed to ALARP by identifying risk reduction measures and assessing acceptability.

2.7 Impact and Risk Evaluation

Environmental impacts and risks cover a wider range of issues, affected by differing species, persistence, reversibility, resilience, cumulative effects and variability in severity. Determining the degree of environmental risk and the corresponding threshold for whether a risk/impact has been reduced to ALARP and is acceptable, is evaluated to a level appropriate to the nature and scale of each impact or risk. The evaluation considers:

- the Decision Type
- the Principles of Ecologically Sustainable Development as defined under the EPBC Act
- the internal context – the proposed controls and risk level are consistent with Woodside policies, procedures and standards (**Section 6** and **Appendix A**)
- the external context – the environment consequence (**Section 6**) and stakeholder acceptability (**Section 5**) are considered
- other requirements – the proposed controls and risk level are consistent with national and international standards, laws and policies.

In accordance with Regulation 10A(a), 10A(b) and 10A(c), and 13(5)(b) of the Environment Regulations, Woodside applies the following process to demonstrate ALARP and acceptability for environmental impacts and risks appropriate to the nature and scale of each impact or risk.

2.7.1 Demonstration of ALARP

Descriptions have been provided in **Table 2-5** to articulate how Woodside demonstrates that different risks, impacts and Decision Types identified within the EP are ALARP.

Table 2-5: Summary of Woodside's criteria for demonstrating ALARP

Risk	Impact	Decision Type
Low and Moderate	***Negligible, Slight, or Minor (D, E or F)***	***A***
Woodside demonstrates these Risks, Impacts and Decision Types are reduced to ALARP if: • controls identified meet legislative requirements, industry codes and standards, applicable company requirements and industry guidelines • further effort towards impact/risk reduction (beyond employing opportunistic measures) is not reasonably practicable without sacrifices grossly disproportionate to the benefit gained.		
High, Very High or Severe	***Moderate and above (A, B or C)***	***B and C***
Woodside demonstrates these higher order Risks, Impacts and Decision Types are reduced to ALARP (where it can be demonstrated using good industry practice and risk based analysis) if: • legislative requirements, applicable company requirements and industry codes and standards are met • societal concerns are accounted for • the alternative control measures are grossly disproportionate to the benefit gained.		

2.7.2 Demonstration of Acceptability

Descriptions have been provided in **Table 2-6** to articulate how Woodside demonstrates that different risks, impacts and Decision Types identified within the EP are Acceptable. (Please also refer to **Figure 2-7** for a visual representation against Woodside's risk matrix).

Table 2-6: Summary of Woodside's criteria for Acceptability

<table>
<tr><th>Risk</th><th>Impact</th><th>Decision Type</th></tr>
<tr><td>Low and Moderate</td><td>Negligible, Slight, or Minor (D, E or F)</td><td>A</td></tr>
<tr><td colspan="3">Woodside demonstrates these Risks, Impacts and Decision Types are 'Broadly Acceptable' if they meet legislative requirements, industry codes and standards, applicable company requirements and industry guidelines. Further effort towards reducing risk (beyond employing opportunistic measures) is not reasonably practicable without sacrifices grossly disproportionate to the benefit gained.</td></tr>
<tr><td>High, Very High or Severe</td><td>Moderate and above (A, B or C)</td><td>B and C</td></tr>
<tr><td colspan="3">Woodside demonstrates these higher order Risks, Impacts and Decision Types are 'Acceptable if ALARP' if it can be demonstrated using good industry practice and risk based analysis, if legislative requirements are met and societal concerns are accounted for and the alternative control measures are grossly disproportionate to the benefit gained.
In undertaking this process for Moderate and High current risks, Woodside evaluates:
• the Principles of Ecological Sustainable Development as defined under the EPBC Act
• the internal context – the proposed controls and consequence/risk level are consistent with Woodside policies, procedures and standards
the external context – the environment consequence (Section 6) and stakeholder acceptability (Section 5) are considered
• other requirements – the proposed controls and consequence/risk level are consistent with national and international industry standards, laws and policies.
Additionally, Very High and Severe risks require 'Escalated Investigation' and mitigation. If after further investigation the risk remains in the Very High or Severe category, the risk requires appropriate business engagement with increasing involvement of senior management in accordance with Woodside's Risk Management Procedure to accept the risk. This includes due consideration of regulatory requirements.</td></tr>
</table>

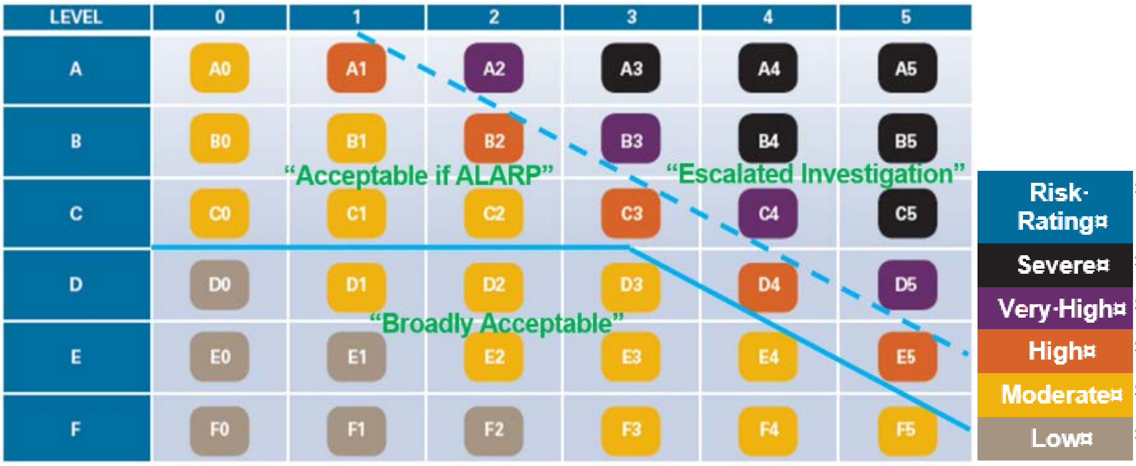


Figure 2-7: Environmental risk evaluation

2.8 Environmental Performance Objectives/Outcomes, Standards and Measurement Criteria

Environmental performance objectives/outcomes, standards, and measurement criteria are defined to address the potential environmental impacts and risks and are explored in **Section 6**.

2.9 Implementation, Monitoring, Review and Reporting

An implementation strategy for the Petroleum Activities Program describes the specific measures and arrangements to be implemented for the duration of the Petroleum Activities Program. The implementation strategy is based on the principles of AS/NZS ISO 14001 Environmental Management Systems, and demonstrates:

- control measures are effective in reducing the environmental impacts and risks of the Petroleum Activities Program to ALARP and acceptable levels
- environmental performance outcomes and standards set out in the EP are met through monitoring, recording, audit, management of non-conformance and review
- all environmental impacts and risks of the Petroleum Activities Program are periodically reviewed in accordance with Woodside's risk management procedures
- roles and responsibilities are clearly defined, and personnel are competent and appropriately trained to implement the requirements set out in this EP, including in actual or potential emergencies
- arrangements are in place for oil pollution emergencies to respond to and monitor impacts
- environmental reporting requirements, including 'reportable incidents'
- appropriate stakeholder consultation is undertaken throughout the activity.

The implementation strategy is presented in **Section 7**.

2.10 Stakeholder Consultation

A stakeholder assessment is performed to identify relevant persons (as defined under Regulation 11A of the Environment Regulations) to whom an activity update is issued electronically to provide a reasonable consultation period. Further details and information is provided to any stakeholder if requested.

A summary and assessment of each stakeholder response is performed and a response, where appropriate, is provided by Woodside.

The stakeholder consultation, along with the process for ongoing engagement and consultation throughout the activity, is presented in **Section 5**.

3. DESCRIPTION OF THE ACTIVITY

3.1 Overview

This section has been prepared in accordance with Regulation 13(1) of the Environment Regulations, and describes the activities to be performed as part of the Petroleum Activities Program under this EP.

3.2 Project Overview

The Petroleum Activities Program will involve drilling and developing up to four production wells, including two dual-zone completions, in Permit Area WA-49-L.

The proposed infield architecture for Julimar Development Phase 2 is illustrated in **Figure 3-1** and consists of four subsea trees connected to a six-slot manifold (JULA), tied in to the existing BRU-XOM through a 22 km, single 18-inch non-pressure seal (NPS), corrosion-resistant alloy (CRA) rigid production flowline. Controls, chemical injection and monoethylene glycol (MEG) supply from BRU-XOM to JULA will be via a subsea umbilical. Modifying the topside equipment on the Wheatstone Platform to tie-in the subsea control system is outside the scope of this EP.

Wells will be drilled using a moored semi-submersible MODU. Typically, two or three vessels will support the MODU during drilling activities, with at least one vessel in the vicinity to complete standby duties, if required. Supply vessels from Dampier Port will frequent the MODU at regular intervals, throughout operations.

The flowline, and potentially manifold and spool connector assembly (SCA), will be installed by a pipelay vessel. The method for installing the pipeline will be either Reel-lay or S-lay. An installation vessel, similar to vessels used for inspection, maintenance and repair (IMR), will be in the field to install the Xmas trees, umbilical/manifold and spools, pre-commission the system and provide support during cold commissioning and subsequent production start-up. Support vessels associated with subsea installation activities may transit between the Operational Area and North West Shelf (NWS) Ports including Dampier, Onslow and Exmouth.

A 500 m petroleum safety zone, from which unauthorised vessels will be excluded, will be in place around the Petroleum Activities Program location for the duration of the activities.

The Julimar Development Phase 2 production system has a design life of 25 years. It will produce gas from the Julimar reservoir via the existing Phase 1 infrastructure and the Chevron-operated Wheatstone Platform and onshore LNG plant. Pre-investment was made in Phase 1 controls, hydraulic and chemical systems to allow for expansion phases. The Phase 1 infrastructure, as illustrated in **Figure 3-1**, has been installed and commissioned (2016/17).

An overview of the Petroleum Activities Program is provided in **Table 3-1**.

Figure 3-1: Generalised schematic of Julimar Development Project Phase 2

Table 3-1: Petroleum Activities Program overview

Item	Description
Permit Area	WA-49-L
Location	Barrow Sub-basin
Water depth (wells)	174 m
Number of wells	• four production wells
Flowline, umbilical and structures installation	• a 22 km 18-inch NPS CRA rigid flowline • two flowline end termination (FLET) structures • one inline tee structure • FLET to manifold jumper spools, including SCAs • a 22 km umbilical with subsea distribution units (SDUs) and umbilical termination assembly (UTA)
Subsea infratructure/ hardware	• six-slot manifold • four subsea production trees • well jumper spools • hydraulic/electric/fibre optic flying leads • pig launcher and receiver
MODU	• semi-submersible moored MODU
Vessels	• pipelay vessel for rigid flowline and FLET installation • installation vessel for Xmas trees and umbilical/manifold installation • activity support vessels, including general supply/spool transport/support vessels and anchor handling vessel(s) (AHV)
Key activities	• anchor holding testing • pre-lay of anchors by AHV and contingent suction piling if necessary • mooring activity on arrival of MODU • top hole section drilling • installation of blow-out preventer (BOP) and marine riser • bottom hole section drilling • installation of four subsea trees • installation of manifold and spools to four trees • completion and unload operations • connection to a cluster production manifold located at the JULA drill centre • formation evaluation, including vertical seismic profiling (VSP) • temporary suspension and/or permanent abandonment of well (if necessary for unforeseen circumstances) • installation of 12-inch NPS in-line tee on the production flowline and a UTA and/or SDUs in the subsea umbilical system to allow for future tie-backs • tie back of manifold to the BRU-XOM through a single 18-inch NPS CRA rigid production flowline • control of umbilical extension from Brunello to JULA • temporary installation of an anchor for potential MODU simultaneous operations (SIMOPS) flowline installation • if required, installation of subsea structures along the flowline route as fixed datum points to monitor pipe buckle initiation

3.3 Location

The proposed Petroleum Activities Program is located in Permit Area WA-49-L, in Commonwealth waters in the Barrow Sub-basin, about 185 km off the Pilbara coast of Western Australia (**Figure 3-2**). The closest landfall to the Permit Area is the Montebello Islands, which are about 50 km southeast.

Approximate location details for the Petroleum Activities Program are provided in **Table 3-2**.

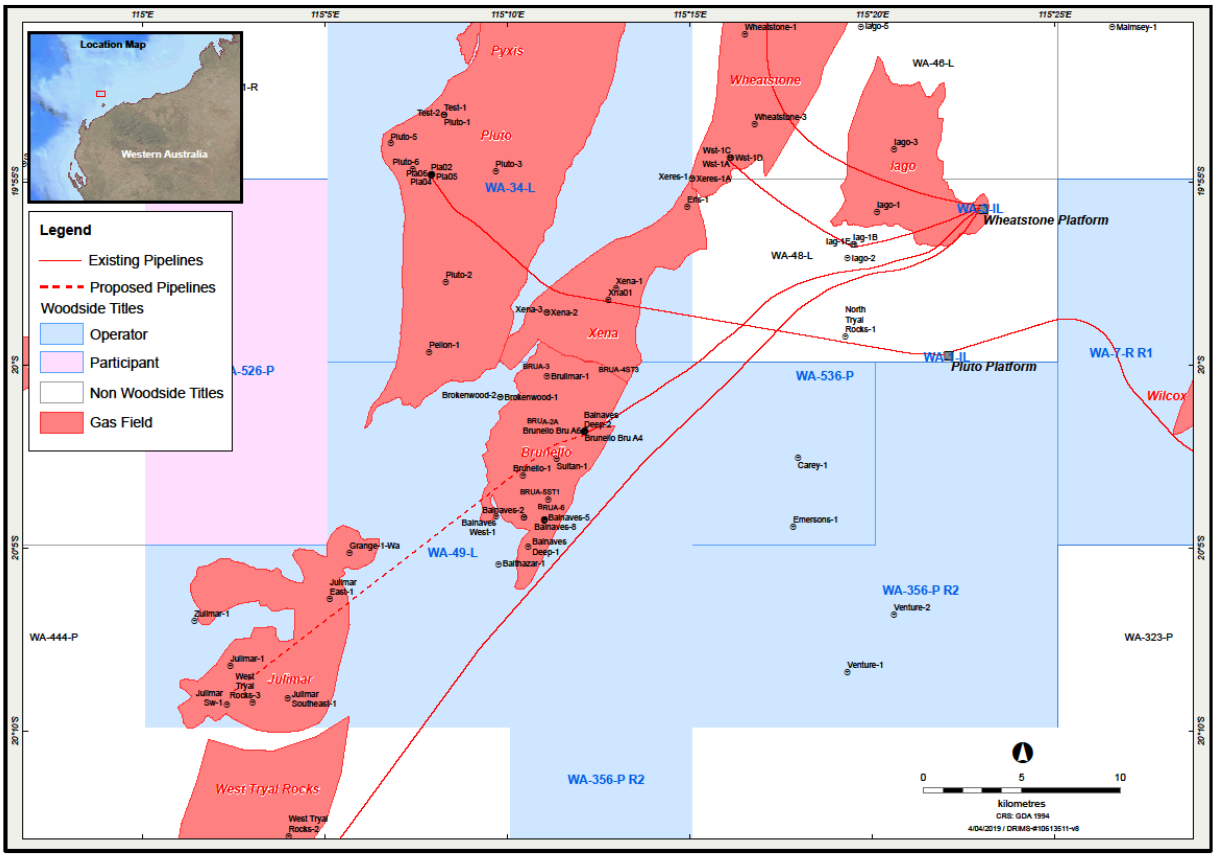


Figure 3-2: Location map

Table 3-2: Approximate location details for the Petroleum Activities Program

Activity	Water Depth (Approx. m LAT)	Latitude	Longitude	Production Licence
JULA-A (JULA01) [3]	174 m	20° 08' 52.996" S	115° 02' 28.377" E	WA-49-L
JULA-C (JULA02)	174 m	20° 08' 52.222" S	115° 02' 26.436" E	WA-49-L
JULA-K (JULA04)	174 m	20° 08' 53.554" S	115° 02' 28.078" E	WA-49-L
JULA-M (JUL03)	174 m	20° 08' 51.855" S	115° 02' 27.005" E	WA-49-L
JULA manifold	174 m	20° 08 '52.917" S	115° 02 '27.23" E	WA-49-L
Flowline route (start)	145 m	20° 01 '53.43" S	115° 12 '09.28" E	WA-49-L
Flowline route (end)	174 m	20° 08 '52.917" S	115° 02 '27.23" E	WA-49-L

[3] Well names in brackets are intended to be applied in future phases and are included here to ensure clarity.

3.3.1 Operational Area

The Operational Area defines the spatial boundary of the Petroleum Activities Program, as described, risk-assessed and managed by this EP, including vessel-related petroleum activities within the Operational Area[4].

For the purposes of this EP, the following operational areas will apply, which are collectively referred to as a single Operational Area:

- A radius of 4000 m from each well centre has been defined as the area in which drilling-related petroleum activities will take place and will be managed under this EP.
- A radius of 1500 m (3000 m corridor) around the subsea installation locations has been defined as the area in which subsea installation, pipelay and pre-commissioning petroleum activities will take place and will be managed under this EP.

The 4000 m (radius) Operational Area allows for MODU mooring operations, including the possible installation of pre-laid moorings and vessel-related petroleum activities. The Operational Area for drilling activities includes a 500 m petroleum safety zone around the MODU to manage vessel movements. The 500 m petroleum safety zone is under the control of the MODU Person in Charge. The 1500 m (radius) Operational Area around subsea installation and pipelay activities allows for the movement and positioning of large vessels.

3.4 Timing

The proposed Petroleum Activities Program is scheduled to commence in the fourth quarter of 2019 and be completed in 2022 (**Table 3-3**).

Drilling of the four production wells is expected to take about 70 days per well to complete, including mobilisation, demobilisation and contingency. The pipelay vessel is expected to be in the field for a cumulative duration of about four to eight weeks, depending on weather and progress.

When ongoing, activities will be 24 hours per day, seven days per week. There are no planned concurrent drilling activities under the EP. SIMOPS activities with subsea installation may occur. Timing and duration of these activities is subject to change due to project schedule requirements, MODU/vessel availability, unforeseen circumstances and weather.

This EP has risk-assessed drilling activities throughout the year (all seasons) to provide operational flexibility for requirements and schedule changes, as well as vessel/MODU availability. All the above timeframes are subject to change and, as no particular time periods have been nominated for avoidance based on environmental and/or stakeholder sensitivities, changes to the above will not be interpreted as 'new stages' against Regulation 17(5).

[4] Vessels supporting the Petroleum Activities Program operating outside of the Operational Area (e.g. transiting to and from port) are subject to all applicable maritime regulations and other requirements, which are not managed under this EP.

Table 3-3: Summary of indicative Petroleum Activities Program

Activity	Approximate timing (and cumulative duration in the field*)	Likely vessel
Installation of anchors for MODU and pipelay vessel	Fourth quarter of 2019	Installation vessel
Drilling and completions	2020 (~280 days)	MODU and up to three support vessels
Xmas tree installation	2020 (8–12 days)	Installation vessel (IMR-type vessel)
Flowline installation	2020/2021 (~4–8 weeks)	Pipelay vessel
Umbilical and manifold installation and well tie-in spools	2021 (~ 6 weeks)	Installation vessel and spool transport vessels
Start-up	2021 (approximate)	IMR vessel

3.5 Project Vessels

Several vessel types will be required to complete the activities associated with the Petroleum Activities Program. These are discussed in further detail in the next section and will include:

- semi-submersible moored MODU
- primary installation vessels:
  - pipelay vessel and pipe supply vessel
  - installation vessel (IMR-type vessel) and spool transport supply vessel.
- support vessels including:
  - AHVs required to set anchors and support the MODU during operations
  - heavy lift vessels for providing floating storage facilities to the installation vessels.
  - activity support vessels for transporting hardware from port/staging area to the Operational Area and pipelay/installation vessels, and for general re-supply and support for the MODU and the pipelay/installation vessels.

All project vessels, are subject to the Marine Offshore Assurance process and review of the Offshore Vessel Inspection Database (OVID). All required audits and inspections will assess compliance with the laws of the international shipping industry, which includes safety and environmental management requirements, and maritime legislation including International Convention for the Prevention of Pollution from Ships, 1973 as modified by the Protocol of 1978 (MARPOL) and other International Maritime Organization (IMO) standards.

A description and assessment of support vessel environmental impacts and risks, credible spill scenarios and environmental sensitivities for the activities within the scope of this EP are included in **Section 4**. Some support vessels may be required on ad-hoc to support periods of high activity and will be subject to the above processes.

For power generation, vessels may use diesel-powered generators and/or LNG. All vessels will display navigational lighting and external lighting, as required for safe operations. Lighting levels will be determined primarily by operational safety and navigational requirements under relevant legislation, specifically the *Navigation Act 2012*. The MODU and support vessels will be lit to maintain operational safety on a 24-hour basis.

3.5.1 MODU

The Petroleum Activities Program will be drilled by the *Ocean Apex* MODU or similar. Due to variabilities such as contractual and operational matters, the MODU used may be subject to change. If this occurs, a MODU meeting the required technical specifications and with similar specifications as listed in **Table 3-4** will be utilised.

Table 3-4: Typical moored MODU specifications ranges for Ocean Apex

Component	Specification Range
Rig type/design/class	Semi-submersible MODU
Accommodation	120 to 200 personnel (maximum persons on board)
Station keeping	Minimum eight-point mooring system
Bulk mud and cement storage capacity	283 to 770 m^3
Liquid mud storage capacity	576 to 2500 m^3
Fuel oil storage capacity	966 to 1400 m^3
Drill water storage capacity	3500 m^3

3.5.2 Primary Installation Vessels

3.5.2.1 Pipelay Vessel and Pipe Supply Vessel

The Petroleum Activities Program flowline installation activities will use a pipelay vessel for either installation method (Reel-lay/S-lay), and will include the major equipment and systems of:

- firing line with welding stations, non-destructive testing station, tensioners, coating stations and roller and track supports between the work stations
- pipelay system – pipe tensioner system, abandonment and recovery winches, stinger winches and a pipelay stinger
- vessel cranes
- welding system
- remotely operated vehicles (ROVs) and ROV launch and recovery systems
- accommodation
- working deck area.

3.5.2.2 Installation Vessel

The Petroleum Activities Program subsea installation scopes of work will also use an installation vessel, which are typically equipped with a variety of material handling equipment, including cranes, winches, ROVs and ROV launch and recovery systems, and flexible product lay system. Lifting operations involve loading and unloading equipment onto the seabed. Cranes are typically equipped with active heave compensation and auto tension modes, and have lifting capacities in excess of lifting loads expected to be encountered during operations.

3.5.2.3 Support Vessels

During the Petroleum Activities Program, the MODU, pipelay vessel and installation vessel will be supported by other vessels, such as general support vessel(s), anchor handling vessel(s), barges, multiservice construction and heavy lift vessel(s).

Support vessels are used to transport equipment and materials between the MODU and primary installation vessels and port. Support vessels may transit between the Operational Area and NWS Ports including Dampier, Onslow and Exmouth. If required, one of the vessels will be at the MODU to perform standby duties as stipulated in Woodside's OneMarine Charterers Instructions. Others will make regular trips between the Operational Area and port for routine, non-routine and emergency operations.

Support vessels do not anchor within the Operational Area during the activities due to water depth; therefore, vessels will utilise Dynamic Positioning (DP).

The support vessels are also available to assist in implementing the Oil Pollution First Strike Plan, should an environmental incident occur (e.g. spills).

3.5.3 Vessel Mobilisation

Vessels may mobilise from the nearest Australian port or directly from international waters to the Operational Area, in accordance with biosecurity and marine assurance requirements.

3.6 Other Support

3.6.1 Remotely Operated Vehicles

The MODU, primary installation vessels and support vessels may be equipped with a ROV system that is maintained and operated by a specialised contractor aboard the vessel. ROVs will be used for activities such as:

- anchor holding testing
- pre-drill seabed and hazard survey
- blow-out preventer land-out and recovery
- BOP well control contingency
- visual observations at seabed during riserless drilling operation
- post-well seabed survey
- monitor pipelay activities
- support leak testing activities
- post-lay survey.

An ROV can be fitted with various tools and camera systems that can be used to capture permanent records (both still images and video) of the operations and immediate surrounding environment. Specifically, during installation, the ROV will be fitted with hydraulically driven tools to facilitate flowline tie-in.

An ROV may also be used in an incident to deploy the Subsea First Response Toolkit. This is discussed further in **Appendix D**.

3.6.2 Helicopters

During the Petroleum Activities Program, crew changes will be performed using helicopters as required. Helicopter operations within the Operational Area are limited to helicopter take-off and landing on the helideck. Helicopters may be refuelled on the helideck. This activity will take place within the Operational Area and has been included in the risk assessment for this EP.

3.7 Project Vessel-Based Activities

3.7.1 Holding Station: Mooring Installation and Anchor Hold Testing/Soil Analysis

Mooring uses a system of chains/ropes and anchors, which may be pre-laid before the MODU arrives at the location, to maintain position when drilling. A mooring analysis will be performed to determine the appropriate mooring system for the Petroleum Activities Program. The mooring analysis will identify whether the mooring system will be pre-laid or set by the rig, proof tension values, or if using synthetic fibre mooring ropes is required. A pre-laid system can generally withstand higher sea states compared to a system that only uses the rig's mooring chain/equipment.

Installation and proof tensioning of anchors involves some disturbance to the seabed. Anchor handling vessels are used to deploy and recover the mooring system.

As part of mooring preparations, anchor hold may be tested at the well locations. Anchor hold testing would be performed if Woodside determines that further assurance is required to ensure a robust mooring design.

Anchor hold testing may consist of an AHV or similar vessel dropping an anchor at a potential mooring location. The AHV would then tension the anchor to determine its ability to hold, embed and not drag at the location. This may have to be repeated several times at each location. A remotely operated underwater vehicle may also be used to judge how deep the anchor has embedded and independently verify the seabed condition. Anchor hold testing activities would occur before the MODU arrives on location.

Soil analysis may also be necessary to provide data on composition and rock/substrate strength as input into the mooring design – and verify seabed conditions for anchor holding. Soil analysis could include taking a physical sample of the seabed using ROV or other tools, or using measuring devices such as a cone penetrometer. These tests would be performed up to several months before the MODU arrives on location, and may occur from a support vessel or anchor handling vessel.

Suction piling may be required as a contingent activity, and will be reviewed with the MODU contractor.

3.8 MODU and Support Vessel Activities

A variety of materials are routinely bulk transferred from support vessels to the MODU, including drilling fluids (e.g. muds), base fluids, cements and drill water. A range of dedicated bulk transfer stations and equipment is in place to accommodate the bulk transfer of each type of material. There is also a capacity to bulk transfer waste oil from the MODU to the support vessel, for back-loading and disposal on shore.

The loading and back-loading of equipment, materials and wastes is one of the most common supporting activities conducted during drilling programs. Loading and back-loading is performed using cranes on the MODU to lift materials in appropriate offshore rated containers (e.g. ISO tanks, skip bins, containers) between the MODU and support vessel.

Seawater is pumped on board and used as a heat exchange medium for the cooling of machinery engines and high temperature drilling fluid on the MODU. It is subsequently discharged from the MODU to the sea surface at potentially a higher temperature. Alternatively, MODUs may utilise closed loop cooling systems.

Potable water, primarily for accommodation and associated domestic areas, may be generated on vessels using a reverse osmosis plant. This process will produce brine, which is diluted and discharged at the sea surface.

The MODU and support vessels will also discharge deck drainage from open drainage areas, bilge water from closed drainage areas, putrescible waste and treated sewage and grey water. Solid hazardous and non-hazardous wastes generated during the Petroleum Activities Program are disposed onshore by support vessels.

3.8.1 Subsea Installation and Support Vessel Activities

The pipelay vessel will be used to install the 18-inch NPS flowline. For a Reel-lay pipe installation, the pipelay vessel will carry the pipe on a dedicated reel with interim mobilisations to replenish the reel stock. Pipe will be transported to the S-lay pipelay vessel by a platform supply vessel, which maintains position alongside the pipelay vessel or cargo barges/vessels.

Depending on the pipelay installation method selected, the installation vessel will perform pre/post pipelay operation support scopes. These are typically structure installation, pipeline cleaning, gauging, flooding and pressure testing, with any post-pipelay mattresses installation for stabilisation/span rectification.

An installation vessel may also be used for various activities, such as pre and post installation survey, installation of subsea structures and infrastructure (e.g. umbilical), tie-in to existing infrastructure, and pre-commissioning activities.

To support the pipelay and installation vessel activities, heavy lift vessels may store equipment and hardware for direct loading/offloading to the vessels. Other support vessels may also be used to transport equipment and hardware from the shore to vessels in the field.

3.8.2 Refuelling

The MODU will be refuelled via support vessels approximately once a month, or as required. This activity will take place within the Operational Area of the well being drilled at the time and has been included in the risk assessment for this EP. Other fuel transfers that may occur on board the MODU include refuelling of cranes, helicopters or other equipment as required.

The pipelay and installation vessels are in the field for relatively short durations and therefore may not require refuelling while in the field. However, this activity has been included in the risk assessment for this EP.

3.9 Drilling Activities

Well construction activities are conducted in a number of stages.

A combination of dual and single zone wells will be completed to maintain ultimate recovery. Detailed well designs will be submitted to the Well Integrity department of NOPSEMA as part of the Approval to Drill and the accepted Well Operation Management Plan (WOMP), as required under the Offshore Petroleum and Greenhouse Gas Storage (Resource Management and Administration) Regulations 2011.

3.9.1 Cement Unit Test

Upon arrival on location at the Operational Area, the MODU may be required to perform a cement unit test, or 'dummy cement job' to test the functionality of the cement unit and the MODU's bulk cement delivery system prior to performing an actual cement job. Proper functioning of the cement system is important for ensuring well integrity. This operation is usually performed after a MODU has been out of operation for an amount of time (warm-stack), if maintenance on the cement unit has been performed, or if it is the first time a MODU is being used in-country and commissioning of the cement unit system is required.

A 'dummy cement job' involves mixing a cement slurry at surface, and once functionality of the cement unit and delivery system has been confirmed, the slurry is discharged through the usual cement unit discharge line (which may be up to 10 m above the sea level) or through drill pipe below sea level, and occur as a cement slurry. The slurry is usually a mix of cement and water, however, may contain stabilisers or chemical additives in low concentrations.

3.9.2 Top Hole Section Drilling

Petroleum Activities Program drilling commences with the top hole section as follows:

- The MODU arrives and establishes position over the well site.
- A pilot hole or holes may be drilled close to the intended well location. Pilot holes are used when confirmation of geology and shallow hazards or further understanding of the structural integrity of the rock is required. Pilot holes are drilled riserless, as described below, and result in additional cuttings, sweeps and potentially mud deposition to seabed.
- Top hole sections are drilled riserless using seawater with pre-hydrated bentonite sweeps/XC polymer sweeps or drilling fluids to circulate drilled cuttings from the wellbore.
- Once each top hole section is drilled, steel tubulars (called conductor or casing) are inserted into the wellbore to form the surface casing, and secured in place by pumping cement into the annular space back to about 300 m above the casing shoe, which may involve a discharge of excess cement at the seabed.
- At some well locations, top-hole section drilling may be done using the batch drilling process. Batch drilling is where a number of wells are drilled together and the same section of each hole is drilled one after another, before going back and drilling the next section of each well until the target depth is reached for each well at the well center.

3.9.3 Blowout Preventer and Marine Riser Installation

After setting the required casing, a BOP is installed on the wellhead, and the marine riser above it, to provide a physical connection between the well and MODU. This enables a closed circulation system to be maintained, where weighted drilling fluids and cuttings can be circulated from the wellbore back to the MODU, via the riser.

In addition, the BOP provides means for sealing, controlling and monitoring the well during drilling operations. The operation of the BOP components uses open hydraulic systems, using water-based BOP control fluids. Each time the BOP is operated (including pressure testing approximately every 21 days and a function test approximately every seven days, excluding the week a pressure test is conducted), the maximum volume of BOP control fluid that will be released to the marine environment per well is up to about 90 L.

Hydraulic fluid used for operating the BOP rams is subject to the chemical assessment process outlined in **Section 3.11.1**.

3.9.4 Bottom Hole Section Drilling

A closed system (riser in place) is used for drilling bottom hole sections to the planned wellbore Total Depth (TD). The preference is for bottom hole sections to be drilled using water-based mud (WBM) drilling fluids; however, non-water based mud (NWBM) may be used (**Section 3.11**).

Protective steel tubulars (casings and liners) are inserted as required. The size, length and inclination of the casing/liner sections within the wellbore is determined by factors such as the geology/subterranean pressures likely to be encountered in the area and any specific information or resource development requirements.

After a string of casing/liners has been installed into the wellbore, it is cemented into place. The casing/liner is then pressure tested. Once the pressure testing is passed, drilling of the next section can resume with the riser in place to circulate drill cuttings and drilling fluids back to the MODU.

Cementing operations are also undertaken to:

- provide annular isolation between hole sections and structural support of the casing as required
- set a plug in an existing well to sidetrack
- plug a well so it can be suspended/abandoned.

Cements are transported as dry bulk to the MODU by the support vessels, mixed as required by the cementing unit on the MODU, and are pumped by high pressure pumps to the surface cementing head then directed down the well.

Excess cement (dry bulk) after well operations are completed will be held onboard and used for subsequent wells, provided to the next operator at the end of the program, or discharged to the marine environment. Excess cement that does not meet technical integrity requirements during the Petroleum Activities Program may also be bulk discharged to the environment. Bulk discharges of cement may occur as a slurry through the usual cement discharge line, or blown as dry bulk and discharged.

3.9.5 Formation Evaluation

Formation evaluation is the interpretation of a combination of measurements taken inside a wellbore to detect and quantify hydrocarbon presence in the rock adjacent to the well once TD is reached. Formation Evaluation While Drilling (FEWD) is the process by which the presence and quantity of hydrocarbon in a reservoir is measured according to its response to radioactive and electrical input. It may include extracting small cores, wireline logging, vertical seismic profiling, full diameter cores and other down-hole technologies, as required. FEWD tools will be incorporated into the drillstring during development drilling and may include gamma ray, directional deep resistivity, callipers, density-neutron, sonic and tools which can measure formation pressures. Some FEWD tools contain radioactive sources; however, no radioactive material will be released to the environment and radiation fields are not generally detectable outside the tool when the tool is not energised. Therefore, they do not present an environmental risk.

VSP is likely to be performed during the Petroleum Activities Program. VSP is used to generate a high-resolution seismic image of the geology in the well's immediate vicinity. It uses a small airgun array, typically comprising either a system of three 250 cubic inch airguns with a total volume of 750 cubic inches of compressed air or nitrogen at about 1800 psi (12,410 kPa) or two 250 cubic inch airguns with a total volume of 500 cubic inches. During VSP operations, four to five receivers are positioned in a section of the wellbore (station) and the airgun array is discharged approximately five times at 20-second intervals. The generated sound pulses are reflected through the seabed and are recorded by the receivers to generate a profile along a 60–75 m section of the wellbore. This process is repeated as required for different stations in the wellbore and it may take up to 24 hours to complete, depending on the wellbore's depth and number of stations being profiled.

3.9.6 Wellbore Cleanout

As required throughout activities with the riser connected, wells will be displaced from one drilling fluid system to another, or from the drilling fluid system to completion brine. A chemical cleanout pill or fluids train will be circulated between the two fluids. This will result in a discharge of operational fluids in accordance with Woodside's internal guidelines to ensure the potential impacts of the chemicals selected are acceptable, ALARP and meet Woodside's expectation for environmental performance.

Cleanout fluids and completion brine will be captured and stored on the MODU and discharged if oil concentration is <1% by volume, or returned to shore if discharge requirements cannot be met.

3.9.7 Completions Activities

Once a well has been drilled, well completion activities will be performed, including installing the lower completion, intermediate completion, production tubing and subsea tree. The well is then pressure-tested for integrity prior to well unloading and suspension.

The single zone wells will be completed with a conventional upper completion. The dual zone wells will be completed with intelligent upper completions, giving control of each reservoir unit for selective production, water management and reservoir appraisal.

Following unloading, the well will be suspended with a gas column and two crown plugs installed in the tubing hanger. Crown plugs will be individually pressure-tested to verify suspension barriers prior to the BOP being removed.

3.9.8 Xmas Tree Installation

Before the upper completion is installed in the wells, the Xmas trees will be installed from an installation vessel in SIMOPS with the MODU, or directly from the MODU. Due to the subsea well layout, the MODU will be required to kedge off the drill centre to allow the installation vessel to install the Xmas trees. Once the Xmas trees have been installed, they will be pressure tested to confirm integrity before the MODU BOP is reconnected to continue with drilling and completions activities.

The Xmas trees will be installed with a preservation mixture in the production and annulus bores.

3.9.9 Well Unloading

3.9.9.1 General Description

During well unloading activities, all completion and reservoir fluids will be flared or discharged to the marine environment via the well test package. The base oil column, completion fluid, hydrocarbons and produced/condensed water will be measured, handled, separated, treated for overboard discharge (non-hydrocarbon) and flared/burned (hydrocarbon) through the temporary production system on the MODU.

3.9.9.2 Produced/Reservoir Water Disposal

The well test water treatment package will be used to treat produced/reservoir water before discharge. Prior to discharging, the fluids are cycled through an oilbond filtration system and gauge tank. Water filtration is standard practice for well unloading operations.

3.9.9.3 Emissions

During well unloading it is expected that condensate, diesel and methanol will be flared. The flare may be extinguished due to water ingress, lack of fuel (propane), weather impact or equipment failure resulting in cold venting of gas from the flare for several minutes.

3.10 Subsea Installation and Pre-Commissioning Activities

The subsea installation scope of work to tie the Julimar production wells back to the Wheatstone Platform will be performed in two campaigns: pipelay followed by electrical hydraulic umbilical (EHU) and spool installation. These campaigns will be conducted by pipelay vessel and installation vessels respectively. These campaigns will include installing all infrastructure summarised in **Table 3-1**. The work scope will include directly installing the flowline from the pipelay vessel and infrastructure from the installation vessel in the relevant location. No wet storage of infrastructure items is currently planned but may be considered when optimising the installation schedule.

3.10.1 Pre-lay Survey

The flowline installation contractor may perform a pre-lay survey before starting to install the flowline. The pre-lay survey may be performed by a dedicated pre-lay survey vessel, which is typically similar in size to support vessels or potentially the installation vessel.

The pre-lay survey is a debris and hazard identification survey and not a full geophysical survey along the pre-determined route or proposed design route. A number of site surveys have already been performed and it is not anticipated that any debris will need to be removed prior to flowline installation. If required, then these activities will fall under this EP and will be performed by an installation vessel, or alternatively, a support vessel or similar.

The pre-lay survey usually uses a side scan sonar fish-towed behind the pre-lay survey vessel, designed to tow cleanly and with stability. It typically incorporates a safety line for emergency recovery. The towfish side scan sonar system is a compact high definition side scan sonar system designed for a wide range of seabed survey and inspection duties. The survey methods are non-intrusive and the equipment, under planned operation, will not disturb the seabed. Information is transferred to the vessel via an umbilical. The pre-lay survey may also be performed with ROV or autonomous underwater vehicle using side scan sonar.

A multi-beam echo sounder may also be used, and is a common survey tool for offshore surveys. It uses a technique of sound pulses to establish the profile of the seabed. Most modern systems work by transmitting a broad acoustic pulse from a hull or pole-mounted transducer.

3.10.2 Underwater Acoustic Positioning

An array of long base line (LBL) transponders and/or ultra short baseline (USBL) transponders may be installed on the seabed as required by the installation activities. The USBL subsea transponder transmits an acoustic pulse back to the vessel receiver, hence providing an accurate positioning of the subsea transponder location. The LBL array provides accurate positioning by measuring ranges to three or more transponders deployed at known locations on the seabed and structures. These transponders will be used to correctly position the flowlines and pre-lay structures, and will be recovered at the end of the installation program. These acoustic positioning methods are common. Transmissions are not continuous but consist of short ‘chirps’ with a duration that ranges from 3 to 40 milliseconds. The LBL transponders may be moored to the seabed by a clump weight. The standard clump weights used will likely weigh about 80 kg. On completion of the positioning operation, the array transponders are recovered by means of a hydrostatic release, which leaves the clump weight on the seabed. The USBL transponders are mounted to the subsea infrastructure and will be removed after installation.

3.10.3 Installation of Flowline Supporting Structure

If required, supporting structures (e.g. buckle initiators, FLET foundations/mudmats, fixed datum points) will be installed by the installation vessel or pre-lay survey vessel before commencing or post flowline installation. Placement of buckle initiators at regular intervals along the flowline route limits the amount of pipe that can feed into each buckle site, thus mitigating the likelihood of a wet buckle. FLET foundations provide a solid base on which to land the FLET structure. Fixed datum structures may be installed for the Reel-lay installation method to provide reference points for future operational inspections of the flowline, to ensure correct buckle initiation and flowline management.

If such supporting structures are required, they may be transported to the field/staging area by general cargo vessel/heavy lift vessel, then transferred by supply vessel to the installation vessel on site for installation.

The structures will be lifted off the installation vessel and lowered to the seabed by the installation vessel main crane. The structures will be positioned accurately on the seabed using the installed

LBL array or USBL. An ROV from the installation vessel will be used to orientate the structures during installation.

3.10.4 Flowline Initiation/Initiation Anchor Deployment

Commencement of the rigid flowline installation generally requires using initiation anchors to pull against, in order to provide the required tension to the flowline as it transitions from the installation vessel to the seabed. The initiation anchors may consist of a suction pile, drag anchor or clump weight/dead-man anchor.

3.10.5 Pipe Laying

Optimum flowline and umbilical routes have been selected taking into account seabed bathymetry, seabed materials, dropped object risk and buckling/walking impact. The flowline routes are applicable to both Reel-lay or S-lay installation methodology, with the pipelay vessel operating in DP throughout the flowline installation.

For the primary Reel-lay flowline installation:

1. Individual pipe sections are assembled at an onshore base location into pipe stalks using a mechanised welding system to deliver a repeatable high quality weld. The welds are then subjected to non-destructive testing by means of either an automatic ultrasonic testing system or real time radiography, then coated with fusion bonded epoxy (FBE). For the flowlines, an injection moulded polypropylene infill system will be applied at the field joints on top of the FBE.
2. At the onshore location quayside, several stalks are joined using the same welding and testing method above to form a continuous length before being reeled onto the Pipelay vessel reel to capacity for the installation operation.
3. Infield, the reeled pipe operation is reversed and the pipeline departs the firing line through the stern ramp at a steep angle (typically 0 to 30 deg to vertical).
4. The stern ramp angle is adjusted to provide the required pipeline departure angle from the vessel and control its curvature during installation. Tension is maintained via tensioning rollers and a controlled forward thrust to keep the pipe from buckling.
5. FLETs and an inline tee assembly (ILTA) will be installed onto the flowline at required locations and laid to the seabed with the flowline. All offshore pipe welds follow the same method as above to maintain high quality repeatability.
6. Pipelay vessel completes interim mobilisations of step 2 through to 5 to achieve the complete pipe length installation.
7. After the pipeline is installed, a post-lay survey of the flowlines and pipelines along the entire route and other subsea infrastructure (e.g. mattresses) will be conducted using an ROV.

For the contingency S-lay flowline installation:

1. Individual pipe sections are transferred from the pipelay vessel hold or pipe loading station to the ready rack towards the firing line tunnel where the welding is performed.
2. A mechanised welding system will be used to deliver a repeatable high quality weld. The welds are then subjected to non-destructive testing by means of either an automatic ultrasonic testing system or real time radiography, then coated with FBE. For the flowlines, an injection moulded polypropylene infill system will be applied at the field joints on top of the FBE.

3. Each joint will progress down the firing line into the next station. After the last station (coating), the pipeline departs the firing line and enters the stinger.
4. The stinger extends from the stern of the vessel to support the pipe as it is moved into the water and to control the curvature of the installation. Tension is maintained via tensioning rollers and a controlled forward thrust to keep the pipe from buckling.
5. FLETs will be installed onto the flowline at required locations and laid to the seabed with the flowline.
6. After the pipeline is installed, a post-lay survey of the flowlines and pipelines along the entire route and other subsea infrastructure (e.g. mattresses) will be conducted using an ROV.

A wet buckle is an event that could occur during pipelay, which causes a pipeline to rupture and flood with seawater. A contingency spread will be made available to be deployed to the pipelay vessel or installation vessel to displace any seawater in the event a wet buckle occurs during flowline installation. A wet buckle may result in a requirement for subsequent cleaning of the flowline and associated discharges.

Continuous monitoring of the flowline touchdown will be performed by ROV during start-up, laydown, installation over buckle initiators and walking anchor interfaces as required.

Other activities included in general flowline installation include:

- welding and non-destructive testing on board
- field joint coating and anode attachment
- as-laid and as-built surveys for data gathering for free-span rectification, deviations from straightness, etc.

3.10.6 Rigid Flowline and Infrastructure Installation

The pipelay vessel will be either a Reel-lay or S-lay vessel. The pipelay vessel will install the flowline to the seabed and associated inline tees and FLETs.

The pipelay vessel may also install the pre-lay structure(s) and the JULA manifold. The base plan is for the manifold to be installed after MODU drilling operations have finished. As a contingency for a delay in MODU operations, the manifold installation while the MODU is infield will be reviewed to assess suitable SIMOPS to maintain project schedule.

The installation vessel may install the manifold, any pre-lay structures and the tie-in spools, i.e. manifold to FLET and manifold to Xmas tree.

Details of the rigid flowline and infrastructure are summarised in **Table 3-5**.

Table 3-5: Rigid flowline infrastructure

Description	Detail	Dimensions (approx.) L × W × H
Rigid flowline	18-inch NPS, CRA clad, carbon steel pipe	About 22 km from existing BRU manifold to new JULA manifold location
Flowline end termination	Two FLET structures housing the flowline isolation ball valve and pig launcher and receiver (PLRs)/spool connection system	~9 m × 4 m × 4 m
In line tee assembly	One ILTA	~9 m × 4 m × 4 m
Manifold and mudmat	One six-slot production manifold housing isolation valves and spool tie in connection systems	Manifold ~9 m × 10 m × 4 m Mudmat ~14 m × 14 m × 1 m
Spool connector assemblies	One SCA for mid spool connection support; the required spool length precludes single spool installation	~6 m × 4 m × 4 m
Manifold to FLET rigid spools	Three pipe spools connecting the manifolds to the FLET at either end of the flowline	~70 m × 0.6 m × 0.6 m
Manifold to Xmas tree spools	Four pipe spools connecting the Xmas tree to the manifold	~30 m × 0.25 m × 4 m

3.10.7 Span Rectification

Spans are undulations in the seabed that do not provide sufficient support to the flowline. Spans are typically identified during the geophysical survey of the flowline route and are generally mitigated by installing structures, such as concrete mattresses, before installing the flowline. The dimensions for each concrete mattress are typically 12 m by 3 m. The concrete mattresses will be transported either directly by installation vessel or by a support vessel to the installation vessel on site or during mobilisation for installation. The mattresses will be lifted off the installation vessel and lowered to the seabed by the vessel's main crane. The ROV from the installation vessel will be used to orientate the mattresses during installation.

Post-lay span rectification may also be required after the flowline is installed. This process typically involves placing grout bags under the span section. The empty bag is moved into position using ROV, then filled with grout supplied from a mixing and pumping spread on the vessel via a downline. Typical grout volumes depend on the size of the span and may vary from about 200 kg to 2000 kg per span. Concrete mattresses may also be used for post-lay span rectification, with the dimensions of mattresses and the process for installation likely to be similar to those described above for pre-lay span rectification.

If grout bags are used, the downline recovery time risks exceeding the grout curing time. If grout cures within the downline and pump, the equipment is likely to be rendered unserviceable, as well as the downline not being safely recoverable in the normal way. Therefore, after grouting activities at each span site, the downline and pump will need to be purged using seawater. This results in an amount of grout, approximately equivalent to the downline volume (5 m^3), being discharged to the ocean. This flushing is required once per grout site. The actual number of grout bags is not known until the line is laid and the need for span rectification determined, if any.

3.10.8 Flood, Clean, Gauge and Hydrotesting Pressure Testing

The production flowline will be laid empty (i.e. filled with air). This will then be flooded, cleaned, gauged and tested (FCGT) by the installation vessel or a separate support vessel.

3.10.8.1 Hydrotesting

The flowline will then be hydrotested FLET to FLET. Hydrotesting of the flowline is required to ensure structural integrity. Pressurisation will be from the pumping skid onboard the installation vessel. Following successful pressure test, the pressure will be vented.

In the event of an issue that indicates remedial construction work is required, or in case of a pipeline wet buckle scenario during pipelay, contingency plans will be implemented.

3.10.8.2 Flooding

The FLET temporary heads will be replaced by a pig launcher and pig receiver, installed at either end of the flowline after laydown. Each FLET will include a full bore ball valve which will be piggable[5]. These will be closed at laydown. After installing the PLRs, the FLET valves will be opened and the flowline will be flooded with chemically treated, filtered seawater, typically corrosion inhibitor, biocide, oxygen scavenger and dye supplied via downline from the installation vessel.

3.10.8.3 Cleaning, Gauging and Dewatering

Cleaning, gauging and pigging/dewatering is performed by using a series of pigs which run through the flowline using nitrogen-driven pressure, delivered via a downline from the installation vessel to drive the pigs from JULA FLET towards the Brunello XOM FLET.

The flowline will be pigged in a controlled way to clean the internal surface of the flowline and to determine if any unacceptable restrictions and/or obstructions exist in the line. An in-line inspection (ILI) and/or calliper pig, to determine a baseline position of the line for future inspection, may also be performed by including as part of the FCG pig train. The pig train may consist of bi-directional pigs, some fitted with a gauge plate or sensor for verifying the internal diameter of the flowline and indicating the presence of buckles.

As the flowline hydrotest requires the flowline to be filled with treated seawater, the full volume of the line will be displaced and therefore discharged as a result of the FCG and ILI pig runs. As treated seawater will separate each pig in the train, it is estimated an additional ~1% of the line volume will also be discharged. About 20% over pumping is required to ensure the pig train has successfully arrived at the pig receiver; therefore, this amount will also require discharge. The estimated discharge volumes including chemical additives are shown in Table 6-4. There is also potential that some debris remaining from pipeline installation activities within the line may be discharged with this water.

After the FCG/ILI pigging is completed, the flowline is left filled with nitrogen in preparation for hydrocarbon commissioning. After dewatering, the line will be dried, either via vacuum or multiple pig runs with nitrogen. After the line is dried, it may be pressured to circa 70 bar with nitrogen in preparation for hydrocarbon commissioning. The FLET valves will be closed and the PLRs will be removed.

3.10.9 Flowline Spools

After the flowline PLRs are removed, the flowline spools will be installed at each end of the flowline between the FLET and the manifold. The spools will be pre-filled with dyed MEG onshore and have low pressure caps installed. The minimal density difference between MEG and seawater results in minimal seawater ingress to the spool/FLET when the caps are removed. The connection will be dosed with chemical sticks to treat any seawater that has entered the connection.

[5] Pigging is the act of forcing a device called a pig, through a pipeline for the purposes of displacing or separating fluids and cleaning or inspecting the line (Schlumberg oil field glossary, accessed online May 2019).

The spools will be subject to a short in-place leak test. Accordingly, the test will be deemed successful either on achieving an acceptable pressure hold period, or following thorough inspection and no visual leaks being present from the connections.

3.10.10 Well Jumpers

The rigid well jumpers between the Xmas tree and production manifold will be MEG filled similar to the flowline spools. Like the flowline spools, they will also be strength-tested onshore and subject to leak test following installation.

3.10.11 Electrical Hydraulic Umbilical

The EHU cores will be pressurised at loadout and the pressure will be monitored throughout the lay.

After laydown of each EHU section, the cores may be pressure-tested and the electrical and fibre optics subject to tests. This is critical for the section connecting to the BRU-XOM to avoid production interruption caused by pressure drop at hook-up. Valves will be included in the UTA to allow pressure to be locked in downstream of the BRU-A connection point.

The flying leads will be connected between the UTAs, manifold and to the Xmas trees. This system will be subject to further pressure testing and electrical and fibre optic continuity and signal tests. This is required to minimise risk to the Brunello drill centre production.

3.10.12 Pre-commissioning of Subsea Infrastructure

The pre-commissioning associated with subsea infrastructure generally includes subsea control systems verification and function testing of valves to verify that the subsea umbilicals, electric and hydraulic flying leads are ready for entry into the commissioning phase.

3.11 Project Fluids

3.11.1 Assessment of Project Fluids

All chemicals that may be operationally released or discharged to the marine environment by the Petroleum Activities Program are evaluated using a defined framework and set of tools to ensure the potential impacts are acceptable, ALARP and meet Woodside's expectation for environmental performance.

All approved drilling and completion chemicals are included on the Drilling and Completions – Master Chemical List which is reviewed during a six month chemical review to drive continuous environmental improvement.

The chemical assessment process follows the principles outlined in the Offshore Chemical Notification Scheme (OCNS) which manages chemical use and discharge in the United Kingdom (UK) and the Netherlands. It applies the requirements of the Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR Convention). The OSPAR Convention is widely accepted as best practice for chemical management.

All chemical substances listed on the OCNS ranked list of registered products have an assigned ranking based on toxicity and other relevant parameters, such as biodegradation and bioaccumulation, in accordance with one of two schemes (as shown in **Figure 3-3**):

- Hazard Quotient (HQ) Colour Band: Gold, Silver, White, Blue, Orange and Purple (listed in order of increasing environmental hazard), or
- OCNS Grouping: E, D, C, B or A (listed in order of increasing environmental hazard). Used for inorganic substances, hydraulic fluids and pipeline chemicals only.

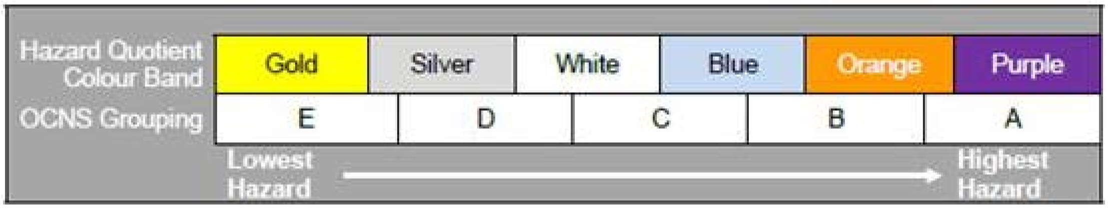


Figure 3-3: OCNS ranking scheme

Chemicals fall into the following assessment types:

- No further assessment: Chemicals with an HQ band of Gold or Silver or an OCNS ranking of E or D with no substitution or product warnings do not require further assessment. Such chemicals do not represent a significant impact on the environment under standard use scenarios and are, therefore, considered ALARP and acceptable.
- Further assessment/ALARP justification required: The following types of chemicals require further assessment to understand the environmental impacts of discharge into the marine environment:
  - chemicals with no OCNS ranking
  - chemicals with an HQ band of White, Blue, Orange, Purple or an OCNS ranking of A, B or C
  - chemicals with an OCNS product or substitution warning.

3.11.1.1 Further Assessment/ALARP Justification

This includes assessing the ecotoxicity, biodegradation and bioaccumulation of the chemicals in the marine environment in accordance with the Centre for Environment, Fisheries and Aquaculture Science (CEFAS) Hazard assessment and the Department of Mine and Petroleum (DMP) Chemical Assessment Guide: *Environmental Risk Assessment of Chemicals used in WA Petroleum Activities Guideline.*

3.11.1.2 Ecotoxicity

Chemical ecotoxicity is assessed using the criteria used by CEFAS to group chemicals based on ecotoxicity results (**Table 3-6**). If a chemical has an aquatic or sediment toxicity within the criteria for the OCNS grouping of D or E this is considered acceptable in terms of ecotoxicity.

Table 3-6: CEFAS OCNS grouping based on ecotoxicity results

Initial grouping	A	B	C	D	E
Results for aquatic-toxicity data (ppm)	<1	>1-10	>10-100	>100-1000	>1000
Result for sediment toxicity data (ppm)	<10	>10-100	>100-1000	>1000-10,000	>10,000

Note: Aquatic toxicity refers to the Skeletonema constatum EC50, Acartia tonsa lethal concentration 50% (LC_{50}) and Scophthalmus maximus (juvenile turbot) LC_{50} toxicity tests; sediment toxicity refers to Corophium volutator LC_{50} test

Biodegradation

The biodegradation of chemicals is assessed using the CEFAS biodegradation criteria, which align with the categorisation outlined in the DMP Chemical Assessment Guide: *Environmental Risk Assessment of Chemicals used in WA Petroleum Activities Guideline*.

CEFAS categorises biodegradation into the following groups:

- Readily biodegradable: results of >60% biodegradation in 28 days to an OSPAR harmonised offshore chemical notification format (HOCNF) accepted ready biodegradation protocol.

- Inherently biodegradable: results >20% and <60% to an OSPAR HOCNF accepted ready biodegradation protocol or result of >20% by OSPAR accepted inherent biodegradation study.
- Not biodegradable: results from OSPAR HOCNF accepted biodegradation protocol or inherent biodegradation protocol are <20%, or half life values derived from aquatic simulation test indicate persistence.
- Chemicals with >60% biodegradation in 28 days to and OSPAR HOCNF accepted ready biodegradation protocol are considered acceptable in terms of biodegradation.

Bioaccumulation

The bioaccumulation of chemicals is assessed using the CEFAS bioaccumulation criteria, which align with the categorisation outlined in the DMP Chemical Assessment Guide*: Environmental Risk Assessment of Chemicals used in WA Petroleum Activities Guideline.*

The following guidance is used by CEFAS:

- Non-bioaccumulative: LogPow <3, or BCF ≤100 and molecular weight is ≥700.
- Bioaccumulative: LogPow ≥3 or BC >100 and molecular weight is <700.

Chemicals that meet the non-bioaccumulative criteria are considered acceptable.

If a product has no specific ecotoxicity, biodegradation or bioaccumulation data available, the following options are considered:

- Environmental data for analogous products can be referred to where chemical ingredients and composition are largely identical. OR
- Environmental data may be referenced for each separate chemical ingredient (if known) within the product.

Alternatives

If no environmental data is available for a chemical or if the environmental data does not meet the acceptability criteria outlined above, potential alternatives for the chemical will be investigated, with preference for options with an HQ band of Gold or Silver, or OCNS Group E or D with no substitution or product warnings.

If no more environmentally suitable alternatives are available, further risk reduction measures (e.g. controls related to use and discharge) will be considered for the specific context and implemented where relevant to ensure the risk is ALARP and acceptable.

Decision

Once the further assessment/ALARP justification has been completed, the relevant environment adviser must concur that the environmental risk as a result of chemical use is ALARP and acceptable.

3.11.2 Drilling Fluid System

3.11.2.1 Water-based Mud System

The Petroleum Activities Program will use a water drilling fluid system as the preferred option.

In addition to the base fluid, drilling muds contain a variety of chemicals, incorporated into the selected drilling fluid system to meet specific technical requirements (e.g. mud weight required to manage pressure, or for borehole stability). All chemicals selected for use have been assessed under Woodside's internal guidelines to ensure potential impacts are acceptable, ALARP and meet Woodside's expectation for environmental performance.

The WBM drilling fluid will either be mixed on the MODU or received pre-mixed, then stored and maintained in a series of pits aboard the MODU. The top hole sections will be drilled riserless with seawater containing pre-hydrated gel sweeps, and cuttings and drilling fluids returned to the seabed. The bottom hole sections may be drilled using WBM in a closed circulation system which enables re-use of the WBM drilling fluids.

WBM drilling fluids that cannot be reused (e.g. due to bacterial deterioration or do not meet required drilling fluid properties) or are mixed in excess of required volumes, may be operationally discharged to the ocean under the MODU's Permit to Work (PTW) system. Opportunities to reuse the WBM drilling fluids at the end of the Petroleum Activities Program are reviewed across current Woodside drilling activities.

WBM may not be able to be reused between drilling sections due to the drilling sequence, technical requirements of the mud (i.e. no tolerance for deterioration of mud during storage) and maintenance of productivity/injectivity.

A number of factors unique to each drilling program will determine the quantities of WBM drilling fluids required and subsequent discharge volumes if no suitable reuse option is available.

3.11.2.2 Non-water Based Mud System

The decision to use NWBM drilling fluids for the bottom hole sections of a particular well is based on a variety of technical factors relevant to wellbore conditions, such as well temperature, well shape and depth, reactivity of the formation to water and well friction. The technical justification to use NWBM includes consideration of environment, health, safety and waste management.

The use of NWBM drilling fluids is subject to a formal written commercial and/or technical justification approved in accordance with Woodside's Best Practice – Overburden Drilling Fluids Environmental Requirements. The main ingredient of NWBM is base oil, and similar to a WBM system, a range of standard solid and liquid additives may be added in the pits to alter specific mud properties for each section of the well, depending on the conditions encountered while drilling.

The NWBM drilling fluid will be primarily mixed onshore (new or re-use existing stock) and transferred to the MODU by a support vessel, where it is stored and maintained in the mud pits. During drilling operations, the NWBM drilling fluid, like the WBM, is pumped by high pressure pumps down the drill string and out through the drill bit, returning via the annulus between the drill string and the casing back to the MODU via the riser.

The used NWBM pumped back to the MODU contains drill cuttings and is pumped to the solids control equipment (SCE), where the drill cuttings are removed before being pumped back to the pits ready for re-use. The technical properties of the NWBM drilling fluids are maintained/altered (e.g. to increase weight) using additives as required when in the mud pits.

The NWBM drilling fluids that cannot be reused (i.e. do not meet required drilling fluid properties or are mixed in excess of required volumes) are recovered from the mud pits and returned to the shore base for onshore processing, recycling and/or disposal. The mud pits and associated equipment/infrastructure are cleaned when NWBM is no longer required, with wash water treated onboard through the SCE prior to discharge with mud pit washings, or returned to shore for disposal if discharge criteria cannot be achieved (refer to **Section 3.11.2.3**).

3.11.2.3 Mud Pits

There are typically a number of mud pits (tanks) on the MODU that provide a capacity to mix, maintain and store fluids required for drilling activities. The mud pits form part of the drilling fluid circulation system. The mud pits and associated equipment/infrastructure are cleaned out at the completion of Drilling and Completions operations. Mud pit wash residue is operationally discharged with less than 1% oil contaminated by volume. Mud pit residue over 1% oil volume is sent to shore for disposal.

3.11.3 Drill Cuttings

Drill cuttings generated from the well are expected to range from very fine to very coarse (<1 cm) particle/sediment sizes. Cuttings generated during drilling of the top hole sections are discharged at the seabed. Estimated volumes of drill cuttings that may be discharged during the Petroleum Activities Program are presented in **Table 6-4**.

The bottom hole sections will be drilled with a marine riser that enables cuttings and drilling fluid to be circulated back to the MODU, where the cuttings are separated from the drilling fluids by the SCE. The SCE comprises but is not limited to shale shakers, cuttings dryers and centrifuges. The SCE uses shale shakers to remove coarse cuttings from the drilling mud. After being processed by the shale shakers, the recovered mud from the cuttings may be directed to centrifuges, which are used to remove fine solids (4.5 to 6 µm). The cuttings are usually discharged below the water line and the mud is recirculated into the fluid system.

If NWBM are needed to drill a well section, the cuttings which are separated from the NWBM via the shakers will also pass through a cuttings dryer and associated SCE, to reduce the average oil on cuttings for the entire well (only section using NWBM) to 6.9% wt/wt or less on wet cuttings, prior to discharge.

3.12 Contingent Activities

The next sections present contingencies that may be required, if operational or technical issues occur during the Petroleum Activities Program. These contingencies have been considered within the relevant impact assessment sections and do not represent significant additional risks or impacts, but may generate additional volumes of drilling fluids and cuttings being operationally discharged.

3.12.1 Respud

A respud may be required for a number of reasons, such as if the conductor or well head slumps or fails installation criteria (typically during top hole drilling). Respudding involves moving the MODU to a suitably close location (e.g. ~50 m from the original location) to recommence drilling. A respud activity would result in repeating top hole drilling (**Section 3.9.2**).

The environmental aspects of respudding are the same as those for drilling and are considered to be adequately addressed by this EP (**Section 6.6.6**), with no significant changes to existing environmental risks or any additional environmental risks likely. The net environmental effect will be limited to an increase in the volume of cuttings generated (**Table 6-4**) and discharged at the seabed, from the repeat drilling of the top hole section.

3.12.2 Sidetrack

The option of a sidetrack instead of a respud may be determined, if operational issues are encountered. The environmental aspects of a sidetrack well are the same as those for undertaking routine drilling activities, which are considered to be adequately addressed by this EP (**Section 6.6.6**), with no significant changes to existing environmental risks or any additional environmental risks likely. The net environmental effect will be limited to an increase in the volume of cuttings generated (**Table 6-4**), potential increase in the use of WBM and the additional emissions (atmospheric and waste) associated with an extended drilling program.

3.12.3 Workover

It is possible the well may be worked over by recovering and replacing the completion string and associated components. The environmental aspects of a workover operation are the same as those for undertaking completions activities, considered to be adequately addressed by this EP (**Section 6.6.6**), with no significant changes to existing environmental risks or any additional environmental risks likely.

3.12.4 Well Suspension

During drilling activities, a well may need to be temporarily suspended. Suspension involves establishing suitable barriers, removing the riser and disconnecting the MODU from the well. The BOP may sometimes be left in place to act as a barrier. Suspension may be short term (e.g. in the case of a cyclone) or longer term (more than one year). On return to a well after suspension, the MODU reconnects to the well via the riser, and with BOP in place, barriers are removed and drilling and completions activity resumes.

3.12.5 Wireline Logging

Wireline contingencies that may be in place for development drilling include but not limited to, fluid sampling, Gamma Ray (GR) and Casing Collar Locator (CCL) for depth correlation, Ultrasonic Imaging Tool and CBL to measure cement integrity, formation pressures, Density, Neutron and Resistivity and punch perforators/tubing cutters suitable for all tubing sizes. Wireline contingency work will be carried out with appropriate isolation barriers in place, i.e. an overbalanced fluid column. If wireline work is required to take place in a live well, or where there is a risk of barrier failure, then the operation will be carried out with full pressure control equipment at the surface.

Some logging tools may contain low activity radiation sources. Radiation fields are not generally detectable outside the tool when the tool is not energised, therefore they do not present an environmental risk.

3.12.6 Well Intervention

An intervention may be performed on any of the Petroleum Activities Program wells. Interventions may performed due to down-hole equipment failure or to address underperformance of a well. Key well intervention methods include wire-line and coiled tubing. Potential environmental impacts from intervention activities have been included in this EP, including discharge of suspension fluids and brines and small volume gas releases subsea due to removal of a tree cap which may be in place if the well was previously suspended.

3.12.7 Well Abandonment

The Petroleum Activities Program covers the drilling of production wells, which are not envisaged to be abandoned until the end of the production field life. For technical reasons, it may be required to abandon the lower section of a well, prior to sidetracking, or in the event that a re-spud is required.

Well abandonment activities are conducted in accordance with Woodside's internal standards. Base oil may be used for inflow testing prior to abandonment, to verify barrier integrity. Base oil would be pumped down the drill string and reverse circulated back to the rig, with fluids collected for disposal onshore. If stored in a mud pit, the base oil and other fluids associated with the test may result in pit wash water contaminated with hydrocarbons. If this is the case, mud pit wash water would be discharged in accordance with requirements in this EP; with a hydrocarbon content <1% by volume.

If required, wells will be abandoned with abandonment cement plugs, including verification of the uppermost cement plug by tagging and/or pressure testing through a prescribed program. A lower section of a well may also be abandoned prior to sidetracking.

Following abandonment activity, the marine riser and BOP will be removed and every reasonable attempt for retrieval of the wellhead. Conventional wellheads are removed by deploying a cutting device on drill pipe which then cuts through the conductor, allowing the wellhead to be retrieved to the surface. Backup cutting equipment is sent offshore as a contingency should the primary set of equipment fail. The conductor cutting equipment is very reliable with a high success rate of cutting wellheads.

If these recognised removal techniques are ineffective, the wellhead may be left in-situ. The integrity of the wellbore is not affected by the wellhead assembly remaining in-situ.

3.12.8 Wellhead Assembly Left In-situ

If a well is abandoned due to the requirement to re-spud, the wellhead assembly may be left in-situ if recognised removal techniques are ineffective. Well abandonment activities would be performed as outlined in **Section 3.12.7**, but the wellhead assembly would remain. The integrity of the wellbore is not affected by the wellhead assembly remaining in-situ. The environmental aspects of the wellhead assembly remaining in-situ are considered to be adequately addressed by this EP, with no significant changes to existing environmental risks or any additional environmental risks likely.

3.12.9 Sediment Mobilisation and Relocation

If required, an ROV-mounted suction pump/dredging unit may be used to relocate sediment/cuttings around the wellhead or other infrastructure, to keep the area clear and safe for operations and equipment. This activity has the potential to generate plumes of suspended sediment during pumping and disturb benthic fauna in the immediate area.

3.12.10 Venting

During drilling of the well, a kick may occur. A kick is an undesirable influx of formation fluid into the wellbore. To maintain well integrity in this situation, a small volume of greenhouse gases is released to the atmosphere via the degasser, in a well control operation known as ‘venting’.

3.12.11 Emergency Disconnect Sequence

An emergency disconnect sequence (EDS) may be implemented if the MODU is required to rapidly disengage from the well. The EDS closes the BOP (i.e. shutting in the well) and disconnects the riser to break the conduit between the wellhead and MODU. Common examples of when this system may be initiated include when moving the MODU outside of its operating circle (e.g. due to a failure of one or more of the moorings) or moving the MODU to avoid a vessel collision (e.g. third-party vessel on a collision course with the MODU). EDS aims to leave the wellhead in a secure condition, but will result in losing the drilling fluids/cuttings in the riser after disconnection.

3.12.12 Flowline Contingency Dewatering

During flowline installation, contingency dewatering may be required to remove untreated seawater from the flowline (e.g. a wet buckle event). This would require the flowline to be dewatered with treated seawater. Seawater will be treated with the same chemicals, in the same concentrations, as for the routine (non-contingent) FCGT process (refer to **Section 3.10.8**). The estimated discharge volumes, including chemical additives for routine dewatering, are shown in **Table 6-4**. While the volume of treated seawater required for contingency dewatering of the flowline could be up to the full flowline length, the dewatering discharge volume would depend on the length of flowline installed prior to the contingency event occurring.

4. DESCRIPTION OF THE EXISTING ENVIRONMENT

4.1 Overview

In accordance with Regulation 13(2) and 13(3) of the Environment Regulations, a description of the existing environment that may be affected by the activity (planned and unplanned activities, as defined in **Section 2.4.1** and described in **Section 3**), including details of the particular relevant values and sensitivities of the environment, is provided in this section and has been used for the risk assessment.

4.2 Summary of Key Existing Environment Characteristics

A summary of the key existing environment characteristics, consistent with the process of identifying and describing the existing environment in relation to the 'nature and scale' of the activity (refer **Section 2.4.2**) is provided in **Table 4-1**. The key existing environment characteristics in **Table 4-1** are described in terms of the Operational Area and the environment that may be affected. The Operational Area is located within offshore waters 160 km north-west of Dampier, while the wider EMBA has been identified by hydrocarbon spill modelling of the credible worst-case scenario (loss of well integrity described in **Section 6.7.2**). The full description is provided in **Sections 4.3** to **4.7**.

Table 4-1: Summary of key existing environment characteristics

	Sensitive receptor	EP section	Description
Physical Habitats	***Climate and meteorology***	***4.4.1***	***Operational Area and wider EMBA*** • Dry tropical climate with hot summers and mild winters. • Tropical monsoon climate, with distinct wet (October to April) and dry (May to September) seasons. • Winds vary seasonally, with a tendency for winds from the south-west during summer months (Sep–Mar) and the south-east in autumn and winter months (Apr–Aug). • Tropical cyclone activity can occur between November and April (summer period) and is most frequent during December to March.
	Seawater characteristics	***4.4.3***	***Operational Area*** • Water quality is expected to reflect the offshore oceanic conditions of the NWS Province and wider region. • Surface water temperatures are relatively warm, ranging seasonally from about 24.3 to 28.5 °C. • Offshore waters are expected to be of high quality, given the distance from shore and lack of terrigenous inputs. ***Wider EMBA*** • Water quality is regulated by the Indonesian Throughflow (ITF), which plays a key role in initiating the Leeuwin Current and brings warm, low-nutrient, low-salinity water to the North West Marine Region (NWMR). It is the primary driver of the oceanographic and ecological processes in the NWS Province. • Variation in surface salinity throughout the year is minimal (35.2 and 35.7 practical salinity units (PSU)). • During summer, the Leeuwin Current typically weakens and the Ningaloo Current develops, facilitating upwelling of cold, nutrient-rich waters up onto the NWS. • Other areas of localised upwelling in the NWMR include the Wallaby Saddle and Exmouth Plateau, where these seabed topographical features force the surrounding deeper, cooler, nutrient-rich waters up into the photic zone. • Turbidity is primarily influenced by sediment transport by oceanic swells and primary productivity.
	Bathymetry and seabed habitats	***4.4.4***	**Bathymetry and Seabed Features** ***Operational Area*** • Located in waters about 130–290 m deep along the middle continental shelf. • The seabed generally comprises a relatively flat and featureless habitat with noted features being: – a large ridgeline transecting the north-west end of the Operational Area – overlapping spatially with the ancient coastline at the 125 m depth contour key ecological feature (KEF) and the continental slope demersal fish community KEF (**Section 4.7.1**).

Sensitive receptor	EP section	Description
		Wider EMBA • The wider EMBA includes a number of topographic features including submerged banks, shoals and valleys, including Rankin Bank and Glomar Shoals. • It is characterised by the inner continental shelf, the middle continental shelf, the outer shelf/continental slope and the abyssal plain. • Broad-scale, biologically important deep-sea seabed habitat includes abyssal plains, marginal plateaus and submarine canyons. • South of the NWMR, the EMBA extends to the Central Western Province, which has a gentle slope rising from offshore towards the foot of the continental slope. **Marine Sediment** ***Operational Area*** • The Operational Area is dominated by soft sediment (fine to coarse sands). ***Wider EMBA*** • Sediments are relatively homogenous and are typically dominated by sands and a small portion of gravel. • Rankin Bank and Glomar Shoal are comprised predominantly of sand (similar to other shoal ecosystems on the NWS) and are considered pristine marine environments.
Air quality	***4.4.5***	There is limited air quality data for the North West Shelf Province and wider EMBA but ambient air quality in the Operational Area and wider offshore EMBA is expected to be of high quality.
Critical habitat – EPBC listed	***4.5.1***	No Critical Habitats or Threatened Ecological Communities, as listed under the EPBC Act, are known to occur within, or in proximity to, the Operational Area or wider EMBA.
Marine primary producers	***4.5.1***	**Coral Reefs** ***Operational Area*** • No coral reefs have been identified within or adjacent to the Operational Area. ***Wider EMBA*** • The nearest coral reef habitat to the Operational Area is at Rankin Bank, about 30 km north-east. Coral reefs can also be found at the Montebello/Barrow/Lowendal Islands Group, Pilbara Islands (Northern and Southern Island Groups), Dampier Archipelago, Glomar Shoals and Muiron Islands, Ningaloo Coast and Shark Bay. **Seagrass/Macroalgae** ***Operational Area*** • No seagrass beds or macroalgae habitat has been identified in the Operational Area.

	Sensitive receptor	EP section	Description
			Wider EMBA • The nearest seagrass/macroalgae habitat is about 40 km south-east of the Operational Area at the Montebello/Barrow/Lowendal Islands Group and can also be found at some islands within the, Northern and Southern Pilbara Island Groups, and the Muiron Islands, the Ningaloo Coast and Shark Bay. **Mangroves** ***Operational Area*** • No mangrove habitat has been identified within the Operational Area. ***Wider EMBA*** • The closest mangrove habitats to the Operational Area are at the Montebello/Barrow/Lowendal Islands Group and are also found along the Ningaloo Coast and Shark Bay.
	Other communities and habitats	***4.5.1***	**Plankton** ***Operational Area*** • Plankton communities in the Operational Area are likely to reflect the broader NWMR. ***Wider EMBA*** • Offshore phytoplankton communities are characterised by smaller taxa (e.g. bacteria) whereas shelf waters are dominated by larger taxa such as diatoms. • Peak primary productivity along the shelf edge of the Ningaloo Reef occurs in late summer/early autumn. **Pelagic and Demersal Fish Communities** ***Operational Area*** • Fish communities in the Operational Area comprise small and large species of pelagic fish, as well as demersal species. • The Continental Slope Demersal Fish Communities KEF (overlapping the Operational Area) supports a high biodiversity of demersal fish species. • Demersal fish biodiversity correlates with habitat complexity, with more complex habitat supporting greater species richness and abundance compared to bare areas. ***Wider EMBA*** • Both Rankin Bank and Glomar Shoals support high demersal fish richness and abundance compared to other shoals and reef locations along the NWS. • Key demersal fish biodiversity areas are likely to occur in other complex habitats, such as coral reefs, and therefore likely includes the Montebello/Barrow/Lowendal Islands Group, the Ningaloo Coast and Muiron Islands, and Shark Bay.

<table>
<tr><th></th><th>Sensitive receptor</th><th>EP section</th><th>Description</th></tr>
<tr><td></td><td></td><td></td><td>Benthic Fauna Communities (including filter feeders)
Operational Area
• Soft sediment communities located within and nearby the Operational Area include sparse (<5% cover) epibenthic fauna comprising occasional anemones, urchins, sea whips, sea pens, feather stars and glass sponges. Infauna are diverse and dominated by polychaete worms and crustaceans.
• The benthic (epifauna and infauna) biota associated with the soft sediment habitat of the Operational Area is expected to be relatively homogenous across the region. This habitat is considered to be of relatively low environmental sensitivity.
Wider EMBA
• Hard coral and macroalgae communities of Rankin Bank and Glomar Shoals (refer to Sections 4.7.12 and 4.7.11, respectively).
• Filter feeding communities associated with cemented sediment outcropping and other hard substrate habitats are recorded throughout the wider EMBA. Recorded locations of such communities include the deeper waters surrounding Rankin Bank and Glomar Shoals, Ningaloo Coast and the Muiron Islands.</td></tr>
<tr><td rowspan="2">Protected Species</td><td>Biologically important areas (BIAs)</td><td>4.5.2</td><td>Operational Area
• There is a flatback turtle internesting buffer zone, about 80 km zone from the nearest foraging, mating and nesting sites for flatback turtles on Barrow, the Montebello and Lowendal Islands during summer (peak period in December and January).
• A whale shark foraging zone is north of Ningaloo Reef/North West Cape along the 200 m isobath (July–November).
• The Operational Area contains a foraging area for the wedge-tailed shearwater during its breeding season (August–April).
• The pygmy blue whale migration extends northward from the Perth canyon towards Indonesia (northward migration April–August; southern migration October–December).
• Pygmy blue whale distribution occurs from the southern coast of Australia and along the WA coast, extending north through the Indian Ocean to Indonesian waters.
Wider EMBA
• There are a large number of BIAs within the wider EMBA.</td></tr>
<tr><td>Marine mammals</td><td>4.5.2</td><td>Marine mammals identified from the EPBC Act Protected Matters Search Tool included four species of Threatened and Migratory cetaceans (the pygmy blue, humpback, sei and fin whale) and six species of Migratory cetaceans that may be present in the Operational Area. The Operational Area does not contain any known critical habitat for any species of marine mammal.
Other marine mammal species including migratory cetaceans
• The Antarctic minke whale, Bryde’s whale, sperm whale, killer whale, southern right whale, spotted bottlenose dolphin and Australian humpback dolphin may infrequently transit the Operational Area and wider EMBA.
• Resident marine mammals such as the dugong are known to occur within the EMBA.
See Section 4.7.1 to Section 4.7.12 for the location of identified values and sensitivities, related to marine mammals, which are protected within the jurisdiction of Commonwealth and State managed areas.</td></tr>
</table>

	Sensitive receptor	EP section	Description
	Marine turtles	***4.5.2***	***Operational Area*** • Five species of Threatened marine turtles (loggerhead, green, leatherback, hawksbill and flatback) may occur in the Operational Area. • The Operational Area does not contain any known critical habitat for any species of marine turtle. However, a BIA for internesting flatback turtles overlaps with the Operational Area. • The presence of marine turtles within the Operational Area is likely to be infrequent and limited to individuals or small numbers transiting through the area. ***Wider EMBA*** • Marine turtles may forage around Rankin Bank and Glomar Shoals, given the relatively shallow depths and suitable foraging habitat. • Green, loggerhead, flatback and hawksbill turtles have significant nesting rookeries on beaches near Montebello/Barrow/Lowendal Islands Group, Muiron Islands and Ningaloo Reef. • Leatherback turtles may occur within the wider EMBA but there are no known nesting beaches in Western Australia.
	Seasnakes	***4.5.2***	***Operational Area*** • Given the offshore location and deeper water depths of the Operational Area, seasnake sightings will likely be infrequent and comprise a few individuals. ***Wider EMBA*** • Seasnakes frequent the waters of the continental shelf area (between 10 and 120 m) in the North West Shelf Province and around offshore islands. • The short-nosed seasnake was identified by the EPBC Act Protected Matters Search Tool as potentially occurring within the wider EMBA.
	Seahorses and pipefish	***4.5.2***	***Operational Area*** • Seahorses and pipefish are uncommon in deeper continental shelf waters (50–200 m) and therefore unlikely to occur within the Operational Area. ***Wider EMBA*** • Seahorses and pipefish occur in both temperate and tropical waters throughout the NWMR and are commonly found among seagrass, mangrove, coral reef and sandy habitats around coastal islands and shallow reef areas.
	Sharks, fish and rays	***4.5.2***	***Operational Area*** • The EPBC Act Protected Matters Search Tool identified five species of Threatened and Migratory sharks (whale shark and great white shark, dwarf sawfish and green sawfish), one species of Threatened shark (grey nurse shark), three species of Migratory sharks (shortfin mako, longfin mako and narrow sawfish) and two Migratory ray species (giant manta ray and reef manta ray) that may occur in the Operational Area.

<table>
<tr><th></th><th>Sensitive receptor</th><th>EP section</th><th>Description</th></tr>
<tr><td></td><td></td><td></td><td>The Operational Area does not contain any known critical habitat for any species of shark or ray. However, a BIA representing a migration pathway and foraging area for whale sharks overlaps the Operational Area; therefore, whale sharks may traverse the Operational Area during their migration between Australia and Indonesia each year.
The presence of EPBC-listed sharks, fish and rays is likely to be infrequent and limited to individuals or small numbers transiting through the area.
Wider EMBA
Whale sharks are known to aggregate annually, from March to July, in areas off Ningaloo and North West Cape, within the EMBA. After the aggregation period, the distribution of the whale sharks is largely unknown but surveys suggest the group disperses widely and up to 1800 km away to likely areas in Indonesia, Christmas Island and Coral Sea.
Grey nurse sharks are likely to be found in shallow waters of the wider EMBA.
Great white sharks, shortfin makos and longfin makos are all known to occur within the wider EMBA.
Dwarf and green sawfish may be found within the wider EMBA, traversing from coastal waters along the mainland Pilbara (outside of the EMBA).
Ningaloo Reef is an important area for manta rays in autumn and winter, and they are known to occur in tropical waters throughout the wider EMBA.
See Section 4.7.1 to Section 4.7.12 for the location of identified values and sensitivities, related to sharks, fish and rays, which are protected within the jurisdiction of Commonwealth and State managed areas.</td></tr>
<tr><td></td><td>Seabirds and/or migratory shorebirds</td><td>4.5.2</td><td>Operational Area
Twelve listed bird species were identified in the EPBC Protective Matters Search Tool as potentially occurring within the Operational Area, five of which are listed as Threatened. No critical habitat associated with these species has been identified for the Operational Area.
A BIA for wedge-tailed shearwaters, during their breeding season, overlaps the Operational Area.
Wider EMBA
There are several BIAs (key breeding/nesting, roosting, foraging and resting areas) for seabirds and migratory shorebirds in the wider EMBA, including areas on the islands of the Montebello/Barrow/Lowendal Islands Group, Dampier Archipelago, the Pilbara Islands, Ningaloo Coast and Muiron Islands.
Seabird and shorebird habitats are discussed further as key environmental sensitivities in Section 4.7.1 to Section 4.7.12.</td></tr>
<tr><td>Socio-economic</td><td>Cultural heritage</td><td>4.6.1</td><td>Operational Area
There are no known sites of Indigenous or European cultural or heritage significance within or in the vicinity of the Operational Area.
There are no heritage listed sites within or immediately adjacent to the Operational Area.</td></tr>
</table>

Sensitive receptor	EP section	Description
		Wider EMBA • Barrow Island, Montebello Islands, Ningaloo Reef and the adjacent foreshore contain numerous registered Aboriginal heritage sites (based on results from Department of Aboriginal Affairs (DAA) searches, **Appendix G**). • The closest historic shipwrecks to the Operational Area are at Tryal Rocks, about 57 km south east of the Operational Area. • National Heritage listed places within the wider EMBA include the Ningaloo Coast World Heritage Area, Shark Bay World Heritage Area and HMAS Sydney II and HSK Kormoran shipwreck sites. • Commonwealth Heritage listed places within the wider EMBA include the Ningaloo Marine Area – Commonwealth waters and HMAS Sydney II and HSK Kormoran shipwreck sites.
Ramsar wetlands	***4.6.2***	Eighty Mile Beach is the closest Ramsar wetland site, located over 470 km from the Operational Area at the furthest extent of the EMBA.
Fisheries – commercial	***4.6.3***	***Operational Area*** There are a number of fisheries extending over the Operational Area; however, only the Pilbara Line Fishery and West Australian Mackerel Managed Fishery are expected to be active within the Operational Area: • Commonwealth fisheries are: – Western Tuna and Billfish Fishery – Western Skipjack Fishery – Southern Bluefin Tuna Fishery. • State fisheries are: – West Australian Mackerel Fishery – Pearl Oyster Managed Fishery, Pearl Leases – Beche-de-mer Fishery – Marine Aquarium Managed Fishery – Specimen Shell Managed Fishery – Pilbara Demersal Scalefish Fisheries (Pilbara Trawl, Trap and Line) – Onslow Prawn Managed Fishery. • There are no aquaculture activities within or adjacent to the Operational Area. ***Wider EMBA*** • Commonwealth fisheries are: – North West Slope Trawl Fishery – Western Deepwater Trawl Fishery.

	Sensitive receptor	EP section	Description
			• State fisheries are: – Nickol Bay Prawn Managed Fishery – Exmouth Gulf Prawn Fishery – Gascoyne Demersal Scalefish Fishery – Shark Bay Prawn and Scallop Managed Fisheries – Shark Bay Blue Swimmer Crab Fishery – Abalone Fishery – West Coast Rock Lobster Fishery – West Coast Demersal Scalefish Fisheries – Octopus Fishery – West Coast Deep Sea Crustacean Managed Fishery. • Aquaculture operations are typically restricted to coastal shallow waters and primarily consist of pearl oyster production at the Montebello Islands.
	Fisheries – traditional	***4.6.4***	***Operational Area*** • There are no traditional or customary fisheries within or adjacent to the offshore Operational Area. ***Wider EMBA*** • Traditional fisheries are typically restricted to shallow coastal waters and/or areas with structures such as reef. • Barrow Island, Montebello Islands and Ningaloo Reef and the adjacent foreshores have a known history of fishing, when areas were occupied (as identified from historical records). • Areas covered by registered native title claims are likely to practice Aboriginal fishing techniques at various sections of the WA coastline.
	Tourism	***4.6.5***	***Operational Area*** • No tourism activities are known to take place specifically within the Operational Area due to water depths and distance offshore. ***Wider EMBA*** • Recreational fishing occasionally occurs at Rankin Bank and Glomar Shoals and is also expected to occur around the Montebello/Barrow/Lowendal Islands Group and the Pilbara Southern Islands Group (including the Mackerel Islands). • The Montebello Islands, Ningaloo Marine Park and Shark Bay World Heritage area are popular for marine nature-based tourist activities.

<table>
<tr><th></th><th>Sensitive receptor</th><th>EP section</th><th>Description</th></tr>
<tr><td></td><td>Shipping</td><td>4.6.6</td><td>Operational Area
• No Australian Maritime Safety Authority (AMSA) shipping fairways pass through the Operational Area.
• AMSA data indicates light shipping traffic within the Operational Area.
Wider EMBA
• The coastal and offshore waters of the region support significant commercial shipping activity, the majority of which is associated with the mining and oil & gas industries.
• Major shipping routes are associated with entry to the ports of Port Hedland, Dampier and Barrow Island.</td></tr>
<tr><td></td><td>Oil & gas and other infrastructure</td><td>4.6.7</td><td>Operational Area
• The Operational Area is located within an area of established oil and gas operations, including subsea infrastructure associated with the Brunello field development located within the north end of the Operational Area.
Wider EMBA
• The Pluto Platform and the Wheatstone Platform are located 16 km and 20 km from the Operational Area respectively.
• John Brookes Platform, Goodwyn Facility, East Spar Platform and North Rankin Complex are between 29 and 108 km from the Operational Area.</td></tr>
<tr><td></td><td>Defence</td><td>4.6.8</td><td>Operational Area
• The Operational Area overlaps with the northern tip of one of the Department of Defence’s practice areas.
Wider EMBA
• There are designated defence practice areas in the offshore marine waters off Ningaloo and the North West Cape.</td></tr>
<tr><td rowspan="2">Protected Areas</td><td colspan="3">The following Protected Areas and sites of high conservation value are located within the Operational Area</td></tr>
<tr><td>Protected Areas within the Operational Area</td><td>4.7.1</td><td>Continental Slope Demersal Fish Communities
• The continental slope demersal fish communities are a KEF due to the notable diversity of the demersal fish assemblages and high levels of endemism.
Ancient Coastline at the 125 m Depth Contour KEF
• The ancient coastline is defined as the depth range 115–135 m in the North West Shelf Province and NWS Transition provincial bioregions as illustrated in Figure 4-18. The ancient coastline is a unique seabed feature that provides areas of enhanced biological productivity. Parts of the ancient coastline, represented as rocky escarpment, are considered to provide biologically important habitat in an area predominantly made up of soft sediment.</td></tr>
</table>

	Sensitive receptor	EP section	Description
	The following Protected Areas and sites of high conservation value are located outside of the Operational Area and are considered due to the extent of the wider EMBA:		
	Montebellos/ Barrow/Lowendal Islands	***4.7.2*** ***4.7.3***	Protected areas in this locality include: • Montebello Australian Marine Park (AMP) (see **Section 4.7.2**) • Montebello Islands Marine Park/Barrow Island Marine Park/Barrow Island Marine Management Area • Barrow Island Nature Reserve • Lowendal Islands Nature Reserves.
	Pilbara Islands	***4.7.4***	Protected areas in this locality include: • Pilbara Islands (Northern Group) • Pilbara Islands (Southern Group).
	Ningaloo Coast and Gascoyne	***4.7.5***	Protected areas in this locality include: • Ningaloo Coast World Heritage Area • Ningaloo AMP • Ningaloo Marine Park and Muiron Island Marine Park and Management Area • Gascoyne AMP.
	Rowley Shoals	***4.7.7***	Protected areas in this locality include: • Argo-Rowley Terrace AMP (the EMBA does not overlap with the three coral atolls that make up the Rowley Shoals).
	Shark Bay	***4.7.8***	Protected areas in this locality include: • Shark Bay World Heritage Area • Shark Bay AMP.
	Abrolhos Islands	***4.7.9***	Protected areas in this locality include: • Abrolhos Islands AMP.
	Carnarvon Canyon	***4.7.10***	Protected areas in this locality include: • Carnarvon Canyon AMP.

	Sensitive receptor	EP section	Description
	Key ecological features	***4.7.11***	KEFs within the Operational Area include: • continental slope demersal fish communities • ancient coastline at the 125 m depth contour. KEFs within the EMBA include: • Exmouth Plateau • Glomar Shoals • canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula • Commonwealth waters adjacent to Ningaloo Reef • Mermaid Reef and Commonwealth waters surrounding Rowley Shoals • canyons linking the Argo Abyssal Plain with the Scott Plateau • Wallaby Saddle • western demersal slope and associated fish communities of the Central Western Province.
	Other sensitive areas	***4.7.12***	Other sensitive areas within the wider EMBA include: • Rankin Bank.

4.3 Regional Context

The Operational Area is located in Commonwealth waters within the North West Shelf, in water depths of about 130–290 m. The Operational Area is located on the border of the NWS Province and Northwest Province (**Figure 4-1)** as defined under the Integrated Marine and Coastal Regionalisation of Australia (IMCRA v4.0). Both Provinces are part of the wider North West Marine Region. The North West Shelf Province encompasses the continental shelf between North West Cape and Cape Bougainville and varies in width from about 50 km at Exmouth Gulf to greater than 250 km off Cape Leveque. It includes water depths of 0–200 m (Department of the Environment, Water, Heritage and the Arts (DEWHA), 2008). The Northwest Province encompasses Commonwealth waters of the continental slope between Exmouth and Port Hedland, covering 16.7% of the North West Marine Region at depths predominantly between 1000 and 3000 m.

The North West Shelf Province is characterised by the following biophysical features (DEWHA, 2008):

- Transitional climatic conditions occur between dry tropics to the south and humid tropics to the north.
- There are strong seasonal winds and moderate offshore tropical cyclone activity.
- Deeper surface waters are tropical year-round and highly stratified during summer months (thermocline occurring at water depths between 30 and 60 m). In winter, surface waters are well mixed with thermoclines occurring at about 120 m depth.
- Surface ocean circulation is strongly influenced by the Indonesian Throughflow via the Eastern Gyre. During the summer when the ITF is weaker, south-west winds cause intermittent reversals in currents. These events may be associated with occasional weak, shelf upwellings.
- The seabed in the region consists of sediments that generally become finer with increasing water depth, ranging from sand and gravels on the continental shelf to mud on the slope and abyssal plain. About 60–90% of the sediments in the region are carbonate derived (Brewer et al., 2007). The distribution and resuspension of sediments on the inner shelf is strongly influenced by the strength of tides across the continental shelf as well as episodic cyclones. Further offshore, on the mid to outer shelf and on the slope, sediment movement is primarily influenced by ocean currents and internal tides, the latter causing resuspension and net downslope deposition of sediments.
- The region has high species richness but a relatively low level of endemism, i.e. species particular to the region in comparison to other areas of Australian waters. Furthermore, the majority of the region's species are tropical and are recorded in other areas of the Indian Ocean and Western Pacific Ocean.
- Benthic communities within the region range from nearshore benthic primary producer habitats such as seagrass beds, coral communities and mangrove forests to offshore soft sediment seabed habitats associated with low density sessile and mobile benthos such as sponges, molluscs and echinoids (with noted areas of sponge hotspot diversity).
- Presence of internationally significant migratory routes, resident populations, breeding and/or feeding grounds for a number of EPBC Act listed threatened and migratory marine species, including humpback whales, marine turtles, whale sharks, seabirds and migratory shorebirds.

The Northwest Province is characterised by the following biophysical features (DEWHA, 2008):

- Cyclone frequency and intensity increases in summer.
- The ITF is the dominant surface flow within the bioregion, which is influenced by seasonal and inter-annual variations described above.
- Narrowing of the continental shelf at North West Cape consolidates southward moving surface waters and begins the Leeuwin Current. The Leeuwin Current is 50–100 km wide and less than 300 m deep, and is undercut by the Leeuwin Undercurrent which flows northward between 250 and 450 m deep.
- The Exmouth Plateau is the largest topographic feature of this bioregion, covering an area of 50,000 km² (Baker et al., 2008). The surface of the plateau is generally rough and undulating with water depths of about 500–5000 m, and is thought to modify the flow of deep waters and potentially uplift deep nutrient-rich waters to the surface. (Brewer et al., 2007).
- The North West Cape is a boundary point for a transition in demersal shelf and slope fish communities, with temperate communities to the south and tropical dominated communities to the north (Last et al., 2005).
- The Montebello Trough occurs on the eastern side of the Exmouth Plateau and represents more than 90% of the area of troughs in the NWMR (Baker et al., 2008).
- With over 500 fish species, 76 of which are endemic, the continental slope between the North West Cape and the Montebello Trough has been identified as one of the most diverse slope habitats of Australia.
- Benthic communities likely include filter feeders and epifauna, such as sea cucumbers, ophiuroids, echinoderms, polychaetes and sea-pens. These epibenthos are likely to have a patchy distribution across soft-bottom environments within the region.
- Internationally significant migratory routes, resident populations, breeding and/or feeding grounds for a number of EPBC Act listed Threatened and Migratory marine species are present, including humpback whales, marine turtles, whale sharks, seabirds and migratory shorebirds.
- Other NWMR bioregions within the wider EMBA include the Northwest Transition, Central Western Transition, the Central Western Shelf Transition and the Central Western Shelf Province.

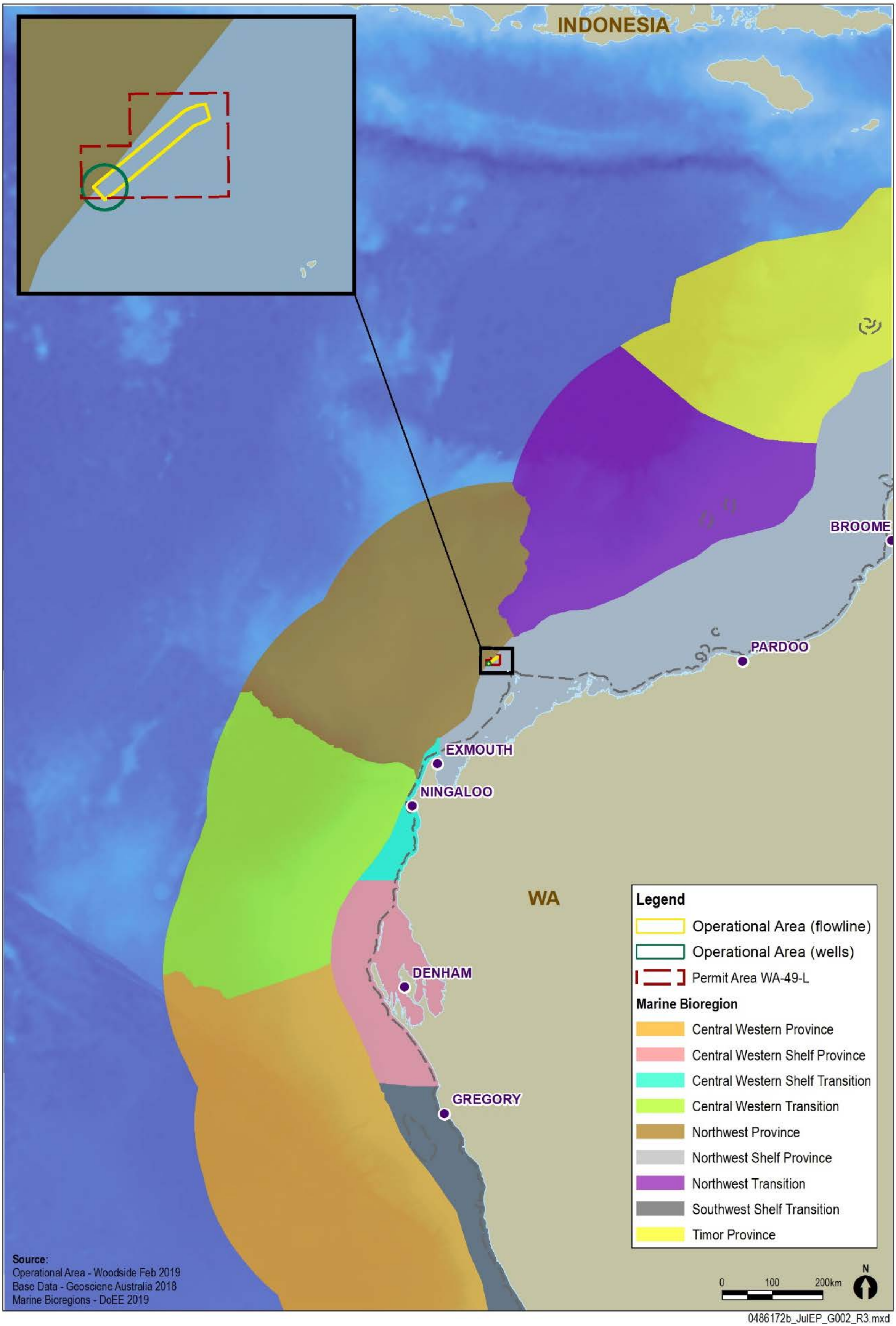


Figure 4-1: North West Marine Region and the location of the Operational Area

4.4 Physical Environment

4.4.1 Climate and Meteorology

4.4.1.1 Seasonal Patterns

The climate of the NWMR is dry tropical, exhibiting a hot summer season from October to April and a milder winter season between May and September (**Figure 4-2**) (Bureau of Meteorology (BoM), 2012). There are often distinct transition periods between the summer and winter regimes, which are characterised by periods of relatively low winds (Pearce et al., 2003).

Air temperatures in the region, as measured at the North Rankin A platform (about 107 km from the Operational Area), indicate maximum average temperatures during summer of 39.5 ºC and minimum temperatures of 15.6 ºC in winter (BoM, 2012; Woodside, 2012).

The region experiences a tropical monsoon climate, with distinct wet (October to April) and dry (May to September) seasons (Pearce et al., 2003). Rainfall in the region typically occurs during the wet season (summer), with highest falls observed during late summer (BoM, 2012), often associated with the passage of tropical low pressure systems and cyclones (Pearce et al., 2003). Rainfall outside of this period is typically low.

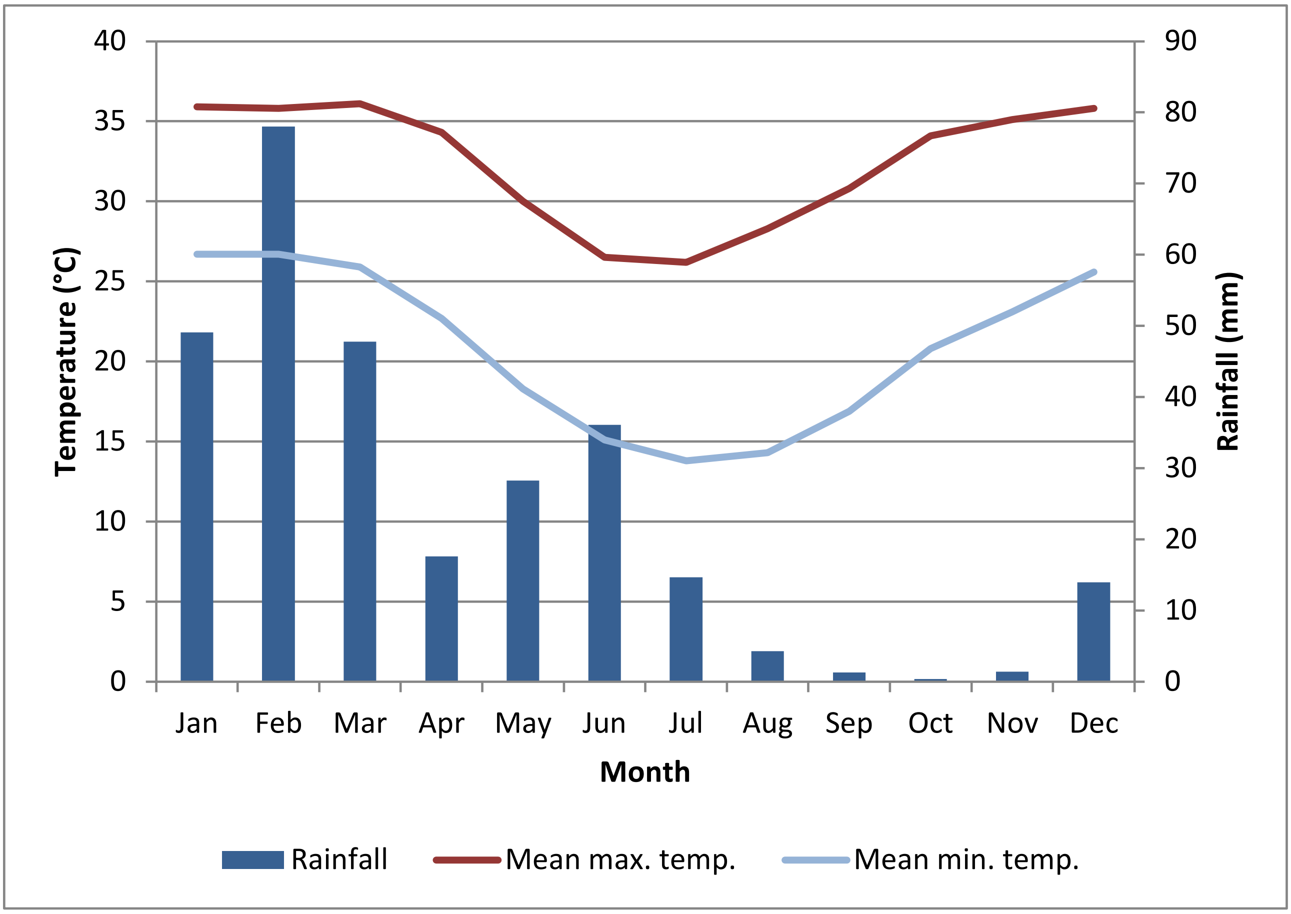


Figure 4-2: Mean monthly maximum temperature, minimum temperature and rainfall from Karratha Aerodrome meteorological station from January 1993 to June 2017 (BoM n.d.)

4.4.1.2 Wind

Winds vary seasonally, with a tendency for winds from the south-west quadrant during summer and the south-east quadrant in winter (**Figure 4-3**). The summer south-westerly winds are driven by high pressure cells that pass from west to east over the Australian continent. During winter months, the relative position of the high pressure cells moves further north, leading to prevailing south-easterly winds blowing from the mainland (Pearce et al., 2003). Winds typically weaken and are more variable during the transitional period between the summer and winter regimes, generally between April and August (**Figure 4-3**).

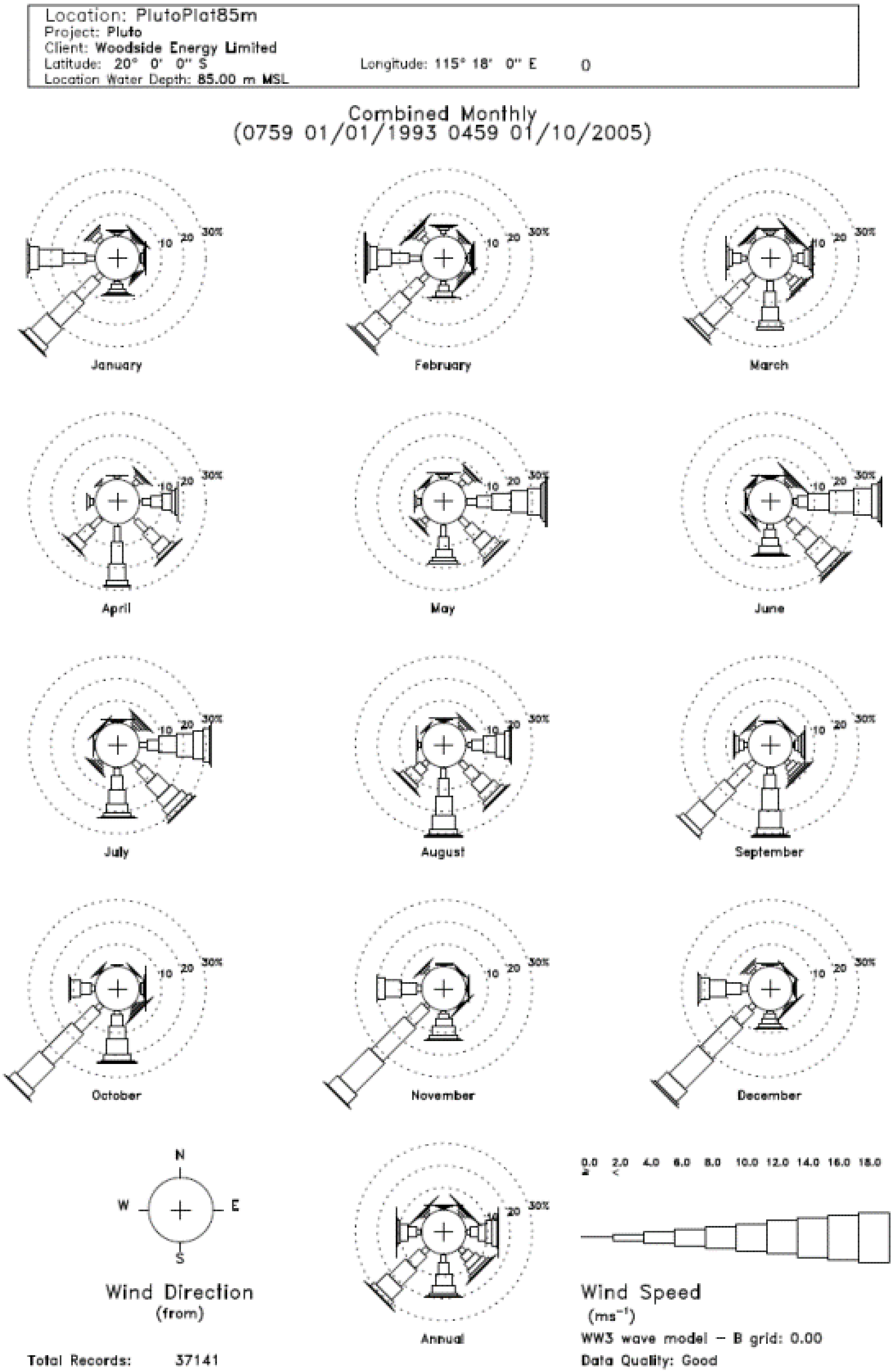


Figure 4-3: Non-cyclonic monthly wind-roses measured at the Pluto Facility location from 1993 to 2005

4.4.1.3 Tropical Cyclones

Tropical cyclones are a relatively frequent event for the region (**Figure 4-4**), with the Pilbara coast experiencing more cyclonic activity than any other region of the Australian mainland coast (BoM, 2012). Tropical cyclone activity can occur between November and April and is most frequent in the region during January to March, with an annual average of about one storm per month. Cyclones are less frequent in the months of November, December and April but historically the worst storms have occurred in April.

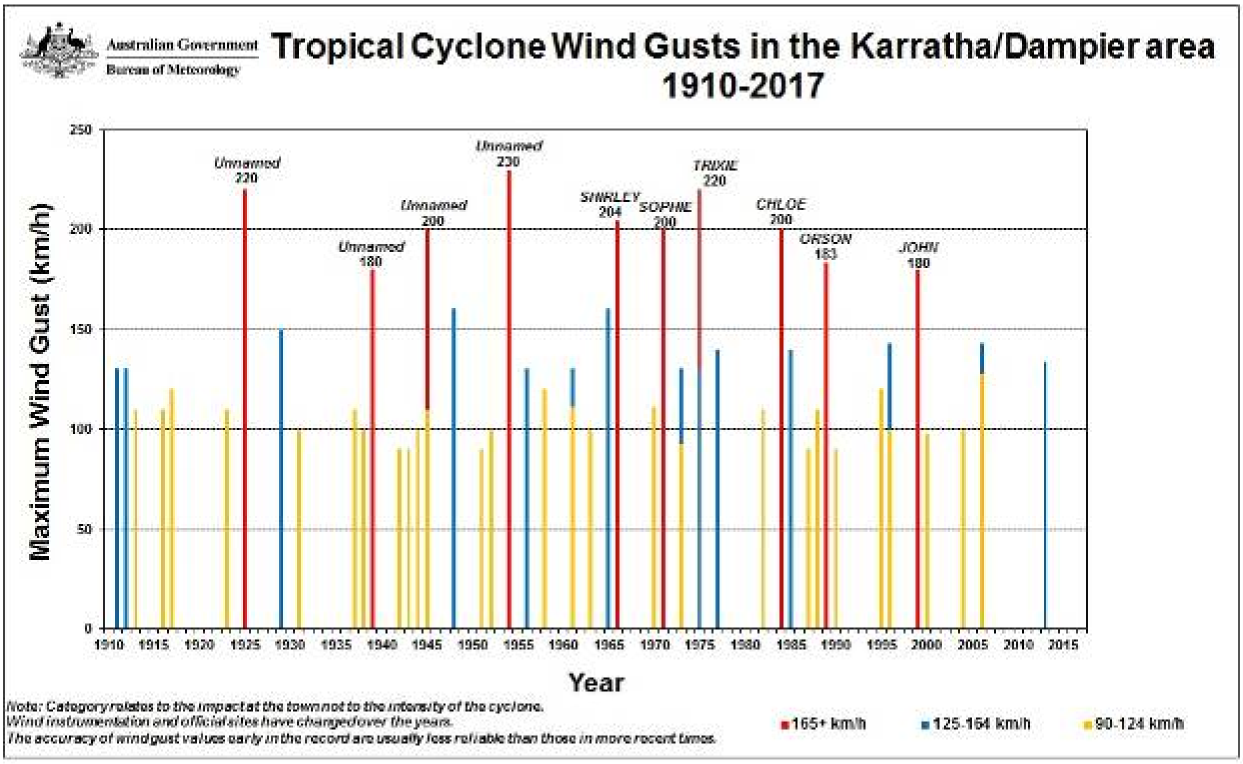


Figure 4-4: Tropical cyclone activity in the Dampier/Karratha region, 1910–2017 (source: BoM, n.d.)

4.4.2 Oceanography

4.4.2.1 Currents and Tides

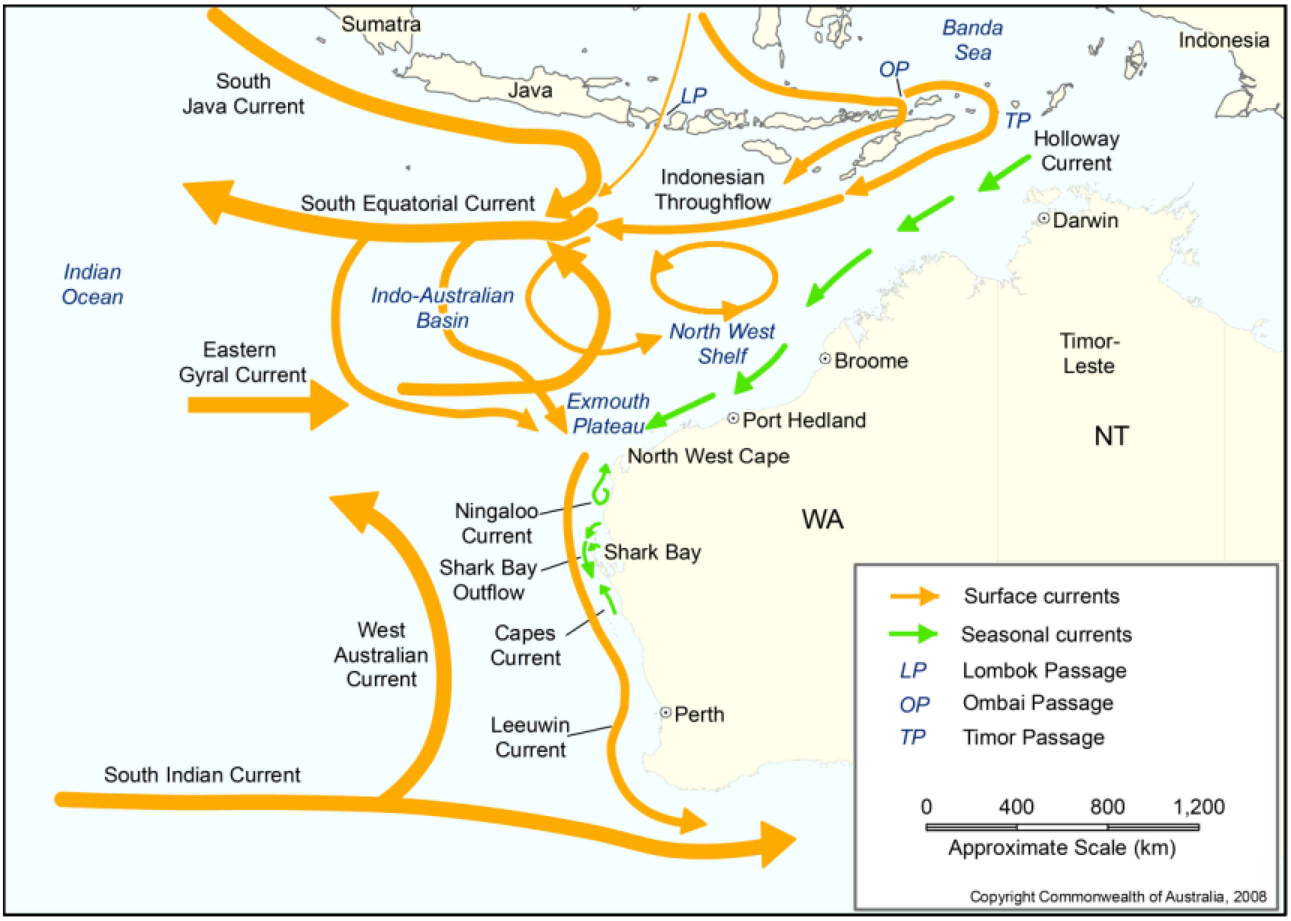
The large-scale ocean circulation of the region is primarily influenced by the Indonesia Throughflow (Meyers et al., 1995; Potemra et al., 2003), and the Leeuwin Current (Godfrey & Ridgway, 1985; Holloway & Nye, 1985; Batteen et al., 1992; James et al., 2004) (**Figure 4-5**). Both of these currents are significant drivers of the region’s ecosystems. The currents are driven by pressure differences between the equator and the higher density cooler and more saline waters of the Southern Ocean, strongly influenced by seasonal change and El Niño and La Niña episodes (Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC), 2012a). The ITF and Leeuwin Current are strongest during late summer and winter (Holloway & Nye, 1985; James et al., 2004). Flow reversals to the north-east associated with strong south-westerly winds are typically weak and short lived, but can generate upwelling of cold deep water onto the shelf (Holloway & Nye, 1985; James et al., 2004; Condie et al., 2006).

The Leeuwin Current, which originates in the region, flows southward along the edge of the continental shelf and is primarily a surface flow (up to 300 m deep). It is strongest during winter (Woodside, 2002). The Ningaloo Current flows in the opposite direction to the Leeuwin Current, running northward along the outside of Ningaloo Reef and across the inner shelf from September to mid-April (**Figure 4-5**). In March, on the termination of the Northwest Monsoon, an ‘extended

Leeuwin Current', currently known as the Holloway Current, develops, flowing to the south-east along the NWS (DSEWPaC, 2012a).

In addition to the synoptic-scale current dynamics, tidally-driven currents are a significant component of water movement along the NWS. Wind-driven currents become dominant during the neap tide (Pearce et al., 2003). In summer, the stratified water column and large tides can generate internal waves over the upper slope of the NWS (Craig, 1988). As these waves pass the shelf break at about 125 m depth, the thermocline may rise and fall by up to 100 m in the water column (Holloway & Nye, 1985; Holloway, 1983). Internal waves of the NWS region are confined to water depths between 70 and 1000 m; the dissipation energy from such waves can enhance mixing in the water column (Holloway et al., 2001).

Tides in the NWS region are semi-diurnal and have a pronounced spring-neap cycle, with tidal currents flooding towards the south-east and ebbing towards the north-west (Pearce et al., 2003). The region exhibits a considerable range in tidal height, from microtidal ranges (<2 m) south-west of Barrow Island to macrotidal (>6 m) north of Broome (Holloway, 1983; Brewer et al., 2007). Storm surges and cyclonic events can also significantly raise sea levels above predicted tidal heights (Pearce et al., 2003).



Source: DEWHA (2008)

Figure 4-5: Generalised schematic of ocean circulation for the wider Western Australian Marine Region

4.4.2.2 Wave Height

Datawell waverider buoys measured wave height from 1993 to 2005 near the Pluto Platform (16 km from the Operational Area), recording a maximum measured non-cyclonic significant wave height of 6.2 m and a combined non-cyclonic and cyclonic maximum wave height of 11.4 m (Woodside, 2007).

Waves within the NWS reflect the direction of the synoptic winds and flow predominantly from the south-west in the summer and from the east in winter (Pearce et al., 2003). Only 10% of significant wave heights off Dampier exceed 1.2 m, with the average wave height being 0.7 m (Pearce et al., 2003). Storms and cyclones may generate swells up to 8.0 m high (Pearce et al., 2003).

4.4.3 Seawater Characteristics

4.4.3.1 Open Water

Seawater temperature records at the Pluto Platform (16 km from the Operational Area) over a period of 13 months from December 2005 to January 2007 show surface waters reach their maximum average temperatures in March and April (average about 28.5 °C) and are coolest in August, September and October (average about 24.3 °C). These temperatures are also reflected in more recent publicly available data (National Oceanic and Atmospheric Administration (NOAA), 2019a).

The offshore oceanic seawater characteristics of the NWS exhibit seasonal and water depth variation in temperature and salinity, being greatly influenced by major currents in the region (see **Section 4.4.2**). Surface waters are relatively warm year round due to the tropical water supplied by the ITF and the Leeuwin Current, with temperatures reaching 30 °C in summer and dropping to 22 °C in winter (Pearce et al., 2003). Near seabed temperatures in deeper waters within the Operational Area range from about 22 °C in depths of 130 m to 13 °C at 290 m (NOAA, 2019). Near seabed, temperatures have low interannual variability, changing by ±1.5 °C at depths of 150 m, and become more stable with increasing depth.

During summer, the water column is thermally stratified due to surface heating, with the thermocline occurring between 30 and 60 m water depth (James et al., 2004). Surface waters are relatively well mixed in winter due to a weaker thermal gradient and persistent south-easterly winds promoting mixing, with the thermocline occurring at around 120 m depth (DEWHA, 2008; James et al*.,* 2004).

Variation in surface salinity along the NWS throughout the year is minimal (between 35.2 and 35.7 PSU), with slight increases occurring during the summer months due to intense coastal evaporation (Pearce et al., 2003; James et al., 2004). This small increase in salinity during summer is then countered by the arrival of the lower salinity waters of the Leeuwin Current and ITF in autumn and winter (James et al., 2004). This is also reflected in more recent publicly available data (NOAA, 2019b).

Turbidity is primarily influenced by sediment transported by oceanic swells and primary productivity (Semeniuk et al., 1982; Pearce et al., 2003). Upwelling of nutrient-rich waters may increase phytoplankton productivity in the photic zone, which may increase local turbidity (Semeniuk et al., 1982; Wilson et al., 2003). In nearshore areas, turbidity is highly variable due to storm runoff, wind-generated waves and large tidal ranges (Pearce et al., 2003). Periodic events, such as major sediment transport associated with tropical cyclones, may influence turbidity on a regional scale (Brewer et al., 2007).

Water quality in the NWMR within the wider EMBA is regulated by the ITF, a low-salinity water mass that plays a key role in initiating the Leeuwin Current (DSEWPaC, 2012a). It brings warm, low-nutrient, low-salinity water from the western Pacific Ocean through the Indonesian archipelago to the Indian Ocean. It is the primary driver of the oceanographic and ecological processes in the region (DEWHA, 2008). South of the NWMR, the Leeuwin Current continues to bring warm, low-nutrient, low-salinity water further south. Eddies formed by the Leeuwin Current transport nutrients and plankton communities offshore (DEWHA, 2008). During summer, the Leeuwin Current typically weakens and the Ningaloo Current develops, facilitating upwellings of cold, nutrient-rich waters up onto the NWS (DSEWPaC, 2012a). Other areas of localised upwelling in the NWMR include the Wallaby Saddle and Exmouth Plateau, where these seabed topographical features force the surrounding deeper, cooler, nutrient-rich waters up into the photic zone (DSEWPaC, 2012a).

4.4.4 Bathymetry and Seabed Habitats

The Operational Area is located in waters about 130–290 m deep on the middle continental shelf. The Operational Area occupies a very small portion of the NWMR and contains no significant geomorphic features. The bathymetry within the Operational Area is characterised by relatively flat and featureless seabed sloping toward the north-west of the Operational Area (**Figure 4-6**). The water depth increases from about 130 m in the north-east end of the Operational Area to 290 m, north-west of the manifold location.

Within the broader NWMR, the North West Shelf Province encompasses more than 60% of the continental shelf in the NWMR (Baker et al., 2008), gradually sloping from the coastline to the shelf break at the edge of the region and includes water depths of 0–200 m. About half of the province is in water depths of 50–100 m (DEWHA, 2008). The North West Shelf Province includes a number of seafloor features such as submerged banks and shoals, and valley features that are thought to be morphologically distinct from other features of these types in different regions of the NWMR (DEWHA, 2008). The Northwest Province covers 16.7% of the NWMR, occurring entirely on the continental slope at depths predominantly between 1000 and 3000 m. Topographic features include terraces, canyons, deep holes and valleys on the inner slope, and the Exmouth Plateau.

Within the wider EMBA, the bathymetry of the NWMR is characterised by four distinct zones: the inner continental shelf, the middle continental shelf, the outer shelf/continental slope and the abyssal plain. These divisions are made on the basis of water depth and geomorphic features in the region (Heap & Harris, 2008). The inner continental shelf is the area from the coast to about 30 m water depth; the middle continental shelf is the area between 30 and 120 m water depth. Several deep-sea geomorphic features in the form of abyssal plains, marginal plateaus and sub-marine canyons provide broad-scale, biologically important seabed habitat in the wider EMBA. These have been defined as KEFs by the Commonwealth Government, and are described in **Section 4.7.11**.

Several steps and terraces caused by Holocene sea level changes are present in the NWMR, with the most prominent of these features occurring as an escarpment along the North West Shelf and Sahul Shelf at a depth of 125 m. This escarpment is related to an ancient sub-aerially exposed land surface and coastline (beach and dune deposits), known as the ancient coastline. The ancient coastline at the 125 m depth contour is designated as a KEF and overlaps the north-eastern extent of the Operational Area. A description of the Ancient Coastline KEF is provided in **Section 4.7.1**. Rankin Bank is the next closest complex bathymetry feature to the Operational Area (about 45 km north-east).

Previous movements in sea-level have had a significant influence on the geology of the Operational Area, as well as the regional NWS area. Between 21,000 and 19,000 years Before Present, the sea level was about 120 to 125 m lower than present day, due to glacio-eustatic (ice equivalent) sea level changes (Lewis et al., 2013). Therefore, the processes responsible for the formations present in the region include sub-aerial exposure of sediment and processes associated with land and coastal environments. Across the NWS region, the occurrence of an undulating cemented surface, expressed at the seabed as a series of ridges interspersed with sediment ponds infilling hollows and troughs, is related to an ancient sub-aerially exposed land surface and coastline (beach and dune deposits). Other coastal features including sand bars and river outlets are also present in this region, complicating the geology and geological sequence adjacent (seaward) to the area of ridges.

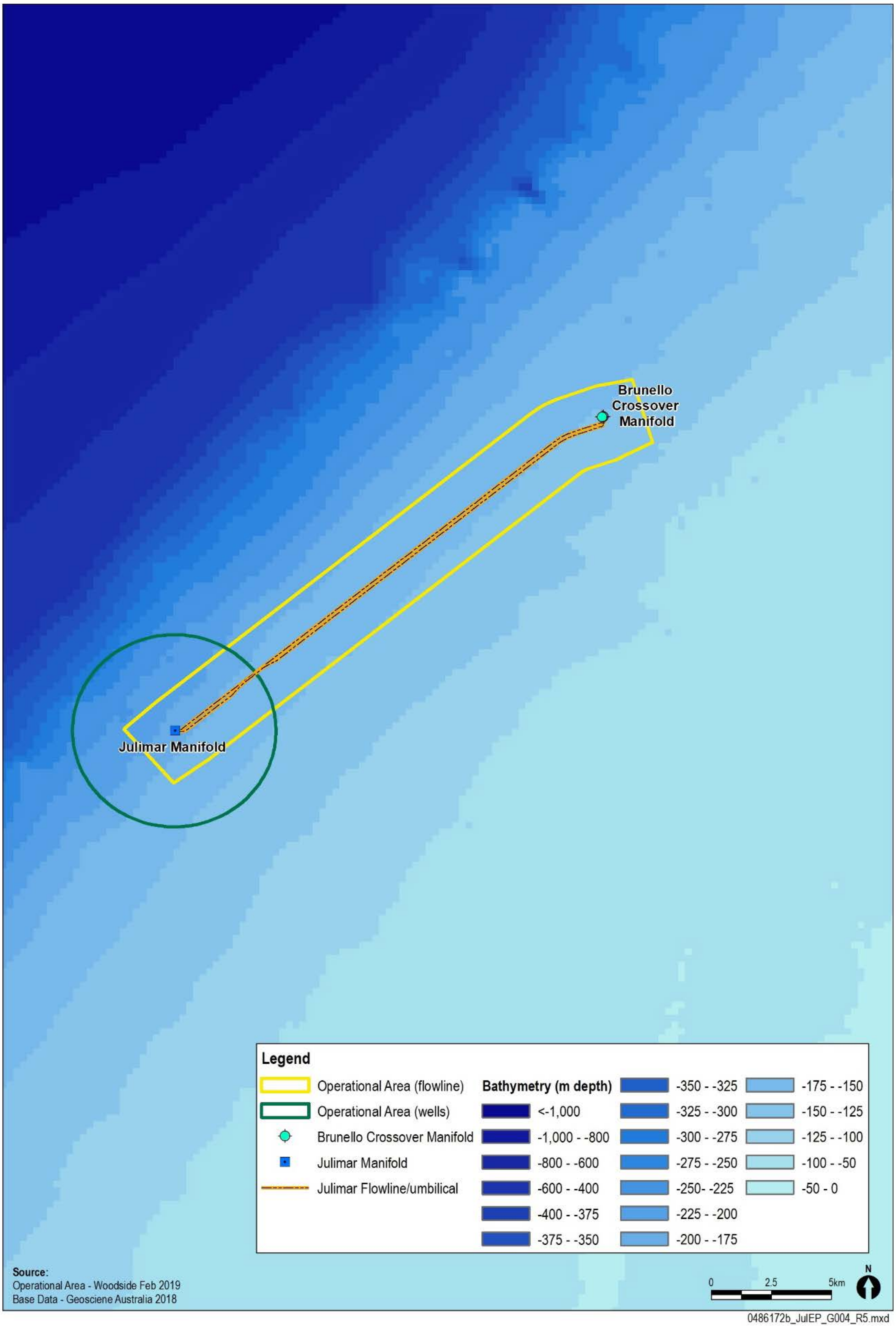


Figure 4-6: Seabed topography of the Operational Area

4.4.4.1 Marine Sediment

A benthic survey conducted as part of the Julimar Operations EP (directly adjacent to the Operational Area) found that the area is dominated by soft sediment (fine to coarse sands) (Neptune Geomatics, 2010; RPS, 2010a, 2011a), similar to previous surveys within the North West Shelf Province and nearby fields at similar water depths (RPS et al., 2004; Chevron 2005, 2010; RPS 2010b, 2011b). Seabed relief in areas of bare sediment consisted mainly of 'small ripples' less than 0.1 m high, which is consistent with tidally-driven bottom currents. Sediments at the nearby Balnaves field, about 6 km north of the Operational Area and in 135 m water depth, are fine silt and mud (RPS, 2011b). Sediments in the area of the Wheatstone Platform, about 21 km north-east of the Operational Area and in 70–250 m water depths, are fine to medium sands with shell and coral fragments (Chevron, 2010).

Sediments of the NWMR (and within the wider EMBA) are comprised of bio-clastic, calcareous and organogenic sediments (Baker et al., 2008). On the continental shelf, sediment is primarily sand and gravels, while the slope and deep ocean seabed is primarily mud.

4.4.5 Air Quality

There is a lack of air quality data for the offshore NWS air shed. Studies have been undertaken for the nearshore Pilbara environment to monitor known sources of potential air pollution for locations such as the Burrup Peninsula and Port Hedland, but no monitoring is undertaken offshore.

Due to the extent of the open ocean area and the activities that are currently performed, the ambient air quality in the Operational Area and wider offshore region is considered to be of high quality.

4.5 Biological Environment

4.5.1 Habitats

4.5.1.1 Critical Habitat – EPBC Listed

No Critical Habitats or Threatened Ecological Communities as listed under the EPBC Act are known to occur within the Operational Area or EMBA, as indicated by the EPBC Act Protected Matters Report produced on 11 February 2019 (**Appendix C**).

4.5.1.2 Marine Primary Producers

Sea floor communities in deeper shelf waters receive insufficient light to sustain ecologically sensitive primary producers such as seagrasses, macroalgae or reef-building corals. Given the depth of water at the Operational Area (about 130–290 m), these benthic primary producer groups will not occur in the area. A number of surveys (Neptune Geomatics, 2010; RPS, 2010a, 2011a) near the Operational Area and in similar water depths have confirmed that benthic primary producer habitat is not present.

A number of benthic primary producer habitats are present in the wider EMBA and are described in the next sections.

Coral Reef

Coral reef habitats have a high diversity of corals and associated fish and other species of both commercial and conservation importance. Coral reef habitats are an integral part of the marine environment within the NWMR. The nearest coral reef habitat to the Operational Area is located at Rankin Bank, about 48 km north-east. Other coral reef habitats in the wider EMBA include Montebello/Barrow/Lowendal Islands Group, Glomar Shoals, Muiron Islands, Ningaloo Coast and

Shark Bay. Further information on coral reef habitats at these locations is provided in **Section 4.7.1** to **Section 4.7.12**.

Seagrass Beds/Macroalgae

Seagrass beds and macroalgae habitats represent a food source for many marine species and also provide key habitats and nursery grounds (Department of Fisheries (DoF), 2011b).

Seagrass beds and macroalgae habitats are present in several locations within the North West Shelf Province. The nearest to the Operational Area, and within the wider EMBA, are about 50 km south-east at the Montebello/Barrow/Lowendal Islands Group, where macroalgae is the dominant macrophyte and occupies about 40% of the benthic habitat cover (Marine Parks and Reserves Authority (MPRA), 2007). Seagrass beds and macroalgae habitat can also be found in the wider EMBA at some islands within the Dampier Archipelago, Northern and Southern Pilbara Island Groups, the Muiron Islands, Ningaloo Coast and Shark Bay.

Further information on seagrass and macroalgal habitats at these locations is provided in **Section 4.7.1** to **Section 4.7.12**.

Mangroves

Mangrove systems provide complex structural habitats that act as nurseries for many marine species as well as nesting and feeding sites for many birds, reptiles and insects. Mangroves also maintain sediment, nutrient and water quality within habitats and minimise coastal erosion.

The closest mangrove habitats to the Operational Area are located at the Montebello/Barrow/ Lowendal Islands Group, about 45 km to the south east. Mangrove communities of the Montebello Islands are considered scientifically important, representing an unusual occurrence of mangrove communities within lagoons on offshore islands (Chevron, 2013). Other mangrove habitats associated with the wider EMBA include the Dampier Archipelago, Ningaloo Coast, Shark Bay and Eighty Mile Beach.

Further information on locations with mangrove habitats is provided in **Section 4.7.1** to **Section 4.7.12**.

4.5.1.3 Lifecycle Stages 'Critical' Habitats

Spawning, Nursery, Resting and Feeding Areas

Critical habitat for species conservation include spawning, nursery, resting and feeding areas. These critical habitats will vary for each species. Any critical habitat for a protected species within the Operational Area, as identified by the EPBC Protected Matters Searches (**Appendix C**), is outlined in **Section 4.5.2** within the relevant species sections, or described in **Section 4.7.1** to **Section 4.7.12**.

Migration Corridors

Many marine species including cetaceans, whale sharks and migratory seabirds and shorebirds migrate seasonally between feeding, breeding and nursery habitats by using migration corridors. Any migration corridor for a protected species that passes through or close to the Operational Area, or within other areas close by, is outlined in **Section 4.5.2** within the relevant species section.

4.5.1.4 Other Communities/Habitats

Plankton

Phytoplankton within the Operational Area is generally expected to reflect the conditions of the NWMR. Primary productivity of the NWMR appears to be largely driven by offshore influences (as reported by Brewer et al., 2007), with periodic upwelling events and cyclonic influences driving coastal productivity with nutrient recycling and advection. There is a tendency for offshore phytoplankton communities in the NWMR to be characterised by smaller taxa (e.g. bacteria), whereas shelf waters are dominated by larger taxa such as diatoms (Hanson et al., 2007).

Zooplankton within the Operational Area may include organisms that complete their lifecycle as plankton (e.g. copepods, euphausiids) as well as larval stages of other taxa such as fishes, corals and molluscs. Peaks in zooplankton such as mass coral spawning events (typically in March and April) (Rosser & Gilmour, 2008; Simpson et al., 1993b) and fish larvae abundance can occur throughout the year.

Within the wider EMBA, peak primary productivity occurs in late summer/early autumn along the shelf edge of the Ningaloo Reef. It also links to a larger biologically productive period in the area that includes mass coral spawning events, peaks in zooplankton and fish larvae abundance (MPRA, 2005) with periodic upwelling throughout the year.

Pelagic and Demersal Fish Populations

Fish species in the NWMR (including the Operational Area and the wider EMBA) comprise small and large pelagic fish, as well as demersal species. Small pelagic fish inhabit a range of marine habitats, including inshore and continental shelf waters. They feed on pelagic phytoplankton and zooplankton and represent a food source for a wide variety of predators including large pelagic fish, sharks, seabirds and marine mammals (Mackie et al., 2007). Large pelagic fish in the NWMR include commercially targeted species such as mackerel, wahoo, tuna, swordfish and marlin. Large pelagic fish are typically widespread, found mainly in offshore waters (occasionally on the shelf) and often travel extensively.

Demersal fish live and feed on or near the seabed and are associated with a wide range of habitats in the NWMR including coastal and estuarine ecosystems, macroalgal and seagrass communities, and coral reefs (Hutchins, 2001; Blaber et al., 1985). Demersal fish also include commercially important species such as groper, cod and snapper. Fish species richness has been shown to correlate with habitat complexity, with more complex habitat supporting greater species richness and abundance than bare areas (Gratwicke & Speight, 2005). Studies at Glomar Shoals and Rankin Bank found that species richness and abundance decreased with water depth, with the highest diversity found in water depths less than 40 m (AIMS, 2014). Cemented sediment outcrops that may occur within the Operational Area would provide habitat for sessile filter feeding communities and would likely provide habitat for demersal fish populations.

Recent studies in the NWMR have provided insight into fish communities associated with subsea oil and gas infrastructure, particularly pipelines and wellheads. Bond et al. (2018) used a baited remote underwater video system (BRUVS) to investigate fish associated with pipelines in the NWS at a depth of ~140 m (similar depths as the Julimar pipeline). They found that species richness was 25% higher on the pipeline compared to the surrounding seabed; relative fish abundance was nearly double on the pipeline. The surveyed pipeline was characterised by large, commercially important species known to associate with complex epibenthic habitat (Bond et al., 2018a). Similarly, a survey that spanned 23 km of pipeline at 130 m depth observed that in addition to enhanced fish communities, structurally complex epibenthic habitat forming invertebrates were present on the pipeline (mesophotic corals, crinoids, gorgonocephalids, hydroids, anemones and sponges) (Bond et al., 2018b). McLean et al. (2018) used ROVs to survey fish and habitats on wellheads. Of the surveyed depth range (78–825 m), the older, taller wellheads in depths < 135 m possessed greater abundances of groupers, snappers, site-attached reef species, and transient pelagic fish species

(McLean et al., 2018). Species richness and relative abundance decreased significantly in depths greater than 350 m.

The Continental Slope Demersal Fish Communities is a KEF that overlaps the south-west of the Operational Area and is identified as one of the most diverse slope assemblages in Australian waters (see **Section 4.7.1**). Diversity of demersal fish assemblages on the continental slope between North West Cape and the Montebello Trough is the highest in Australia (>500 species of which 76 are endemic) (DEWHA, 2008). Demersal fish species occupy two distinct demersal community types (biomes) associated with the upper continental slope (water depth of 225–500 m) and the mid continental slope (750–1000 m) 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 (Brewer et al., 2007). Higher-order consumers may include carnivorous fish, deepwater sharks, large squid and toothed whales (Brewer et al., 2007).

Within the wider EMBA, Rankin Bank and Glomar Shoals (40 km north-east and 170 km north-east from the Operational Area, respectively) are the closest areas identified as supporting high demersal fish richness and abundance despite their isolated locations. The fish communities at Rankin Bank and Glomar Shoals are comparable to other shoals and reef locations within the NWMR (AIMS, 2014). Further information on the fish communities of Rankin Bank and Glomar Shoals is provided in **Section 4.7.1** and **Section 4.7.11**. Key demersal fish biodiversity areas are likely to occur in other complex habitats, such as coral reefs, and therefore likely include the Montebello/Barrow/Lowendal Island Group, the Ningaloo Coast, Muiron Islands and Shark Bay.

Soft Sediments and Benthic Fauna

Benthic communities associated with the soft sediment seabed habitat within the Operational Area include fauna living within the sediments (infauna) and those living on or above the seabed (sessile and mobile epifauna). These fauna are predominantly mobile burrowing species including molluscs, crustaceans (crabs, shrimps and smaller related species), polychaetes, sipunculid and platyhelminth worms, asteroids (sea stars), echinoids (sea urchins) and other small animals.

A benthic survey conducted 6 km north of the Operational Area as part of the Balnaves Development recorded sparse (less than 5% cover) epibenthic fauna comprising occasional anemones, urchins, sea whips, sea pens, feather stars and glass sponges (RPS, 2011b). Infauna were diverse and dominated by polychaete worms and crustaceans (RPS, 2011b). Similarly, at the Pluto Platform (about 16 km from the Operational Area), sampling revealed a sparsely abundant, variable and diverse infauna community dominated by polychaetes, nemerteans, sipunculids and crustaceans (SKM, 2006). The infaunal assemblages at East Spar facilities off the west coast of Barrow Island, in 80–90 m water depth, are similarly dominated by polychaete worms and crustaceans (Chevron, 2005). Video surveys of the benthic habitats found similar sparse epibenthic communities to those reported in the sampling for the Balnaves Development in proximity to the Operational Area.

These results support the findings of other NWS sampling programs, which indicate a widespread and well represented infauna assemblage along the continental shelf and upper slopes (Rainer, 1991; Le Provost et al., 2000; Woodside, 2004; Brewer et al., 2007; RPS, 2012a). Additionally, it is expected that these infauna communities will be widely represented within the wider EMBA.

Small areas of cemented sediments (which can also be described as limestone pavement with a sand veneer) have been recorded during seabed surveys in various locations throughout the NWS (AIMS, 2014). Such habitat may be in the Operational Area and could provide habitat for sessile filter feeding communities comprising gorgonians (sea whips and fans) and sponges. Such areas support a higher diversity and abundance of epifauna (including mobile invertebrates such as crustacea and echinoderms) and fishes as compared to soft sediment habitats (RPS, 2011a).

4.5.2 Protected Species

The EPBC Act Protected Matters Search Tool was used to identify listed species under the EPBC Act that may occur within and adjacent to the Operational Area. The results of the search inform the assessment of planned events as well as unplanned events in **Section 6** that are confined to the Operational Area. It should be noted that the EPBC Act Protected Matters Search Tool is a general database that conservatively identifies areas in which protected species have the potential to occur.

Further information about species in the wider region of the EMBA is included in **Section 4.7**; the species described in both this section and in **Section 4.7** informs the assessment of unplanned events in **Section 6** that are not confined to the Operational Area (i.e. hydrocarbon spills).

A total of 63 EPBC Act listed marine species were identified as potentially occurring within the Operational Area (**Appendix C**). Of those listed, 19 are considered threatened marine species (MNES) and 33 migratory species under the EPBC Act (**Table 4-2**).

A total of 119 EPBC Act listed marine species were identified as potentially occurring within the wider EMBA (**Appendix C**). Of those listed, 36 species within the EMBA are considered threatened marine species (MNES) and 61 migratory species under the EPBC Act (**Table 4-2**).

Table 4-2: Threatened and migratory marine species under the EPBC Act potentially occurring with the Operational Area

Species	Common Name	Threatened Status	Migratory Status	Potential Occurrence	
				Operational Area	EMBA
Mammals					
Balaenoptera musculus	Blue Whale	Endangered	Migratory	✓	✓
Megaptera novaeangliae	Humpback Whale	Vulnerable	Migratory	✓	✓
Balaenoptera borealis	Sei Whale	Vulnerable	Migratory	✓	✓
Balaenoptera physalus	Fin Whale	Vulnerable	Migratory	✓	✓
Balaenoptera edeni	Bryde's Whale	N/A	Migratory	✓	✓
Orcinus orca	Killer Whale, Orca	N/A	Migratory	✓	✓
Physeter macrocephalus	Sperm Whale	N/A	Migratory	✓	✓
Tursiops aduncus	Spotted Bottlenose Dolphin (Arafura/Timor Sea populations)	N/A	Migratory	✓	✓
Eubalaena australis	Southern Right Whale	Endangered	Migratory	x	✓
Balaenoptera bonaerensis	Antarctic Minke Whale	N/A	Migratory	x	✓
Sousa chinensis	Indo-Pacific Humpback Dolphin	N/A	Migratory	x	✓
Dugong dugon	Dugong	N/A	Migratory	x	✓
Reptiles					
Caretta caretta	Loggerhead Turtle	Endangered	Migratory	✓	✓
Chelonia mydas	Green Turtle	Vulnerable	Migratory	✓	✓
Dermochelys coriacea	Leatherback Turtle	Endangered	Migratory	✓	✓
Eretmochelys imbricata	Hawksbill Turtle	Vulnerable	Migratory	✓	✓
Natator depressus	Flatback Turtle	Vulnerable	Migratory	✓	✓
Aipysurus apraefrontalis	Short-nosed Seasnake	Critically Endangered	N/A	x	✓

Species	Common Name	Threatened Status	Migratory Status	Potential Occurrence	
				Operational Area	EMBA
Sharks, Fish and Rays					
Rhincodon typus	Whale Shark	Vulnerable	Migratory	✓	✓
Carcharius taurus	Grey Nurse Shark	Vulnerable	N/A	✓	✓
Carcharodon carcharias	Great White Shark	Vulnerable	Migratory	✓	✓
Pristis clavata	Dwarf Sawfish	Vulnerable	Migratory	✓	✓
Pristis zijsron	Green Sawfish	Vulnerable	Migratory	✓	✓
Anoxypristis cuspidata	Narrow Sawfish	N/A	Migratory	✓	✓
Isurus oxyrinchus	Shortfin Mako	N/A	Migratory	✓	✓
Isurus paucus	Longfin Mako	N/A	Migratory	✓	✓
Manta birostris	Giant Manta Ray	N/A	Migratory	✓	✓
Manta alfredi	Reef Manta Ray	N/A	Migratory	✓	✓
Lamna nasus	Porbeagle Shark	N/A	Migratory	x	✓
Avifauna					
Macronectes giganteus	Southern Giant-Petrel	Endangered	Migratory	✓	✓
Calidris canutus	Red Knot	Endangered	N/A	✓	✓
Calidris ferruginea	Curlew Sandpiper	Critically Endangered	Migratory	✓	✓
Numenius madagascariensis	Eastern Curlew	Critically Endangered	Migratory	✓	✓
Sternula nereis nereis	Australian Fairy Tern	Vulnerable	N/A	✓	✓
Anous stolidus	Common Noddy	N/A	Migratory	✓	✓
Calonectris leucomelas	Streaked Shearwater	N/A	Migratory	✓	✓
Fregata ariel	Lesser Frigatebird	N/A	Migratory	✓	✓
Calidris melanotos	Pectoral Sandpiper	N/A	Migratory	✓	✓

Species	Common Name	Threatened Status	Migratory Status	Potential Occurrence	
				Operational Area	EMBA
Pandion haliaetus	Osprey	N/A	Migratory	✓	✓
Actitis hypoleucos	Common Sandpiper	N/A	Migratory	✓	✓
Calidris acuminate	Sharp-tailed Sandpiper	N/A	Migratory	✓	✓
Diomedea amsterdamensis	Amsterdam Albatross	Endangered	Migratory	x	✓
Anous tenuirostris	Australian Lesser Noddy	Vulnerable	N/A	x	✓
Diomedea exulans	Wandering Albatross	Vulnerable	Migratory	x	✓
Limosa lapponica baueri	Bar-tailed Godwit	Vulnerable	Migratory	x	✓
Limosa lapponica menzbieri	Northern Siberian Bar-tailed Godwit	Critically Endangered	Migratory	x	✓
Macronectes halli	Northern Giant-Petrel	Vulnerable	Migratory	x	✓
Malurus leucopterus edouardi	White-winged Fairy-wren (Barrow Island)	Vulnerable	N/A	x	✓
Malurus leucopterus leucopterus	White-winged Fairy-wren (Dirk Hartog Island)	Vulnerable	N/A	x	✓
Papasula abbotti	Abbott’s Booby	Endangered	N/A	x	✓
Pterodroma mollis	Soft-plumaged Petrel	Vulnerable	N/A	x	✓
Thalassarche carteri	Indian Yellow-nosed Albatross	Vulnerable	Migratory	x	✓
Thalassarche cauta cauta	Tasmanian Shy Albatross	Vulnerable	Migratory	x	✓
Thalassarche cauta steadi	White-capped Albatross	Vulnerable	Migratory	x	✓
Thalassarche impavida	Campbell Albatross	Vulnerable	Migratory	x	✓
Thalassarche melanophris	Black-browed Albatross	Vulnerable	Migratory	x	✓
Apus pacificus	Fork-tailed Swift	N/A	Migratory	x	✓
Ardenna carneipes	Flesh-footed Shearwater	N/A	Migratory	x	✓
Ardenna pacifica	Wedge-tailed Shearwater	N/A	Migratory	x	✓
Fregata minor	Great Frigatebird	N/A	Migratory	x	✓

Species	Common Name	Threatened Status	Migratory Status	Potential Occurrence	
				Operational Area	EMBA
Hydroprogne caspia	Caspian Tern	N/A	Migratory	x	✓
Onychoprion anaethetus	Bridled Tern	N/A	Migratory	x	✓
Phaethon lepturus	White-tailed Tropicbird	N/A	Migratory	x	✓
Sterna dougallii	Roseate Tern	N/A	Migratory	x	✓
Sternula albifrons	Little Tern	N/A	Migratory	x	✓
Charadrius veredus	Oriental Plover	N/A	Migratory	x	✓
Glareola maldivarum	Oriental Pratincole	N/A	Migratory	x	✓
Thalasseus bergii	Crested Tern	N/A	Migratory	x	✓
Tringa nebularia	Common Greenshank	N/A	Migratory	x	✓

A number of terrestrial species were identified in the EPBC search as occurring within the wider EMBA, but have been excluded in this EP due to lack of a credible impact scenario, being:

- Night Parrot (*Pezoporus occidentalis*)
- Boodie (*Bettongia lesueur* – Barrow and Boodie Islands subspecies)
- Woylie (*Bettongia penicillata ogilbyi*)
- Golden Bandicoot (*Isoodon auratus barrowensis*)
- Spectacled Hare-wallaby (*Lagorchestes conspicillatus conspicillatus*)
- Mala, Rufous Hare-Wallaby (*Lagorchestes hirsutus* – Central Australian subspecies)
- Barrow Island Wallaroo (*Osphranter robustus isabellinus*)
- Black-flanked Rock-wallaby (*Petrogale lateralis lateralis*)
- Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia* – Pilbara form)
- Monte Bello Worm-lizard (*Aprasia rostrata rostrata*)
- Northwestern Coastal Ctenotus (*Ctenotus angusticeps*)
- Hamelin Ctenotus (*Ctenotus zastictus*)
- Western Spiny-tailed Skink (*Egernia stokesii badia*)
- Barn Swallow (*Hirundo rustica*)
- Grey Wagtail (*Motacilla cinerea*)
- Yellow Wagtail (*Motacilla flava*)
- Blind Gudgeon (*Milyeringa veritas*).

The full list of species identified from the Protected Matters Search is provided in the EPBC Act Protected Matters Search Report (**Appendix C**).

4.5.2.1 Listed Threatened Species Recovery Plans and Conservation Advice

The requirements of the species recovery plans and conservation advices (**Table 4-3**) will be considered to identify any requirements that may apply to the risk assessment (**Section 6**). Recovery plans are enacted under the EPBC Act and remain in force until the species is removed from the threatened list. Conservation advice provides guidance on immediate recovery and threat abatement activities that can be performed to facilitate the conservation of a listed species or ecological community.

Table 4-3 outlines the recovery plans and conservation advices relevant to those species identified by the EPBC Protected Matters search (**Appendix C**) as potentially occurring within or using habitat in the Operational Area and wider EMBA, and summarises the key threats to those species, as described in relevant recovery plans and conservation advices.

Table 4-3: Conservation advice for EPBC Act listed species considered during environmental risk assessment and their relevance to the Operational Area and wider EMBA

Species/sensitivity	Recovery plan/conservation advice (date issued)	Key threats identified in the recovery plan/ conservation advice	Relevant conservation actions
All vertebrate fauna			
All vertebrate fauna	Threat abatement plan for the impacts of marine debris on the vertebrate wildlife of Australia's coasts and oceans (Department of the Environment and Energy (DoEE), 2018)	Marine debris	Identify offshore installations such as oil rigs as a potential source of marine debris.
Marine mammals			
Sei whale	Conservation advice *Balaenoptera borealis* sei whale (Threatened Species Scientific Committee, 2015a)	Noise interference	Assess and manage acoustic disturbance.
		Vessel disturbance	Assess and manage physical disturbance and development activities.
Blue whale	Conservation management plan for the blue whale: *A recovery plan under the Environment Protection and Biodiversity Conservation Act 1999* 2015-2025 (Commonwealth of Australia, 2015a)	Noise interference	Assess and address anthropogenic noise.
		Vessel disturbance	Minimise vessel collision.
Fin whale	Conservation advice *Balaenoptera physalus* fin whale (Threatened Species Scientific Committee, 2015b)	Noise interference	Once the spatial and temporal distribution (including biologically important areas) of fin whales is further defined, assess the impacts of increasing anthropogenic noise (including seismic surveys, port expansion, and coastal development) on this species.
		Vessel disturbance	Develop a national vessel strike strategy that investigates the risk of vessel strikes on fin whales and also identifies potential mitigation measures. Ensure all vessel strike incidents are reported in the National Vessel Strike Database.
Humpback whale	Approved conservation advice for *Megaptera novaeangliae* (humpback whale) (Threatened Species Scientific Committee, 2015c)	Noise interference	For actions involving acoustic impacts (example pile driving, explosives) on humpback whale calving, resting, feeding areas, or confined migratory pathways, perform site-specific acoustic modelling (including cumulative noise impacts).

Species/sensitivity	Recovery plan/conservation advice (date issued)	Key threats identified in the recovery plan/ conservation advice	Relevant conservation actions
		Vessel disturbance	Ensure the risk of vessel strike on humpback whales is considered when assessing actions that increase vessel traffic in areas where humpback whales occur and, if required, appropriate mitigation measures are implemented to reduce the risk of vessel strike.
Southern right whale	Conservation management plan for the southern right whale: a recovery plan under the *Environment Protection and Biodiversity Conservation Act 1999* 2011–2021 (DSEWPaC, 2012b)	Noise interference	Assess and address anthropogenic noise: shipping, industrial and seismic surveys.
		Vessel disturbance	Address vessel collisions.
Reptiles			
Loggerhead turtle, hawksbill turtle, green turtle, and flatback turtle	Recovery plan for marine turtles in Australia (DoEE, 2017)	Vessel disturbance	No specific management actions in relation to vessels prescribed in the plan; vessel interactions identified as a threat.
		Light pollution	Minimise light pollution. Identify the cumulative impact on turtles from multiple sources of onshore and offshore light pollution.
		Acute chemical discharge (oil pollution)	Ensure spill risk strategies and response programs include management for turtles and their habitats.
Leatherback turtle, leathery turtle, luth	Approved conservation advice for *Dermochelys coriacea* (Leatherback Turtle) (DEWHA, 2008b)	Vessel disturbance	No explicit relevant management actions; vessel strikes identified as a threat.
	Recovery plan for marine turtles in Australia (DoEE, 2017)		
Short-nosed seasnake	Approved conservation advice for *Aipysurus apraefrontalis* (Short-nosed Sea Snake) (DSEWPaC, 2011a)	Habitat degradation/ modification	None applicable.
Sharks, fish and rays			
Great white shark	Recovery plan for the white shark (*Carcharodon carcharias*) (DSEWPaC, 2013)	No additional threats identified (ex. marine debris)	None applicable.
Dwarf sawfish, green sawfish	Approved conservation advice for *Pristis clavata* (dwarf sawfish) (DEWHA, 2009a)	Habitat degradation/ modification	No explicit relevant management actions; habitat loss, disturbance and modification identified as threats.

Species/sensitivity	Recovery plan/conservation advice (date issued)	Key threats identified in the recovery plan/ conservation advice	Relevant conservation actions
	Sawfish and river shark multispecies recovery plan (DoE, 2015a)		Identify risks to important sawfish and river shark habitat and measures needed to reduce those risks.
Whale shark	Conservation advice *Rhincodon typus* whale shark (Threatened Species Scientific Committee, 2015d)	Vessel disturbance	Minimise offshore developments and transit time of large vessels in areas close to marine features likely to correlate with whale shark aggregations and along the northward migration route that follows the northern Western Australian coastline along the 200 m isobath.
	Whale shark (*Rhincodon typus*) recovery plan 2005-2010[6] (DEH, 2005a)	Habitat degradation/ modification	No explicit relevant management actions; seasonal aggregations of Ningaloo recognised as important habitat.
Grey nurse shark (west coast population)	Recovery plan for the Grey Nurse Shark (*Carcharias taurus*) (DoEE, 2014a)	No additional threats identified (ex. marine debris)	None applicable.
Seabirds			
Red knot	Conservation advice *Calidris canutus* red knot (Threatened Species Scientific Committee, 2016a)	Habitat degradation/ modification	No explicit relevant management actions; oil pollutions recognised as a threat.
Curlew sandpiper	Conservation advice *Calidris ferruginea* curlew sandpiper (DoE, 2015b)	Habitat degradation/ modification (oil pollution)	No explicit relevant management actions; oil pollutions recognised as a threat.
Eastern curlew	Conservation advice *Numenius madagascariensis* eastern curlew (DoE, 2015c)		
Southern giant-petrel, Amsterdam Albatross, wandering albatross, northern giant petrel, Indian yellow-nosed albatross, Tasmanian shy albatross, white-capped albatross, Campbell albatross, black-browed albatross	National recovery plan for threatened albatrosses and giant petrels 2011–2016 (DSEWPaC, 2011b)	No additional threats identified (ex. marine debris)	No explicit relevant management actions; oil pollutions recognised as a threat.
Soft-plumaged petrel	Conservation advice *Pterodroma mollis* soft-plumage petrel (Threatened Species Scientific Committee, 2015e)	Habitat degradation and modifications	No explicit relevant management actions.

[6] While the Whale shark (*Rhincodon typus*) recovery plan ceased to be in effect on 1 October 2015, the conservation advice in this plan was considered to inform the context of the environmental risk assessment for the Petroleum Activities Program.

Species/sensitivity	Recovery plan/conservation advice (date issued)	Key threats identified in the recovery plan/ conservation advice	Relevant conservation actions
Australian lesser noddy	Conservation Advice Anous *tenuirostris melanops* Australian lesser noddy. (Threatened Species Scientific Committee, 2015e)	Habitat degradation and modifications	No explicit relevant management actions.
Australian fairy tern	Conservation advice for *Sterna nereis nereis* (fairy tern) (DSEWPaC, 2011c)	Habitat degradation/ modification (oil pollution)	Ensure appropriate oil-spill contingency plans are in place for the subspecies' breeding sites which are vulnerable to oil spills.
Common sandpiper, red knot, pectoral sandpiper, sharp-tailed sandpiper, bar-tailed godwit, oriental pratincole, oriental plover, common greenshank	Wildlife conservation plan for migratory shorebirds (Commonwealth of Australia, 2015b)	Habitat degradation/ modification (oil pollution)	No explicit relevant management actions; oil spills recognised as a threat.
Northern Siberian bar-tailed godwit	Conservation advice *Limosa lapponica menzbieri* Bar-tailed godwit (northern Siberian) (Threatened Species Scientific Committee, 2016b)	Habitat degradation and modifications (oil pollution)	No explicit relevant management actions; oil spills recognised as a threat.
White-winged fairy-wren (Barrow Island)	Approved conservation advice for *Malurus leucopterus edouardi* (White-winged Fairy-wren (Barrow Island)) (DEWHA, 2008c)	No additional threats identified	No explicit relevant management actions.
White-winged fairy-wren (Dirk Hartog Island)	Advice for *Malurus leucopterus leucopterus* (White-winged Fairy-wren (Barrow Island)) (DEWHA, 2008d)	No additional threats identified	No explicit relevant management actions.
Abbott's booby	Conservation advice *Papasula abbotti* Abbott's booby (Threatened Species Scientific Committee, 2015g)	Habitat degradation/ modification	No explicit relevant management actions.
Soft-plumaged petrel	Conservation advice *Pterodroma Mollis* soft-plumaged petrel (Threatened Species Scientific Committee, 2015h)	Habitat degradation/ modification	No explicit relevant management actions.

4.5.2.2 Habitat Critical to the Survival of a Species

The Recovery Plan for Marine Turtles in Australia (DoEE, 2017) has established a 'Habitat Critical to the Survival of a Species' that identifies critical habitats for the survival of marine turtle stocks under the EPBC Act. Habitat critical to the survival of a species is defined by the EPBC Act Significant Impact Guidelines 1.1 – Matters of National Environmental Significance as areas necessary:

- for activities such as foraging, breeding or dispersal

- for the long-term maintenance of the species (including the maintenance of species essential to the survival of the species)
- to maintain genetic diversity and long term evolutionary development
- for the reintroduction of populations or recovery of the species.

Nesting and internesting habitats have been identified, described and mapped for the green turtle, loggerhead turtle, flatback turtle, hawksbill turtle, olive ridley turtle and the leatherback turtle (DoEE, 2017).

The Operational Area does not include any 'habitat critical to the survival of a species'. The areas of 'habitat critical to the survival of a species' that are located within the wider EMBA are shown in **Figure 4-7**.

It is noted that 'habitat critical to the survival of a species' differs from 'Critical Habitat' as defined under Section 207A of the EPBC Act (Register of Critical Habitat). No 'Critical Habitat' has been identified and listed for marine turtles.

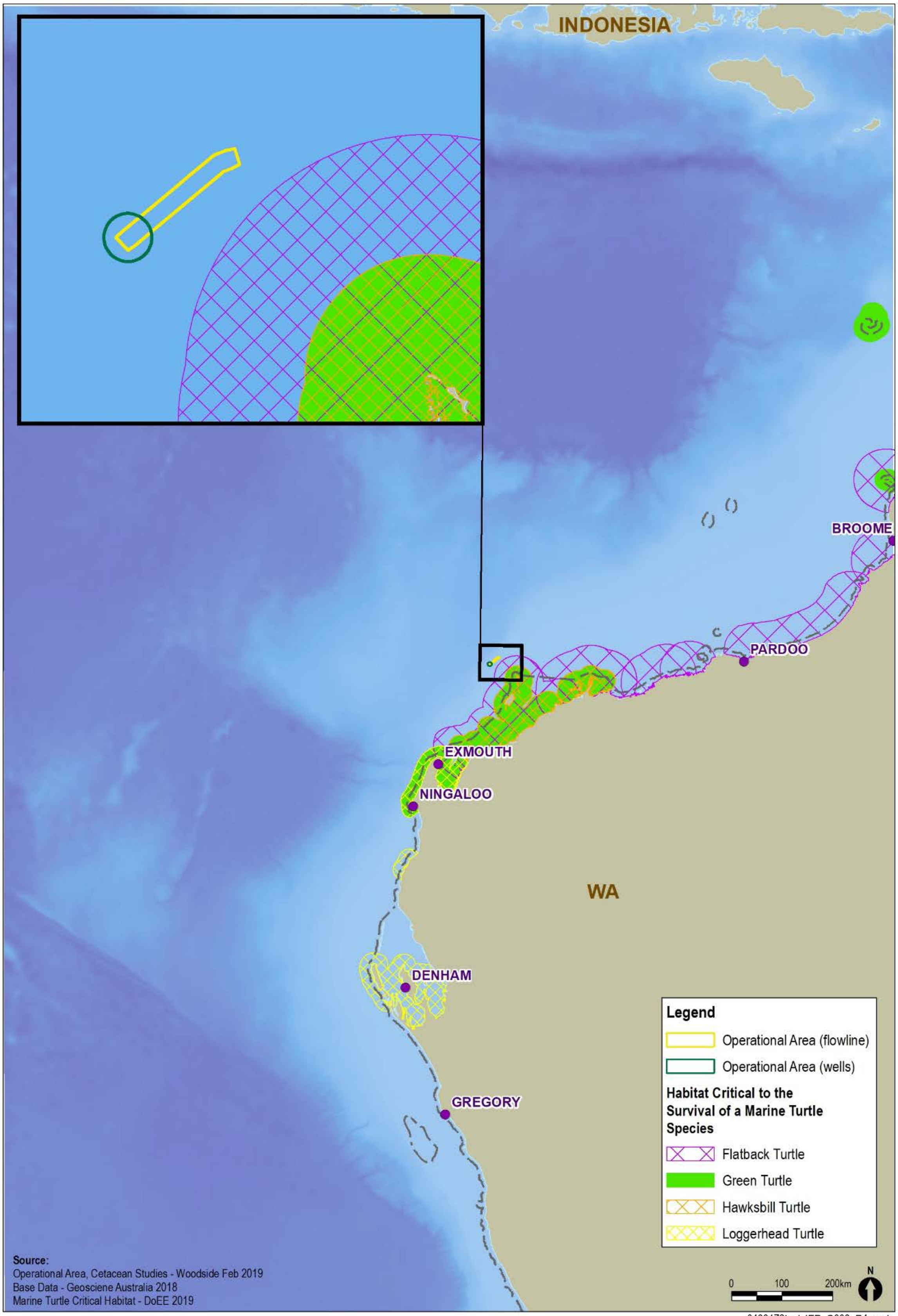


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Figure 4-7: Habitat critical to the survival of a marine turtle species in the region of the Operational Area

4.5.2.3 Biologically Important Areas

A review of the Conservation Values Atlas identified that the following BIAs overlap spatially with the Operational Area:

- Flatback turtle internesting buffer zone, about 80 km zone from the nearest foraging, mating and nesting sites for flatback turtles on Barrow, the Montebello and Lowendal Islands during summer (peak period in December and January) (**Figure 4-10**).
- Whale shark foraging northward from the Ningaloo Marine Park along the 200 m isobath (July–November) (Figure 4-11).
- Foraging area for the wedge-tailed shearwater during its breeding season (August–April).
- Pygmy blue whale migration corridor extending northward form the Perth canyon towards Indonesia (Figure 4-8). The northward migration occurs past Exmouth from April to August and the southern migration occurs from October to late December.
- Pygmy blue whale distribution occurring from the southern coast of Australia and along the WA coast, extending north through the Indian Ocean to Indonesian waters (**Figure 4-8**).

BIAs not within the Operational Area but within the wider EMBA are listed in **Table 4-4**.

Table 4-4: BIAs beyond the Operational Area but within the wider EMBA

Species	BIA type	Approximate distance from the Operational Area
Mammals		
Humpback whale	Migration (North and South)	21
	Resting (Exmouth Gulf)	189
Pygmy blue whale	Foraging (Ningaloo Coast)	212
Dugong	Multi-use (breeding/calving/foraging/nursing) (Exmouth)	192
Reptiles		
Flatback turtle	Multi-use (foraging/mating/nesting/aggregation) (Montebello Islands)	46
	Internesting (Dampier Archipelago	69
	Multi-use (foraging/mating/nesting/) (Barrow Island)	63
	Nesting (Pilbara Southern Island Group)	44
	Internesting (Pilbara Southern Island Group)	124
	Nesting (Eighty Mile Beach)	476
Loggerhead turtle	Internesting (Montebello Islands)	35
	Nesting (Montebello Islands)	55
	Internesting (Muiron Islands)	170
	Nesting (Muiron Islands)	150
	Internesting (Ningaloo Coast)	176
	Nesting (Ningaloo Coast)	196

Species	BIA type	Approximate distance from the Operational Area
Green turtle	Internesting (Montebello Islands)	22
	Multi-use (foraging/interesting/mating/nesting) (Montebello Islands)	49
	Internesting (Barrow Island)	44
	Multi-use (foraging/mating/nesting/basking) (Barrow Island)	63
	Internesting (North West Cape)	150
Hawksbill turtle	Internesting (Montebello/Lowendal/Barrow Island Group)	26
	Multi-use (mating/nesting/foraging) (Montebello/Lowendal/Barrow Island Group)	46
	Internesting (Thevenard Island)	117
	Nesting (Thevenard Island)	137
	Internesting (Ningaloo Coast)	176
	Nesting (Ningaloo Coast)	196
Sharks, Fish and Rays		
Whale shark	Foraging (Ningaloo)	206
Avifauna		
Bridled tern	Foraging (Shark Bay)	668
Fairy tern	Breeding and foraging (Montebello Island)	44
	Breeding and foraging (Barrow Island)	62
	Breeding and foraging (Thevenard Island)	123
	Breeding (North West Cape)	206
	Breeding (Dirk Hartog Island)	671
Lesser crested tern	Breeding and foraging (Lowendal Island)	41
	Breeding and foraging (Thevenard Island)	108
	Breeding (Dirk Hartog Island)	671
Little tern	Resting (Rowley Shoals)	462
Roseate tern	Breeding and foraging (Lowendal Island)	41
	Breeding and foraging (Thevenard Island)	108
	Breeding (Ningaloo)	267
	Breeding (Dirk Hartog Island)	671
Sooty tern	Foraging (Abrolhos Islands)	679
While-tailed tropicbird	Foraging (Rowley Shoals)	367
	Breeding (Rowley Shoals)	462
Wedge-tailed shearwater	Breeding (Montebello)	63
	Internesting (Pilbara South Island Group)	29
	Breeding (Pilbara South Island Group)	129
	Foraging (Shark Bay)	600

4.5.2.4 Seasonal Sensitivities of Protected Species

Periods of the year coinciding with key environmental sensitivities in and around the Operational Area, including EPBC Act listed threatened and/or migratory species potentially occurring within the Operational Area, are presented in **Table 4-5**. These relate to breeding, foraging or migration of the indicated fauna.

The following species were listed in the EPBC Act Protected Matters Search (see **Table 4-2** and **Appendix C**) but have been excluded from **Table 4-5**:

- Antarctic minke whale, Bryde's whale and sperm whales may occasionally transit the area. However, information is not available to support a definitive seasonality in the North West Shelf Province.
- The leatherback turtle is not confirmed as a nesting species within WA (Limpus, 2008, DoEE, 2017).
- Great white, shortfin mako and longfin mako sharks have not been included as seasonality is not defined, as they are ocean-going and can be present at any time, but are not known to have significant populations with regular migratory routes or breeding/foraging aggregations within the Operational Area.

Table 4-5: Key environmental sensitivities and timings for fauna (indicative). Migratory whale periods are specific to the NWS Region based on scientific literature. Timing will vary with geographic location along the WA coast.

Species	January	February	March	April	May	June	July	August	September	October	November	December
Blue whale – northern migration (Exmouth, Montebello, Scott Reef)[1]												
Blue whale – southern migration (Exmouth, Montebello, Scott Reef)[2]												
Humpback whale – northern migration (Jurien Bay to Montebello)[3]												
Humpback whale – southern migration (Jurien Bay to Montebello)[4]												
Bryde's whale – foraging (Shark Bay)[6]												
Killer whale – foraging (Shark Bay)[6]												
Green turtle – various nesting areas within EMBA[8]												
Flatback turtle – various nesting areas within EMBA[8]												
Loggerhead turtle – various nesting areas within EMBA[8]												
Hawksbill turtles – various nesting areas within EMBA[8,9]												

Species	January	February	March	April	May	June	July	August	September	October	November	December
Manta rays – presence/ aggregation/breeding (Ningaloo)[11]												
Whale shark* – foraging/ aggregation near Ningaloo[10]												
Caspian tern – breeding (Ningaloo)[13]												
Crested tern – breeding (Ningaloo)[13]												
Fairy tern – breeding (Ningaloo)[13]												
Osprey – breeding (Ningaloo)[13]												
Roseate tern – breeding (Ningaloo)[13]												
Wedge-tailed shearwater – various breeding sites[14]												
	Species likely to be present in the region											
	Peak period. Presence of animals reliable and predictable each year											

References for species seasonal sensitivities:

1. DoE, 2016; McCauley & Jenner, 2010; McCauley & Duncan, 2011
2. DoE, 2016; McCauley & Jenner, 2010
3. Department of Conservation and Land Management (CALM), 2005; Environment Australia, 2002; Jenner et al., 2001a; McCauley & Jenner, 2001
4. McCauley & Jenner, 2001
5. McCauley & Duncan, 2011
6. Department of Environmental Protection, 2001
7. CALM, 2005; Department of Environmental Protection, 2001; DSEWPaC, 2012a; Environment Australia, 2002; Limpus and Chatto, 2004
8. DoEE, 2017; Chevron Australia Pty Ltd, 2015;CALM, 2005; DSEWPaC, 2012a, 2012c
9. Chevron Australia Pty Ltd, 2015; DSEWPaC, 2012c
10. CALM, 2005; DSEWPaC, 2012a; Environment Australia, 2002; Sleeman et al., 2010
11. Environment Australia, 2002
12. Commonwealth of Australia, 2007
13. CALM, 2005; Environment Australia, 2002
14. DSEWPaC, 2012c; Environment Australia, 2002.

** Periods of sensitivity include whale shark foraging off Ningaloo coast and foraging northward from the Ningaloo Marine Park along the 200 m isobath.*

4.5.2.5 Marine Mammals

Cetaceans – Migratory Whales

Blue Whale

There are two recognised subspecies of blue whale in the Southern Hemisphere, which are both recorded in Australian waters. These are the southern (or 'true') blue whale (*Balaenoptera musculus*) and the 'pygmy' blue whale (*Balaenoptera musculus brevicauda*) (DoE, 2016a). In general, southern blue whales occur in waters south of 60°S and pygmy blue whales occur in waters north of 55°S (i.e.

not in the Antarctic) (Department of Environment and Heritage (DEH), 2005b). On this basis, nearly all blue whales sighted in the NWS Region are likely to be pygmy blue whales. The 2015 Conservation Management Plan for the Blue Whale (Commonwealth of Australia, 2015a) has delineated the distribution area of blue whales in Australian waters and identified a number of BIAs for WA waters (migratory corridor and foraging areas).

Pygmy blue whale migration is thought to follow deep oceanic routes (DEWHA, 2008). In the NWMR and within the wider EMBA, pygmy blue whales migrate along the 500–1000 m depth contour on the edge of the slope, where they are likely to feed opportunistically on ephemeral krill aggregations (DEWHA, 2008). This area has been defined by the DoEE as a BIA for the species and spatially overlaps the north west portion of the Operational Area (**Figure 4-8**). Sea noise loggers at various locations along the WA coast have detected an annual northbound migration past Exmouth and the Montebello Islands between April and August, and southbound migration from October to the end of December, peaking in late November to early December for north of the Montebello Islands (McCauley & Jenner, 2010; McCauley & Duncan, 2011, Double et al., 2012).

Recent satellite tagging (2009–2012) confirmed the general distribution of pygmy blue whales was offshore in water depths over 200 m and commonly over 1000 m (Double et al., 2012) (**Figure 4-6**), generally west of the Operational Area within the NWMR and wider EMBA. This data was revisited in 2014 and showed that whales tagged in WA during March and April migrated northwards post tag deployment. The tagged whales travelled relatively near to the Australian coastline (100.0 ± 1.7 km) in water depths of 1369.5 ± 47.4 m, until reaching the North West Cape, after which they travelled offshore (238.0 ± 13.9 km) into progressively deeper water (2617.0 ± 143.5 m). Whales reached the northern terminus of their migration and potential breeding grounds in Indonesian waters by June (Double et al., 2014). Although the BIA for this species has been defined as the migration corridor centred between the 500 m and 1000 m depth contours, this data suggests individuals transit the deeper waters to the west of the Operational Area between mid-April to early August (**Figure 4-8**) during the northern migration.

There are no known key aggregation areas (resting, breeding or feeding) located within or immediately adjacent to the Operational Area. However, given the location of the Operational Area in proximity to the pygmy blue whale migration route and BIA, it is expected that individuals may transit the Operational Area during their northbound/southbound migration.

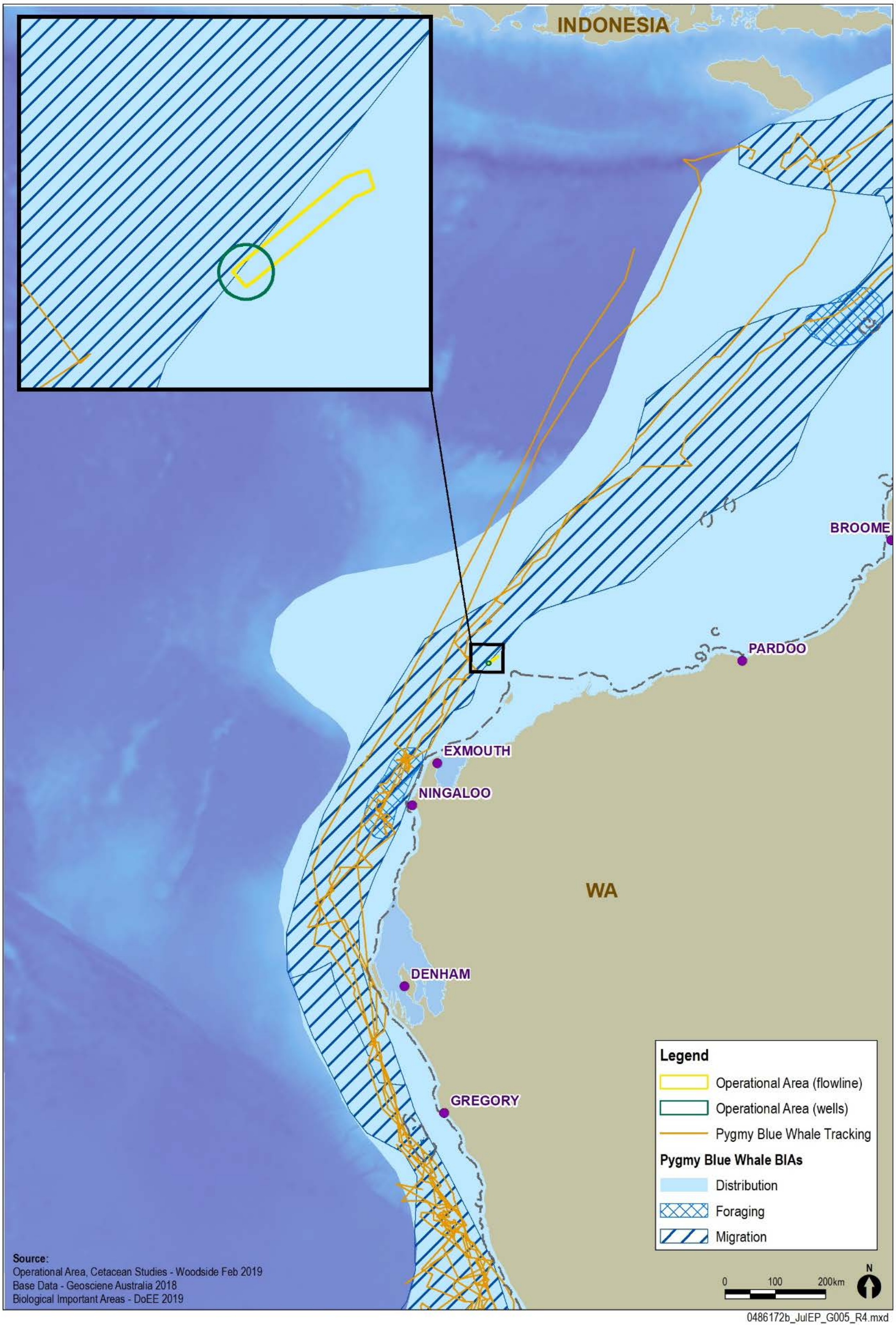

Figure 4-8: Pygmy blue whale satellite tracking, illustrating migration route

Humpback Whale

The humpback whale (*Megaptera novaeangliae*) migrates along the WA coastline annually as this EPBC Act listed Vulnerable and Migratory marine species completes its seasonal northern and southern migration to and from high latitude feeding grounds to low latitude breeding and calving areas (Commonwealth of Australia, 2015b). Humpback whales travel to and from the southern Kimberley to the northern end of Camden Sound (the main breeding and calving area) in the winter and spring months (Jenner et al., 2001; Commonwealth of Australia, 2015a), after feeding in Antarctic waters during the summer months (Bannister & Hedley, 2001). The Commonwealth of Australia's Conservation Advice for humpback whales (October 2015), identifies the humpback whale's distribution on the west and east coasts of Australia. Calving occurs at the northern extent of the migration corridor (outside of the EMBA for the Petroleum Activities Program). The DoEE has defined the migration corridor (both north and south bound) as a BIA for humpback whales. The BIA is located about 21 km south east of the Operational Area and within the wider EMBA (**Figure 4-9**).

Woodside has conducted marine megafauna aerial surveys that have confirmed that the temporal distribution of migrating humpback whales off the North West Cape, in the wider EMBA, has remained consistent since baseline surveys were first conducted in 2000 to 2001 (RPS, 2010a). The majority of the whales occurred in depths less than 500 m, with the greatest density of whales concentrated in water depths of 200–300 m. Only small numbers of whales were observed to occur in the deeper offshore waters. The humpback whale population that migrates along the WA coast has been estimated to be as large as 33,300 in 2008 (Salgado Kent et al., 2012).

From the North West Cape, north-bound humpback whales travel along the edge of the continental shelf passing to the west of the Muiron, Barrow and Montebello islands. The southern migratory route follows a relatively narrow track between the Dampier Archipelago and Montebello Islands, south of the Operational Area (**Figure 4-9)**. Within the wider EMBA, Exmouth Gulf and Shark Bay are known resting/aggregation areas for southbound humpback whales. In particular, cow/calve pairs may stay for up to two weeks in Exmouth Gulf. The Exmouth Gulf resting/aggregation BIA lies about 192 km from the Operational Area and partially overlaps the wider EMBA. The Shark Bay BIA is outside the wider EMBA.

The southward migration of cow/calf pairs is generally during October (extending into November and December). The peak of the northward migration within/near the Operational Area is during July, while the southern migration peak is late August/early September.

Given this data and the location of the Operational Area in relation to the known humpback migration route (**Figure 4-9**), it is considered that humpback whales may transit within the Operational Area between June and October, during both their northern and southern migrations. The Operational Area is not located in or adjacent to any known critical habitat areas for this protected migratory whale species (e.g. feeding, breeding or calving). Observed whales are most likely to be transiting between the known aggregation areas of Camden Sound (about 1010 km north-east) and Exmouth Gulf (about 196 km south-west), rather than feeding, resting or breeding.

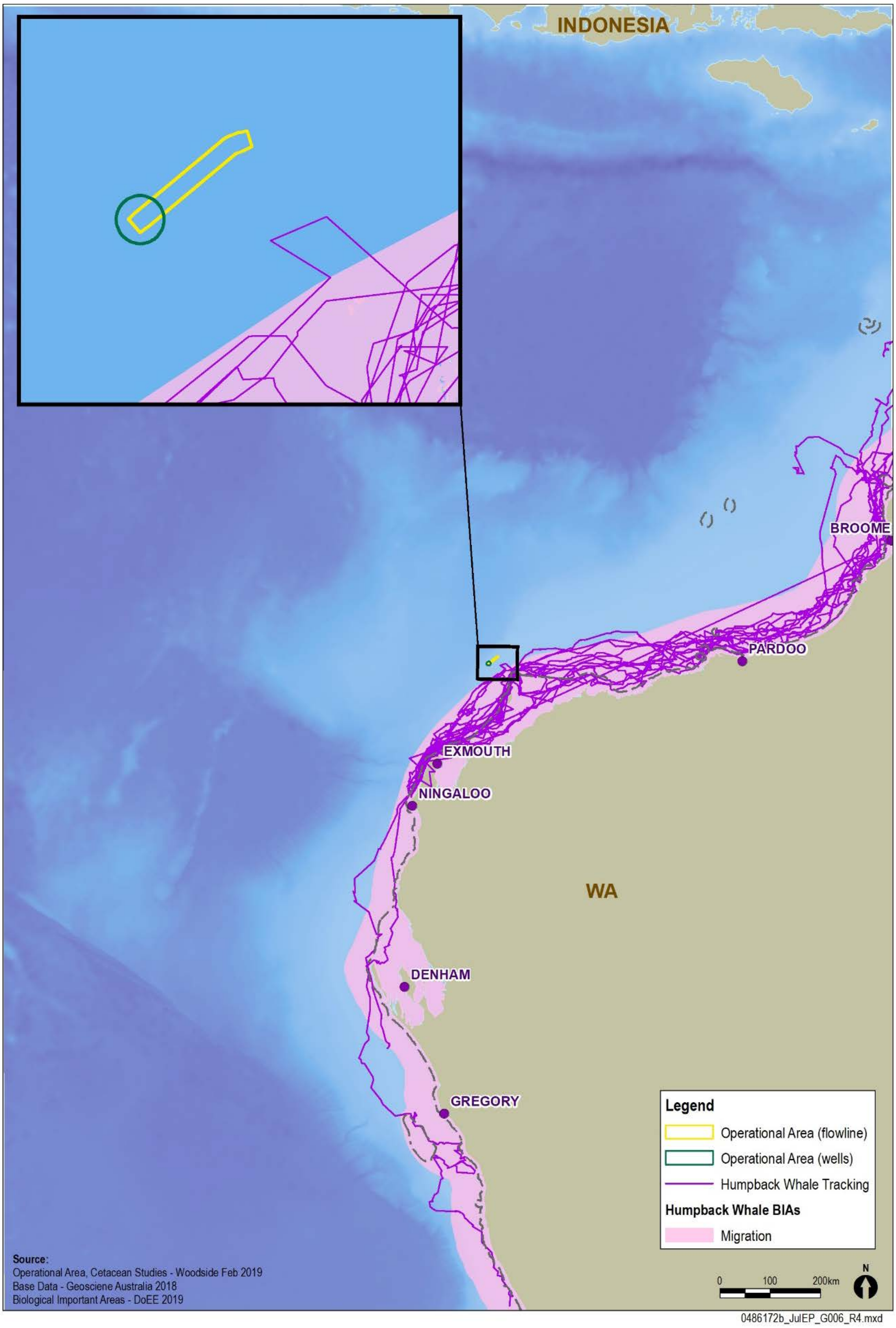

Figure 4-9: Humpback whale satellite tracking, illustrating migration routes in the region of the Operational Area

Bryde's Whale

The Bryde's whale occurs in tropical and temperate waters off all Australian states (Bannister et al., 1996). Bryde's whales occur in both oceanic and inshore waters, with the only key localities recognised in WA being in the Abrolhos Islands and north of Shark Bay (Bannister et al., 1996). Two forms are recognised: inshore and offshore Bryde's whales. It appears that the offshore form may migrate seasonally, heading towards warmer tropical waters during the winter; however, information on migration is not well known.

Within the wider EMBA, Bryde's whales tend to transit seasonally through a broad area of the continental shelf (McCauley & Duncan, 2011; RPS, 2012b). This species has been detected within the North West Shelf Province from mid-December to mid-June, peaking in late February to mid-April (RPS, 2012b). Given the distribution of Bryde's whales, the Operational Area is unlikely to represent an important habitat for this species so their presence is considered unlikely and limited to a few individuals infrequently transiting the area.

Sperm Whale

The sperm whale has a worldwide distribution in deep waters (greater than 200 m) off continental shelves and sometimes near shelf edges, averaging 20–30 nautical miles offshore (Bannister et al., 1996).

Within the wider EMBA, sperm whales have been recorded in deep water off North West Cape (Jenner et al., 2010; RPS, 2010c; Woodside, 2010) and appear to occasionally venture into shallower waters in other areas (RPS, 2010c). The only key locality recognised in WA waters for sperm whales is along the southern coastline between Cape Leeuwin and Esperance (Bannister et al., 1996), outside of the EMBA for the Petroleum Activities Program.

The species is known to migrate northwards in winter and southwards in summer, but detailed information on the distribution and migration patterns of sperm whales off the WA coast is not available. Given the wide distribution of sperm whales and their preference for deeper oceanic waters, the Operational Area is unlikely to represent an important habitat for this species. Their presence is likely to be a rare occurrence and limited to a few individuals infrequently transiting the area.

Sei Whale

The sei whale is a baleen whale which, like many species of baleen whales, was significantly reduced in numbers by commercial whaling operations. The species has a worldwide oceanic distribution, and is expected to seasonally migrate between low latitude wintering areas and high latitude summer feeding grounds (Bannister et al., 1996; Prieto et al., 2012). Sei whales have been infrequently recorded in Australian waters (Bannister et al., 1996b), which could be due to the similarity in appearance of sei whales and Bryde's whales leading to incorrect recordings.

There are no known mating or calving areas, or other BIAs for sei whales in Australian waters (DoE, 2016a). The species has a preference for deep waters, and typically occurs in oceanic basins and continental slopes (Prieto et al., 2012); records of the species occurring on the continental shelf (<200 m water depth) are uncommon in Australian waters (Bannister et al., 1996a). Given the Operational Area is located in deeper waters on the continental slope, sei whales are likely to infrequently occur within the Operational Areas, mainly during winter months when the species may move away from Antarctic feeding areas.

Fin Whale

The fin whale is a large baleen whale with a cosmopolitan distribution in all ocean basins between 20 and 75°S (DEH, 2005b). The global population of fin whales was reduced significantly by commercial whaling, with the species being targeted due to its large size and broad distribution. Like other baleen whales, fin whales migrate annually between high latitude summer feeding grounds and lower latitude over-wintering areas (Bannister et al., 1996).

Fin whales are thought to follow oceanic migration paths, and are uncommonly encountered in coastal or continental shelf waters. The Australian Antarctic waters are important feeding grounds for fin whales but there are no known mating or calving areas in Australian waters (Morrice et al., 2004). There are no known BIAs for fin whales in the NWMR. As such, the species is likely to infrequently occur within the Operational Area, mainly during winter months when the species may move away from Antarctic feeding areas.

Antarctic Minke Whale

The Antarctic minke whale is distributed worldwide and has been recorded off all Australian states, feeding in cold waters and migrating to warmer waters to breed. It is thought that the Antarctic minke whale migrates up the WA coast to about 20°S to feed and possibly breed (Bannister et al., 1996). However, detailed information on timing and location of migrations and breeding grounds is not well known. Given the wide distribution of Antarctic minke whale, the Operational Area is unlikely to represent an important habitat for this species. Their presence is likely to be a remote occurrence and limited to a few individuals infrequently transiting the area.

Southern Right Whale

Southern right whales were identified as occurring within the wider EMBA, not within the Operational Area. The southern right whale occurs primarily in waters between about 20°S and 60°S and moves from high latitude feeding grounds in summer to warmer, low latitude, coastal locations in winter (Bannister et al., 1996). Southern right whales aggregate in calving areas along the south coast of WA, such as Doubtful Island Bay, east of Israelite Bay and to a lesser extent Twilight Cove (DoE, 2016). During the calving season, between May and November, female southern right whales that are either pregnant or with calf can be in shallow protected waters along the entire southern Western Australian coast and west up to about Two Rocks, north of Perth. Sightings in more northern waters are relatively rare; however, they have been recorded as far north as Exmouth (Bannister et al., 1996).

Cetaceans – Toothed Whales and Dolphins

Killer Whale

The killer whale has a widespread distribution from polar to equatorial regions of all oceans and has been recorded off all states of Australia (Bannister et al., 1996). Killer whales appear to be more common in cold, deep waters; however, they have been observed along the continental slope and shelf (Bannister et al., 1996), as well as in shallow coastal areas of WA (RPS, 2010c). Anecdotal evidence suggests killer whales may feed on dugongs in Shark Bay but there are no recognised key localities or important habitats for killer whales within the Operational Area or wider EMBA.

Given the wide distribution of killer whales and their preference for colder waters, the Operational Area is unlikely to represent an important habitat for this species. Their presence is likely to be a rare occurrence and limited to a few individuals infrequently transiting the area.

Spotted Bottlenose Dolphin (Arafura/Timor Sea Populations)

The spotted bottlenose dolphin is generally considered to be a warm water subspecies of the common bottlenose dolphin. Distribution is primarily in inshore waters, often in depths of less than 10 m (Bannister et al., 1996). They are known to occur from Shark Bay, north to the western edge of the Gulf of Carpentaria. Given the distribution of spotted bottlenose dolphins and their preference for shallow coastal waters, the Operational Area is unlikely to represent an important habitat for this species. Their presence is likely to be a rare occurrence and limited to infrequent transiting of the area. The spotted bottlenose dolphin is likely to be present in nearshore and coastal waters, within the wider EMBA.

Indo-Pacific Humpback Dolphin

The Indo-Pacific humpback dolphin is not expected to occur in the Operational Area based on an EPBC Act Protected Matters search, but may be present in the wider EMBA. It is now recognised as two distinct species; the Indo-Pacific humpback dolphin (*Sousa chinensis*) and the Australian humpback dolphin (*S. sahulensis*) (Jefferson & Rosenbaum, 2014). Although the EPBC Act Protected Matters Search Tool lists the Indo-Pacific humpback dolphin (*S. chinensis*), which is found in waters around India, China and south-east Asia, this EP will herein refer to the Australian humpback dolphin (*S. sahulensis*) that is known to occur in waters of the NWS and Sahul Shelf from northern Australia to New Guinea. Distribution of the humpback dolphin in Australia is linked to the warm eastern boundary current, with resident groups within Ningaloo Reef (Bannister et al., 1996). Humpback dolphins inhabit shallow coastal, estuarine habitats in tropical and subtropical regions, generally in depths of less than 20 m (Corkeron et al., 1997; Jefferson, 2000; Jefferson & Rosenbaum, 2014). Given their preference for shallow coastal habitats, the Operational Area is unlikely to represent an important habitat for this species.

Other Marine Mammals

Dugong

Dugongs (*Dugong dugon*) are not expected to occur in the Operational Area based on an EPBC Act Protected Matters search, but may be present in the wider EMBA. They are large herbivorous marine mammals that generally inhabit coastal areas. Key populations along the WA coast are located at Shark Bay (the largest resident population in Australia), Ningaloo Marine Park and Exmouth Gulf, the Pilbara coast and offshore areas, and further north at Eighty Mile Beach and off the Kimberley Coast region coastline (Marsh et al., 2002; DoE, 2015). Dugong distribution is determined by the location of foraging habitat which is specific to certain seagrass species and the size of seagrass meadows. Dugongs are known to migrate hundreds of kilometres between seagrass habitats.

4.5.2.6 Marine Reptiles

Marine Turtles

Five of the six marine turtle species recorded for the NWS have the potential to occur within the Operational Area (**Appendix C**): the loggerhead, green, leatherback, hawksbill and flatback turtles.

There is no emergent habitat within the Operational Area. Therefore, nesting aggregations of marine turtles would not be expected. The flatback turtle internesting BIA extends for 80 km from the nesting beaches on the northern end of the Montebello Islands and overlaps with part of the Operational Area. The BIA is considered very conservative as it is based on the maximum range of internesting females. However, many turtles are likely to remain near their nesting beaches, and as they leave beaches they typically spread out and consequently, density decreases rapidly with increasing distance from a nesting beach. It is also possible that marine turtles forage at Rankin Bank, the nearest submerged shoal containing biota that turtles eat (e.g. sponges and macroalgae – see **Section 4.7.12**).

Four of the turtle species (green, loggerhead, flatback and hawksbill) have significant nesting rookeries on beaches along the mainland coast and islands in the wider EMBA region including the Montebello/Barrow/Lowendal Islands, Muiron Islands, North West Cape and Ningaloo Reef (Environment Australia, 2003; DoEE, 2017). **Table 4-6** provides additional details of the marine turtle species identified, including breeding and nesting seasons, diet and key habitats (including BIAs) within the NWMR (including areas outside of the wider EMBA region).

Table 4-6: Key information on marine turtles in the North West Marine Region

Turtle Species	Key Seasons within the North West Shelf Province	Diet	Key Habitats
Green turtle – North West Shelf genetic stock	**Breeding:** About September to March **Nesting**: November to March. Peak period from January to February	Seagrasses and algae	**Preferred habitat**: Nearshore reef habitats in the photic zone. **Distribution**: Ningaloo Coast to Lacepede Islands. **Major nesting sites**: Adele Island, Maret Island, Cassini Island, Lacepede Islands, Barrow Island, Montebello Islands (all with sandy beaches), Serrurier Island, Dampier Archipelago, Thevenard Island, Northwest Cape, Ningaloo Coast (DoEE, 2017) **Internesting habitat**: Generally within 10 km of nesting beaches (Waayers et al., 2011). **Nearest BIA**: Nesting on the Montebello Islands during summer, with a 20 km internesting buffer, therefore the key habitat is outside the Operational Area but within the wider EMBA.
Loggerhead turtle – Western Australia genetic stock	**Breeding:** About September to March **Nesting**: October to March. Peak period from late December to early January	Carnivorous – feeding mainly on molluscs and crustaceans	**Preferred habitat**: Nearshore and island coral reefs, bays and estuaries in tropical and warm temperate latitudes. **Distribution:** Shark Bay to North West Cape and as far north as Muiron Islands and Dampier Archipelago. **Major nesting sites**: Principally from Dirk Hartog Island, along the Gnarloo and Ningaloo coast to North West Cape and the Muiron Islands. There have been occasional records from Varanus and Rosemary Islands in the Pilbara. Late summer nesting recorded for Barrow Island, Lowendal Islands and Dampier Archipelago. **Internesting habitat:** Limited data on Australian loggerhead turtles; however, literature indicates internesting habitat for this species is generally within 20 km of nesting beaches (DoEE, 2017). **Nearest BIA**: Nesting on the Montebello Islands (peak late December–early January) with a 20 km internesting buffer. Loggerhead nesting turtle habitat is outside the Operational Area but within the wider EMBA.
Hawksbill turtle – Western Australia genetic stock	**Nesting**: October to February with a peak period in December and January	Mainly sponges – also seagrasses, algae, soft corals and shellfish	**Preferred Habitat:** Nearshore and offshore reef habitats. **Distribution:** Shark Bay north to Dampier Archipelago. **Major nesting sites:** The most significant rookery in WA is at Rosemary Island. Other rookeries include Varanus Island in the Lowendal group, some islands in the Montebello group and along the Ningaloo Coast. **Internesting habitat:** Limited data on Australian hawksbill turtles; however, literature indicates internesting habitat for this species is generally within 20 km of nesting beaches (DoEE, 2017). **Nearest BIA**: Nesting on the Montebello Islands in spring and early summer (peak October) with a 20 km internesting buffer. Hawksbill turtle nesting habitat is outside the Operational Area but within the wider EMBA.

Turtle Species	Key Seasons within the North West Shelf Province	Diet	Key Habitats
Flatback turtle – Pilbara genetic stock	**Nesting**: October to March with peak period in December and January	Carnivorous – feeding mainly on soft bodied prey such as sea cucumbers, soft corals and jellyfish	**Preferred Habitat**: Nearshore and offshore sub-tidal and soft bottomed habitats of offshore islands. **Distribution:** Shark Bay north to Dampier Archipelago. **Major nesting sites**: The largest nesting sites of the Pilbara region are Barrow Island and the mainland coast (Mundabullangana Station near Cape Thouin and smaller nesting sites at Cemetery Beach in Port Hedland and Bell's Beach near Wickham). Other significant rookeries include Thevenard Island, the Montebello Islands, Varanus Island, the Lowendal Islands, and islands of the Dampier Archipelago. **Internesting habitat:** Up to 70 km from nesting beaches (Waayers et al., 2011). Satellite tracking of flatback turtle nesting populations at Barrow Island indicates this species travels to the east of Barrow Island, towards WA mainland coastal waters, between nesting events (Chevron, 2009; RPS, 2010d). **Nearest BIA:** Foraging, mating and nesting at the Montebello Islands in summer with an 80 km internesting buffer. Therefore this key habitat overlaps the Operational Area.
Leatherback turtle – Australia genetic stock	No confirmed nesting activity in Western Australia	Carnivorous – feeding mainly in the open ocean on jellyfish and other soft-bodied invertebrates	**Preferred Habitat**: Nearshore, coastal tropical and temperate waters, may be encountered within the North West Shelf Province but noted that there are no known nesting sites within the Province.

Source: DEC (2012), DSEWPaC (2012a), DoEE (2017)

Flatback turtles internest in shallow waters and generally on the eastern side of the offshore islands of Barrow, Montebellos and the Lowendals. Whittock et al. (2014) tracked flatback turtles from beaches on the east coast of Barrow Island, with the range and preference for shallow waters demonstrated. Dr Pendoley (K. Pendoley, personal communication 16 December 2015) has observed across all flatback rookeries in the region, behaviours that show internesting flatbacks moving towards shallow, coastal waters. There has been no observations of flatbacks moving offshore to deeper waters during the internesting period. For flatback turtles associated with the Montebello Islands, it is considered that during internesting they will move either towards Barrow Island or towards shallower coastal waters (K. Pendoley, personal communication 16 December 2015).

Although a BIA for internesting flatback turtles during summer overlaps with the Operational Area, the distance offshore (about 48 km north-west of the Montebello Islands), the depth range of the offshore waters of the Operational Area (about 130–290 m), internesting range and patterns in shallow and coastal waters, and the absence of potential nesting sites (i.e. no emergent islands, reef habitat or shallow shoals) indicate that it is highly unlikely flatback turtles will be encountered in the Operational Area.

Post-nesting migratory routes for green, hawksbill and flatback turtles recorded for the North West Shelf Province (Barrow Island and mainland sites) (Chevron, 2012) and green turtle tracking for post-nesting individuals from Scott Reef (Guinea, 2011), outside the EMBA, indicate no overlap with the Operational Area. Green, flatback and hawksbill turtles travelling from nesting sites to foraging grounds generally travelled east or south of Barrow Island, around or through the Dampier Archipelago and along the coast towards foraging grounds to the north (north of Broome). The hawksbill turtle is an exception as it tends to travel south to the coastal island chain south of Barrow

Island (Chevron, 2012). Tracking data indicates the three marine turtle species recorded for the North West Shelf Province travel and forage in coastal waters that are relatively shallow (Chevron, 2012) as follows:

- hawksbill turtles – less than 10 m deep
- green turtles – less than 25 m deep
- flatback turtles – less than 70 m deep.

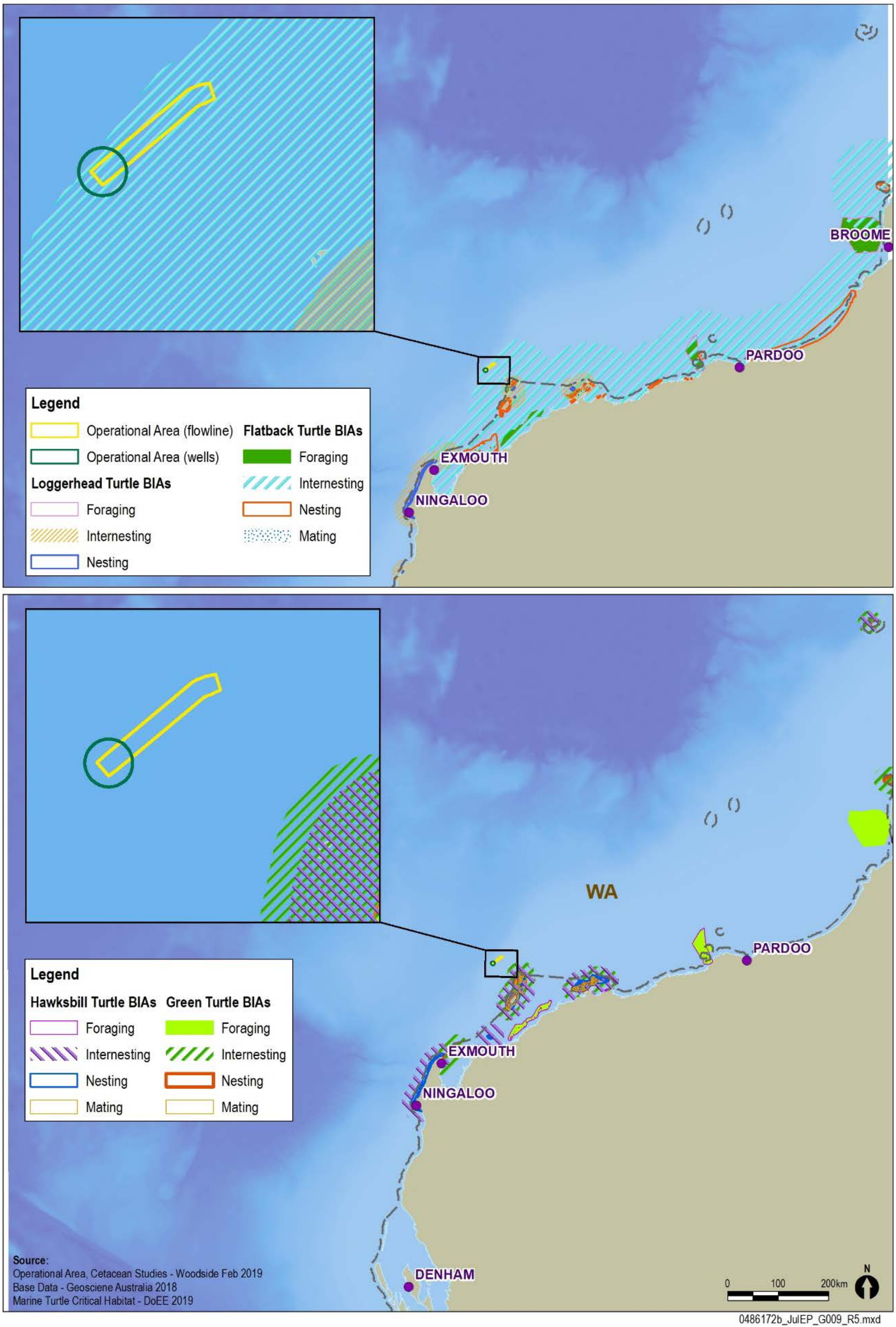

Figure 4-10: BIAs for marine turtles in the region of the Operational Area

Seasnakes

Seasnakes occur across the NWMR and are reported to occur in offshore and nearshore waters. They occupy diverse habitats including coral reefs, turbid water habitats and deeper water (Guinea et al*.,* 2004). Species exhibit habitat preferences depending on water depth, benthic habitat, turbidity and season (Heatwole and Cogger, 1993). The majority of information on the occurrence of seasnakes has been sourced from by-catch logs maintained by the Northern Prawn Fishery (DEWHA, 2008). (This fishery does not overlap the Operational Area or wider EMBA.)

The short-nosed seasnake, listed as Critically Endangered under the EPBC Act, was identified as potentially occurring within the wider EMBA (although not within the Operational Area). There are a small number of records of individuals collected along the Western Australian coast from the Exmouth Gulf to Broome (Storr et al., 2002; Kangas et al., 2018). The origin of these specimens has not been determined, but they may have been vagrants or they may represent a population which has not yet been identified. This species may have a wider distribution; however, there are no conclusive records relating to the species distribution outside Australian waters (DSEWPaC, 2011a).

Seasnakes of the families *Hydrophidae* and *Laticaudidae* are widespread in the wider EMBA and are protected under the EPBC Act. The Protected Matters Search identified 12 species of seasnake listed as marine under the EPBC Act within the wider EMBA (**Appendix C**). The most commonly sighted seasnake in the region is the olive seasnake (*Aipysurus laevis*), which is generally found along lower reef edges and upper lagoon slopes of leeward reefs. The olive seasnake is associated with shallow water, as large, deep water expanses create a significant barrier to movement. Given the water depth of the Operational Area, seasnake sightings will be infrequent and likely comprise few individuals. Seasnakes have a higher likelihood of occurrence in shallower (< 100 m deep) waters of the Montebello AMP within the EMBA.

4.5.2.7 Sharks, Fish and Rays

Seahorses and Pipefish

A search of the EPBC Act Protected Matters database identified the potential for 30 species of pipefish and five species of seahorse to occur in the Operational Area (**Appendix C**). However, by-catch data (DoF, 2010) indicates they are uncommon in deeper continental shelf waters (50–200 m) and therefore are unlikely to occur within the Operational Area.

This family (*Syngnathidae*) are commonly found within the nearshore and coastal waters of the wider EMBA, especially in seagrass and sandy habitats around coastal islands and shallow reef areas along the NWS. *Syngnathidae* are likely to be found in coastal areas including the Ningaloo area and the Dampier Archipelago. Recent data collected using BRUVS at Rankin Bank and Glomar Shoals did not record any seahorses or pipefish (AIMS, 2014).

Sharks and Rays

A search of the EPBC Act Protected Matters database identified the potential for eight listed shark species and two rays to occur within the Operational Area (**Table 4-2**, **Appendix C**), being:

- whale shark (*Rhincodon typus*) – threatened and migratory
- grey nurse shark (*Carcharias taurus*) – threatened
- great white shark (*Carcharodon carcharias*) – threatened and migratory
- dwarf sawfish (*Pristis clavata*) – threatened and migratory
- green sawfish (*Pristis zijsron*) – threatened and migratory
- narrow sawfish (*Anoxypristis cuspidata*) – migratory
- shortfin mako (*Isurus oxyrinchus*) – migratory

- longfin mako (*Isurus paucus*) – migratory
- giant manta ray (*Manta birostris*) – migratory
- reef manta ray (*Manta alfredi*) – migratory.

Further information on these species is provided in the next sections.

Whale Shark

The DoEE has defined a BIA for foraging whale sharks (post aggregation at Ningaloo) centred on the 200 m isobath from July to November (Commonwealth of Australia, 2015d; **Figure 4-11**). This area extends northward from the Ningaloo aggregation area and intersects the Operational Area. Anecdotal evidence from sightings data collected from the Woodside offshore facilities on the NWS indicate whale sharks are present on the NWS in the months of April, July, August, September and October, corresponding with the whale shark's seasonal migration to and from the Ningaloo Reef. However, the numbers of individual whale sharks that transit through the Operational Area is expected to be low, based on the number of whale sharks aggregating at Ningaloo and on the different migration paths that the sharks may follow (see below).

In the wider EMBA, whale sharks aggregate annually to feed in the waters around Ningaloo Reef (about 191 km south west of the Operational Area) from March to July, with the largest numbers recorded in April and May (Sleeman et al., 2010). However, seasonal aggregation can be variable, with individual whale sharks recorded at other times of the year. The super-population (comprising individuals that visit the reef at some point during their lifetime) has been estimated to range between 300 and 500 individuals. It is expected that the number visiting Ningaloo Reef in any given year will be somewhat smaller (Meekan et al., 2006). Timing of the whale shark migration to and from Ningaloo coincides with the coral mass spawning period when there is an abundance of food (krill, planktonic larvae and schools of small fish) in the waters adjacent to Ningaloo Reef. At Ningaloo Reef, whale sharks stay within a few kilometres of the shore and in waters about 30–50 m deep (Woodside, 2002; Wilson et al., 2006).

After the aggregation period, the distribution of the whale sharks is largely unknown. Tagging, aerial and vessel surveys suggest that the group disperses widely, up to 1800 km away into Indonesian waters. Satellite tracking has shown that the sharks may follow three migration routes from Ningaloo:

1. north-west, into the Indian Ocean
2. directly north, towards Sumatra and Java
3. north-east, passing through the NWS and Browse, travelling along the shelf break and continental slope (Meekan & Radford, 2010) (**Figure 4-11**).

Though the BIA has been defined as foraging for whale sharks, based on the literature it is more likely to be a migration pathway with whale sharks undertaking opportunistic foraging. Given the BIA for whale sharks spatially overlaps the Operational Area, it is expected that whale sharks may traverse the vicinity of the Operational Area during their migrations to and from Ningaloo Reef. However, it is expected that whale shark presence within the area would be of a relatively short duration and not in significant numbers, given the main aggregations are recorded in coastal waters, particularly the Ningaloo Reef edge (MPRA, 2005).

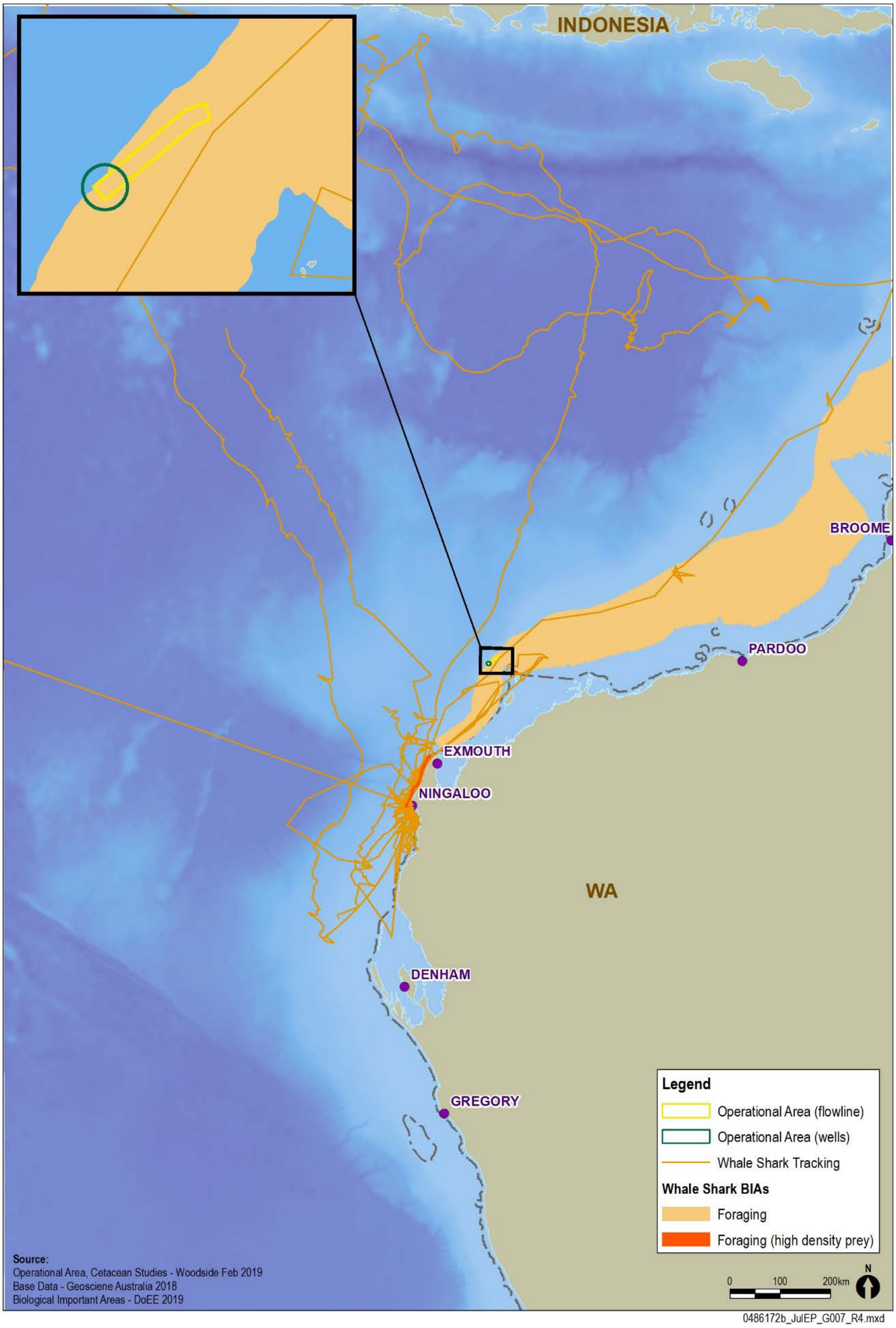

Figure 4-11: Short- and long-term satellite tracking of 15 whale sharks tagged between 2005 and 2008

Grey Nurse Sharks

The grey nurse shark has a broad inshore distribution, primarily in sub-tropical to cool temperate waters (Last & Stevens, 1994) and is predominantly found in the south-west coastal waters of WA and as far north as the NWS (Stevens, 1999; Pogonoski et al., 2002). The grey nurse shark is generally found between 15 and 40 m (Otway & Parker, 2000). The Operational Area is in offshore waters and as such, sightings of grey nurse sharks are considered highly unlikely to occur in the Operational Area. However, grey nurse sharks are likely to be found within the wider EMBA.

Great White Shark

The great white shark typically occurs between the coast and the 100 m depth contour, although adults and juveniles have been recorded diving to depths of 1000 m (Bruce et al., 2006; Bruce & Bradford, 2008). They are also known to make open ocean excursions of several hundred kilometres and can cross ocean basins (for instance from South Africa to the western coast of Australia) (Weng et al., 2007). Along the WA coastline, great white sharks move up the coast as far as North West Cape during spring and appear to return during the summer (CMAR, 2007). Great white sharks are often found in regions with high prey density, such as pinniped colonies (DEWHA, 2009b). Occurrence of great white sharks within the Operational Area is likely to be infrequent and restricted to transiting individuals.

Dwarf Sawfish

The dwarf sawfish is found in Australian coastal waters extending north from Cairns around the Cape York Peninsula in Queensland to the Pilbara coast (Commonwealth of Australia, 2015e). Dwarf sawfish typically inhabit shallow (2 to 3 m) silty coastal waters and estuarine habitats, occupying relatively restricted areas and moving only small distances (Stevens et al., 2008). The majority of capture locations for the species in WA waters have occurred within King Sound and the lower reaches of the major rivers that enter the sound, including the Fitzroy, Mary and Robinson rivers (Morgan et al., 2009). Individuals have also been recorded from Eighty Mile Beach in the Pilbara. Occasional individuals have also been taken from considerably deeper water from trawl fishing (Morgan et al., 2009). The Operational Area is in offshore waters and as such, the area is not considered critical habitat, with sightings of dwarf sawfish considered highly unlikely to occur within the Operational Area. However, they may be present within the wider EMBA.

Green Sawfish

Green sawfish were once widely distributed in coastal waters along the northern Indian Ocean, although it is believed that northern Australia may be the last region where significant populations exist (Stevens et al., 2005). Within Australia, green sawfish are currently distributed from around the Whitsundays in Queensland, across northern Australian waters to Shark Bay in Western Australia (Commonwealth of Australia, 2015e). Green sawfish are present in coastal waters and tidal creeks and, despite records for deeper offshore waters, their range is mostly restricted to the inshore fringe with a strong association to mangroves and adjacent mudflat habitats (Commonwealth of Australia, 2015e). The Multi-species Recovery Plan for Sawfish and River Sharks indicates ‘known to occur’ distribution includes offshore waters of the North West Shelf, with pupping ‘likely to occur’ south of Port Hedland, Exmouth Gulf and North West Cape (Commonwealth of Australia, 2015e). The Operational Area is not considered a sensitive area for the green sawfish.

Based on the distance from preferred shallow coastal habitats and the water depth of the Operational Area (about 130–290 m), sightings of green sawfish are considered highly unlikely within the Operational Area although they may be present within the wider EMBA.

Narrow Sawfish

The narrow sawfish occurs from the northern Arabian Gulf to Australia and north to Japan. The species inhabits inshore and estuarine waters and offshore waters up to depths of 100 m (D'Anastasi et al., 2013) and are most commonly found in sheltered bays with sandy bottoms. They are not currently listed as threatened but are commonly caught as by-catch, and constituted over half of sawfish by-catch in the Northern Prawn Fishery in 2013 (Morgan et al., 2010). The species was not identified as occurring within the Operational Area; however, narrow sawfish may occur in the wider EMBA, particularly in nearshore estuarine environments.

Shortfin Mako

The shortfin mako is a wide-ranging oceanic pelagic shark that is widespread in Australian waters, though rarely recorded in water temperatures below 16 °C (DEWHA, 2010). Recently tagged shortfin makos spent most of their time in water less than 50 m deep but with occasional dives up to 880 m deep (Stevens et al., 2010; Abascal et al., 2011). Little is known about the population size and distribution of shortfin mako sharks in WA; however, it is possible they will transit the Operational Area. It is expected that the number of individuals encountered will be low due to their preference for shallow waters (<50 m) but it is likely they will be within the broader EMBA.

Longfin Mako

The longfin mako (*Isurus paucus*) is a widely distributed but rarely encountered oceanic tropical shark found in Australian waters south to Geraldton in WA (outside the wider EMBA) and to at least Port Stephens in New South Wales (DEWHA, 2010). The longfin mako is often confused with the shortfin mako. There is very little information about these sharks in Australia, with no available population estimates or distribution trends. Occurrence within the Operational Area is likely to be infrequent and restricted to transiting individuals. However, it is likely they will be within the broader area including the NWS region and the wider EMBA.

Porbeagle Shark

The porbeagle shark is found in temperate, sub-Arctic and sub-Antarctic waters worldwide. The porbeagle shark has a wide vertical range within the water column, with tagging studies recording the species between the surface and >700 m water depth (Saunders et al., 2011). Given its preference for cooler waters (Bruce, 2013), the porbeagle shark may occur in the southern portion of the wider EMBA. The species was not identified as occurring within the Operational Area.

Giant Manta Ray

The giant manta ray is very common in tropical waters of Australia, including the proposed Dampier Archipelago Marine Park and Regnard Marine Management Area, Ningaloo Marine Park, Muiron Islands Marine Park and Management Area, and the Montebello Islands Marine Park/Barrow Island Marine Management Area, all located within the wider EMBA. The giant manta ray primarily inhabits near-shore environments along productive coastlines with regular upwelling, but they appear to be seasonal visitors to coastal or offshore sites including offshore island groups, offshore pinnacles and seamounts (Marshall et al., 2011). The Operational Area is not located in or adjacent to any known key aggregation areas for the species (e.g. feeding or breeding). However, Ningaloo Reef, over 191 km south west of the Operational Area (but within the wider EMBA) is an important area for giant manta rays in autumn and winter (Preen et al., 1997). Occurrence of giant manta rays within the Operational Area is likely to be infrequent, and restricted to individuals transiting the area.

Reef Manta Ray

The reef manta ray is globally distributed in tropical and subtropical waters. It is a planktivorous species and is thought to migrate relatively long distances, travelling up to 70 km per day and moving between specific productive areas (Couturier et al., 2011; van Duinkerken, 2010). The reef manta ray is most often sighted inshore, around coastal areas and coral reefs. Species residency has been recorded along the Western Australian coastline, most notably at Ningaloo Marine Park. The Operational Area is not located in or adjacent to any known key aggregation areas for the species (e.g. feeding or breeding). Occurrence of giant manta rays within the Operational Area is likely to be infrequent, and restricted to individuals transiting the area.

4.5.2.8 Birds

Seabirds and/or Migratory Shorebirds Within the Operational Area

Twelve species of listed birds (described in detail below) were identified by the EPBC Act Protected Matters Search (**Appendix C**) as potentially occurring within the Operational Area (**Table 4-2**), being:

- southern giant-petrel (*Macronectes giganteus*) – endangered and migratory
- red knott (*Calidris canutus*) – endangered
- curlew sandpiper (*Calidris ferruginea*) – critically endangered
- eastern curlew (*Numenius madagascariensis*) – critically endangered
- Australian fairy tern (*Sternula nereis nereis*) – vulnerable
- common noddy (*Anous stolidus*) – migratory
- streaked shearwater (*Calonectris leucomelas*) – migratory
- lesser frigatebird (*Fregata ariel*) – migratory
- pectoral sandpiper (*Calidris melanotos*) – migratory
- osprey (*Pandoin heliaetus*) – migratory
- common sandpiper (*Actitis hypoleucos*) – migratory
- sharp-tailed sandpiper (*Calidris acuminate*) – migratory.

The Operational Area may be occasionally visited by migratory and oceanic birds but does not contain any emergent land that could be used as roosting or nesting habitat. It contains no known critical habitats (including feeding) for any species. However, a BIA defined by the DoEE for the migratory wedge-tailed shearwater during its breeding period in the region (August to April) overlaps the Operational Area. The wedge-tailed shearwater is a breeding visitor to the Kimberley, Pilbara and Gascoyne coasts and is listed as Migratory under the EPBC Act. Note that the EPBC Protected Matters Search did not identify wedge-tailed shearwaters as potentially occurring within the Operational Area.

There is a National Recovery Plan for Threatened Albatrosses and Giant Petrels 2011–2016, which identifies critical habitat for foraging in waters south of 25 degrees (DSEWPaC, 2011b). No critical habitat associated with the southern giant-petrel has been identified for the Operational Area; therefore the presence of this species within the Operational Area is likely to be infrequent as individuals traverse the area.

Based on the results of two survey cruises and other unpublished records, Dunlop et al. (1995) recorded the occurrence of 18 species of seabirds over the North West Shelf Province. These included a number of species of petrel, shearwater, tropicbird, frigatebird, booby and tern, as well as the silver gull. Of these, eight species occur year-round, and the remaining ten are seasonal visitors. From these surveys, it was noted that seabird distributions in tropical waters were generally patchy, except near islands. Migratory shorebirds may be present in or fly through the region between July and December, and again between March and April, as they complete migrations between Australia and offshore locations (Environment Australia, 2002).

Southern Giant-Petrel

The southern giant-petrel is the largest species of petrel, and is listed as Endangered and Migratory under the EPBC Act. The southern giant-petrel occurs in Antarctic to subtropical waters, and breeds on six sub-Antarctic and Antarctic islands which are all outside the wider EMBA. The species is thought to travel varied and potentially long migratory pathways between foraging and breeding habitat (DSEWPaC, 2012d). Due to preferred habitat and known movement patterns, the species is not expected to occur within the Operational Area, but may be in the southern region of the wider EMBA.

Red Knot

The red knot is listed as Endangered and Migratory under the EPBC Act. The species undertakes long distance migrations from breeding grounds in high northern latitudes, where it breeds during the boreal summer, to the southern hemisphere during the austral summer. Both Australia and New Zealand host significant numbers of red knots during their non-breeding period (Bamford et al., 2008). As with other migratory shorebirds, the species occurs in coastal wetland and intertidal sand or mudflats throughout the wider EMBA, but is unlikely to occur in the Operational Area, aside from individuals occasionally transiting through during migrations, due to the lack of emergent habitat.

Curlew Sandpiper

The curlew sandpiper is listed as Critically Endangered and Migratory under the EPBC Act. The species occurs around the coast of Australia, and can be found inland (although in smaller numbers). No breeding occurs on the Australian continent, with breeding grounds occurring in Siberia. Within Australia, the curlew sandpiper generally forages on mudflats and wetlands, feeding on invertebrates such as worms, molluscs and crustaceans (DoE, 2016e). They are sparsely distributed between Carnarvon and Dampier Archipelago; however, occur in the thousands at Eighty Mile Beach during migration (Australian summer). Due to the lack of emergent habitat, the curlew sandpiper is not expected to occur within the Operational Area; however, it may be present at coastal locations within the wider EMBA.

Eastern Curlew

The eastern curlew is Australia's largest shorebird, and is listed as Critically Endangered and Migratory under the EPBC Act. The eastern curlew is a coastal species with a continuous distribution north from Barrow Island to the Kimberley region. The species is endemic to the East Asian–Australasian Flyway. The species is a non-breeding visitor to Australia from August to March, primarily foraging on crabs and molluscs in intertidal mudflats. Due to the lack of emergent habitat, the eastern curlew is not expected to occur within the Operational Area; however, will potentially be present at coastal locations within the wider EMBA, particularly at the peak of migration during the Australian summer.

Australian Fairy Tern

The Australian fairy tern is listed as Vulnerable under the EPBC Act. It has a coastal distribution from Sydney, south to Tasmania and around southern Western Australia up to Dampier. The Australian fairy tern feeds on small baitfish and roosts and nests on sandy beaches below vegetation (Higgins & Davies, 1996; Van de Kam et al., 2004). Although identified by the EPBC search as occurring within the Operational Area, due to the coastal distribution of the species the Australian fairy tern is unlikely to occur within the Operational Area. However, it is likely to occur in the coastal regions of the wider EMBA.

Common Noddy

The common noddy is the largest species of noddy found in Australian waters, and is listed as Migratory under the EPBC Act. The species is widespread in tropical and subtropical areas beyond Australia. This seabird typically forages in coastal waters around nesting sites, taking prey such as small fish, but may occur longer distances out to sea. Nesting occurs broadly across tropical and subtropical Australia in coastal areas, particularly on islands such as the Houtman Abrolhos island group (Johnstone et al., 2013). The common noddy is thought to undertake seasonal movements, with some nesting sites abandoned during the non-breeding season (which is protracted between spring and autumn). The species is unlikely to occur within the Operational Area, aside from individuals occasionally transiting through during migration periods. The species will occur within the wider EMBA, particularly around offshore and coastal islands.

Streaked Shearwater

The streaked shearwater is listed as Migratory under the EPBC Act. It is most commonly found in pelagic and inshore waters of the Pacific Ocean. Within Australian waters, the species is commonly distributed from Exmouth, across northern Australia to Queensland, south to New South Wales (DSEWPaC, 2012). Its diet consists of invertebrates and epipelagic fishes (Atlas of Living Australia, 2019). The species breeds in temperate regions of east and south-east Asia before migrating to tropical regions near the equator; however, little is known about their movements during the non-breeding period (Yamamoto et al., 2010).

Lesser Frigatebird

The lesser frigatebird is listed as Migratory under the EPBC Act. This seabird is the most widely distributed frigatebird in Australian tropical seas, and is the smallest species of frigatebird. The species is well-adapted for an aerial existence and may range considerable distances from land. Food consists largely of fish taken at the sea surface or stolen from other birds. Beyond Australia, the lesser frigatebird occurs throughout the tropical Indian Ocean, the western tropical Pacific Ocean, and the south-western tropical Atlantic Ocean. The lesser frigatebird may occur within the Operational Area and the tropical seas of the wider EMBA.

Pectoral Sandpiper

The pectoral sandpiper is listed as Migratory under the EPBC Act. As with other species of sandpiper, the pectoral sandpiper breeds in the northern hemisphere during the boreal summer, before undertaking long distance migrations to feeding grounds in the southern hemisphere. The species occurs throughout mainland Australia between spring and autumn. The pectoral sandpiper prefers coastal and near-coastal environments such as wetlands, estuaries and mudflats. Given the species' preferred habitat the pectoral sand piper is not expected to occur within the Operational Area, but is expected to occur in suitable habitats within the wider EMBA.

Osprey

Ospreys are listed as Migratory under the EPBC Act. Within Australia, Ospreys are most commonly found in littoral and coastal habitats and terrestrial wetlands of tropical and temperate Australia and offshore islands. In Australia Ospreys breed from April to February in individual pairs. Ospreys are mostly resident around breeding territories, foraging more widely during non-breeding season and feeding primarily on fish. Due to the lack of emergent habitat, Ospreys are not expected to occur within the Operational Area; however, will potentially be present at fragmented coastal locations within the wider EMBA.

Common Sandpiper

The common sandpiper is listed as Migratory under the EPBC Act. The species is a small, migratory sandpiper with a very large range through which it migrates annually between breeding grounds in the northern hemisphere (Europe and Asia) and non-breeding areas in the Asia-Pacific region (Bamford et al., 2008). The species congregates in large flocks and forages in shallow waters and tidal flats between spring and autumn. Specific critical habitat in Australia has not been identified due to the species' broad distribution (Bamford et al., 2008). The common sandpiper may be present in coastal wetland and intertidal sand or mudflats throughout the wider EMBA, but is unlikely to occur in the Operational Area, aside from individuals occasionally transiting through during migrations, due to the lack of emergent habitat.

Sharp-Tailed Sandpiper

The sharp-tailed sandpiper is listed as Migratory under the EPBC Act. Like other species of sandpiper, the sharp-tailed sandpiper is a migratory wading shorebird and seasonally migrates long distances between breeding grounds in the northern hemisphere and over-wintering areas in the southern hemisphere (Bamford et al., 2008). The species may occur in Australia between spring and autumn. The species is unlikely to occur within the Operational Area due to the lack of suitable habitat, but may occur seasonally in coastal wetland and intertidal sand or mudflats throughout the wider EMBA.

Seabirds and/or Migratory Shorebirds Within the Wider EMBA

Forty listed species of seabird and shorebirds were identified as potentially occurring within the wider EMBA (**Table 4-2**). There are several important habitats for seabirds and migratory shorebirds within the wider EMBA, including key breeding/nesting areas, roosting areas and surrounding waters, important foraging and resting areas. These include the islands of the Montebello/Barrow/Lowendal Islands Group (including known nesting habitats on Boodie, Double and Middle islands), Dampier Archipelago, the Pilbara Islands Northern Island Group (Passage Islands chain including Great Sandy Islands and North Sandy Island Nature Reserves), the Pilbara Southern Island group, Ningaloo Coast, Eighty Mile Beach and Muiron Islands. These habitats are discussed further as key environmental sensitivities in **Section 4.7**. BIAs for seabirds and migratory shorebirds within the EMBA are described at the beginning of this section.

4.6 Socio-economic and Cultural

4.6.1 Cultural Heritage

4.6.1.1 European Sites of Significance

There are no known sites of Indigenous or European cultural heritage significance within the vicinity of the Operational Area.

4.6.1.2 Indigenous Sites of Significance

Within the wider EMBA, Barrow Island, Montebello Islands, Dampier Archipelago, Exmouth, Ningaloo Reef and the adjacent foreshores have a long history of occupancy by Aboriginal communities. Indigenous heritage places are protected under the *Aboriginal Heritage Act 1972* (WA) or EPBC Act. The DAA Heritage Inquiry System was searched from Cape Cuvier to the North West Cape, on to the Pilbara Island Group and Montebello/Barrow Islands (**Appendix G**). The search indicated numerous registered sites, including middens, burial, ceremonial, artefacts, rock shelters, mythological and engraving sites (**Appendix G**). The exact location, access and traditional practices for a number of these sites are not disclosed and if required, such as in the event of a major oil spill, would involve prioritising further consultation with key contacts within DAA and local Aboriginal communities.

4.6.1.3 Historic Shipwrecks

A search of the National Shipwreck Database (DoE, 2014b) indicates there are no known historic shipwrecks within the Operational Area.

There are seven shipwrecks in the vicinity of the Montebello/Barrow/Lowendal Islands and near the Pilbara coastline (**Table 4-7**; DoE, 2014b). The closest known wrecks are the four wrecks of the Curlew, the Wild Wave (China), the Marietta and the Vianen, near the Montebello Islands and about 40 km from the Operational Area. These four vessels are classified as a historic shipwreck under the Commonwealth *Historic Shipwrecks Act 1976* and a Protected Place under the EPBC Act.

Table 4-7: Recorded shipwrecks in the Montebello Islands/Dampier area

Vessel Name	Year Wrecked	Wreck Location*	Latitude**	Longitude**
Wild Wave (China)	1873	Montebello Islands	20.0ºS***	115.17ºE***
Curlew	1911	At Onslow, Montebello Group	20.0ºS***	115.17ºE***
Marietta	1905	Montebello Islands	20.0ºS***	115.17ºE***
Vianen	1628	Barrow Island	20.0ºS***	115.17ºE***
Tanami	1622	Trial Rocks 16 km NW of Montebello Islands	20.28ºS	115.37ºE
Trial	1622	Trial Rocks	20.29ºS	115.38ºE
Unidentified boat	1893	Montebello Islands	16.75ºS	122.0ºE

** Wreck location names are as stated by DoEE (2019). ** WGS84. *** Considered an unreliable generic location – refer to stated wreck location.*

The EPBC search identified the HMAS Sydney II and HSK Kormoran shipwreck sites as occurring within the EMBA. The shipwrecks are the result of a naval battle fought between the Australian and German warships during World War II and have high cultural and national significance. The wrecks were discovered in 2008, about 290 km south west of Carnarvon (over 680 km from the Operational Area) in depths of 2470 m. The wrecks are listed as National Heritage Property.

4.6.1.4 National and Commonwealth Heritage Listed Places

There are no heritage listed sites within or immediately adjacent to the Operational Area.

Within the wider EMBA, three National Heritage listed places occur: the Ningaloo Coast (about 168 km from the Operational Area), Shark Bay (about 545 km from the Operational Area) and the HMAS Sydney II and HSK Komoran shipwreck sites (over 680 km from the Operational Area).

There are two places on the Commonwealth Heritage list within the wider EMBA: the Ningaloo Marine Area – Commonwealth waters, and the HMAS Sydney II and HSK Kormoran shipwreck sites. The borders for these Commonwealth Heritage Places are contiguous with the National Heritage Places above.

The significant values of the National Heritage and Commonwealth Heritage Listed Places are outlined in **Section 4.7**.

4.6.2 Ramsar Wetlands

Ramsar wetlands are sites that have been included on the List of Wetlands of International Importance on the basis of representativeness or uniqueness or of biodiversity values. There are no Ramsar wetlands within or immediately adjacent to the Operational Area. The closest Ramsar wetland occurs at Eighty Mile Beach, over 470 km east of the Operational Area but within the wider

EMBA. The mudflats have a high diversity of infauna. Microphytobenthos within the substrate form the basis of food webs for a large variety of organisms including shorebirds and fish (Department of Parks and Wildlife (DPaW), 2014; Bennelongia, 2009). Eighty Mile Beach is part of the East Asian–Australasian Flyway and is the primary staging area for Asian, Alaskan and Siberian shorebirds (DSEWPaC, 2012d). The site regularly supports more than 200,000 shorebirds during summer and more than 20,000 during winter, many of which are considered of national and international importance.

4.6.3 Fisheries – Commercial

4.6.3.1 Commonwealth and State Fisheries

A number of Commonwealth and State fisheries are located within, adjacent to, or in the region of the Operational Area. **Table 4-8** provides further detail on the fisheries that have been identified through desk based assessment and consultation (**Section 5**).

Figure 4-12 and **Figure 4-13** provide the designated fisheries management areas in relation to the location of the Operational Area.

Table 4-8: Commonwealth and State fisheries within or adjacent to the Operational Area

Fishery	Fishery overlap with		Description
	Operational Area	Wider EMBA	
Commonwealth			
Western Tuna and Billfish Fishery	✓	✓	**Description:** The Western Tuna and Billfish Fishery management area extends west from the Gulf of Carpentaria to the South Australian/Victorian border. Fisheries data indicates that this long-line fishery has been declining since 2001, with a total of 95 statutory fishing rights and five active vessels since 2005 (Department of Agriculture, Fisheries and Forestry (DAFF), 2018). The majority of fishing effort occurs in south-west Australia, distant from the Operational Area and outside the wider EMBA. No fishing occurred within the Operational Area in the 2013 fishing season (Georgeson et al., 2014) (**Figure 4-12**). **Fishing boundary distance from the Operational Area:** Overlaps the Operational Area. **Vessels:** Four vessels (three pelagic longline, one minor longline).
Southern Bluefin Fishery and Western Skipjack Fishery	✓	✓	**Description:** The Southern Bluefin Tuna Fishery management area and the Western Skipjack Tuna Fishery (WSTF) management area covers the entire Australian Fishing Zone. Both fisheries constitute a single, highly migratory stock that spawns in the north-east Indian Ocean and migrates throughout the temperate southern oceans. Tuna is one of the most highly valued fish species and is targeted by fishing fleets from a number of nations, both on the high seas and within the Exclusive Economic Zones of Australia, New Zealand, Indonesia and South Africa (Australian Fisheries Management Authority (AFMA), 2010). The majority of the fishing effort for the Southern Bluefin Tuna Fishery occurs in the Great Australian Bight and north-east of Eden in New South Wales (AFMA, 2013; Georgeson et al., 2014). No fishing activity for the WSTF has been recorded since the 2008–2009 fishing season as a result of the natural variability of skipjack tuna stocks in Australian waters and low unit price for this species (Georgeson et al., 2014). Fishing activity for either of these tuna fisheries is not expected within the Operational Area. **Fishing boundary distance from the Operational Area:** Overlaps the Operational Area. **Vessels**: Six purse seine vessels, 16 longline vessels (Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES), 2018). No vessels are active in the WSTF.
Western Deepwater Trawl Fishery	x	✓	**Description:** The Western Deepwater Trawl Fishery is permitted to operate only in deep waters from the 200 m isobath, as far north as the North West Cape, outside of the Operational Area but within the wider EMBA (**Figure 4-12**). This fishery targets a number of deep water, demersal finfish and crustacean species. The nominated fishing grounds are extensive; however, most of the fishing effort is south and offshore of the North West Cape. Areas of medium and high density fishing activity are located to the south of Ningaloo Reef and west of Shark Bay, beyond the 200 m isobath (Georgeson et al., 2014). **Fishing boundary distance from the Operational Area:** The Western Deepwater Trawl Fishery management boundary is located about 80 km west of the Operational Area. **Vessels:** One vessel (ABARES, 2018).

Fishery	Fishery overlap with		Description
	Operational Area	Wider EMBA	
North West Slope Trawl Fishery	x	✓	**Description:** The North West Slope Trawl Fishery (NWSTF) licence area is located to the north of the Julimar Operational Area within the wider EMBA, from 114°E to 125°E, from the 200 m isobath to the outer limit of the Australian Fishing Zone. The NWSTF traditionally targets scampi and deepwater prawns. Fishing for scampi occurs over soft, muddy sediments or sandy habitats, typically at depths of 350–600 m using demersal trawl gear on the continental slope (DAFF, 2014). The major landing ports for the NWSTF include Darwin and Point Samson (**Figure 4-12**). The most recent publicly available fisheries data indicate that fishing effort in 2016–17 was approximately 2,869 hours, increased from the 2,241 hrs in 2015–16 (ABARES, 2018). Total scampi catch in the fishery was slightly higher in 2016 to 2017 than in the previous year, 54.8 t up to 57.8 t (ABARES, 2018). **Fishing boundary distance from the Operational Area:** The NWSTF management boundary is located approximately 3 km north west of the Operational Area. **Effort:** The most recent publicly available fisheries data indicate that fishing effort in 2016–17 was approximately 2,869 hours, increased from the 2,241 hrs in 2015–16 (ABARES, 2018). Total scampi catch in the fishery was slightly higher in 2016 to 2017 than in the previous year, 54.8 t up to 57.8 t (ABARES, 2018).
State			
West Australian Mackerel Managed Fishery	✓	✓	**Description:** The West Australian Mackerel Managed Fishery operates in waters within the Operational Area and the wider EMBA, targeting Spanish mackerel (*Scomberomorus commerson*) using near-surface trolling gear from small vessels in coastal areas around reefs, shoals and headlands. Jig fishing is also used to capture grey mackerel (*S. semifasciatus*), with other species from the genera *Scomberomorus* (Molony et al., 2014). Spanish mackerel is found in Australian waters from Geographe Bay in south-west Western Australia, throughout northern Australian waters and down the east coast as far as St. Helens in Tasmania (DoF, 2004). The commercial fishery extends from Geraldton to the Northern Territory border. There are three managed fishing areas: Kimberley (Area 1), Pilbara (Area 2), and Gascoyne and West Coast (Area 3). The majority of the catch is taken in the Kimberley region, reflecting the tropical distribution of mackerel species (Molony et al., 2014). The Operational Area is located in the Pilbara fishing area (Area 2), where the majority of fishing activity occurs around the coastal reefs of the Dampier Archipelago and Port Hedland area, away from the Operational Area, with the seasonal appearance of mackerel in shallower coastal waters most likely associated with feeding and gonad development prior to spawning (Molony et al., 2014). The wider EMBA extends into Area 3, which extends from the Gascoyne to Cape Leeuwin. The commercial fishery takes place over about six months, when Spanish mackerel are abundant in coastal areas (Molony et al., 2014). Spanish mackerel spawn between September and January when inhabiting coastal reef areas of the North West Shelf, with females exhibiting serial spawning behaviour (spawning every one to three days) over the spawning period. Outside the main fishing season it is unclear where the mackerel populations inhabit, although there is anecdotal evidence to suggest populations move into deeper offshore waters (Fletcher & Santoro, 2014). Current data identifies the Mackerel Managed Fishery as active in the waters near the Operational Area, with three vessels catching 19 tonnes of fish over 41 days in 2017 (Department of Primary Industries and Regional Development (DPIRD),

Fishery	Fishery overlap with		Description
	Operational Area	Wider EMBA	
			2019a). Three vessels have been consistently active in the waters near the Operational Area since 2013; however, data is not available at a spatially large enough scale to determine whether actual fishing effort takes place within the Operational Area. **Fishing boundary distance from the Operational Area:** Overlaps the Operational Area. **Vessels:** Not stated for 2016 though 33 people were directly employed in the Mackerel Managed Fishery during the mackerel fishing season, primarily from May to November (Lewis and Jones, 2018); 14 vessels in 2014 (Molony et al., 2015).
Pearl Oyster Managed Fishery, Pearl Leases	✓	✓	**Description:** The fishery is separated into four zones. The Operational Area overlaps the Pearl Oyster Zone 1, which extends from North West Cape (including Exmouth Gulf) (119°30´E) to Cape Thouin (118°20´E). Fishing in Zone 1 has occurred as a low proportion (<1%) of the total annual catch after a hiatus from 2008–2013 (Hart et al., 2018). The number of wild-caught pearl oyster shell in Zone 1 was 4594 in 2016. The wider EMBA encompasses Zones 1, 2 and 3. The annual value of the total industry in 2017 was estimated to be $71 million, which is slightly lower than 2016. Primary spawning of the pearl oyster occurs from mid-October to December. A smaller secondary spawning occurs in February and March (Hart et al., 2014). The Western Australian Pearl Oyster Fishery is the only remaining significant wild-stock fishery for pearl oysters in the world (Hart et al., 2014). The species targeted is the Indo-Pacific silver-lipped pearl oyster (*Pinctada maxima*), which is collected in shallow coastal waters along the NWS using divers, and are mainly used to culture pearls. Within the wider EMBA, in the Gascoyne region, oysters are produced in hatcheries. Hatcheries in Carnarvon and Exmouth supply significant quantities of *P. maxima* spat to pearl farms in Exmouth Gulf and the Montebello Islands, while several hatcheries supply juveniles of the blacklip pearl oyster (*P. margaritifera*) to the region's developing black pearl farms. **Fishing boundary distance from the Operational Area:** The Operational Area overlaps the Pearl Oyster Zone 1. **Divers:** 19,699 diver hours (Hart et al., 2018).
Beche-de-mer Fishery	✓	✓	**Description:** The sea cucumber or 'Beche-de-mer' fishery is a hand-harvested fishery that can be conducted within all Western Australian waters. The fishery is unlikely to operate within the Operational Area due to collection methods being limited to shallow, coastal waters (methods principally by diving or wading). This nearshore fishery was predominantly a single species fishery with 99% of the catch being sandfish (*Holothuria scabra*). A deepwater species redfish (*Actinopyga echinites*) has more recently emerged as a target species, but recent catch data indicates a rapid decline in the catch of this species (50% reduction in overall catch of the fishery from 2010 to 2011). The fishery was worth an estimated $300,000 in 2017 (Hart et al., 2018b) with a total catch of 93 tonnes. There are specific areas closed to this fishery including the Dampier Archipelago and Rowley Shoals (DoF, 2012a). Recent data indicates the fishery has been active in the Montebello/Barrow Islands Group in recent years (2014, 2016 and 2017), although effort is considered to be relatively low with less than three licences operating here (DPIRD, 2019a). Fishing is usually concentrated in the Kimberley region (Gaughan & Santoro, 2018). There was no fishing activity in 2013 for this fishery (Fletcher & Santoro, 2014). **Fishing boundary distance from the Operational Area:** Overlaps the Operational Area. **Vessels:** Not applicable (shore-based).

Fishery	Fishery overlap with		Description
	Operational Area	Wider EMBA	
Marine Aquarium Managed Fishery	✓	✓	**Description:** The Marine Aquarium Fishery (MAF) can be conducted in Western Australia state waters, within the Operational Area and wider EMBA. The MAF is primarily a dive-based fishery that uses hand-held nets to capture target species operating from boats up to 8 m in length, and is therefore unlikely to operate within the Operational Area. The fishery is typically active from Esperance to Broome, with popular areas including the coastal waters of the Capes region, Dampier and Exmouth. In 2017, eight licenses operated in the MAF. The landed catch was predominantly ornamental fish but also included hermit crabs, seahorses, invertebrates, corals and live rock (Newman et al., 2014). Recent data indicates the MAF has not been active in the Montebello/Barrow Island area since 2013, when less than three vessels were active (DPIRD, 2019b). **Fishing boundary distance from the Operational Area:** Overlaps the Operational Area. **Licences:** Eleven licences were active in 2016 (Newman et al., 2018).
Specimen Shell Managed Fishery	✓	✓	**Description:** The Specimen Shell Managed Fishery can operate in Western Australia state waters, within the Operational Area and wider EMBA. Effort is concentrated in the areas adjacent to the largest population centres, such as Broome, Karratha, Exmouth, Carnarvon and Perth (Fletcher & Santoro, 2014) and is therefore unlikely to operate within the Operational Area. The Specimen Shell Managed Fishery collects specimen shells for display, collection, cataloguing and sale. Collection is predominantly by hand when diving or wading in shallow coastal waters and is therefore unlikely to operate within the Operational Area. However, deeper water collection has recently commenced with the employment of ROVs at water depths up to 300 m. Recent data shows consistent fishing in the Montebello/Barrow Island area, with less than three licences fishing in the area between 2013 and 2017 (DPIRD, 2019b). In 2017 there were 31 licence holders in the fishery, with 23 of these being active in 2016 (Hart et al., 2018c). The Specimen Shell Managed Fishery reported a total catch of 8531 shells in 2016, with a catch rate of 10–40 shells per day. **Fishing boundary distance from the Operational Area:** Overlaps the Operational Area. **Vessels:** Thirty one authorisation holders in this fishery with around seven licences recording consistent activity. The number of people employed regularly in the fishery is likely to be around 11 (Hart et al, 2018).
Onslow Prawn Managed Fishery	✓	✓	**Description:** The Onslow Prawn Managed Fishery encompasses a portion of the Pilbara region including nearshore waters and offshore waters within the Operational Area and wider EMBA (**Figure 4-13**). However, trawling activity is only permitted in seven managed nearshore areas, with strict seasonal fishing and voluntary moon closure periods for three days around the full moon period (Sporer et al., 2014). The catch was negligible in the 2015/16 season, at <1 t (Gaughan and Santoro, 2018). Recent fishing data confirmed that no fishing occurs within at least 90 km of the Operational Area (DPIRD, 2019a). **Fishing boundary distance from the Operational Area:** Overlaps the Operational Area. **Vessels:** One vessel (Kangas et al., 2018).

Fishery	Fishery overlap with		Description
	Operational Area	Wider EMBA	
Pilbara Demersal Scalefish Fisheries (Pilbara Trawl, Trap and Line)	✓	✓	**Description:** The State-regulated North Coast Demersal Fisheries comprise several management units in the Pilbara and Kimberley regions targeting a range of low and high value finfish species using several gear types (trawl, trap and line). Within the Pilbara, the Pilbara Demersal Scalefish Fisheries include the Pilbara Fish Trawl (Interim) Managed Fishery, the Pilbara Trap Managed Fishery and the Pilbara Line Fishery. The highest effort for this fishery occurs between September and May (Fletcher & Santoro, 2014). The bulk of the catch consists of small, low value fish (spangled emperor, flagfish, threadfin bream). However, larger and more valuable fish such as red emperor, jobfish and rankin cod are also targeted. The Pilbara Fish Trawl Managed Fishery is of high intensity and is divided into two zones: Zone 1 is closed to trawling and Zone 2 comprises six management areas, with Areas 3 and 6 closed to trawling (DoF, 2010). The Pilbara Fish Trawl Managed Fishery lands the largest component of the catch and operates in waters between 50 and 200 m water depth, although both zones are located outside of the Operational Area (Fletcher & Santoro, 2014) (**Figure 4-13**). The Pilbara Trap Managed Fishery covers the area from Exmouth northwards and eastwards to the 120° line of longitude, and offshore as far as the 200 m isobath. It includes six licences consolidated onto three vessels, operating principally from Onslow. Traps are limited in number with the greatest effort in waters less than 50 m depth. This fishery targets high value species such as red emperor and goldband snapper. Similar to the trawl fishery, Area 3 is closed to trapping, and trap fishing occurs in zones that are located outside of the Operational Area (Fletcher & Santoro, 2014). As such, there is likely to be no trap fishing activity in the Operational Area. The Pilbara Line Fishery encompasses all of the 'Pilbara waters' and is the smallest fishery in terms of monetary value (Fletcher & Santoro, 2014), and by annual catch (Newman et al., 2018). Area 3 is closed to line fishing. There are no stated depth limits and the western extent of the fishery is the boundary of the Australian Fishing Zone. The proposed timing of the Petroleum Activities Program may overlap with the spawning times for a number of key fish species that have the potential to spawn within the region (Spanish mackerel *S. commerson*, Sep–Jan; red emperor *Lutjanus sebae*, Aug–May, peaks in Oct–Mar; baldchin groper *Choerodon rubescens*, Sep–Feb; spangled emperor *Lethrinus nebulosus*, Sep–Dec; goldband snapper *Pristipomoides multidens,* Sep–May; rankin cod *Epinephelus multiinotatus*, Jun–Dec; blue spotted emperor *Lethrinus punctulatus,* Jun–Apr, peaks in Jul–Oct and Mar). Current data indicates less than three vessels from the Pilbara Trap Managed Fishery have been consistently active in the waters surrounding the Operational Area since at least 2013 (DPIRD, 2019a). Fishing effort for the Pilbara Trap Managed Fishery is therefore expected to occur in the wider EMBA. No vessels from the Pilbara Trawl Fishery have been active in the waters within or adjacent to the Operational Area since at least 2013 (DPIRD, 2019a). Fishing effort for the Pilbara Fish Trawl Managed Fishery is therefore expected to occur in the wider EMBA. Three or four vessels from the Pilbara Line Fishery have been active in the waters surrounding the Operational Area since at least 2013 (DPIRD, 2019a). It is expected that line fishing activity may occur in the Operational Area. **Fishing boundary distance from the Operational Area:** Overlaps the Operational Area. **Vessels:** Ten active in 2016 (two trawl, three trap and five line fishery vessels).

Fishery	Fishery overlap with		Description
	Operational Area	Wider EMBA	
South West Coast Salmon Managed Fishery	✓	✓	**Description:** The South West Coast Salmon Managed Fishery operates on various beaches south of metropolitan Perth and includes all Western Australian waters north of Cape Beaufort except Geographe Bay. This fishery uses beach seine nets to take Western Australian salmon (*Arripis truttaceus*). No fishing takes place north of the Perth metropolitan area, despite the managed fishery boundary extending to the Western Australia/Northern Territory border. No interactions with participants in the fishery will occur during the Petroleum Activities Program. **Fishing boundary distance from the Operational Area:** Overlaps the Operational Area. **Vessels:** Not applicable (shore-based).
West Coast Deep Sea Crustacean Managed Fishery	✓	✓	**Description:** The West Coast Deep Sea Crustacean Managed Fishery operates outside of the Operational Area but within the wider EMBA, targeting crystal (snow) crabs (*Chaceon albus*), giant (king) crabs (*Pseudocarcinus gigas*) and champagne (spiny) crabs (*Hypothalassia acerba*) using baited pots operated in a long-line formation in the shelf edge waters (>150 m but mostly in depths of 500–800 m) of the west coast. The fishery has an estimated value of $4.8 million. In 2016, two vessels reported a total catch of 153.3 t. **Fishing boundary distance from the Operational Area:** Partially overlaps the Operational Area. **Vessels:** Two active in 2016 (How and Yerman, 2018).
Abalone Fishery	✓	✓	**Description:** The Western Australian Abalone Fishery includes all coastal waters from the Western Australian and South Australian border to the Western Australian and Northern Territory border. Shark Bay is considered the northern range limit for the commercial abalone species (DoF, 2004) and therefore operates outside of the Operational Area but within the wider EMBA. In addition, abalone is harvested by hand using an abalone iron from reefs and rock shelves within Western Australian waters (DoF, 2004), limiting the fishery to shallow waters. The abalone fishery targets the greenlip abalone (*Haliotis laevigata*), brownlip abalone (*H. conicopora*) and Roe's abalone (*H. roei*) (DoF, 2004). The commercial fishery was valued at $1.17 million in 2016. The commercial fishery reported a total commercial catch of 49 t in 2016. **Fishing boundary distance from the Operational Area:** Overlaps the Operational Area. **Vessels:** Twenty-two vessels active in Roe's abalone fishery (Strain et al., 2018).
Nickol Bay Prawn Managed Fishery	x	✓	**Description:** The Nickol Bay Prawn Managed Fishery operates in nearshore and offshore waters of the Pilbara region along the NWS, outside of the Operational Area but within the wider EMBA region (**Figure 4-13**). The major species caught for this fishery are the banana prawn, king prawn and tiger prawn. The season for this fishery extends from March to November, with several specific areas restricted to May to September to protect nursery areas (Sporer et al., 2014). Trawling has been reported to occur at several locations along the Pilbara coast to the east of the Burrup Peninsula including within the waters of Nickol Bay (Fletcher & Santoro, 2014). **Fishing boundary distance from the Operational Area:** 160 km east of the Operational Area. **Vessels:** The precise number of vessels is unreported, though low effort produced a catch of 17 t in 2016 (Kangas et al., 2018).

Fishery	Fishery overlap with		Description
	Operational Area	Wider EMBA	
Exmouth Gulf Prawn Managed Fishery	x	✓	**Description:** The Exmouth Gulf Prawn Managed Fishery is a limited entry fishery comprising about 16 vessels operating outside of the Operational Area but within the wider EMBA region out of Exmouth and bases to the south. The fishery occupies a total area of 4000 km² with only half of this area being trawled (Sporer et al., 2014). The major species caught in Exmouth Gulf are western king prawn, tiger prawn, endeavour prawn and banana prawn. Coral prawns are also caught and sold but are considered a by-product of the fishery. The fishing season extends from April to mid-November, with activities within the fishing area being further restricted by sequential closures to protect the permanent prawn nursery area. In the 2016 season, a fishing effort of about 23,000 hours resulted in a catch of 822 t. **Fishing boundary distance from the Operational Area:** 164 km south west of the Operational Area. **Vessels:** The precise number of vessels is unreported; however, 18 people are employed in this fishery (Gaughan and Santoro, 2018).
Gascoyne Demersal Scalefish Fishery	x	✓	**Description:** The Gascoyne Demersal Scalefish Fishery (GDSF) is located between the southern Ningaloo Coast to south of Shark Bay (23°07.30'S to 26°30'S) with a closure area at Point Maud to Tantabiddi (21°56.30'S). The GDSF comprises commercial and recreational fishing for demersal scalefish in the continental waters of the Gascoyne Coast Bioregion (Fletcher & Santoro, 2014), operating outside of the Operational Area but within the wider EMBA. Since November 2010, the GDSF has incorporated vessels that previously operated as the Shark Bay Snapper Fishery, a limited number of open-access wetline vessels and recreational fishing vessels, both licensed charter and private (Fletcher & Santoro, 2014). Commercial vessels have traditionally targeted the oceanic stocks of pink snapper (*Pagrus auratus*) during the winter months (fishing spawning aggregations in the peak season of June–July). The present GDSF continues with this pink snapper fishery and, in addition, fisheries operating throughout the year targeting other demersal species including the goldband snapper (*Pristipomoides* spp.), red emperor (*Lutjanus sebae*), emperors and cod. The GDSF reported a total commercial catch of 270 t in 2016. **Fishing boundary distance from the Operational Area:** 365 km south of the Operational Area. **Vessels:** Seventeen vessels (Gaughan and Santoro, 2018).
Shark Bay Blue Swimmer Crab Fishery	x	✓	**Description:** The blue swimmer crab (*Portunus armatus*) resource in Shark Bay is harvested commercially by the Shark Bay crab trap and Shark Bay prawn trawl fisheries, both of which operate outside of the Operational Area but within the wider EMBA. Commercial fishing for blue swimmer crabs in Shark Bay was voluntarily halted by industry in April 2012 to facilitate stock rebuilding. The stock is still in a recovery phase; however, the fishery has resumed and reported a total commercial catch of 372 t in the 2015/16 season (Chandrapavan et al., 2017). **Fishing boundary distance from the Operational Area:** The Shark Bay Blue Swimmer Crab Fishery is located 523 km south of the Operational Area. **Vessels:** The precise number of vessels in the Shark Bay Blue Swimmer Crab Fishery is unreported; however, about 110 people are employed in this fishery (Gaughan and Santoro, 2018).

<table>
<tr><th rowspan="2">Fishery</th><th colspan="2">Fishery overlap with</th><th rowspan="2">Description</th></tr>
<tr><th>Operational Area</th><th>Wider EMBA</th></tr>
<tr><td>Shark Bay Prawn and Scallop Managed Fisheries</td><td>x</td><td>✓</td><td>Description: The Shark Bay Prawn Managed Fishery is the highest producing Western Australian fishery for prawns. It targets the western king prawn (Penaeus latisulcatus) and brown tiger prawn (Penaeus esculentus) and takes a variety of smaller prawn species including endeavour prawns (Metapenaeus spp.) and coral prawns (various species). In 2017, the value of the fishery was $24 million.
The Shark Bay Scallop Managed Fishery targets the saucer scallop (Amusium balloti) and is usually WA's most productive scallop fishery, but is currently in a recovery phase due to the results from the pre-season survey of stock abundance (Fletcher & Santoro, 2014; Kangas et al., 2017).
They are limited entry and both use low opening, otter trawls as the fishing method and incorporate in-season real time management to ensure sustainability and maximise economic efficiency. The Shark Bay Prawn Managed Fishery reported a catch of 1529 t, and the Shark Bay Scallop Managed Fishery reported a catch of 192 t (meat weight).
Fishing boundary distance from the Operational Area: The Shark Bay Scallop Managed Fishery and Shark Bay Prawn Managed Fishery management boundaries are located 427 km south of the Operational Area.
Vessels: The precise number of vessels in the Shark Bay Prawn Managed Fishery is unreported; however, about 100 people are employed in this fishery (Gaughan and Santoro, 2018). About 20 skippers and crew are employed in scallop fishing in the Shark Bay and South Coast fisheries</td></tr>
<tr><td>West Coast Rock Lobster Fishery</td><td>x</td><td>✓</td><td>Description: The West Coast Rock Lobster Fishery operates outside of the Operational Area but within the wider EMBA, targeting the western rock lobster (Panulirus cygnus) from Shark Bay south to Cape Leeuwin using baited traps (pots). In 2008, it was determined that the allocated shares of the West Coast Rock Lobster resource would be 95% for the commercial sector, 5% to the recreational sector, and one tonne to customary fishers.
The commercial fishery has been Australia's most valuable single-species wild capture fishery. In 2012/2013, the fishery moved to an Individually Transferable Quota fishery. The fishery is managed using zones, seasons and total allowable catch. The recreational fishery targets the western rock lobsters using baited pots and by diving between North West Cape and Augusta in water depths of less than 20 m. In 2016, 226 vessels reported a total catch of 6086 t (Gaughan and Santoro, 2018).
Fishing boundary distance from the Operational Area: 290 km south-west of the Operational Area.
Vessels: 226 vessels (Gaughan and Santoro, 2018).</td></tr>
<tr><td>Octopus Fishery</td><td>x</td><td>✓</td><td>Description: The octopus fishery in Western Australia operates outside of the Operational Area but within the wider EMBA, primarily targeting Octopus cf. tetricus, with occasional by-catch of O. ornatus and O. cyanea in the northern parts of the fishery, and O. maorum in the southern and deeper sectors. The developing Octopus Fishery operates from Kalbarri Cliffs in the north to Esperance in the south, and uses both passive shelter pots and active traps. In 2016 the fishery had an estimated value of $2.1 million (Hart et al., 2018d). In 2016, about 200 vessels reported a total catch of 252 t (Hart et al., 2018d).
Fishing boundary distance from the Operational Area: Over 700 km south of the Operational Area.
Vessels: About 20 vessels fish within the octopus specific fisheries, and about 200 vessels from the West Coast Rock Lobster Fishery catch octopus as by-catch (Gaughan and Santoro, 2018).</td></tr>
</table>

Fishery	Fishery overlap with		Description
	Operational Area	Wider EMBA	
West Coast Demersal Scalefish Fisheries	x	✓	**Description:** These fisheries target a suite of inshore (20–250 m water depth) and offshore (>250 m water depth) demersal scalefish species operating outside of the Operational Area but within the wider EMBA. These fisheries include the West Coast Demersal Scalefish (interim) Managed Fishery (51 boats), the West Coast Demersal Gillnet and Demersal Longline (Interim) Managed Fishery and the temperate Demersal Gillnet and Demersal Longline Fisheries. The West Coast Demersal Scalefish Managed Fishery is the main commercial fishery that targets demersal species in the West Coast Bioregion. It encompasses the waters from just south of Shark Bay down to just east of Augusta and extends seaward to the 200 nm boundary. The fishery is divided into four inshore management areas and one offshore management area. In 2016, the West Coast Demersal Scalefish (interim) Managed Fishery reported a total catch of 256 t. **Fishing boundary distance from the Operational Area:** 730 km south of the Operational Area. **Vessels:** The precise number of vessels in the West Coast Demersal Scalefish Fisheries is unreported; however, about 100 people are employed in this fishery which is restricted to 59 interim managed fishery permit holders.

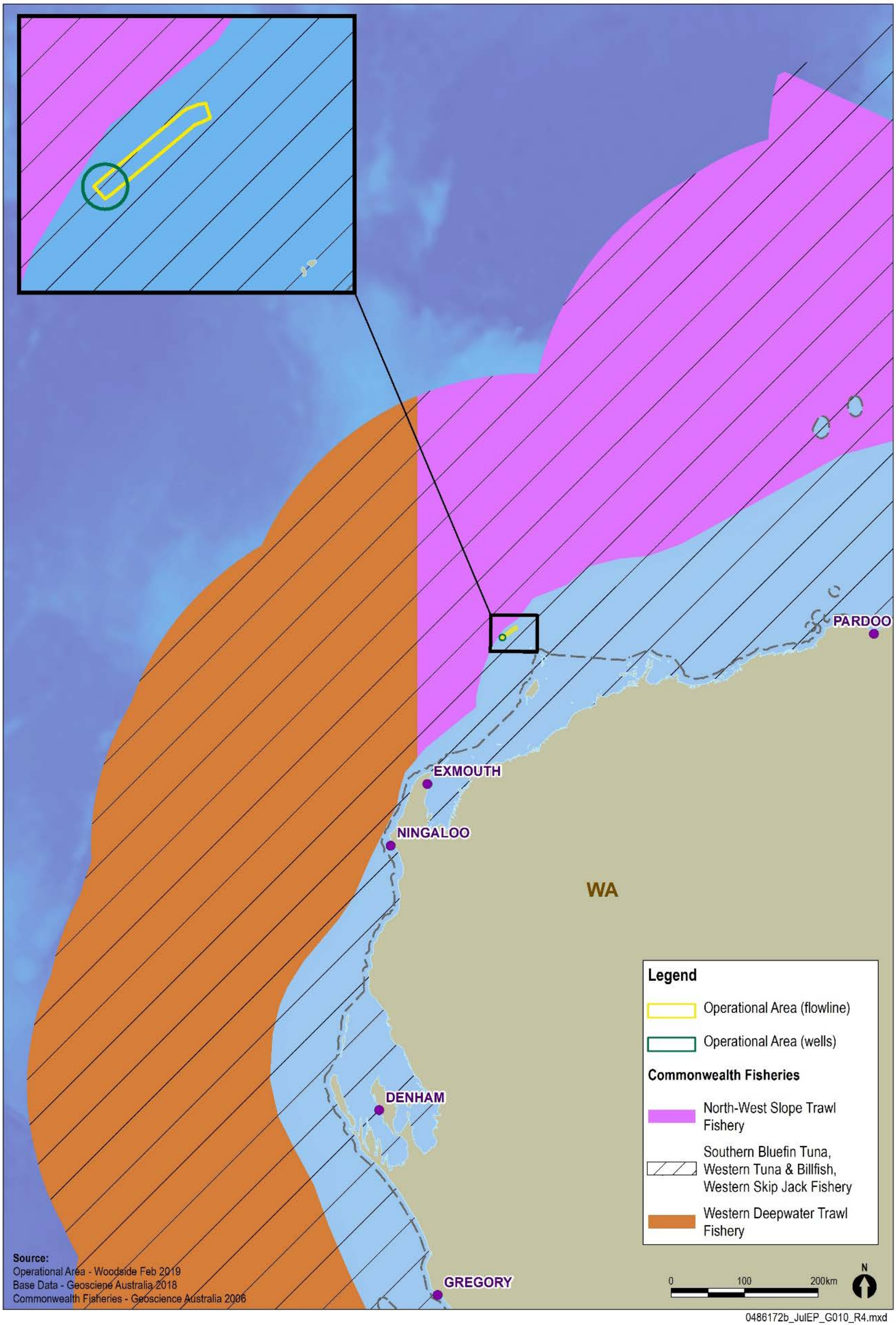

Figure 4-12: Location of Commonwealth fisheries in relation to the Operational Area

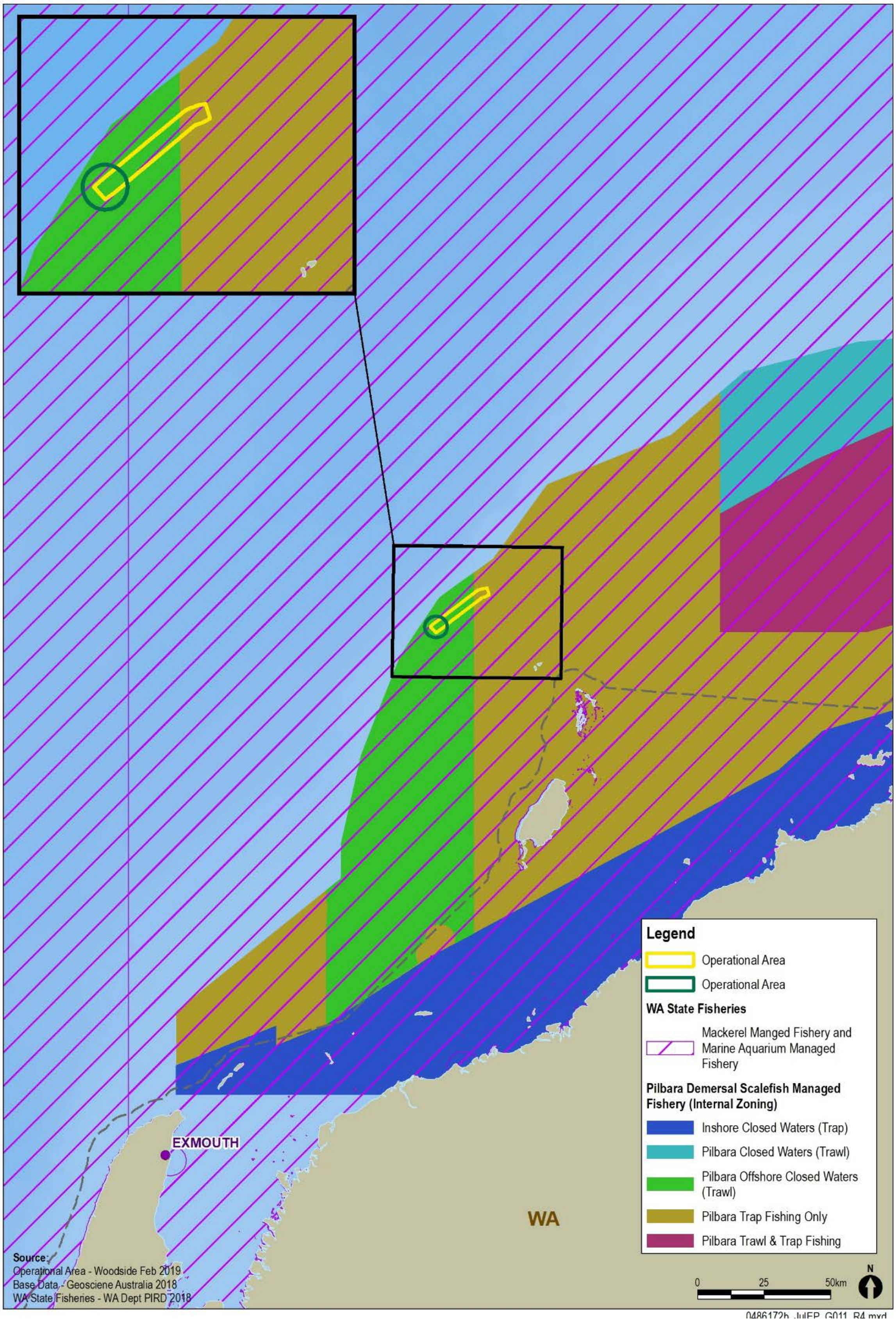

Figure 4-13: Location of State fisheries in relation to the Operational Area

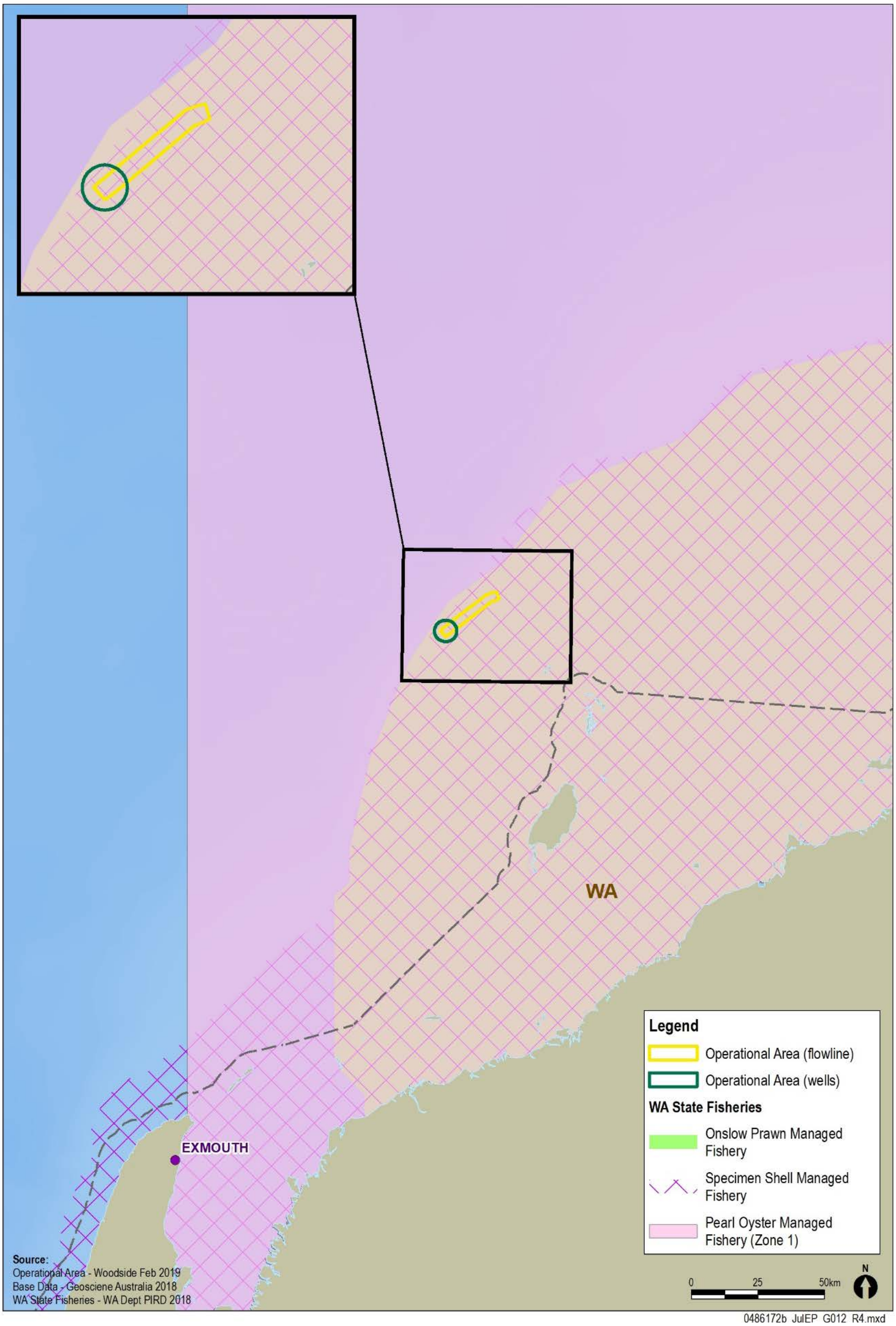

Figure 4-14: Location of State fisheries in relation to the Operational Area

Aquaculture

There are no aquaculture activities within or adjacent to the Operational Area. Aquaculture in the wider region is typically restricted to shallow coastal waters and consists primarily of culturing hatchery, reared and wild caught oysters (*Pinctada maxima*) for pearl production.

Pearl farm site locations nearest to the Operational Area, in the wider EMBA, are those at the Montebello Islands. In the Gascoyne Coast region oyster, hatcheries are important, with those located in Carnarvon and Exmouth supplying significant quantities of *P. maxima* spat to pearl farms in Exmouth Gulf and Montebello Islands (DoF, 2011). Leases typically occur in shallow coastal waters at depths of less than 20 m (DoF, 2011).

Primary spawning of the pearl oyster occurs from mid-October to December. A smaller secondary spawning occurs in February and March (Fletcher & Santoro, 2012).

4.6.4 Fisheries – Traditional

There are no traditional, or customary, fisheries within the Operational Area, as these are typically restricted to shallow coastal waters and/or areas with structures such as reef. However, it is recognised that Barrow Island, Montebello Islands, Exmouth, Ningaloo Reef and the adjacent foreshores have a known history of fishing when areas were occupied (as from historical records). Areas that are covered by registered native title claims are likely to practice Aboriginal fishing techniques at various sections of the Western Australia coastline.

4.6.5 Tourism and Recreation

No tourism activities take place specifically within the Operational Area but it is acknowledged that there are growing tourism and recreational sectors in Western Australia. These sectors have expanded in area over the last couple of decades. Potential for growth and further expansion in tourism and recreational activities in the Pilbara and Gascoyne regions is recognised, particularly with the development of regional centres and a workforce associated with the resources sector (Gascoyne Development Commission, 2012).

Recreational fishing in the North West Shelf Province is mainly concentrated around the coastal waters and islands (including Dampier Archipelago, Ningaloo Marine Park, North West Cape area, the Montebello Islands, and other islands and reefs in the region) (DoF, 2011). It has grown exponentially with the expanding regional centres and increasing residential and fly in/fly out work force, particularly in the Pilbara region. Occasional recreational fishing occurs at Rankin Bank and Glomar Shoals (located about 47 km and 149 km from the Operational Area, respectively). The Montebello Islands (48 km from the Operational Area) are the next closest location for tourism, with some charter boat operators taking visitors to these remote islands (DEC, 2013).

Within the wider EMBA, tourism is one of the major industries of the Gascoyne region and contributes significantly to the local economy in terms of both income and employment. The main marine nature-based tourist activities are concentrated around and within the Ningaloo Marine Park and North West Cape area. Activities include recreational fishing, snorkelling and scuba diving, whale shark encounters (April to August) and manta rays (September to November), whale watching (July to October) and turtle watching (all year round) (Shire of Exmouth). Recreational use of the Ningaloo Marine Park varies in intensity throughout the year, depending on school holidays and seasonal peaks of marine fauna being observed. Coral Bay is documented as one of the most heavily used areas (MPRA, 2005).

4.6.6 Shipping

The region supports commercial shipping activity, the majority of which is associated with the mining and oil & gas industries (**Figure 4-15**). AMSA has introduced a network of marine fairways on the NWS of WA to reduce the risk of vessel collisions with offshore infrastructure. The fairways are not mandatory but AMSA strongly recommends commercial vessels remain within the fairway when transiting the region. None of these fairways intersect with the Operational Area and only light traffic occurs in the Operational Area as a whole (**Figure 4-15**). Major shipping routes in the area are associated with entering the ports of Dampier and Barrow Island. Shipping activities in the region include:

- international bulk freighters/tankers arriving and departing from Dampier including mineral ore, hydrocarbons (LNG, liquefied petroleum gas, condensate) and salt carriers
- domestic support/supply vessels servicing offshore facilities and Barrow Island development
- construction vessels/barges/dredges
- offshore survey vessels.

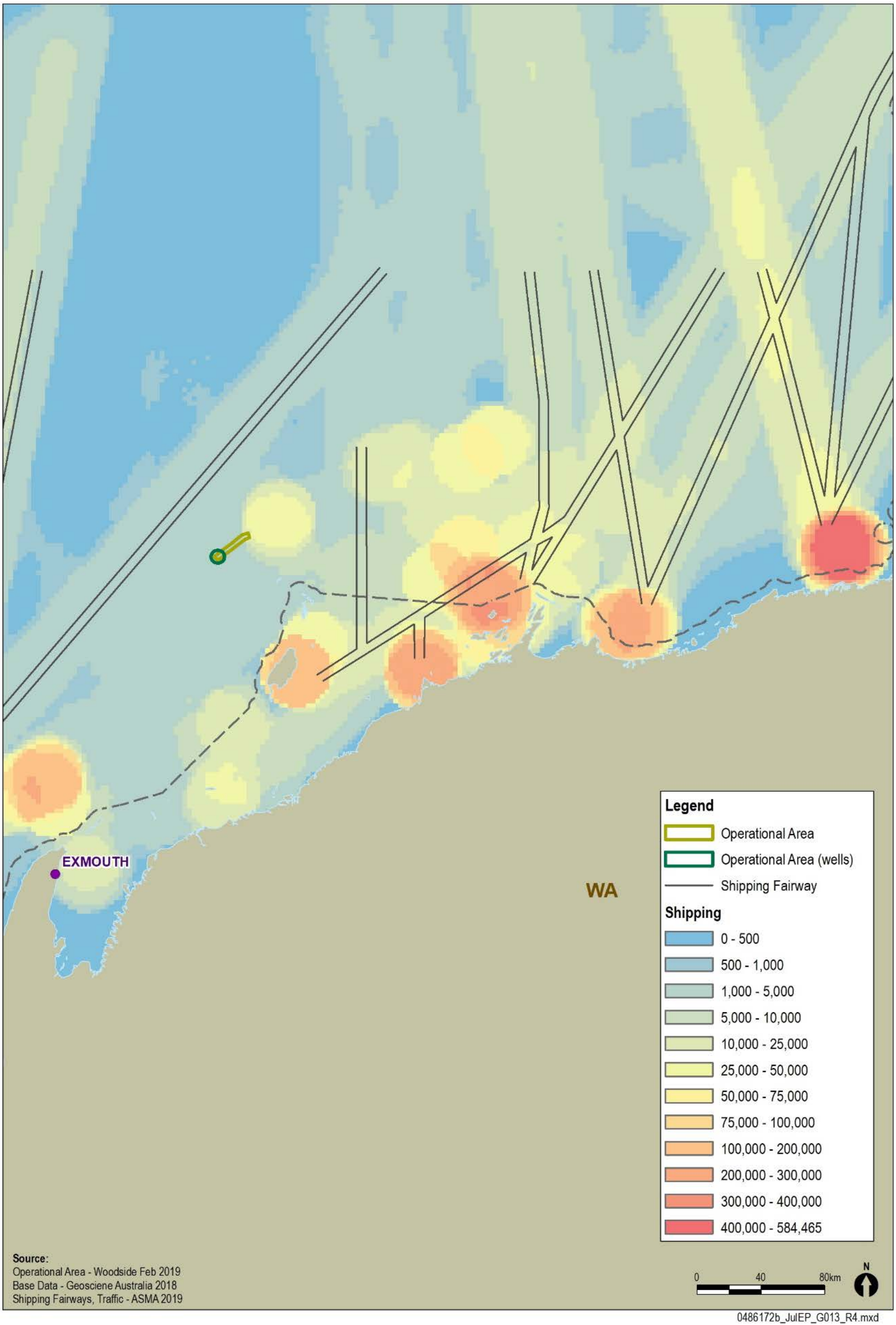

Figure 4-15: Vessel density map for the Operational Area from 2013, derived from AMSA satellite tracking system data

4.6.7 Existing Oil and Gas Infrastructure

The Operational Area is located within an area of established oil and gas operations, with additional infrastructure in the broader North West Shelf region (**Figure 3-2**). **Table 4-9** details other facilities located in proximity to the Operational Area. Subsea infrastructure is also present in the Operational Area, including the subsea wellheads, umbilicals and flowlines that form the Julimar Field Production System and intercept the north east portion of the Operational Area (**Figure 3-2**). Six abandoned appraisal wells with wellheads are also located in Permit Area WA-49-L (**Figure 3-2**).

Table 4-9: Other oil and gas operations located within the area

Facility Name and Owner	Approximate Distance from Operational Area	Direction
Pluto Platform (operated by Woodside)	16 km	East-north-east
Wheatstone Platform (operated by Chevron)	20 km	North-east
John Brookes (operated by Quadrant Energy)	29 km	South
East Spar (operated by Quadrant Energy)	59 km	South
Goodwyn (operated by Woodside)	85 km	North-east
North Rankin (operated by Woodside)	108 km	North-east

4.6.8 Defence

There are designated defence practice areas in the offshore marine waters off Ningaloo and the North West Cape in the wider EMBA. The Operational Area lies within the northern tip of one of these defence practice areas: the Royal Australian Air Force Base Learmonth. The closest site where unexploded ordinance is known to occur is 8 km east of Trimouille Island in depths of about 40 metres, located about 60 km south east of the Operational Area.

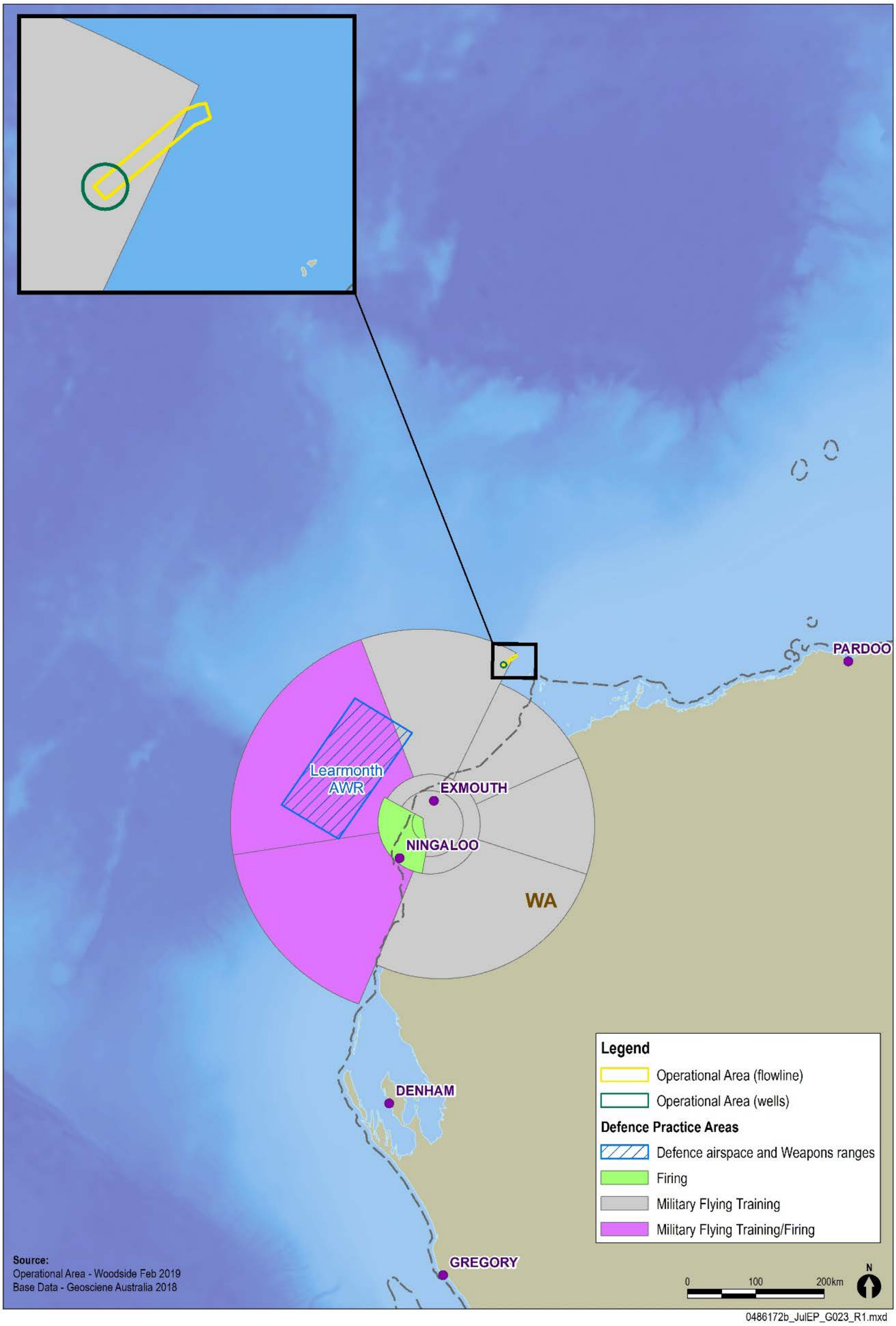

Figure 4-16: Department of Defence demarcated marine offshore areas for military and defence practice with reference to the location of the Operational Area

4.7 Values and Sensitivities

The values and sensitivities of the Operational Area and wider regional perspective are presented in this section.

The nearest habitats of significant conservation value to the Operational Area are the Ancient Coastline at 125 m depth contour (KEF), and Continental Slope Demersal Fish Communities (KEF) which both spatially overlap the Operational Area. The offshore environment of the North West Shelf Province contains environment (such as habitat and species) of high value or sensitivity including Commonwealth offshore waters, as well as the wider regional context including coastal waters and habitats such as the Montebello/Barrow/Lowendal Island Group. Sensitivities include the associated resident, temporary or migratory marine life including EPBC Act species such as marine mammals, turtles and birds. The marine environment of these offshore locations is pristine and many sensitive receptor locations are protected as part of Commonwealth and State managed areas, including the 2017 proclaimed network of North West Marine Bioregion AMPs.

The following section outlines the values and sensitivities of the established and proposed Marine Protected Areas (MPAs) and other sensitive areas in the wider regional environmental setting (listed in **Table 4-10** and illustrated in **Figure 4-17**) that may be impacted by the Petroleum Activities Program (planned and unplanned).

Table 4-10: Summary of established and proposed MPAs and other sensitive locations in the region relating to the Operational Area

	Distance from Operational Area to Values/Sensitivity Boundaries (km)	International Union for Conservation of Nature (IUCN) Protected Area Category
Nearest Habitats of Significant Conservation Value		
Ancient Coastline at 125 m Depth Contour (KEF)	Overlaps	N/A
Continental Slope Demersal Fish Communities	Overlaps	N/A
Montebello AMP	3.7	VI – Multiple Use Zone
Established Australian Marine Parks		
Gascoyne AMP	145	II – Marine National Park Zone IV – Habitat Protection Zone VI – Multiple Use Zone
Ningaloo AMP	185	II – Recreational Use Zone
Argo-Rowley Terrace AMP	280	II – Marine National Park Zone VI – Multiple Use Zone
Shark Bay AMP	502	VI – Multiple Use Zone
Carnarvon Canyon AMP	513	IV – Habitat Protection Zone
Abrolhos AMP	660	IV – Habitat Protection Zone

	Distance from Operational Area to Values/Sensitivity Boundaries (km)	International Union for Conservation of Nature (IUCN) Protected Area Category
State Marine Parks and Nature Reserves		
Established		
Montebello Islands Marine Park/Barrow Island Marine Park/Barrow Island Marine Management Area	40	Ia – Sanctuary Zone
Lowendal Islands Nature Reserve	71	Ia – Sanctuary Zone
Barrow Island Nature Reserve (including the Boodie, Double and Middle Islands Nature Reserve)	61	Ia – Sanctuary Zone
Pilbara Islands – Southern Island Group (Serrurier, Thevenard, Bessieres, Airlie and Round Islands Nature Reserves)	135	Ia – Sanctuary Zone
Ningaloo Marine Park*	185	Ia – Sanctuary Zone II – Marine National Park Zone
Muiron Islands Marine Management Area*	168	Ia – Sanctuary Zone (islands) II – Marine National Park Zone
Eighty Mile Beach Marine Park	446	VI – Multiple Use Zone II – Recreational Use Zone
Proposed		
Nil		
World Heritage Areas (WHA)		
The Ningaloo Coast WHA	168	N/A
Shark Bay WHA	542	N/A
KEFs		
Ancient Coastline at 125 m Depth Contour	Overlaps	N/A
Continental Slope Demersal Fish Communities	Overlaps	N/A
Exmouth Plateau	85	N/A
Glomar Shoals	149	N/A
Canyons Linking the Cuvier Abyssal Plain and the Cape Range Peninsula	143	N/A
Commonwealth Waters Adjacent to Ningaloo Reef	185	N/A
Wallaby Saddle	675	N/A
Western Demersal Slope and associated fish	669	N/A
Canyons linking the Argo Abyssal Plain and Scott Plateau	757	N/A
Other Sensitivities		
Rankin Bank	47	N/A

** Muiron Islands (Marine Management Area) is managed under the same management plan as the State Reserve of Ningaloo (MPRA, 2005)*

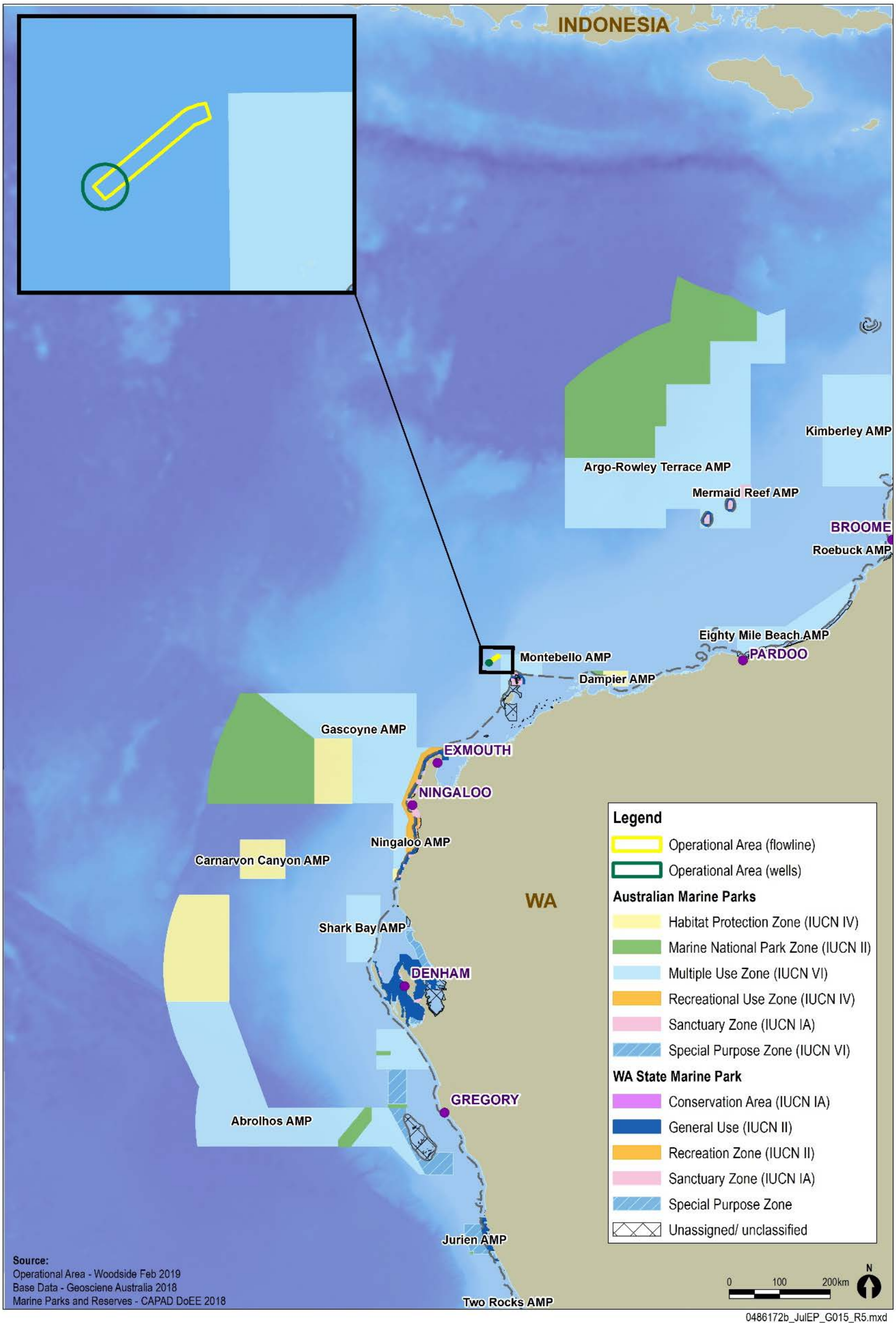

Figure 4-17: Established and proposed Commonwealth and State MPAs in relation to the Operational Area

4.7.1 Sensitive Receptors within the Operational Area

4.7.1.1 The Ancient Coastline at the 125 m Depth Contour

The ancient coastline at 125 m depth contour is listed as a KEF in the Operational Area EPBC Act Protected Matters Search Report (**Appendix C**) and partially overlaps with the Operational Area. The conservation and environmental values of this KEF are detailed in **Section 4.7.11**.

4.7.1.2 Continental Slope Demersal Fish Communities

The Continental Slope Demersal Fish Communities is listed as a KEF in the Operational Area EPBC Act Protected Matters Search Report (**Appendix C**) and partially overlaps the Operational Area. The conservation and environmental values of this KEF are detailed in **Section 4.7.11**.

4.7.2 Montebello Australian Marine Park

The Montebello Marine Park covers about 3413 km² and ranges in depth from less than 15 to 150 m. At its closest point, the Montebello Marine Park lies about 3.7 km east of the Operational Area (**Figure 4-7**). The reserve lies about 20 km north of Barrow Island and 125 km west of Dampier, and contains several conservation values including:

- foraging and staging areas adjacent to important breeding areas for migratory seabirds
- breeding habitat for seabirds (includes the largest breeding population of roseate terns in western Australia) (DSEWPaC, 2012d)
- foraging areas for Vulnerable and Migratory whale sharks
- foraging areas adjacent to important nesting sites for marine turtles
- part of the migratory pathway and resting area of the protected humpback whale (DSEWPaC, 2012e)
- heritage site the wreck of the Trial – the earliest known shipwreck in Australian waters (Director of National Parks, 2013).

The Marine Park includes shallow shelf environments and provides protection for shelf and slope habitats, as well as pinnacle and terrace seabed features. Examples of the seabed habitats and communities of the NWS as well as the Pilbara (offshore) meso-scale bioregion (Heap et al., 2005) are found within the Marine Park. The Montebello Marine Park also includes a small portion of the Ancient Coastline at 125 m Depth Contour KEF, which is a unique seabed feature that provides areas of enhanced biological productivity.

The Montebello Marine Park is zoned as a multiple use zone (IUCN VI), allowing for long-term protection and maintenance of the AMP in conjunction with sustainable use, including oil and gas exploration activities. The AMP is contiguous with the existing Montebello Marine Park in State waters.

4.7.3 Montebello/Barrow/Lowendal Islands

The marine and coastal environments of the Montebello/Barrow/Lowendal Islands region represent a unique combination of offshore islands, intertidal and subtidal coral reefs, mangroves, macroalgal communities and sheltered lagoons, and are considered a distinct coastal type with very significant conservation values (Department of Environment and Conservation (DEC), 2007).

4.7.3.1 Montebello Islands Marine Park/Barrow Island Marine Park/Barrow Island Marine Management Area

The Montebello Islands Marine Park, Barrow Island Marine Park and Barrow Island Marine Management Area are jointly managed and cover a combined area of 1770 km², located about 39 km south east of the Operational Area. The reserves' park area encompasses a complex seabed and island topography with coastlines dominated by cliffs, beaches, sheltered lagoons and channels. As a result of this complexity, the park area is characterised by a diverse range of communities including subtidal coral reefs, macroalgal and seagrass communities, subtidal soft-bottom communities, rocky shores, intertidal reef platforms and mangrove communities (MPRA, 2007). A Sanctuary Zone covers the entire Barrow Island Marine Park, giving the 4100 ha park the highest percentage of 'no take' areas of any marine park in WA (Chevron, 2010). The Barrow Island Marine Management Area covers 114,500 ha and includes most of the waters surrounding Barrow Island and Lowendal Islands, except for the port areas around Barrow and Varanus islands. Key conservation and environmental values within the reserves include (DEC, 2007):

- a complex seabed and island topography consisting of subtidal and intertidal reefs, sheltered lagoons, channels, beaches, cliffs and rocky shores
- pristine sediment and water quality, supporting a healthy marine ecosystem
- undisturbed intertidal and subtidal coral reefs and bommies with a high diversity of hard corals
- important mangrove communities, particularly along the Montebello Islands, which are considered globally unique as they occur in offshore lagoons
- extensive subtidal macroalgal and seagrass communities
- important habitat for cetaceans and dugongs
- nesting habitat for marine turtles
- important feeding, staging and nesting areas for seabirds and migratory shorebirds
- rich finfish fauna with at least 456 species
- culture of the pearl oyster (*Pinctada maxima*) in the reserves, producing some of the highest quality pearls in the world (DEC, 2007).

These islands support significant colonies of wedge-tailed shearwaters and bridled terns. The Montebello Islands support the biggest breeding population of roseate terns in Western Australia. Ospreys, white-bellied sea-eagles, eastern reef egrets, Caspian terns, and lesser crested terns also breed in this area. Observations suggest an area to the west of the Montebello Islands may be a minor zone of upwelling in the region, supporting large feeding aggregations of terns. There is also some evidence that the area is an important feeding ground for Hutton's shearwaters and soft-plumaged petrels. Barrow Island is ranked equal tenth among 147 sites in Australia that are important for migratory shorebirds. Barrow, Lowendal and Montebello islands are internationally significant sites for six species of migratory shorebirds, supporting more than 1% of the East Asian–Australasian Flyway population of these species (DSEWPaC, 2012d).

The Montebello Islands Marine Park/Barrow Island Marine Park/Barrow Island Marine Management Area is contiguous with the Montebello Australian Marine Park. The intertidal habitats of the Montebello/Barrow/Lowendal Islands region are influenced by the passage of regular tropical cyclones that shape sandy beaches (RPS, 2005). The dominant habitats on the exposed west coasts of islands in the area are sandy beaches, rocky shores and cliffs. The predominant physical habitats of the sheltered east coasts of islands are sand flats, mud flats, rocky pavements and platforms (RPS, 2005).

4.7.3.2 Barrow Island Nature Reserve

The Barrow Island Nature Reserve is a Class A Nature Reserve covering about 235 km² and extends to the low water mark adjacent to the Montebello Islands/Barrow Island Marine Parks. The Reserve lies about 67 km from the Operational Area and adjoins the wider EMBA. The islands surrounding Barrow Island including Boodie, Double and Middle Islands make up the Boodie, Double and Middle Islands Nature Reserve, covering 587 ha (DPaW, 2015). Together, these two nature reserves are commonly referred to as the Barrow Group Nature Reserves (DPaW, 2015).

The Barrow Island coastline consists of dry creek beds, beaches, clay and salt flats, mangroves, intertidal flats and reefs and is bordered by high cliffs on the western side (DoE, 2014c). Key conservation values within the reserves include (DEC, 2011):

- significant habitat values, such as intertidal mudflats, rock platforms, mangroves, rock piles and cliffs, clay pans and caves
- diverse range of marine habitats and associated primary producer communities, including corals, seagrasses and macroalgae
- important biological refuge, as it contains an array of endemic species (some of which are extinct or near-extinct on the mainland)
- significant number of fauna species with high conservation values (e.g. turtles and birds)
- important mammal conservation area
- important habitat and migration terminus for migratory shorebirds
- regionally and nationally significant turtle rookeries (especially green and flatback turtles).

4.7.3.3 Lowendal Islands Nature Reserve

The Barrow Island Marine Management Area includes the waters around the Lowendal Islands, which covers 114,500 ha. The Lowendal Islands Nature Reserve incorporates the islands of the Lowendal Archipelago, about 69 km south east of the Operational Area and 15 km south of Montebello Islands. The Lowendal Islands Group is made up of 34 islands and islets, with the largest being Varanus Island at 83 ha. The islands are limestone rocks that extend a few metres above the sea level and have sparse vegetation (DSEWPaC, 2012a).

Key conservation values within the reserve include:

- feeding and breeding habitat for the shorebirds including the common greenshank, common sandpiper and the red-necked stint
- foraging habitat for hawksbill turtles
- support for resident populations of common bottlenose dolphins and Indo-Pacific humpback dolphins
- critical nesting and internesting habitat for hawksbill turtles (Varanus Island), and support for an important flatback turtle rookery
- support for seabird colonies for species such as the wedge-tailed shearwaters and bridled terns
- foraging and staging area for migratory shorebirds (DSEWPaC, 2012a) and internationally significant site for six species of migratory shorebirds, supporting more than 1% of the East Asian–Australasian Flyway population for these species
- seagrass habitat for dugongs.

4.7.4 Pilbara Islands

Within the nearshore waters between the Muiron Islands and the Dampier Archipelago are a series of islands collectively termed the Northern, Middle and Southern Island Groups. This area has been defined as the Pilbara offshore region (greater than 10 m water depth) and includes islands, shoals and rocky outcrops.

The Northern Island Group and Middle Island Group, including the Great Sandy Islands Nature Reserve, the Passage Islands, the Mary Anne Reefs and neighbouring small islands, are outside the wider EMBA and will therefore not be discussed further in this EP. The Southern Island Group includes Serrurier, Bessieres and Thevenard Islands Nature Reserves, which lie about 135 km from the Operational Area but within the wider EMBA. The nearshore habitats of these islands generally consist of fringing reefs on the seaward side and wide intertidal sand flats on the leeward side. Despite generally high turbidity in the area and relatively low abundance, hard coral biodiversity is high (Chevron, 2010). The coral community structure within this area, and others within the region, is highly temporally variable due to cyclonic activity.

The large islands of the groups provide important nesting habitat for seabirds and marine turtles (Chevon, 2010). In the Southern Island Group, a number of seabirds, including Caspian terns, little terns, wedge-tailed shearwaters and ospreys breed on Serrurier Island and nearby Airlie Island. Serrurier Island also is a major nesting area for green turtles and may also be a foraging area for this species. Thevenard Island supports a significant flatback turtle rookery, along with small numbers of green turtles and a known feeding area for green turtles.

Chevron (2010) documented the key subtidal habitats of the Pilbara offshore region as:

- limestone pavement supporting dense macroalgae
- biogenic fringing coral reefs
- coral communities associated with hard substrate (shoals and rocky outcrops)
- filter feeding communities (sponges and ascidians) on sand veneered pavement
- sand/gravel plains and shoals supporting sparse foliose macroalgae.

4.7.5 Ningaloo Coast and Gascoyne

4.7.5.1 The Ningaloo Coast World Heritage Area

The Ningaloo Coast WHA includes North West Cape and the Muiron Islands, and was inscribed under criteria (vii) and criteria (x) by the World Heritage Committee onto the World Heritage Register in June 2011. The Ningaloo Coast WHA is located about 168 km south west of the Operational Area but within the wider EMBA. The statement of Outstanding Universal Value for the Ningaloo Coast was based on the natural criteria and recognised that it contained:

- land seascapes comprised of mostly intact and large-scale marine, coastal and terrestrial environments
- lush and colourful underwater scenery and its contrast with the arid and rugged land
- annual aggregation of whale sharks, one of the largest in the world
- important aggregations of other fish species and marine mammals
- high marine diversity, including an unusual diversity of marine turtle species
- rare and diverse subterranean creatures found nowhere else in the southern hemisphere
- diversity of reptiles and vascular plants in the drylands.

The Ningaloo Coast WHA is recognised as being of outstanding conservation value, supporting a rich array of habitats and a diverse and abundant marine life (DoE, 2014d). The region has a high diversity of marine habitats including coastal mangrove systems, lagoons, coral reef, open ocean, continental slope and the continental shelf (MPRA, 2005). The dominant feature of the Ningaloo Coast WHA is Ningaloo Reef, the largest fringing reef in Australia. Ningaloo Reef supports both tropical and temperate species of marine fauna and flora and more than 300 species of coral (MPRA, 2005).

The Ningaloo Coast WHA provides important nesting habitat for four species of marine turtle found in Western Australia. The North West Cape and Muiron Islands are major nesting sites for loggerhead turtles, with about 400 and 600 females nesting annually on the Ningaloo Coast (particularly North West Cape area) and Muiron Islands, respectively (Department of Environmental Protection, 2001). The North West Cape is also a major nesting habitat for hawksbill and green turtles, with an estimated 1000–1500 green turtles nesting in the area annually (DEC, 2009). The Muiron Islands are minor nesting sites for flatback and hawksbill turtles (DEC, 2009).

Each year, the largest congregation of whale sharks anywhere in the world takes place off the coast of the Ningaloo WHA. It is estimated that between 300 and 500 whale sharks visit each year between March and July, coinciding with the annual mass coral spawning events.

It is these natural heritage values, iconic wilderness, seascapes, wildlife and biodiversity which are major attractions of the WHA and therefore the main driver for tourism on the North West Cape. All properties inscribed on the World Heritage List must have adequate management to ensure their protection, thus the Ningaloo WHA is managed via the Australian Marine Park and State Marine Park (see subsections below).

Ningaloo Australian Marine Park

The Ningaloo Australian Marine Park covers 2435 km² and is about 10 km north of Exmouth. It is contiguous with the Western Australian Ningaloo Marine Park. The Ningaloo Australian Marine Park is located about 185 km south-west of the Operational Area but within the wider EMBA. The Ningaloo Australian Marine Park adds additional protection to the Ningaloo Reef, which lies in State waters within the State managed Marine Park. Water depths range from shallow water of 30 m depth to oceanic waters at 1000 m deep. Major conservation values of the reserve include (Director of National Parks, 2013):

- foraging areas adjacent to important breeding areas for migratory seabirds, whale sharks and marine turtles
- important nesting sites for marine turtles
- part of the migratory pathway of the humpback whale
- shallow shelf environments with depths ranging from 15 to 150 m, providing protection for the shelf and slope habitats, as well as pinnacle and terrace sea-floor features
- examples of the seafloor habitats and communities of the Central Western Shelf Transition.

The reserve has international and national significance due to its diverse range of marine species and unique geomorphic features. The reserve provides essential biological and ecological links that sustain the biodiversity and ecological processes, including supplying nutrients to reef communities from deeper waters further offshore, to the Ningaloo Reef ecosystem.

4.7.5.2 Ningaloo Marine Park and Muiron Islands Marine Management Area

The Ningaloo Marine Park (State waters) was established in 1987 and stretches 300 km from the North West Cape to Red Bluff. It encompasses the State waters covering the Ningaloo Reef system and a 40 m strip along the upper shore. The State Marine Park is located about 185 km south-west of the Operational Area but within the wider EMBA. The Muiron Islands Marine Management Area is managed under the same management plan as for the Ningaloo State Marine Park (MPRA, 2005). The Ningaloo Marine Park is part of the Ningaloo Coast WHA.

Ecological and conservation values of the Ningaloo Marine Park and Muiron Islands are summarised below. Generally, all ecological values are presumed to be in an undisturbed condition except for some localised high use areas (MPRA, 2005). The ecological and conservation values include:

- Unique geomorphology has resulted in a high habitat and species diversity.
- There is high sediment and water quality.
- Subtidal and intertidal coral reef communities provide food, settlement substrate and shelter for marine flora and fauna.
- Filter feeding communities (sponge gardens) occur in the northern part of the North West Cape and the Muiron and Sunday Islands.
- Shoreline intertidal reef communities provide feeding habitat for larger fish and other marine animals during high tide.
- Soft sediment communities are found in deeper waters, characterised by a surface film of microorganisms that provide a rich source of food for invertebrates.
- Macroalgae and seagrass communities are an important primary producer, providing habitat for vertebrate and invertebrate fauna.
- Mangrove communities occur only in the northern part of the Ningaloo Marine Park and are important for reef fish communities (Cassata & Collins, 2008) and support a high diversity of infauna, particularly, molluscs (600 mollusc species).
- There is diverse fish fauna (about 460 species).
- Foreshores and nearshore reefs of the Ningaloo coast and Muiron/Sunday islands provide internesting, nesting and hatchling habitat for several species of marine turtles including the loggerhead, green, flatback and hawksbill turtles.
- Whale sharks aggregate annually to feed in the waters around Ningaloo Reef, from March to July, with the largest numbers recorded around April and May (Sleeman et al., 2010). The season can be variable, with individual whale sharks being recorded at other times of the year. Timing of the whale sharks' migration to and from Ningaloo coincides with the mass coral spawning period when there is an abundance of food (krill, planktonic larvae and schools of small fish) in the waters adjacent to Ningaloo Reef. At Ningaloo Reef, whale sharks stay within a few kilometres of the shore and in waters less than 50 m depth (Woodside, 2002).
- Seasonal shark aggregations and manta rays are commonly found in the area with a permanent population of manta rays (*Manta alfredi*) inhabiting the Ningaloo Reef. Numbers are boosted periodically by roaming and seasonal animals. Small aggregations coincide with small pulses of target prey and the spawning events of many reef inhabitants, while larger aggregations coincide with major seasonal spawning events. The number of species in the Ningaloo Reef area peaks during autumn, which corresponds to coral spawning, and during spring, which corresponds with the crab spawning event (McGregor, 2004).
- Annual mass coral spawns on Ningaloo Reef. Synchronous, multi-specific spawning of tropical reef corals occurs during a brief predictable period in late summer/early autumn, generally seven to nine nights after a full moon on neap, nocturnal ebb tides March/April each year (Simpson, 1991).
- Large coral slicks generally form over shallow reef areas in calm conditions. It is noted that there are minor spawning activities on the same nights after the February and April full

moons, and in some years the mass spawning event occurs after the April full moon (Simpson et al., 1993).

- Marine mammals such as dugong and small cetacean populations frequent or reside in nearshore waters. Dugong numbers in Ningaloo Marine Park are considered to be in the order of about 1000 individuals, with a similar number in Exmouth Gulf (MPRA, 2005). The Ningaloo/Exmouth Gulf region supports a significant population of dugongs which is interconnected with the Shark Bay resident population (which represents less than 10% of the world's dugongs).
- Nesting and foraging habitat occurs for seabirds and shorebirds. About 33 species of seabirds are recorded in the Ningaloo Marine Park (13 resident and 20 migratory) and there are five known rookeries as well as isolated rookeries on the Muiron and Sunday Islands.

In addition to the ecological and conservation values, the Ningaloo Marine Park has a number of social values including culture heritage (both Aboriginal and maritime; **Section 4.6.1**) and marine-based tourism and recreation (water-sports and fishing; **Section 4.6.5**). The Ningaloo Marine Park (State waters) is contiguous with the Ningaloo Australian Marine Park (**Figure 4-17**).

Ningaloo Shoreline, Shallow Subtidal Reef and Intertidal Habitats

The Ningaloo Marine Park reef and lagoonal systems comprise a variety of shallow subtidal and intertidal communities that comprise shallow outer reef slope (spur and groove habitat), reef crest (emergent at low tide), reef flat (coralline algae and high cover tabular *Acropora* coral communities), back reef lagoon (coral, soft sediment and macro-algal communities), sublittoral limestone platform (turf algae/molluscs/echinoderm community), and intertidal mangrove, mud flat and salt marsh communities (Cassata & Collins, 2008).

The area seaward of the reef crest is characterised by a coralline algae/coral community (spur and groove reef slope). The area has a series of perpendicular spur and grooves from 5 to 40 m depth range consisting of narrow, deep channels filled with sand and coral rubble and rock spurs with diverse hard coral communities (with dominant tabular *Acropora* growing in small, compact colonies), together with soft corals, *Millepora* (fire coral), sponges and macroalgae. Coralline algae encrust dead corals, rocks and coral rubble. Coral growth is most prolific between 5 and 10 m depth.

On the landward side of the reef crest is a reef flat habitat and back reef lagoon with a number of subtidal and intertidal habitats (Cassata & Collins, 2008) as follows:

- Outer reef flat (very shallow, less than 1 m depth) at the back of the reef crest: Coralline algae/coral community (spur and groove). Similar morphology to the reef slope.
- Rocky middle/inner reef flat (about 1 m depth): Tabular Acropora community.
- Back reef lagoon (greater than 2 m depth): Patchy staghorn, massive and sub-massive coral community.
- Lagoonal sand flat (1–2 m depth): Sparse corals and algae community. This habitat is characterised by sheltered areas of limestone pavement with a veneer of sand and small outcrops of corals (*Porites*, *Acropora*) with scattered patches of macroalgae (*Sargassum*, *Halimeda*, *Caulerpa*) or seagrass (*Halophila*).
- Lagoonal and inter-reef sandy depressions (3–15 m depth): Coral 'bommies' and algal patch community. A distinctive habitat type composed of sandy depressions either found as large deep regions within the lagoon or small depressions/channels inside the reef flat.
- Lagoon, shoreward reef channels (shallow): Macroalgal community. Fleshy algae colonising subtidal limestone pavement that is covered in sand with *Sargassum* up to 0.5 m high and other red and green algal species. There are also small patches of hard and soft corals, sponges and ascidians.

- Sublittoral limestone platform: Turf algae/mollusc/echinoderm community. This habitat is composed of a flat limestone pavement often contiguous with the rocky shoreline, and supports intertidal and subtidal fauna comprising molluscs (limpets, chitons, small mussels, cowries and giant clams) and echinoderms (sea cucumbers, starfish and sea urchins) with isolated hard and soft coral colonies. The limestone pavement also has a ubiquitous coverage of turf algae.
- Mangrove coastal swamps: Although not a common habitat type within Ningaloo Marine Park, there are mangrove stands in the upper intertidal zone on a muddy substrate of carbonate silt and clay. The mangrove communities are located within the Mangrove Sanctuary Zone (where they occupy a large section of coast between Low Point and Mangrove Bay) and sporadically within the Osprey Sanctuary Zone on the Yardie Creek banks. There are three species of mangrove: *Avicennia marina*, *Rhizophora stylosa* and *Bruguiera exaristata*. *Avicennia marina* is most common and widespread. This habitat supports a diverse community of invertebrate fauna including gastropods, crabs and burrowing worms and is also a nursery area for the juveniles of many species of reef fish.
- Intertidal mud flats: Mud flats occur in the lower intertidal zone of the lagoon, formed from the deposition of mud in the sheltered tidal waters.
- Salt marshes: The salt marsh habitat is seaward of the mangroves and is represented by salt tolerant vegetation and sandy patches.

Muiron Islands: Shallow Subtidal, Intertidal and Shoreline Habitats

Coastal sensitivity mapping identified the onshore sensitivities to be turtle rookeries and turtle nesting occurring from October to April (Joint Carnarvon Basin Operators, 2012). Most of the western coast consists of limestone coastal cliffs interspersed with sandy beaches and intertidal rock platforms. The nearshore sensitivities include the intertidal/nearshore reef (Joint Carnarvon Basin Operators, 2012). Soft coral communities dominate the reefs on the western side of the Muiron Islands. Habitats on the eastern side of the Muiron Islands are more sheltered, consisting of sandy beaches and shallow lagoons with diverse soft and hard coral communities (Cassata & Collins, 2008).

4.7.5.3 Gascoyne Australian Marine Park

The Gascoyne Australian Marine Park covers about 81,766 km² and includes waters from less than 15 m depth to 6000 m depth. The Gascoyne Marine Park lies about 145 km south west of the Operational Area but within the wider EMBA. Conservation values identified within the reserve include:

- foraging areas for migratory seabirds (including the wedge-tailed shearwater), hawksbill and flatback turtles and whale sharks
- a continuous connectivity corridor from 15 to over 5000 m
- seafloor features including canyon, terrace, ridge, knolls, deep hole/valley and continental rise
- sponge gardens in the south of the reserve adjacent to Western Australian coastal waters
- examples of the ecosystems of the Central Western Shelf Transition, the Central Western Transition and the North West Province provincial bioregions as well as the Ningaloo meso-scale bioregion (Director of National Parks, 2013).

The reserve contains three key conservation values for the region:

1. canyons on the slope between the Cuvier Abyssal Plain and the Cape Range Peninsula (associated enhanced productivity, aggregations of marine life and unique sea-floor feature)

2. Exmouth Plateau (unique seafloor feature associated with internal wave generation)
3. continental slope demersal fish communities (high species diversity and endemism which is the most diverse slope bioregion in Australia with over 500 species recorded of which 76 are endemic to the area).

The reserve boundary is adjacent to the existing Commonwealth portion of the Ningaloo MPA.

4.7.6 Eighty Mile Beach State Marine Park

The Eighty Mile Beach State Marine Park lies about 446 km from the Operational Area. The shoreline of Eighty Mile Beach Marine Park is located within the wider EMBA. The values of the Eighty Mile Beach shoreline relate to high diversity and relative abundance of infauna and microphytobenthos within the substrate, providing excellent foraging for resident and migratory seabirds. Microphytobenthos living on the surface of the intertidal flats are thought to provide the basis of food webs for a wide variety of organisms (Bennelongia, 2009). Eighty Mile Beach is a listed Ramsar Wetland, the values of which are described in **Section 4.6.2**.

4.7.7 Rowley Shoals

4.7.7.1 Argo-Rowley Terrace Australian Marine Park

The Argo-Rowley Terrace Australian Marine Park covers 146,099 km² of the MPA network, including the Commonwealth waters surrounding the Rowley Shoals (each reef managed as separate State and Australian Marine Parks). The Argo-Rowley Terrace Australian Marine Park encompasses water depths from about 220–6000 m.

The ecological and conservation values include (Director of National Parks, 2013):

- important foraging areas for migratory seabirds and, reportedly, the loggerhead turtle
- support for relatively large populations of sharks (compared with other areas in the region)
- a range of seafloor features such as canyons, continental rise and the terrace, among others
- connectivity between the reefs of the Rowley Shoals
- linkage of the Argo Abyssal Plain with the Scott Plateau through canyons.

4.7.8 Shark Bay

4.7.8.1 Shark Bay World Heritage Area

The EMBA reaches the Shark Bay WHA at an oceanic (non-linear) distance of about 671 km from the Operational Area, towards the furthest extent of the EMBA. The Shark Bay WHA includes Bernier Island, Dorre Island and Dirk Hartog's landing site. Shark Bay was inscribed by the World Heritage Committee onto the World Heritage Register under all four natural criteria (criterion vii, viii, ix, and x) in 1991. The statement of Outstanding Universal Value for the Shark Bay WHA was based on natural criteria and recognised the following:

- Stromatolites, in the hypersaline Hamelin Pool, represent the oldest form of life on earth and are comparable to living fossils.
- It is one of the few marine areas in the world dominated by carbonates not associated with reef-building corals.
- It contains one of the largest seagrass meadows in the world, covering 103,000 ha, with the most seagrass species recorded in one area.

- Marine fauna occur such as dugong, dolphins, sharks, rays, turtles, fish, and migratory seabirds in great numbers.
- The hydrologic structure of Shark Bay, altered by the formation of the Faure Sill and a high evaporation, has produced a basin where marine waters are hypersaline (almost twice that of seawater) and contributed to extensive beaches consisting entirely of shells.
- The Wooramel Seagrass Bank is also of great geological interest due to the extensive deposit of limestone sands associated with the bank, formed by the precipitation of calcium carbonate from hypersaline waters.
- Shark Bay provides outstanding examples of processes of biological and geomorphic evolution taking place in a largely unmodified environment.
- One of the exceptional features of Shark Bay is the steep gradient in salinities, creating three biotic zones that have a marked effect on the distribution and abundance of marine organisms.
- Shark Bay is a refuge for many globally threatened species of plants and animals.
- The property contains either the only or major populations of five globally threatened mammals, including the burrowing bettong (now classified as Near Threatened), Rufous hare wallaby, banded hare wallaby, the Shark Bay mouse and the western barred bandicoot.
- Significant population of dugongs, considered to represent up to 10% of the global population, utilise seagrass habitats for foraging and nursing year round and breed during the summer months.
- It provides breeding habitat for 14 species of seabirds, and more than 50 other seabirds passing through the area.
- A major loggerhead turtle nesting site lies on Dirk Hartog Island.
- There are minor nesting areas on islands for green turtles.
- Habitat exists for whale sharks and manta rays.
- It provides important staging and socialising locations for humpback whales during their annual migration.
- A large population of resident Indo-Pacific bottlenose dolphins occurs, estimated to number between 2000 and 3000 individuals (Preen et al., 1997).

4.7.8.2 Shark Bay Australian Marine Park

The Shark Bay Australian Marine Park lies an oceanic distance of about 402 km from the Operational Area and partially within the wider EMBA. The Marine Park covers about 7443 km² and includes waters in the depth range of about 15–220 m (DoE, 2014e; Director of National Parks, 2013). The marine reserve encompasses offshore waters that buffer the State waters of Shark Bay and the barrier islands of Dirk Hartog, Dorre and Bernier. The reserve contains a number of conservation values (as listed below) and social values relating to marine nature-based tourism and recreation (water-sports and fishing) (**Section 4.6.5**), including:

- foraging area adjacent to important breeding areas for several species of migratory birds
- part of the migratory pathway of protected humpback whales
- adjacent to the largest nesting area for loggerhead turtles (the largest in Australia)
- protection to shelf and slope habitats as well as terrace features

- examples of shallower ecosystems of the Central Western Shelf Province and Central Western Transition provincial bioregions including the Zutydorp Meso-Scale bioregion
- connectivity between inshore waters of the Shark Bay World Heritage Area and deeper waters offshore.

4.7.9 Abrolhos Australian Marine Park

The Abrolhos Australian Marine Park lies over 780 km from the Operational Area and partially within the wider EMBA. The Marine Park covers a large offshore area of adjacent to the Abrolhos Islands, extending from the State water boundary to the edge of the exclusive economic zone. The Marine Park covers 88,060 km² and includes waters in the depth range of about 15–6000 m (Director of National Parks, 2018). The reserve contains a number of conservation values, including (Director of National Parks, 2018):

- part of the migratory pathway for the protected humpback whale and pygmy blue whale
- foraging habitat for Australian sea lions and white sharks
- foraging and breeding habitat for several species of seabirds
- examples of ecosystems representative of the Central Western Province, Central Western Shelf Province, Central Western Transition, and South-west Shelf Transition
- seven KEFs, including the Commonwealth marine environment surrounding the Houtman Abrolhos Islands, demersal slope and associated fish communities of the central western province, mesoscale eddies, Perth Canyon and adjacent shelf break, western rock lobster, ancient coastline between 90 and 120 m depth, and the Wallaby Saddle.

4.7.10 Carnarvon Canyon Australian Marine Park

The Carnarvon Canyon Australian Marine Park lies about 513 km from the Operational Area, partially within the wider EMBA. The Marine Park covers 6177 km² and includes water depths in the range of 1500–6000 m (Director of National Parks, 2018). The reserve contains a number of conservation values, including (Director of National Parks, 2018):

- deep water ecosystems associated with the Carnarvon Canyon, a single-channel canyon covering the entire depth range of the canyon
- examples of ecosystems representative of the Central Western Transition
- support for a range of species protected under the EPBC Act, however species' use of the Marine Park is not well understood.

4.7.11 Key Ecological Features

KEFs identified were identified in the Operational Area and wider EMBA using the EPBC Protected Matters Search Tool (**Appendix C**). **Figure 4-18** shows these features in relation to the Operational Area.

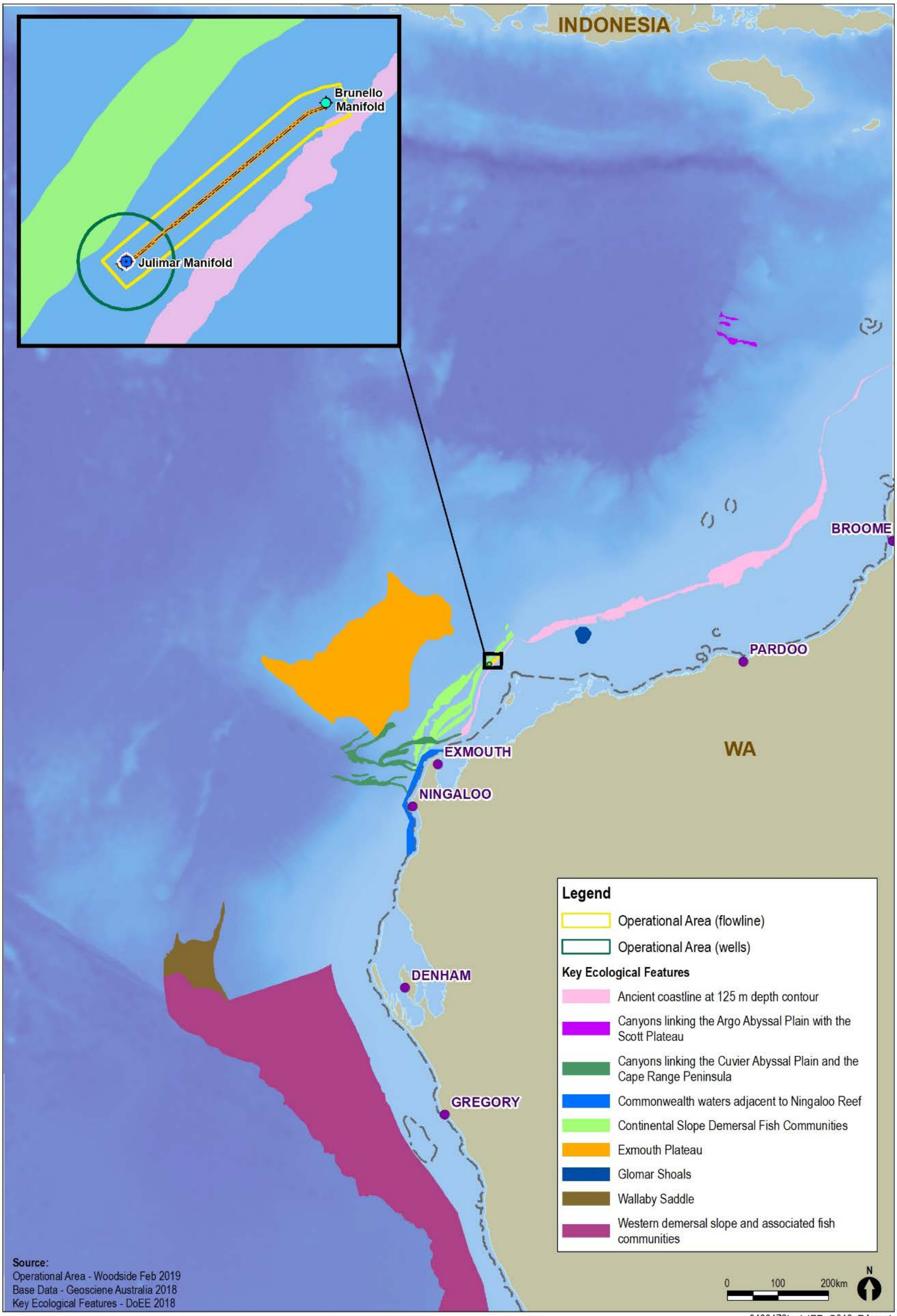

Figure 4-18: KEFs in relation to the Operational Area

4.7.11.1 Key Ecological Features Within the Operational Area

Ancient Coastline at the 125 m Depth Contour (KEF)

The 'ancient coastline at 125 m depth contour' overlaps the Operational Area and is defined as the depth range 115–135 m in the North West Shelf Province and NWS Transition provincial bioregions (**Figure 4-18**). The Operational Area overlaps <1 km² of the ancient coastline at the 125 m depth contour, and the proposed flowline route does not intersect the 125 m depth contour at any point. Several steps and terraces as a result of Pleistocene sea level changes occur in the region, with the most prominent of these features occurring as an escarpment along the NWS and Sahul Shelf at a water depth of 125 m. The ancient coastline is not continuous and is fragmented along the 125 m depth contour. Where the ancient submerged coastline provides areas of hard substrate, it may contribute to higher diversity and enhanced species richness relative to soft sediment habitat (DEWHA, 2008a).

The ancient submerged coastline is an important divide between carbonate, cemented sands and the fine, less cemented slope materials offshore. It is valued as a unique seafloor feature with ecological properties of regional significance. Parts of the ancient coastline, represented as rocky escarpment, are considered to provide biologically important habitat in an area predominantly made up of soft sediment. The escarpment type features may also potentially facilitate mixing within the water column due to upwelling, providing a nutrient-rich environment.

Continental Slope Demersal Fish Communities

The continental slope demersal fish communities in the region have been identified as a KEF of the North West Shelf Province (DoEE, 2019) (**Appendix C**), and overlaps with the north-eastern extent of the Operational Area. The continental slope between North West Cape and the Montebello Trough has been identified as one of the most diverse slope assemblages in Australian waters, with over 508 fish species and the highest number of endemic species (76) of any Australian slope habitat (DEWHA, 2008a). Additional features relating to the fish populations of this area are as follows:

- Continental slope demersal fish communities of the NWS Province have been identified as a KEF of the NWMR due to the notable diversity of the demersal fish assemblages and high levels of endemism (DoEE, 2019).
- The North West Cape marine region is a transition area for demersal shelf and slope fish communities between the tropical dominated communities to the north and temperate communities to the south (Last et al., 2005). The benthic shelf and slope communities offshore of the North West Cape comprise both tropical and temperate fish species with a north-south gradient (DEWHA, 2008).
- The fish fauna of the North West Cape area, like the ichthyofauna of many regions, exhibits decreasing species richness with depth (Last et al., 2005). Fish species diversity has been shown to be positively correlated with habitat complexity, with more complex habitats (e.g. coral reefs) typically hosting higher species richness than simpler habitats such as bare, unconsolidated muddy sediments (Gratwicke & Speight, 2005). A total of 500 finfish species from 234 genera and 86 families have been recorded within the Ningaloo Marine Park, and 393 species were identified at study sites of the Muiron Islands (MPRA, 2005). The offshore sediment habitats of the Operational Area are expected to support lower fish species richness than other shallower, more complex habitats in the coastal areas of the region.

4.7.11.2 Key Ecological Features Within the EMBA

Exmouth Plateau

The Exmouth Plateau is a large, mid-slope, continental margin plateau that lies off the north-west coast of Australia, located to the west of the Operational Area with its closest point approximately 86 km north-west of the Operational Area. It ranges in depth from about 800 to 3500 m and is a major structural element of the Carnarvon Basin (Geoscience Australia, 2013). The plateau is bordered by the Rankin Platform and the Exmouth sub-basin of the Northern Carnarvon Basin to the east, the Argo Abyssal Plain to the north, and the Gascoyne and Cuvier Abyssal Plains to the north-west and south-west. The plateau is recognised as a KEF because it is an area of enhanced biological productivity that supports a range of species (TGS, 2011).

The Exmouth Plateau has a relatively uneven seabed, which includes pinnacles and canyon systems in the northern section. The canyon systems are recognised as a distinct feature and are localised areas of high biological productivity (TGS, 2011). Biological productivity on the top of the Exmouth Plateau is comparatively low due to tropical oligotrophic waters, with increased productivity identified around the plateau boundaries as a result of internal waves and upwelling (TGS, 2011). The sediments of the plateau are assumed to consist of abyssal red clays, which indicate that benthic communities are likely to include filter feeders and epifauna, including sea cucumbers, polychaetes and sea-pens (TGS, 2011). Pelagic species are likely to include nekton, small pelagic fish and large predators such as billfish, sharks and dolphins (TGS, 2011). Protected and migratory species are also known to pass through the region including whale sharks, cetaceans and marine turtles.

Glomar Shoals

The Glomar Shoals are about 149 km north-west of the Operational Area but within the wider EMBA. These submerged shoals are large (768 km^2), complex bathymetrical features on the outer western shelf of the West Pilbara. The largest shoal rises on all sides from 80 m depth and shallows gradually to include a plateau region situated within 40 m of the surface. The shoals are relatively shallow with water depths reaching 22–28 m at its shallowest point. Together with Rankin Bank, these remote shallow water areas represent regionally unique habitats and are likely to play an important role in the productivity of the Pilbara regions (AIMS, 2014).

The Glomar Shoals have been identified as a KEF of the continental shelf within the NWMR, based on their regionally important habitat supporting high biological diversity and high localised productivity (Falkner et al., 2009). On a regional level, the Glomar Shoals are also known to be an important area for a number of commercial and recreational fish species (DSEWPaC, 2012a).

The Glomar Shoals were surveyed by AIMS in 2013 as part of a co-investment project between Woodside and AIMS to better understand the habitats and complexity of Rankin Bank and Glomar Shoals. The research included collecting continuous coverage multibeam data to produce a bathymetry dataset, underwater towed camera transects to assess benthic communities, and BRUVS sampling of the fish assemblages (AIMS, 2014).

The shoals have relatively high seafloor temperatures and high biological productivity. The benthic community composition and distribution of Glomar Shoals was assessed, quantitatively, using the images from the towed video system. Results from the 2013 AIMS survey show that the benthic habitats of Glomar Shoals are characterised by sand/silt substrate and low epibenthic cover (about 53% total cover), with soft corals and sponges the most abundant fauna. The most abundant benthic organisms were plants, with turf algae present on many substrates. Hard corals at Glomar Shoals are not a major habitat type and overall abundance is very low (0.4%), with small patches of 10% cover in its shallowest regions. Corals appeared healthy, with no areas of coral mortality identified (AIMS, 2014). Overall, the benthic habitats of Glomar Shoals are considered pristine and similar to other shoals within the NWMR.

The fish abundance and diversity of the demersal fish communities of Glomar Shoals are influenced by the seabed habitat type, with genera associated with sandy habitats common, including threadfin breams (*Nerripterus* spp.) and triggerfish (*Abalisters* spp.). Species richness and abundance are influenced by habitat depth and the degree of coral cover. In general, the fish abundance and diversity of Glomar Shoals are considered comparable with other regional Australian reefs and the North West submerged shoals and banks.

Canyons Linking the Cuvier Abyssal Plain with the Cape Range Peninsula

The canyons that link the Cuvier Abyssal Plain with the Cape Range Peninsula lie off the north-west coast of Australia, over 140 km south-west of the Operational Area but within the wider EMBA. The canyons are believed to support the productivity and species richness of Ningaloo Reef (Commonwealth of Australia, 2012). Interactions with the Leeuwin current and strong internal tides are thought to result in upwelling at the canyon heads, thus creating conditions for enhanced productivity in the region (Brewer et al., 2007). As a result, aggregations of whale sharks, manta rays, humpback whales, seasnakes, sharks, predatory fish and seabirds are known to occur in the area due to the enhanced productivity (Sleeman et al., 2007).

Commonwealth Waters Adjacent to Ningaloo Reef

The Commonwealth waters adjacent to Ningaloo Reef KEF lies adjacent to the 3 nm State waters limit along Ningaloo Reef and includes the Ningaloo Australian Marine Park. See **Section 4.7.5** for further information for the values and sensitivities associated with this KEF.

Canyons Linking the Argo Abyssal Plain with the Scott Plateau

The canyons linking the Argo Abyssal Plain with the Scott Plateau lie adjacent to the south-west corner of Scott Plateau, 575 km from the Operational Area. The canyons cut into the Scott Plateau at a depth of 2000–3000 m, transporting sediments to depths of more than 5500 m on the Argo Abyssal Plain. The KEF was defined for having high productivity and aggregations of marine life.

Wallaby Saddle

The Wallaby Saddle is located 657 km from the Operational Area, covering an area of 7,880 km^2, and includes depths between 4000–4700 m. The KEF connects the margin of the Carnarvon Terrace on the cupper continental slope to the north west margin of the Wallaby Plateau. The KEF has been defined for its high productivity and aggregations of marine life. The Wallaby Saddle is thought to be a unique habitat that may have been associated with historical aggregations of sperm whales.

Western Demersal Slope and Associated Fish Communities of the Central Western Province

The ‘western demersal slope and associated fish communities of the Central Western Province’ KEF covers 669 km^2 between Perth and the northern boundary of the South-west Marine Region, and (north-south) and from the shelf edge to the boundary of the Exclusive Economic Zone (east-west). At least 480 species of demersal fish inhabit the central western slope, 31 of which are considered endemic to the bioregion. Unlike other slope fish communities in Australia, many of these species do not appear to migrate vertically in the water column as part of their daily feeding habits (Williams et al., 2001). The KEF has therefore been defined for its high levels of biodiversity and endemism.

4.7.12 Other Sensitive Areas

4.7.12.1 Rankin Bank

Rankin Bank is on the continental shelf, about 47 km north-east of the Operational Area and within the EMBA. While Rankin Bank is not protected and is not a KEF, along with Glomar Shoals it is the only large, complex bathymetrical feature on the outer western shelf of the West Pilbara and represents habitats that are likely to play an important role in the productivity of the Pilbara region (AIMS, 2014). Rankin Bank consists of three submerged shoals delineated by the 50 m depth contour with water depths of about 18–30.5 m (AIMS, 2014).

Rankin Bank, along with the Glomar Shoals, was surveyed by AIMS in 2013 as part of a co-investment project between Woodside and AIMS to better understand the habitats and complexity of the submerged shoal ecosystems. Rankin Bank represents a diverse marine environment, predominantly composed of consolidated reef and algae habitat (~55% cover), followed by hard corals (~25% cover), unconsolidated sand/silt habitat (~16% cover), and benthic communities composed of macroalgae, soft corals, sponges and other invertebrates (~3% cover) (AIMS, 2014). Hard corals are a significant component of the benthic community of some parts of the bank, with abundance in the upper end of the range observed elsewhere on the submerged shoals and banks of North West Australia (Heyward et al., 2011).

In shallower reef habitats (20–30 m depth), patches of high coral cover (exceeding 80%) extended for lengths up to 500 m, although patches with cover of 40–50% extending for shorter lengths (40–70 m) were more common (AIMS, 2014). Extensive hard coral habitats were also present in deeper waters (40–80 m), where the solitary mushroom coral *Diaseris* sp. formed large beds, some extending for more than a kilometre with an average of about 50% cover (AIMS, 2014).

Overall, Rankin Bank has a higher cover of hard corals, macroalgae and unconsolidated reef than the Glomar Shoals. Hard coral communities were more diverse at Rankin Bank (33 genera) than at Glomar Shoals (21 genera) but soft corals were more diverse at Glomar Shoal than at Rankin Bank (AIMS, 2014).

Other key characteristics of the Rankin Bank include:

- The fish abundance and diversity of the demersal fish communities of Rankin Bank are comparable with other regional Australian reefs and the NW submerged shoals and banks.
- Over 200 fish species were recorded at Rankin Bank and were generally classified as reef-associated species including surgeonfishes, emperors and coronation trout (AIMS, 2014).
- Species richness and abundance were influenced by depth, with shallower areas (<40 m) supporting the most species and highest number of individuals found in <20 m.
- Sediment at Rankin Bank is predominantly sand, with an increase in mud at deeper, more protected areas (AIMS, 2014). Sediment quality is considered pristine and unpolluted by anthropogenic impacts (AIMS, 2014).

5. STAKEHOLDER CONSULTATION

5.1 Summary

Woodside is committed to consulting relevant stakeholders to ensure their feedback informs our decision-making and planning for proposed petroleum activities.

Consultation activities conducted for the proposed activity build upon Woodside's extensive and ongoing stakeholder consultation for its offshore petroleum activities in the region.

Stakeholder consultation for this activity was initially conducted on the basis of the proposed Julimar production wells and associated infrastructure, and the Gemtree exploration well and an appraisal well. The Gemtree well and appraisal well was not progressed as an activity for this Environment Plan.

Woodside also performed additional consultation to reflect new transparency arrangements for Environment Plans, as well as change to the timing of the activity and additional project definition.

5.2 Stakeholder Consultation Guidance

Woodside 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 Government to which the activities to be performed under the EP, or the revision of the EP, may be relevant
- each Department or agency of a State or the Northern Territory Government to which the activities to be performed under the EP, or the revision of the EP, 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 performed under the EP, or the revision of the EP
- any other person or organisation that the Titleholder considers relevant.

Woodside's assessment of stakeholder relevance is outlined in **Table 5-1**.

5.3 Stakeholder Consultation Objectives

In support of this EP, Woodside has sought to:

- ensure all relevant stakeholders are identified and engaged in a timely and effective manner
- develop, and make available to stakeholders, communications material that is relevant to their interests and information needs
- incorporate stakeholder feedback into managing the proposed activity where practicable
- provide feedback to stakeholders on Woodside's assessment of their feedback and record all engagements
- make available opportunities to provide feedback during the life of this EP.

5.4 Stakeholder Expectations for Consultation

Stakeholder consultation for this activity has also been guided by stakeholder organisation expectations for consultation on planned activities. This guidance includes:

NOPSEMA

- GL1721 – Environment plan decision making, Rev 5, June 2018
- GN1847 – Responding to public comment on environment plans, Rev 0, April 2019
- GN1344 – Environment plan content requirements, Rev 4, April 2019
- GN1488 – Oil pollution risk management, Rev 2, February 2018.

Australian Government

- Offshore Petroleum and Greenhouse Gas Activities: Consultation with Australian Government agencies with responsibilities in the Commonwealth Marine Area.

Australian Fisheries Management Authority

- Petroleum industry consultation with the commercial fishing industry.

Department of Primary Industries and Regional Development

- Guidance statement for oil and gas industry consultation with the Department of Fisheries.

WA Department of Transport

- Offshore Petroleum Industry Guidance Note.

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

Woodside consultation arrangements typically provide stakeholders up to 30 days (unless otherwise agreed) to review and respond to proposed activities where stakeholders are potentially affected. Woodside considers this consultation period an adequate timeframe in which stakeholders can assess potential impacts of the proposed activity and provide feedback.

Table 5-1: Assessment of relevant stakeholders for the proposed activity

Stakeholder	Relevant to activity	Reasoning
Australian Government department or agency		
Australian Customs Service – Border Protection Command	Yes	Responsible for coordinating maritime security.
Australian Fisheries Management Authority	Yes	Responsible for managing Commonwealth fisheries.
Australian Hydrographic Office (AHO)	Yes	Maritime safety and responsible for Notice to Mariners.
Australian Maritime Safety Authority	Yes	Statutory agency for vessel safety and navigation and legislated responsibility for oil pollution response in Commonwealth waters.
Department of Defence (DoD)	Yes	Operational Area is within a Defence activity area.
Department of the Environment and Energy	No	Responsible for designing and implementing Australian Government policy and programs to protect and conserve the environment, water and heritage, promote climate action, and provide adequate, reliable and affordable energy. The proposed activity does not trigger any of the DoEE's functions, interests or activities.
Department of Industry, Innovation and Science	Yes	Department of relevant Commonwealth Minister and is required to be consulted under the Regulations.
Director of National Parks (DNP)	No	Management of Commonwealth reserves and conservation zones. While planned activities do not affect the functions, interests or activities of the DNP, Woodside has chosen to provide information on arrangements for unplanned events, such as an oil spill, which have potential to impact the values within a Commonwealth marine reserve.
Department of Agriculture and Water Resources	No	Responsible for implementing Commonwealth policies and programmes to support the agriculture, fisheries, food and forestry industries. The proposed activity is unlikely to impact Commonwealth fisheries and as a result does not trigger any of the Department's functions or interests.
Western Australian Government department or agency		
Department of Biodiversity, Conservation and Attractions	No	Responsible for managing Western Australia's parks, forests and reserves. Planned activities do not impact the Department's functions, interests or activities.
Department of Mines, Industry Regulation and Safety (DMIRS)	Yes	Department of relevant State Minister and is required to be consulted under the Regulations.
Department of Primary Industries and Regional Development	Yes	Responsible for managing State fisheries.

Stakeholder	Relevant to activity	Reasoning
Department of Transport (DoT)	Yes	Legislated responsibility for oil pollution response in State waters.
Commonwealth fisheries*		
Southern Bluefin Tuna and Western Skipjack Fishery	No	Fishery overlaps the Operational Area but there has been no recent fishing effort in the area.
Western Tuna and Billfish Fishery	No	Fishery overlaps the Operational Area but there has been no recent fishing effort in the area.
State fisheries*		
Beche-de-mer Fishery	No	Fishery overlaps the Operational Area but typical water depth for fishing is not relevant to the area.
Mackerel Managed Fishery – Pilbara (Area 2)	Yes	Fishery overlaps the Operational Area and there has been recent fishing effort in the area.
Marine Aquarium Managed Fishery	No	Fishery overlaps the Operational Area but typical water depth for fishing is not relevant to the area.
Onslow Prawn Managed Fishery	No	Fishery overlaps the Operational Area but there has been no recent fishing effort in the area.
Pearl Oyster Managed Fishery	Yes	Zone 1 of the fishery overlaps the Operational Area and there has been recent fishing effort in this Zone.
Pilbara Demersal Scalefish Managed Fisheries:		
Pilbara Trawl	No	Fishery overlaps the Operational Area but there has been no recent fishing effort in the area.
Pilbara Trap	No	Fishery overlaps the Operational Area but in Zones outside the Operational Area.
Pilbara Line	Yes	Fishery overlaps the Operational Area and there has been recent fishing effort.
South West Coast Salmon Managed Fishery	No	Fishery overlaps the Operational Area but there has been no recent fishing effort in the area.
Specimen Shell Managed Fishery	No	Fishery overlaps the Operational Area but typical water depth and shell collection method is not relevant to the area.
Industry		
Chevron	Yes	Adjacent Titleholder.
Industry representative organisations		
Australian Petroleum Production and Exploration Association (APPEA)	Yes	Represents the interests of oil and gas explorers and producers in Australia.

Stakeholder	Relevant to activity	Reasoning
Commonwealth Fisheries Association	No	Represents the interests of commercial fishers with licences in Commonwealth waters. Activities are unlikely to impact commercial fishers.
Pearl Producers Association (PPA)	Yes	Represents the interests of the Australian South Sea Pearling industry. Potential for interaction with pearl fishers.
Recfishwest	No	Represents the interests of recreational fishers in Western Australia. Activities are unlikely to impact recreational fishers given distance from shore.
Western Australian Fishing Industry Council (WAFIC)	Yes	Represents the interests of commercial fishers with licences in State waters. Potential for interaction with commercial fishers.
Community and environmental representative organisations		
Australian Conservation Foundation	No	Australian national environmental organisation. While the proposed activity does not directly impact the organisation, Woodside has provided information about the activities in line with consultation for previous EPs and prior to the introduction of new transparency arrangements.
International Fund for Animal Welfare	No	Global animal welfare and conservation charity that works to rescue individual animals, safeguard populations, preserve habitat, and advocate for greater protections. While the proposed activity does not directly impact the organisation, Woodside has provided information about the activities in line with consultation for previous EPs and prior to the introduction of new transparency arrangements.
Wilderness Society	No	Australian, community-based, not-for-profit non-governmental environmental advocacy organisation. While the proposed activity does not directly impact the organisation, Woodside has provided information about the activities in line with consultation for previous EPs and prior to the introduction of new transparency arrangements.
World Wide Fund for Nature	No	International non-governmental organisation working in the field of the wilderness preservation, and the reduction of human impact on the environment. While the proposed activity does not directly impact the organisation, Woodside has provided information about the activities in line with consultation for previous EPs and prior to the introduction of new transparency arrangements.

** Fisheries have been identified as being relevant on the basis of fishing licence overlap with the proposed Operational Area, as well as consideration of fishing effort data, fishing methods and water depth.* ***Table 4-8*** *provides a detailed assessment of Commonwealth and State fisheries within or adjacent to the Operational Area.*

5.5 Stakeholder Consultation Plan

Consultation activities undertaken for the proposed activity are outlined in **Table 5-2**.

Table 5-2: Stakeholder consultation activities

Activity		Timing	Information Provided
Consultation – all relevant stakeholders		8 February 2019	• Email advising of proposed activity and consultation Information Sheet. • Website publication of the consultation Information Sheet at www.woodside.com.au/sustainability/transparency/consultation-activities. • Provision of toll free 1800 phone number.
Consultation – specific stakeholders requiring bespoke information	AFMA	8 February 2019	• Email advising of proposed activity, consultation Information Sheet and Commonwealth fisheries map relevant to proposed activity.
	AHO	8 February 2019	• Email advising of proposed activity, consultation Information Sheet and shipping lane map relevant to proposed activity.
	AMSA	8 February 2019	• Email advising of proposed activity, consultation Information Sheet and shipping lane map relevant to proposed activity.
	Chevron	8 February 2019	• Email advising of proposed activity, consultation Information Sheet and titles map relevant to proposed activity.
	DoD	8 February 2019	• Email advising of proposed activity, consultation Information Sheet and defence areas map relevant to proposed activity.
	DNP	8 April 2019	• Email advising of proposed activity and no impacts from planned activities to the values of a Commonwealth marine reserve. Advice also provided on response planning in for an unplanned event that may impact marine reserve values, such as an oil spill.
	DPIRD	8 February 2019	• Email advising of proposed activity, consultation Information Sheet and State fisheries map relevant to proposed activity.
	WAFIC	8 February 2019	• Email advising of proposed activity including potential impacts to commercial fishers and proposed management/mitigation measures, consultation Information Sheet and State fisheries map relevant to proposed activity.
Consultation – relevant State fishery licence holders		8 February 2019	• Letter to licence holders providing information on potential impacts to fishers and Woodside's proposed management and mitigation measures.

Activity	Timing	Information Provided
Consultation – relevant stakeholders that provided feedback seeking comment on NOPSEMA transparency arrangements and confidentiality of information	16 April 2019	• Email advising of new transparency arrangements for Environment Plans, offering stakeholders option for their feedback to be confidential to NOPSEMA and not published in the accepted Environment Plan.
Consultation – all relevant stakeholders advising of change of timing and additional project definition	18 April 2019	• Email advising of a change in timing and additional project definition for the proposed activity.
Oil Pollution Consultation – DoT	18 April 2019	• Email and a copy of the Oil Pollution First Strike Plan.
Oil Pollution Consultation – AMSA	18 April 2019	• Email and a copy of the Oil Pollution First Strike Plan.

Copies of communications material outlined in **Table 5-2** is included in this section.

5.6 Consultation Feedback

A summary of stakeholder feedback and Woodside's responses is outlined in **Table 5-3**.

Table 5-3: Stakeholder consultation feedback

Stakeholder	Stakeholder feedback	Woodside response
WAFIC	On 8 February 2019 WAFIC provided feedback by phone that Specimen Shell fishery and Onslow Prawn fishery were not impacted and they should not have been consulted. WAFIC also advised that only Zone 2 mackerel fishers should have been consulted and only fished to a depth of about 100 m.	Woodside acknowledged that while it may have over-consulted, the stakeholder raised no claims or objections.
	On 8 February 2019 WAFIC emailed Woodside acknowledging that Woodside had improved its consultation approach with commercial fishers and aligns with increased transparency arrangements for EPs.	Woodside acknowledged the feedback and no further action required for this EP.
	On 16 April 2019 WAFIC emailed Woodside advising that feedback provided by WAFIC did not need to be redacted as it did not provide commercial-in-confidence information. The email was in response to Woodside asking relevant stakeholders whether previously provided feedback should be considered confidential to NOPSEMA. WAFIC asked Woodside to note sensitivity of information provided by commercial fishers/companies on precise fishing locations, catch per unit effort and financial information.	Woodside acknowledged the feedback and no further action required for this EP.

Stakeholder	Stakeholder feedback	Woodside response
	On 18 April 2019 WAFIC requested additional information on specific impacts to commercial fishers and the commercial fishing resource following advice provided by Woodside on 18 April 2019 about a change in timing and additional project definition for the proposed activity. WAFIC sent a follow-up email on 7 May 2019 seeking a response.	On 10 May 2019 Woodside emailed WAFIC confirming it expected no impact to a change in the activity timing and project definition.
Recfishwest	On 8 February 2019 Recfishwest advised that proposed activities were unlikely to affect recreational fishers given the distance to shore.	Woodside acknowledged the feedback and no further action required for this EP.
AHO	On 11 February 2019 AHO emailed Woodside acknowledging it had received Woodside's advice and it would register, assess, prioritise and validate data in preparation for updating its Navigational Charting products.	Woodside acknowledged the feedback and no further action required for this EP.
DMIRS	On 11 February 2019 DMIRS emailed Woodside thanking Woodside for keeping the Department informed about its activities in Commonwealth waters, acknowledging NOPSEMA jurisdiction for the proposed activities. DMIRS stated it required no additional information. The Department sought commencement and cessation notifications for the activities.	Woodside will provide DMIRS with commencement and cessation notifications.
	On 16 April 2019 DMIRS advised by email it would confirm its position on new transparency arrangements for EPs.	Woodside noted DMIRS's advice.
	On 3 May 2019 DMIRS advised by email the changes to activity timing and additional project definition. It also advised it had no issues with its feedback being made publicly available and would advise specifically on matters of sensitivity for future consultation activities.	No action required for this EP.
DoT	On 14 March DoT emailed Woodside requesting consultation in line with its Offshore Petroleum Industry Guidance Note – Marine Oil Pollution if there is a risk of a spill impacting State waters from proposed activities.	On 18 April 2019 Woodside emailed DoT providing information about the activity in line with DoT's Guidance Note and a copy of the Oil Pollution First Strike Plan.
DPIRD	On 15 March 2019 DPIRD emailed Woodside acknowledging Woodside's advice and provided the following feedback:	
	Request for Woodside to engage with the following representative bodies: • Western Australian Fishing Industry Council • Pearl Producers Association of WA • Recfishwest • relevant Traditional Owner group.	Woodside provided advice to the Department about fisheries and representative organisations consulted for the activity, and has for this EP provided information to WAFIC, PPA and Recfishwest. Woodside is not aware of any Traditional Owner fishing in the Operational Area.

Stakeholder	Stakeholder feedback	Woodside response
	Request for Woodside to consult individual commercial fishers and charter operators with an entitlement to fish in the affected area. The Department provided advice on how to access government data to identify relevant fisheries and understand the fish stocks in the proposed area.	Woodside confirmed that relevant fishing licence holders had been advised of commercial fishing risks from planned petroleum activities, as well as proposed mitigation and/or management measures. Key fishing industry risks are: • vessel interaction • seabed disturbance • underwater noise • marine discharges. Charter operators were not consulted given the distance of the activity from shore.
	Contact details for Departmental officers and timeframe in which to be contacted in the event of a marine pollution event were provided by the Department. The Department also requested Woodside to collect and maintain marine baseline data and consider spawning grounds and nursery areas for key fish species when developing an Oil Pollution Emergency Plan. Request for Woodside to include in the EP activities and mitigation measures to manage environmental impacts arising from subsea installation. The Department also requested Woodside consult fishers on temporary exclusion from fishing areas, the installed pipeline creating a potential snagging hazard, and potential for longer-term fishery production issues due to fish aggregation where equipment is installed on the sea floor.	Woodside provided advice on oil spill arrangements, notifications and development of oil spill plans, which included consideration of potential impacts to spawning grounds and nursery areas. Woodside confirmed it had also provided advice on fishing industry risks for unplanned activities, these being hydrocarbon release to the environment and the introduction of invasive marine species.
Recfishwest	On 18 April 2019 Recfishwest noted advice provided by Woodside about a change in timing and additional project definition for the proposed activity.	Woodside acknowledged the feedback and no further action required for this EP.
AHO	On 18 April 2019 AHO acknowledged receipt of Woodside's email advising of change of timing and additional project definition.	No action required for this EP.
DPIRD	On 23 April 2019 DPIRD asked for more information about the additional project definition, specifically the number of anchors that may need to be installed and the expected seabed disturbance.	Woodside provided information in response to DPIRD's request and no further action required for this EP.
DNP	On 17 May 2019 DNP emailed Woodside acknowledging the opportunity to comment on the proposed activity. DNP noted that there was no overlap of activities on Australian Marine Parks and no authorisations were required by the DNP, adding that it required no further notification based on planned activities as communicated by Woodside.	Woodside acknowledged the feedback and no further action required for this EP.

Stakeholder	Stakeholder feedback	Woodside response
	DNP advised that Woodside had incorrectly called the Montebello Marine Park the Montebello Islands Marine Reserve in its stakeholder consultation materials. It also provided information on some of the values of the Montebello Marine Park.	Woodside acknowledged the feedback and no further action required for this EP.
	DNP advised it had worked with NOPSEMA to prepare a guidance note for titleholders to consider in preparing an EP for petroleum activities that may affect an Australian Marine Park, ensuring the management plan: • identifies and manages the impacts and risks on Australian Marine Park values to an acceptable level and has considered all options to avoid or reduce them to ALARP • clearly demonstrates that the activity will not be inconsistent with the management plan.	Woodside acknowledged the feedback, noting it had considered the Australian Government's guidance, which includes reference for engaging with the DNP, for the proposed activity. No further action required for this EP.
	DNP provided advice on emergency response arrangements, noting Woodside's commitment to inform the DNP if an environmental incident occurs that may impact on the values of an Australian Marine Park. The DNP provided contact details and expectations on content and timeliness of communications in the event of such an incident.	Woodside acknowledged the feedback and no further action required for this EP.

5.7 Ongoing Stakeholder Consultation

Woodside is committed to the engagements listed in **Table 5-4**, based on stakeholder feedback.

Table 5-4: Ongoing stakeholder consultation

Stakeholder	Activity
AMSA	Woodside will notify AMSA's Joint Rescue Coordination Centre 24 to 48 hours before operations commence.
	Woodside will notify the AHO no less than four working weeks before operations commence.
DMIRS	Woodside will provide DMIRS activity commencement and cessation notifications.

6. ENVIRONMENTAL RISK ASSESSMENT, PERFORMANCE OUTCOMES, STANDARDS AND MEASUREMENT CRITERIA

6.1 Overview

This section presents the environmental impact and risk analysis, evaluation and environment performance outcomes, environmental performance standards and measurement criteria for the Petroleum Activities Program, using the methodology described in **Section 2** of the EP.

6.2 Impact and Risk Analysis and Evaluation

As required by Regulations 13(5) and 13(6) of the Environment Regulations, the following analysis and evaluation demonstrates that the identified impacts and risks associated with the Petroleum Activities Program are reduced to ALARP, are of an acceptable level and consider all operations of the activity, including potential emergency conditions. The impact assessment for planned activities has been based on the size of the Operational Area, which includes a 4 km radius around each well and a 1.5 km radius around subsea installation locations.

The impacts and risks identified during the ENVID workshop (including decision type, current risk level, acceptability of impacts and risks, and tools used to demonstrate acceptability and ALARP) have been divided into two broad categories:

- planned activities (routine and non-routine) which have the potential for inherent environmental impacts
- unplanned events (accidents, incidents or emergency situations) with an environmental consequence are termed risks.

Within these categories, impact and risk assessment groupings are based on environmental aspects[7] e.g. emissions, physical presence, etc. In all cases, the worst case risk was assumed.

The ENVID (performed in accordance with the methodology described in **Section 2**) identified 21 sources of environmental impacts and risks. A summary of the ENVID is provided in **Table 6-1**.

The impact and risk analysis and evaluation for the Petroleum Activities Program indicate that all current environmental impacts and risks associated with the activity are reduced to ALARP and are of an acceptable level, as discussed further in **Sections 6.6** and **6.7**.

6.2.1 Cumulative Impacts

Existing subsea infrastructure within the Permit Area and nearby petroleum facilities are described in **Section 4.6.7**. Woodside has assessed the cumulative impacts of the Petroleum Activities Program in relation to other relevant petroleum activities which could realistically result in overlapping temporal and spatial extents. Woodside is not aware of any other petroleum activities[8] within Permit WA-49-L within the proposed time of the Petroleum Activities Program. Other facilities located in proximity to the Operational Area were identified within **Section 4.6.7**, with the closest being the Pluto and Wheatstone platforms which are located 16 and 20 km, respectively, north-east of the Operational Area. Woodside will not conduct concurrent drilling within WA-49-L under this EP.

[7] An environmental aspect is an element of the activity that can interact with the environment.

[8] Cumulative impacts from the Petroleum Activities Program (e.g. drilling of four development wells and subsea installation) is addressed under each relevant impact in **Section 6.6.**

Given the distance between the location of the Operational Area and the nearby petroleum facilities, no cumulative risks or impacts will credibly occur.

Table 6-1: Environmental impact and risk analysis and summary

Aspect	EP Section	Current Risk Rating				Acceptability of Risk
		Consequence	Potential Consequence level of impact[2]	Likelihood	Current Risk Rating	
Physical presence: Disturbance to other users	**6.6.1**	F	Social and Cultural – no lasting effect (<1 month), localised impact not significant to areas/items of cultural significance.	-	-	Broadly Acceptable
Physical presence: Disturbance to benthic habitat from MODU anchoring, drilling operations, subsea infrastructure installation and ROV operations	**6.6.2**	E	Environment – slight, short term local impact (< 1 year) on species, habitat (but not affecting ecosystems function), physical or biological attributes.	-	-	Broadly Acceptable
Routine acoustic emissions: Generation of noise from VSP	**6.6.3**	F	Environment – no lasting effect (<1 month), localised impact not significant to environmental receptors (e.g. protected species).	-	-	Broadly Acceptable
Routine acoustic emissions: Generation of noise from project vessels, MODU, positioning equipment and helicopter transfers	**6.6.4**	F	Environment – no lasting effect (<1 month), localised impact not significant to environmental receptors (e.g. protected species).	-	-	Broadly Acceptable
Routine and non-routine discharges to the marine environment: MODU and project vessels	**6.6.5**	F	Environment – no lasting effect (<1 month), localised impact not significant to environmental receptors (e.g. water quality).	-	-	Broadly Acceptable
Routine and non-routine discharges to the marine environment: Drill cuttings and drilling fluids (WBM and NWBM)	**6.6.6**	E	Environment – slight, short term local impact (< 1 year) on species, habitat (but not affecting ecosystems function), physical or biological attributes.	-	-	Broadly Acceptable
Routine and non-routine discharges to the marine environment: Cement, cementing fluids, grout, subsea well fluids and unused bulk products	**6.6.7**	E	Environment – slight, short term local impact (<1 year) on species, habitat (but not affecting ecosystems function), physical or biological attributes.	-	-	Broadly Acceptable

Aspect	EP Section	Current Risk Rating				Acceptability of Risk
		Consequence	Potential Consequence level of impact[2]	Likelihood	Current Risk Rating	
Routine and non-routine discharges to the marine environment: Flowline and subsea installation fluids	**6.6.8**	E	Environment – slight, short term local impact (<1 year) on species, habitat (but not affecting ecosystems function), physical or biological attributes.	-	-	Broadly Acceptable
Routine atmospheric emissions: Fuel combustion, flaring, incineration and venting	**6.6.9**	F	Environment – no lasting effect (<1 month), localised impact not significant to environmental receptors (e.g. air quality).	-	-	Broadly Acceptable
Routine light emissions: External lighting on MODU and project vessels	**6.6.10**	F	Environment – no lasting effect (<1 month), localised impact not significant to environmental receptors (e.g. species).	-	-	Broadly Acceptable
Accidental hydrocarbon release: Loss of well integrity	**6.7.2**	B	Environment – major, long term impact (10–50 years) on highly valued ecosystems, species, habitat, physical or biological attributes. Reputation/brand – national concern and/or international interest. Medium to long-term impact (5–20 years) to reputation and brand. Venture and/or asset operations restricted.	2	H	Acceptable if ALARP
Accidental hydrocarbon release: Vessel collision	**6.7.3**	D	Environment – minor, short-term impact (1–2 years) on species, habitat (but not affecting ecosystems), physical or biological attributes.	1	M	Broadly Acceptable
Accidental hydrocarbon release: Bunkering	**6.7.4**	E	Environment – slight, short term local impact (<1 year) on species, habitat (but not affecting ecosystems function), physical or biological attributes.	2	M	Broadly Acceptable
Unplanned discharges: Drilling fluids	**6.7.5**	E	Environment – slight, short term local impact (<1 year) on species, habitat (but not affecting ecosystems function), physical and biological attributes.	1	L	Broadly Acceptable
Unplanned discharges: Deck and subsea spills	**6.7.6**	F	Environment – no lasting effect (<1 month), localised impact not significant to environmental receptors (e.g. water quality).	2	L	Broadly Acceptable

Aspect	EP Section	Current Risk Rating				Acceptability of Risk
		Consequence	Potential Consequence level of impact[2]	Likelihood	Current Risk Rating	
Unplanned discharges: Loss of solid hazardous and non-hazardous wastes/equipment	**6.7.7**	F	Environment – no lasting effect (<1 month), localised impact not significant to environmental receptors (e.g. water quality).	2	L	Broadly Acceptable
Physical presence: Vessel collision with marine fauna	**6.7.8**	E	Environment – slight, short term local impact (<1 year) on species, habitat (but not affecting ecosystems function), physical or biological attributes.	1	L	Broadly Acceptable
Physical presence: Disturbance to seabed from loss of station keeping	**6.7.9**	E	Environment – slight, short term local impact (<1 year) on species, habitat (but not affecting ecosystems function), physical or biological attributes.	2	M	Broadly Acceptable
Physical presence: Dropped object resulting in seabed disturbance	**6.7.10**	F	Environment – no lasting effect (<1 month), localised impact not significant to environmental receptors (e.g. benthic habitats).	2	L	Broadly Acceptable
Physical presence: Accidental introduction and establishment of invasive marine species	**6.7.11**	D	Environment – no credible risk identified. Reputation and Brand – minor, short-term impact (1–2 years) to reputation and brand. Close scrutiny of asset level operations or future proposals.	0	L	Broadly Acceptable

6.3 Environmental Performance Outcomes, Standards and Measurement Criteria

Regulation 13(7) of the Environment Regulations requires that an EP includes environmental performance outcomes, environmental performance standards and measurement criteria that address legislative and other controls to manage the environmental impacts and risks of the activity to ALARP and Acceptable levels.

Environmental performance outcomes, standards and measurement criteria for the Petroleum Activities Program have been identified to allow the measurement of Woodside's environmental performance and the implementation of this EP to determine whether the environmental performance outcomes and standards have been met.

The environmental performance outcomes, standards and measurement criteria specified are consistent with legislative requirements and Woodside's standards and procedures. They have been developed based on the Codes and Standards, Good Industry Practices and Professional Judgement outlined in **Section 3**, as part of the acceptability and ALARP justification process.

The environmental performance outcomes, environmental performance standards and measurement criteria are presented throughout this section and in **Appendix D** (Oil Spill Preparedness and Response). A breach of these environmental performance outcomes or standards constitutes a 'Recordable Incident' under the Environment Regulations (refer to **Section 7.8.4**).

6.4 Presentation

The environmental impact and risk analysis and evaluation (ALARP and acceptability), environmental performance outcomes, standards and measurement criteria are presented in the following tabular form throughout this section. Italicised/green text in the following example denotes the purpose of each part of the table with reference to the relevant sections of the Environment Regulations and/or this EP.

Context <Description of the context for the impact/risk. Regulation 13(1, 13(2) and 13(3)>		
Description of the Activity – Regulation 13(1)	*Description of the Environment – Regulations 13(2)(3)*	*Consultation – Regulation 11A*

Impacts and Risks Evaluation Summary – ***Summary of ENVID outcomes***															
Source of impact/risk *Regulation 13(1)*	**Environmental Value Potentially Impacted** *Regulations 13(2)(3)*							**Evaluation** ***Section 2.6*** *and* ***Section 2.7***							
	Soil and Groundwater	***Marine Sediment***	***Water Quality***	***Air Quality (incl Odour)***	***Ecosystems/Habitat***	***Species***	***Socio-Economic***	***Decision Type***	***Consequence***	***Likelihood***	***Current Risk Rating***	***ALARP Tools***	***Acceptability***	***Outcome***
Summary of source of impact/risk														

Description of Source of Impact/Risk
Description of the identified impact/risk including sources or threats that may lead to the risk or identified event. Regulation 13(1).

Impact Assessment
Environmental Value/s Potentially Impacted
Discussion and assessment of the potential impacts to the identified environment value(s). Regulations 13(5)(6). *Potential impacts to environmental values have been assigned and discussed based on Woodside's Environmental Consequence Definitions for Use in Environmental Risk Assessments (**Table 2-3**).*

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS)[9]***	***Benefit in Impact/Risk Reduction[10]***	***Proportionality***	***Control Adopted***
ALARP Tool Used – Section 2.7				
Summary of control considered to ensure the impacts and risks are continuously reduced to ALARP. *Regulation 13(5)(c).*	*Technical/logistical feasibility of the control.* *Cost/sacrifice required to implement the control (qualitative measure).*	*Quantum of impact/risk that could be averted (measured in terms of reduction of likelihood, consequence and current risk rating) if the cost/sacrifice is made and the control is adopted.*	*Proportionality of cost/sacrifice vs environmental benefit. If proportionate (benefits outweigh costs) the control will be adopted. If disproportionate (costs outweigh benefits) the control will not be adopted.*	*If control is adopted: Reference to Control # provided.*
ALARP Statement *Made on the basis of the environmental risk assessment outcomes, use of the relevant tools appropriate to the decision type (**Section 2.6.1** and **Figure 2-4**) and a proportionality assessment. Regulation 10A(b).*				

[9] Qualitative measure
[10] Measured in terms of reduction of likelihood (L), consequence (C) and current risk rating (CRR)

Demonstration of Acceptability
Acceptability Statement
*Made on the basis of the application of the process described in **Section 2.7.2** and **Figure 2-7**, taking into account internal and external expectations, risk to environmental thresholds and use of environment decision principles. Regulation 10A(c).*

Environmental Performance Outcomes, Standards and Measurement Criteria			
Outcomes	***Controls***	***Standards***	***Measurement Criteria***
EPO# **S: *Specific performance which addresses the legislative and other controls that manage the activity and against which performance by Woodside in protecting the environment will be measured.*** **M: *Performance against the outcome will be measured by measuring implementation of the controls via the measurement criteria.*** **A: *Achievability/feasibility of the outcome demonstrated via discussion of feasibility of controls in ALARP demonstration. Controls are directly linked to the outcome.*** **R: *The outcome will be relevant to the source of risk and the potentially impacted environmental value.*** **T: *The outcome will state the timeframe during which the outcome will apply or by which it will be achieved.***	**C#** *Identified control adopted to ensure the impacts and risks are continuously reduced to ALARP.* *Regulation 13(5)(c).*	**PS#** *Statement of the performance required of a control measure. Regulation 13(7)(a)*	**MC#** *Measurement criteria for determining whether the outcomes and standards have been met. Regulation 13(7)(c)*

6.5 Potential Environmental Risks Not Included Within the Scope of the Environmental Plan

The ENVID identified a number of environmental risks that were assessed as not being applicable (not credible) (refer **Section 2.5**) within or outside the Operational Area as a result of the Petroleum Activities Program. Therefore, they were determined to not form part of this EP. These are described in the following sections for information only.

6.5.1 Shallow/Near-shore Activities

The Petroleum Activities Program is located in water depths of about 130–290 m and at a distance of about 50 km from the nearest landfall (this being the Montebello Islands). Consequently, risks associated with shallow/near-shore activities such as anchoring and vessel grounding were assessed as not credible.

6.5.2 Helicopter Interference With Other Users

Aerial interference with other users is not considered credible as the Operational Area is more than 257 km from mainland Australia and there are no other identified users of the airspace over the Operational Area, e.g. Royal Australian Air Force.

6.5.3 Loss of Containment of Existing Subsea Infrastructure

As described in **Section 4.6.7**, existing subsea infrastructure is present in the Operational Area as part of the Julimar Field Production System. The Operational Area of any of the wells to be drilled under this EP will not overlap any of this infrastructure. The Operational Area for installing the subsea flowline and umbilical overlaps the Julimar Field Production System at the tie-in to the BRU-XOM. The risk of dropped objects or a dragged anchor from project vessels in this area resulting in rupture of subsea infrastructure associated with the Julimar Field Production System and loss of containment is assessed in **Section 6.7.3** of the current Julimar Operations EP. The assessment details the release scenarios and control measures associated with an unplanned release from the operating subsea infrastructure. This risk is therefore not assessed again as part of this EP. However, the relevant control measures and performance outcomes, standards and measurement criteria identified in **Section 6.7.3** of the Julimar Operations EP will apply to vessels performing the Petroleum Activities Program for this EP that overlap the Operational Area for the Julimar Field Production System.

6.5.4 Loss of Containment from Abandoned Wellheads

Several existing wellheads occur in the Operational Area for this EP that have been plugged and abandoned in accordance with applicable legislation at the time of the activity (refer to **Section 4.6.7**). Barriers are in place down the wells, so if a wellhead was inadvertently damaged or removed through dropped objects or anchor drag, no loss of containment would occur. Therefore, the scenario of loss of containment from existing wellheads is not considered credible and is not assessed further.

6.6 Planned Activities (Routine and Non-routine)

6.6.1 Physical Presence: Disturbance to Other Users

Context		
Project vessels – **Section 3.5** Subsea infrastructure – **Section 3.10** Wellhead assembly left in-situ – **Section 3.12.8**	Socio-economic environment – **Section 4.6**	Stakeholder consultation – **Section 5**

Impacts and Risks Evaluation Summary

Source of Impact	*Environmental Value Potentially Impacted*							*Evaluation*						
	Soil and Groundwater	***Marine Sediment***	***Water Quality***	***Air Quality (incl Odour)***	***Ecosystems/Habitat***	***Species***	***Socio-Economic***	***Decision Type***	***Consequence***	***Likelihood***	***Current Risk Rating***	***ALARP Tools***	***Acceptability***	***Outcome***
Displacement of other users – proximity of MODU, primary installation vessels and support vessels interfering with or displacing third party vessels (commercial fishing, recreational fishing and commercial shipping)							X	A	F	-	-	GP PJ	Broadly Acceptable	EPO 1
Presence of subsea infrastructure (including wellhead left in-situ) interfering with or displacing third party vessels (commercial/ recreational fishing)							X	A	F	-	-	GP PJ	Broadly Acceptable	EPO 1

Description of Source of Impact

Activities that are potential sources of disturbance to other users are:

- MODU, support vessels and primary installation vessels
- subsea infrastructure.

Drilling of the four production wells is expected to take about 70 days per well to complete. Only one well will be drilled at a time, therefore, a MODU and support vessels may be present within the Operational Area for up to about a year.

Support vessels will assist the MODU. If required, one of the vessels will be at the MODU to perform standby duties as stipulated in the OneMarine Charterers Instructions, and others will transit in and out of the Operational Area to port for routine, non-routine and emergency operations. The support vessels will make about two to four trips per week.

The pipelay vessel will be present for a cumulative duration of about four to eight weeks to complete flowline and umbilical installation activities, dependant on weather and progress.

The presence of the MODU, primary installation vessels and other project vessel movements could present a navigational hazard to shipping and commercial fishing activities in the Operational Area. Activities will be 24 hours per day, seven days per week.

As outlined in **Sections 3.12.7** and **3.12.8**, wells may need to be abandoned if a re-spud is required. This is considered a contingent activity and if a well is abandoned due to re-spud, routine techniques will be used to remove the wellhead(s). Wellhead assemblies may be left in-situ if these routine removal techniques are unsuccessful. If a wellhead is left in-situ, it could potentially interfere with third party activities (particularly fishing activities).

Impact Assessment

Potential Impacts to Socio-Economic Environment

Displacement to Commercial Fishing Activities

A number of Commonwealth and State managed fisheries overlap the Operational Area (**Section 4.6.3**). The proposed wells are situated within three Commonwealth and seven State managed fisheries. However, only two fisheries, the Mackerel Managed Fishery and Pilbara Line Fishery, are considered to be active in the vicinity of the Operational Area. The Operational Area is located in water depths ranging from about 130–290 m, which is beyond the upper depth limit where typical Mackerel Managed Fishery effort occurs (up to about 100 m). Therefore, interactions with participants in the commercial fishery is unlikely.

Consultation with WAFIC identified that the Specimen Shell Fishery and Onslow Prawn Fishery are not impacted by the proposed activity. The Operational Area is located within a closed (indefinite) area of the Pilbara Trawl and Pilbara Trap Fishery, and therefore effort from these fisheries is not expected within the Operational Area. Although overlapping with the boundaries of the Beche-de-mer, Pearl Oyster, or Marine Aquarium Managed Fisheries, the Operational Area is considered too far offshore to credibly impact these fisheries.

Potential impacts to commercial fishing if a well is abandoned during drilling and the wellhead remains in-situ, are snag hazards to fishing equipment such as trawl nets that operate along the seabed. The one fishery that uses trawl practices and overlaps with the Operational Area is the Pilbara Trawl Fishery. However, current FishCube data indicates no vessels from the Pilbara Trawl Fishery have been active in the waters within or adjacent to the Operational Area since at least 2013 (DPIRD, 2019a; **Table 4-7**). Given the water depths in the Operational Area (about 130–290 m), impacts to commercial fishing activities if any wellhead remains in-situ are considered highly unlikely.

Given the low level of fishing activity expected in the Operational Area, the presence of commercial fishing vessels in the Operational Area would likely be short term, potentially resulting in a minor interference (navigational hazard) and localised displacement/avoidance by commercial fishing vessels within the immediate vicinity of the MODU or project vessels. However, there was no direct response from commercial fisheries during the stakeholder consultation period, and as such the potential impact is considered to be minor and temporary.

Displacement of Recreational Fishing

Stakeholder consultation did not identify any key recreational fishing activity within the Operational Area. Recreational fishing in the region is concentrated around the coastal waters and islands of the NWMR such as the Montebello Islands. Due to the distance offshore and water depths, recreational fishing is unlikely to occur in the Operational Area. If recreational fishing effort occurred within the Operational Areas while drilling or subsea installation is being performed, displacement as a result of the Petroleum Activities Program would be minimal and relate only to the 500 m petroleum safety zone, around the MODU and primary installation vessels. Additionally, fishing activity may be excluded from the immediate area around primary installation vessels. Therefore, the potential impact is considered to be slight and would be isolated to only short term impacts to reputation and brand.

Given the distance of the Operational Area offshore and water depths greater than 130 m, snagging hazards to recreational fishing equipment as a result of a wellhead remaining in-situ are highly unlikely.

Displacement to Commercial Shipping

The presence of the MODU and project vessels could potentially cause temporary disruption to commercial shipping. The Operational Area lies beyond designated shipping fairways in the region and is not subject to significant commercial vessel traffic (**Figure 4-15**). AMSA provided no response or comment at the end of the consultation period closing 11 March 2019. The potential impacts associated with this Petroleum Activities Program include displacement of vessels as they make slight course alteration to avoid the MODU or primary installation vessels. Therefore, the potential impact is considered to be isolated and temporary.

Given the water depth of the proposed wells, impacts to commercial shipping as a result of a wellhead remaining in-situ are not considered credible.

Cumulative Impacts

There are no cumulative impacts from drilling activities, as no wells will be drilled concurrently. However, there may be cumulative impacts to commercial fisheries from concurrent drilling and subsea installation activities. Of the two fisheries considered active in the vicinity of the Operational Area, the Mackerel Managed Fishery, operates at depths (up to about 100 m) found outside of the Operational Area and impacts are therefore not expected. Potential cumulative impacts to vessels associated with the Pilbara Line Fishery that overlaps the Operational Area would be slight and short-term.

Summary of Potential Impacts to Environmental Values

Given the adopted controls, it is considered that physical presence of the MODU, primary installation vessels, support vessels and the potential presence of a wellhead left in-situ (if required) will not result in a potential impact greater than slight, short term impact to shipping and commercial/recreational fishing interests (i.e. Reputation and Brand Impacts – E).

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/ Sacrifice (CS)[11]***	***Benefit in Impact Reduction***	***Proportionality***	***Control Adopted***
Legislation, Codes and Standards				
No controls identified.				
Good Practice				
Australian Hydrographic Service (AHS) will be notified of activities and movements no less than 4 working weeks prior to scheduled activity commencement date.	F: Yes. CS: Minimal cost. Standard practice.	Notification to AHS will enable them to generate navigation warnings (Maritime Safety Information Notifications (MSIN) and Notice to Mariners (NTM) (including AUSCOAST warnings where relevant)).	Benefits outweigh cost/sacrifice. Control is also Standard Practice.	Yes C 1.1
Notify DPIRD (Western Australia) (formerly the WA Department of Fisheries) of activities within three months of drilling.	F: Yes. CS: Minimal cost. Standard practice.	Communicating the Petroleum Activities Program to other marine users ensures they are informed and aware, thereby reducing the likelihood of interfering with other marine users.	Benefits outweigh cost/sacrifice. Control is also Standard Practice.	Yes C 1.2
Notify AMSA Joint Rescue Coordination Centre (JRCC) of activities and movements 24-48 hours before operations commence..	F: Yes. CS: Minimal cost. Standard practice.	Communicating the Petroleum Activities Program to other marine users ensures they are informed and aware, thereby reducing the likelihood of interfering with other marine users.	Benefits outweigh cost/sacrifice. Control is also Standard Practice.	Yes C 1.3
Professional Judgement – Eliminate				
Limit drilling activities to avoid peak shipping and commercial fishing activities.	F: No. Shipping occurs year-round and cannot be avoided. SIMOPS with fishing seasons cannot be eliminated as exact timings for all activities are not confirmed. CS: Not considered – control not feasible.	Not considered – control not feasible.	Not considered – control not feasible.	No
Professional Judgement – Substitute				
No additional controls identified.				

[11] Qualitative measure

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/ Sacrifice (CS)***[11]	***Benefit in Impact Reduction***	***Proportionality***	***Control Adopted***
Professional Judgement – Engineered Solution				
Over-trawl protection on subsea infrastructure.	F: Yes. Over-trawl protection could mitigate the potential for commercial fishing trawl gear to damage subsea infrastructure and/or result in loss of trawl gear. CS: Significant additional cost.	Reduces the potential for snagging trawl nets if a wellhead is left in-situ following abandonment during drilling. However, given the low level of trawling activity occurring in the Operational Area, the benefit is low.	Disproportionate. Significant additional costs.	No
ALARP Statement On the basis of the environmental impact assessment outcomes and use of the relevant tools appropriate to the decision type (i.e. Decision Type A), Woodside considers the adopted controls appropriate to manage the impacts of the physical presence of the MODU, project vessels, subsea infrastructure and potentially a wellhead left in-situ (if required) on other users, such as commercial fisheries, recreational fishing and shipping. As no reasonable additional/alternative controls were identified that would further reduce the impacts without grossly disproportionate sacrifice, the impacts and risks are considered ALARP.				

Demonstration of Acceptability
Acceptability Statement The impact assessment has determined that, given the adopted controls, physical presence of the MODU, project vessels and potentially a wellhead left in-situ (if required) is unlikely to result in potential impact greater than isolated and short-term impacts to commercial fishing, recreational fishing and shipping. Further opportunities to reduce the impacts and risks have been investigated above. The adopted controls are considered good oil-field practice/industry best practice and meet requirements of Australian Marine Orders, and expectations of AMSA and AHS provided in consultation with stakeholders. The potential impacts and risks are considered broadly acceptable if the adopted controls are implemented. Therefore, Woodside considers the adopted controls appropriate to manage the impacts and risks of physical presence of the Petroleum Activities Program to a level that is broadly acceptable.

Environmental Performance Outcomes, Standards and Measurement Criteria			
Outcomes	***Controls***	***Standards***	***Measurement Criteria***
EPO 1 Marine users aware of the Petroleum Activities Program.	**C 1.1** Notify AHS of activities and movements no less than four working weeks prior to the scheduled activity commencement date.	**PS 1.1** Notification to AHS of activities and movements to allow generation of navigation warnings (Maritime Safety Information Notifications (MSIN) and Notice to Mariners (NTM) (including AUSCOAST warnings where relevant)).	**MC 1.1.1** Consultation records demonstrate that AHS has been notified before commencing an activity to allow generation of navigation warnings (MSIN and NTM (including AUSCOAST warnings where relevant)).
	C 1.2 Notify DPIRD (Western Australia) (formally the WA Department of Fisheries) of activities within three months of drilling.	**PS 1.2** Notification to DPIRD to inform other marine users of the activities to reduce activities interfering with other marine users for longer than necessary.	**MC 1.2** Consultation records demonstrate that DPIRD has been notified prior to commencing drilling.

Environmental Performance Outcomes, Standards and Measurement Criteria			
Outcomes	***Controls***	***Standards***	***Measurement Criteria***
	C 1.3 Notify AMSA JRCC of activities and movements 24–48 hours before operations commence.	**PS 1.3** Notification to AMSA JRCC to prevent activities interfering with other marine users. AMSA's JRCC will require the MODU's details (including name, callsign and Maritime Mobile Service Identity (MMSI)), satellite communications details (including INMARSAT-C and satellite telephone), area of operation, requested clearance from other vessels and need to be advised when operations start and end.	**MC 1.3** Consultation records demonstrate that AMSA JRCC has been notified before commencing the activity within required timeframes.

6.6.2 Physical Presence: Disturbance to Benthic Habitat from MODU Anchoring, Drilling Operations, Subsea Infrastructure Installation and ROV Operations

Context	
Mooring installation and anchor holding testing – **Section 3.7.1** Project vessels – **Section 3.5** Other support – **Section 3.6** Drilling and completions activities – **Section 3.9** Subsea installation and pre-commissioning activities – **Section 3.10** Wellhead assembly left in-situ – **Section 3.12.8**	Biological environment – **Section 4.5** Values and sensitivities – **Section 4.7**

Impacts and Risks Evaluation Summary

Source of Impact	*Environmental Value Potentially Impacted*							*Evaluation*						
	Soil and Groundwater	***Marine Sediment***	***Water Quality***	***Air Quality (incl Odour)***	***Ecosystems/Habitat***	***Species***	***Socio-Economic***	***Decision Type***	***Consequence***	***Likelihood***	***Current Risk Rating***	***ALARP Tools***	***Acceptability***	***Outcome***
Disturbance to seabed from drilling operations					X			A	E	-	-	GP PJ	Broadly Acceptable	EPO 2
Disturbance to seabed from subsea infrastructure installation					X			A	E	-	-			
Disturbance to seabed from ROV operation (including localised sediment relocation from jetting activities)					X			A	E	-	-			
Disturbance to seabed from MODU station holding (MODU mooring, including anchor holding testing), and temporary anchor for flowline installation					X			A	E	-	-			
Disturbance to seabed from wellhead remaining in-situ (if required)					X			A	E	-	-			

Description of Source of Impact

Drilling

Drilling activities will result in direct seabed disturbance of up to 100 m radius around each well location due to the installation of the BOP and conductor. The generation and discharge of cuttings and drilling fluids are not considered in this section; refer to **Section 6.6** for an assessment of drill cuttings and drilling fluids.

MODU Anchoring and Anchor Holding Testing

The use of a moored MODU will result in seabed disturbance from the anchor holding testing and MODU anchor mooring system, including placement of anchors and chain/wire on the seabed, potential dragging during tensioning and recovery of anchors. Suction piling may be required for installing the anchors. Overall, the mooring of the MODU and anchor holding testing activities will result in localised, small scale seabed disturbance relating to the spatial extent of the benthic habitats described in **Section 4.4.4**. Mooring is likely to require an 8–12 point pre-laid mooring system at each well location. There are four well locations for the Petroleum Activities Program, equating to the need for up to about 48 anchor installations.

The planned anchoring activities will be within the parameters defined in the Anchoring of Vessels and Floating Facilities Environment Plan Reference Case (Department of Industry, Innovation and Science, undated) for all anchoring activities performed by vessels and floating facilities (excluding floating production, storage and offtake vessels and floating LNG vessels) while performing petroleum activities including:

- locations of water depth greater than 70 m (this boundary is set to exclude areas of sensitive primary producer habitats, such as coral and seagrass, that occur in shallower waters)
- installation of moorings, buoys, equipment or other infrastructure for a period of up to two years
- wet storage on seabed of anchor chains, etc., during activities up to two years
- activities with total areas of seabed disturbance less than 13,000 m².

Flowline and Subsea Infrastructure Installation Activities

The subsea infrastructure for the proposed Julimar Development Phase 2 program is outlined in **Table 3-1** and includes installing a 22 km flowline between the Julimar manifold and the existing BRU-XOM. Commencement of the pipe-lay may require deploying an initiation anchor, which may consist of a suction pile, drag anchor or clump weight/dead man anchors. The dead man anchor will weigh about 15 t with about 1100 m of 7 cm diameter wire to initiate the pipe-lay. The flukes of this type of anchor are able to flip over, depending on which way it lands on the seabed, and it is anticipated that there will be no need to reset the anchor. This will cause localised and temporary impacts to water quality from increased turbidity and may cause localised and temporary impacts to benthic habitats.

Span rectification may be required through installing structures such as concrete mattresses, positioned at identified free span locations using ROV. The dimensions for each concrete mattress are expected to be 12 m by 3 m. Post-lay span rectification may involve placing grout bags on the seabed, with the extent of any impact limited to the footprint of the installed flowline.

An array of underwater acoustic positioning transponders will be placed on the seafloor and are critical for accurately positioning the flowline and pre-lay structures. LBL transponders may be moored to the seabed by a clump weight. The standard clump weights used will likely weigh about 80 kg. When installation is complete, the LBL transponders will be recovered via an acoustic release mechanism, leaving only the concrete clump weight on the seafloor. Steel chains are used as they rust and gradually degrade in seawater over time.

The installation of subsea infrastructure and supporting structures (including FLET, wellheads, jumpers, manifolds, skids, buckle initiator structures, concrete mattresses) may also result in localised disturbance to benthic habitats in the form of a scour around the subsea infrastructure during the lifespan of the equipment. A suction pile or piles may be required to secure the well centre manifold.

No wet storage of infrastructure items is currently planned but may be considered when optimising the installation schedule. Wet storage of subsea equipment associated with the Petroleum Activities Program would result in localised temporary disturbance to the seafloor.

ROV

Use of the ROV during Petroleum Program Activities may result in temporary seabed disturbance and suspension of sediment, causing increased turbidity as a result of working close to or occasionally on the seabed. ROV used close to or on the seabed is limited to that required for effective and safe subsea activities. The footprint of a typical ROV is about 2.5 m × 1.7 m. Additionally, the ROV may be used to relocate small amounts of sediment material (known as jetting) to create a stable, level surface and reduce the potential for scouring from subsea equipment (e.g. manifolds). This will cause localised and temporary impacts to water quality from increased turbidity and may cause localised and temporary impacts to benthic habitats.

Wellhead Remains In-situ

As outlined in **Section 3.12.7** and **3.12.8**, wells may need to be abandoned if a re-spud is required. This is considered a contingent activity and if a well must be abandoned due to re-spud, routine techniques will be used to remove the wellhead(s). Wellhead assemblies may be left in-situ if these routine removal techniques are unsuccessful. If a wellhead is left in-situ, there would be localised seabed disturbance around the wellhead location.

Impact Assessment

Potential Impacts to Ecosystems/Habitats

Deepwater Benthic Habitats

Drilling operations, MODU mooring (including anchor hold testing), installation of the flowline and other subsea infrastructure and ROV operations are likely to result in localised physical modification to a small area of the seabed and disturbance to soft sediment. Bathymetry surveys indicate the seabed within the Operational Area is predominantly flat and featureless, except the slope at the north west region that forms part of the Continental Slope Demersal Fish Communities KEF and the Ancient Coastline at 125 m Depth Contour KEF at the north-east extent of the Operational Area. The proposed location of the Julimar development wells or flowline and other subsea infrastructure do not overlap with either of these KEFs, as described below. However, it is possible that the anchor spread for the MODU may overlap these KEFs.

The Operational Area is expected to consist primarily of soft, fine unconsolidated sediments, which are typical of the broader NWMR. As such, physical impacts to the seabed are expected to be highly localised, non-significant disturbance to deepwater soft sediments. Due to the presence of soft sediments and lack of hard substrate, the seabed is likely to be inhabited by a low abundance of patchy distributions of filter feeders and other epifauna, including mobile epibenthos (e.g. sea cucumbers, ophiuroids, echinoderms, polychaetes and sea-pens, characteristic of the wider NWMR (Brewer et al., 2007). Impacts from drilling activities are expected to be confined to sediment-burrowing infauna and surface epifauna invertebrates, particularly filter feeders, inhabiting the seabed directly around the well location, typically within 100 m of the well (Gates and Jones, 2012; Hughes et al., 2010). Impacts to these broadly represented communities are expected to be highly localised with no significant impact to environment receptors.

The Continental Slope Demersal Fish Communities KEF (**Section 4.7.1**) overlaps the Operational Area, but is over 2.4 km from the closest proposed Julimar well and flowline locations. The north-east extent of the Operational Area also overlaps with the Ancient Coastline at 125 m Depth Contour KEF which, at its closest point, lies about 1.1 km from the flowline and 1.3 km from the Brunello manifold. Any impacts to the benthic habitats of the two KEFs would be limited to minor disturbance from potentially overlapping anchor spreads. However, such impacts would be minor and temporary and are not expected to impact the ecological values of the KEFs as described in **Section 4.7.11**.

The flowline and umbilical routes have been optimised to account for seabed bathymetry, seabed materials, dropped object risk and buckling/walking impact. The short term benthic impacts associated with the pipelaying activity include temporary and localised disturbance to sediment and disturbance to sessile benthic organisms. Long term impacts include the addition of a hard substrate to the marine environment for the duration of the activity. Given the widespread representation of the infauna communities within the Operational Area and the broader NWMR, impacts are expected to be restricted to a minor portion of infauna and are considered low. Benthic impacts will be similar regardless of whether a Reel-lay or S-lay flowline installation is used.

ROV activities near the seafloor and small amounts of sediment relocation may result in slight and short-term impacts to deepwater biota, detailed above, as a result of elevated turbidity and the clogging of respiratory and feeding parts (turbidity) of filter feeding organisms. However, elevated turbidity would only be expected to be very short-term and temporary, and is therefore, not expected to have any significant impact to environment receptors.

In the unlikely event that a well is abandoned during drilling as a result of a well re-spud, and the wellhead cannot be removed, over time the cement surrounding the wellhead will likely become buried in sediment as a result of prevailing ocean currents. The steel wellhead structure will also corrode over time and marine fouling is expected to accumulate, whereby a marine life structure may remain above the seafloor. If any wellhead remains in-situ, it is expected to have a localised impact not significant to environment receptors. No further impacts to benthic habitats are likely.

Cumulative Impacts

Given the number of wells planned to be drilled during the Petroleum Activities Program, and 31 historically drilled wells within the Operational Area, there is the potential for cumulative disturbance to the seabed and benthic communities. Cumulative seabed disturbance associated with the Petroleum Activities Program is expected to be restricted to an accumulation of disturbance areas from overlapping well and other subsea infrastructure footprints (if well locations and subsea infrastructure are within hundreds of metres of each other).

The most recently drilled wells existing within the Operational Area are associated with the Brunello hydrocarbon (gas) development project which are currently commissioned. The Julimar and Brunello well footprints do not overlap with each other, therefore posing no risk for cumulative impacts. The tie-in of the flowline and umbilical will disturb benthic habitat as a result of pipelaying and ROV activity. Disturbance will be limited to surface sediment dispersion and will be highly localised and short term.

Benthic habitats within the Operational Area are well represented throughout the NWMR; therefore, cumulative impacts associated with seabed disturbance from overlapping well footprints and subsea installation activities, including pipelay, are not expected to significantly increase the risk to benthic habitats within the Operational Area.

Summary of Potential Impacts to Environmental Values

Given the adopted controls, seabed disturbance from the Petroleum Activities Program will result in localised, slight and short-term impacts to benthic habitat and communities (i.e. Environment Impact – E).

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS)[12]***	***Benefit in Impact Reduction***	***Proportionality***	***Control Adopted***
Legislation, Codes and Standards				
No additional controls identified.				
Good Practice				
Project-specific Basis of Well Design, which includes an assessment of seabed sensitivity.	F: Yes. CS: Minimal cost. Standard practice.	Reduces the likelihood of anchoring occurring in areas of high sensitivity. Assessment of seabed topography reduces the likelihood of anchor drag leading to seabed disturbance.	Benefits outweigh cost/sacrifice.	Yes C 2.1
Project-specific Mooring Design Analysis.	F: Yes. CS: Additional costs associated with upgraded MODU mooring design.	The mooring design analysis determines the number and spread of anchors required based on sediment type and seabed topography, reducing the likelihood of anchor drag leading to seabed disturbance.	Benefits outweigh cost/sacrifice.	Yes C 2.2
LBL or USBL positioning technology used.	F: Yes. CS: Minimal cost. Standard practice.	Using positioning technology to accurately position infrastructure on the seabed will reduce seabed disturbance.	Benefits outweigh cost/sacrifice.	Yes C 2.3
Environmental monitoring of the seabed before and after the Petroleum Activities Program to assess any impacts to seabed.	F: Yes. CS: Significant. Monitoring of the seabed, particularly the deep waters of the Operational Area, would have significant additional costs to obtain and analyse data with the spatial resolution to accurately assess changes to the seabed habitat.	Environmental monitoring would not result in any additional information of the seabed above that already collected. Therefore, no additional reductions in likelihood or consequence would occur.	Control grossly disproportionate. Monitoring will not reduce the consequence or likelihood of any impacts to the seabed, and the cost associated with the level of monitoring required to accurately assess any impacts greatly outweighs the benefits gained. Although adopting this control could be used to verify EPOs, alternative controls identified also allow demonstration that the environmental outcome has been met based on the nature of the activity (i.e. predictable impacts) and relatively low sensitivity of the area.	No

[12] Qualitative measure

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS)[12]***	***Benefit in Impact Reduction***	***Proportionality***	***Control Adopted***
Professional Judgement – Eliminate				
Only use DP MODU (no anchoring required).	F: No. CS: It is not technically feasible for the MODU to use DP in the water depth of the well locations (about 174 m). Woodside has a demonstrated capacity to manage the environmental risks and impacts from mooring to a level that is ALARP and acceptable.	Not assessed, control not feasible.	Not assessed, control not feasible.	No
Do not use ROV close to, or on, the seabed.	F: No. The use of ROVs (including work close to or occasionally landed on the seabed) is critical as the ROV is the main tool used to guide and manipulate equipment during drilling. ROV usage is already limited to only that required to conduct the work effectively and safely. Due to visibility and operational issues, ROV work on or close to the seabed is avoided unless necessary. CS: Not assessed, control not feasible.	Not assessed, control not feasible.	Not assessed, control not feasible.	No
Professional Judgement – Substitute				
No additional controls identified.				
Professional Judgement – Engineered Solution				
No additional controls identified.				
ALARP Statement On the basis of the environmental impact assessment outcomes and use of the relevant tools appropriate to the decision type (i.e. Decision Type A), Woodside considers the adopted controls appropriate to manage the impacts of benthic habitat disturbance from MODU station holding, drilling operations, flowline and other subsea infrastructure installation and ROV operations. As no reasonable additional/alternative controls were identified that would further reduce the impacts without grossly disproportionate sacrifice, the impacts and risks are considered ALARP.				

Demonstration of Acceptability
Acceptability Statement The impact assessment has determined that, given the adopted controls, disturbance to benthic habitats is unlikely to result in a potential impact greater than a slight and temporary effect on habitat (but not affecting ecosystems function). Further opportunities to reduce the impacts and risks have been investigated above. The adopted controls are considered good oil-field practice/industry best practice and meet the requirements of Woodside's relevant systems and procedures. The potential impacts and risks are considered broadly acceptable if the adopted controls are implemented. Therefore, Woodside considers the adopted controls appropriate to manage the impacts and risks of seabed disturbance to a level that is broadly acceptable.

Environmental Performance Outcomes, Standards and Measurement Criteria			
Outcomes	***Controls***	***Standards***	***Measurement Criteria***
EPO 2 No impact to benthic habitats greater than a consequence level of F inside the Operational Area during the Petroleum Activities Program.[13]	**C 2.1** Project-specific Basis of Well Design, which includes an assessment of seabed sensitivity.	**PS 2.1** MODU well site locations consider seabed sensitivities.	**MC 2.1.1** Records confirm Basis of Well Design includes the assessment of seabed sensitivities.
	C 2.2 Project-specific Mooring Design Analysis.	**PS 2.2** Seabed disturbance from MODU mooring limited to that required to ensure adequate MODU station holding capacity.	**MC 2.2.1** Records demonstrate Mooring Design Analysis completed and implemented during anchor deployment.
	C 2.3 LBL or USBL positioning technology used.	**PS 2.3** Infrastructure will be positioned in the planned location[14] where impacts have been assessed.	**MC 2.3.1** Records confirm LBL transponders or USBL in place and functioning correctly.
			MC 2.3.2 As-built surveys verify installation of equipment within acceptable tolerance[13].

[13] Defined as 'Slight, short term local impact (<1 year), on species, habitat but not affecting ecosystem function), physical or biological attributes' as in **Figure 2-6/Section 2.6.3**.

[14] Acceptable tolerance is considered to be ±150 m, given the homogenous and low sensitivity habitat.

6.6.3 Routine Acoustic Emissions: Generation of Noise from VSP

Context	
Project vessels – **Section 3.5**	Biological environment – **Section 4.5**

Impacts and Risks Evaluation Summary

	Environmental Value Potentially Impacted							*Evaluation*						
Source of Impact	***Soil and Groundwater***	***Marine Sediment***	***Water Quality***	***Air Quality (incl Odour)***	***Ecosystems/Habitat***	***Species***	***Socio-Economic***	***Decision Type***	***Consequence***	***Likelihood***	***Current Risk Rating***	***ALARP Tools***	***Acceptability***	***Outcome***
Generation of acoustic signals from VSP					X	X		A	F	-	-	LCS GP	Broadly Acceptable	EPO 3&4

Description of Source of Impact

Vertical seismic profiling operations can generate noise that could exceed ambient levels generated by wind and wave action and biological noise (ambient noise levels range from about 90 dB re 1 µPa under very calm, low wind conditions, to 120 dB re 1 µPa under windy conditions) (McCauley, 2005).

VSP is a standard method used during well logging (as described in **Section 3.12.5)**. The duration of VSP is short, up to 24 hours for each well (i.e. up to 4 × 24 hours during the Petroleum Activities Program if VSP is required for all wells), and uses relatively small airguns that generate impulsive low frequency noise.

The VSP source (typically 750 cui and comprising three 250 cui airguns) is expected to generate a peak pressure around 239 dB re 1 µPa pk @ 1 m, a sound pressure level (SPL) of 224 dB re 1 µPa SPL (root mean square, or ‘rms’) and sound exposure level (SEL) of 225 dB re 1 $\mu Pa^2.s$ @ 1 m, with the majority of the noise concentrated at low (<100 Hz) frequencies (Jimenez-Arranz et al., 2017).

Impact Assessment

Potential Impacts to Protected Species

To determine impacts to EPBC listed species, an assessment was performed of the expected ranges of noise levels that could result in impacts. When acoustic waves propagate through water, there is a significant loss of intensity due to geometric spreading, reflection, absorption and scattering (International Association of Oil and Gas Producers (IOGP), 2008). The sum of these losses is referred to as ‘transmission loss’. The short range spherical spreading loss component of this can be estimated to determine expected noise levels at short range using the spherical spreading loss calculation below:

$$\text{Transmission Loss (TL)} = 20 \log_{10}(r) + \alpha r$$

Where:

- r is the slant range between the source and the receiver
- α is the frequency-dependent absorption coefficient for seawater (dependent on temperature, pH and salinity) calculated using the equation of Fisher and Simmons (1977); estimated to be 0.001 for typical seawater in the Operational Area. Note that for low frequency sound, such as VSP, the contribution of α to transmission loss is small compared to the geometric spreading term.

Based on this equation, the expected range where noise levels will be equal to or greater than the relevant thresholds is detailed in **Table 6-2**.

Table 6-2: Noise level thresholds for cetaceans, marine turtles and whale sharks and expected distance from the source where noise levels will dissipate to below the relevant thresholds

Species Group	Threshold		Expected range of noise levels ≥ thresholds
Cetaceans	Permanent threshold shift (PTS)	230 dB re 1 µPa (pk) OR 198 dB re 1 µPa2.s SEL (m-weighted)	~3 m ~23 m
	Behavioural response	160 dB re 1 µPa SPL (rms)	~1600 m
Marine turtles	Permanent threshold shift	No data available	NA
	Behavioural response	166 dB re 1 µPa SPL (rms)	~800 m
Whale sharks	Permanent threshold shift	>213 dB re 1 µPa SPL (rms) OR >216 dB re 1 µPa2.s SEL	~20 m OR ~3 m
	Behavioural response	No data available	NA
Fish (where swim bladder is involved in hearing)	Permanent threshold shift	203 dB re 1 µPa2.s (cSEL) OR >207 dB re 1 µPa (pk)	<10 m
	Temporary threshold shift (TTS)	186 dB re 1 µPa2.s (cSEL)	<150 m

Marine Fauna (Cetaceans)

Elevated underwater noise can affect marine fauna, such as whales, in three main ways (*Oceans of noise*, 2004; Richardson et al., 1995; Southall et al., 2007):

- by causing direct physical effects on hearing or other organs (injury)
- by masking or interfering with other biologically important sounds (including vocal communication, echolocation, signals and sounds produced by predators or prey)
- through disturbance leading to behavioural changes or displacement from important areas.

Available data on marine mammal behavioural responses to pulsed sounds are highly variable and context-specific. Recent studies on the behavioural response of humpback whales to seismic airguns has demonstrated a behavioural response to seismic airguns above received SELs of 140 dB re 1 µPa2.s (Dunlop et al., 2017). This study used the behavioural response of humpback whales to noise from two different moving airgun arrays (20 and 140 cubic inch airgun array) to determine whether a dose–response relationship existed. To do this, a measure of avoidance of the source was developed, and the magnitude (rather than probability) of this response was tested against dose. The proximity to the source, and the vessel itself, was included within the one analysis model. Humpback whales were more likely to avoid the airgun arrays (but not the controls) within 3 km of the source at SELs over 140 dB re 1 µPa2.s, meaning that both the proximity and the received level were important factors and the relationship between dose (received level) and therefore the 140 dB re 1 µPa2.s cannot be adopted as a standalone threshold if the source proximity is greater than 3 km. This study tested towing an airgun source directly into the incoming path of a southern humpback migration which included mother and calf humpback whales. Therefore, the context and applicability of these results may not be directly relevant to the behavioural response to all cetaceans in every context and has not been adopted for the assessment of potential behavioural impacts from VSP, due to that fact that the source is stationary. It should be noted that Dunlop et al. (2017) makes reference that their result are surprisingly consistent with previous studies with humpback whales in different behavioural contexts. For example, feeding humpback whales responded at ranges up to 3 km from the source, at levels of 150–169 dB re 1 µPa (Malme et al., 1985) and resting female humpback whales with calves displayed avoidance reactions at 140 dB re 1 µPa, though other cohorts reacted at higher levels (157–164 dB re 1 µPa; McCauley et al., 2003).

The United States (US) National Marine Fisheries Service guidance (NMFS, 2005) sets the Level B harassment threshold for marine mammals at 160 dB re 1 µPa (rms) for impulsive noise. The value for impulsive sound sits in the upper-mid range for disturbance impacts identified in Southall et al. (2007) and in alignment with other studies referred above (McCauley et al., 2003; Malme et al., 1985); consequently, this criterion has been used (in lieu of more suitable up to date criteria) for assessing onset of potentially strong behavioural reaction in this assessment.

The relevant criteria proposed by Southall et al*.* (2007) for assessing the potential for PTS due to multiple and single pulse sounds are considered to be an un-weighted peak pressure level of 230 dB re 1 µPa (pk) and an m-weighted SEL of 198 dB re 1 μPa^2.s for all cetaceans. These injury criteria values are derived from values for onset of TTS with an additional allowance of +6 dB for peak sound and +15 dB for SEL to estimate the potential onset of PTS (Southall et al., 2007).

Marine Fauna (Fish and Marine Turtles)

Popper et al. (2014) investigated, through a literature review, mortality, impairment and behaviour thresholds for fishes, and found greater than 186 dB re 1 µPa².s was required to elicit even a temporary threshold shift for fish. It is expected that potential impacts to the most sensitive fish species (fish with swim bladder involved in hearing) from VSP will be limited to 150 m from the source for TTS and less than 10 m for PTS. There is a paucity of data regarding responses of marine turtles, whale sharks and rays to underwater noise. Finneran et. al. (2017) defined PTS and TTS thresholds of 232 dB re 1 µPa and 226 dB re 1 µPa, respectively for turtles. The Popper et al. (2014) review also assessed thresholds for marine turtles and found qualitative results that TTS was only high for near-field exposure, while TTS was low for both intermediate and far-field exposure (Popper et al., 2014). McCauley et al. (2000) noted that sea turtles exhibit increased swimming activity at 166 dB re 1 µPa. To assess the potential impacts to whale sharks, the fish (no swim bladder) threshold (Popper et al., 2014) was adopted whereby potential impacts are expected to be limited to within 20 m from the source.

Impact to EPBC Listed Species

Controls including marine fauna observers, pre-start visual observations and operational procedures, as described below in the demonstration of ALARP, will reduce potential impacts by allowing animals to move from the source of the sound to beyond the 1600 m threshold zone (behavioural response for cetaceans). Any impacts to whale sharks, cetaceans and marine turtles is expected to be limited to short-term avoidance of a localised area with no long-term impacts.

Seasonal Sensitivities of Marine Fauna

The use of VSP has the potential to cause temporary (up to about 24 hours for each well) and localised disturbance to marine fauna in response to received noise levels of about 160 dB re 1 µPa SPL (rms). As the Petroleum Activities Program may take place at any time, VSP may overlap with the migration seasons for pygmy blue whales, humpback whales, sei whales, fin whales and whale sharks. The Operational Area overlaps the migration BIA for pygmy blue whales and other whale species may also occur in the vicinity of the Operational Area at various times during the year, with increased numbers during peak periods (**Section 4.5.2**). Given the Operational Area overlaps with the whale shark foraging BIA, presence of this species during peak periods (May to July, **Section 4.5.2**) is expected. VSP may also overlap with nesting seasons for marine turtles at the Montebello Islands (about 50 km southeast of the Operational Area. It is possible that these species will occur, in small numbers, in the vicinity of the Operational Area at various times during the year, with increased numbers during peak periods (**Section 4.5.2**). However, even with an increased likelihood of interaction, the potential impacts are considered to be localised and not significant to environmental receptors (as described above).

It is reasonable to expect that cetaceans, whale sharks, rays and marine turtles may demonstrate avoidance or attraction behaviour in the vicinity of the VSP activity. However, any avoidance or attraction behaviours displayed by these transient animals resulting from the VSP activities are expected to be localised and temporary, based on the short duration of the VSP activities. Furthermore, VSP activities will be spread out sporadically for the four wells (if required for all wells). The intensity of noise dissipates with distance from its source. Based on the likely low abundance of MNES species in close proximity to the Operational Area during VSP activities and the properties of the noise emissions, it is considered unlikely that there will be any significant impacts.

Other Ecological Communities (Zooplankton)

Zooplankton in the Operational Area is expected to include organisms that complete their lifecycle as plankton (e.g. copepods, euphausiids) as well as larval stages of other taxa such as fishes, corals and molluscs (**Section 4.5.1**). Experiments by McCauley et al (2017) indicated that seismic activity, based on the use of a 150 cui airgun, may significantly decrease abundance of some zooplankton (copepods, cladocerans and euphausiids larvae) and increase the mortality rate. However, zooplankton populations are expected to recover quickly due to their fast growth rates and the dispersal and mixing of zooplankton from outside the impacted area (Richardson et al., 2017). Therefore, due to the short duration of the use of the VSP (up to about 24 hours for each well) and the expected rapid recovery, impacts are expected to be localised with no lasting effect.

Cumulative Impacts

There are no cumulative impacts as no wells will be drilled concurrently.

Summary of Potential Impacts to Environmental Values

VSP may be conducted for up to 24 hours per well during the Petroleum Activities Program (i.e. up to four times 24 hours if VSP is required for all wells). Given the short duration and adopted controls, it is considered that VSP operations will not result in a potential impact greater than localised disruption with no lasting effect (i.e. Environment Impact – F).

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS)[15]***	***Benefit in Impact Reduction***	***Proportionality***	***Control Adopted***
Legislation, Codes and Standards				
VSP pre-start visual observations and operating procedures for whales. This includes requirements for: • **Pre-start visual observations:** Whales must be observed visually to the extent of the observation zone (3 km from VSP source) by a suitably trained crew member for at least 30 minutes before operations commence. • **Operating procedures:** While the VSP acoustic source is operating: – visual observations of the observation zone (3 km from VSP source) must be maintained continuously to identify if there are any whales present – if a whale is sighted within the caution zone (1 km from VSP source), the operator of the acoustic source must be placed on standby to power down the acoustic source – if a whale is sighted within the shutdown zone (500 m from the VSP source), the acoustic source must be shut down. • **Low visibility operating procedures**: During periods of low visibility (where the observation zone cannot be clearly viewed), including night time, the VSP source may be used as described in operating procedures, provided that during the preceding 24-hour period: – there have not been three or more instigated shut down situations for the same type of marine fauna – a two-hour period of continual observation was undertaken in good visibility and no whales were sighted in the observation zone.	F: Yes. Measures consistent with industry standards. CS: Minimal. Bridge crews already maintain a constant watch during operations (including during VSP activities).	The likelihood of VSP emissions leading to long term disturbance or harm to species or ecosystems is reduced by implementing measures such as constant bridge watch and shutdown procedures which are consistent with industry standards.	Benefits outweigh cost/sacrifice.	Yes C 3.1

15 Qualitative measure

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS)[15]***	***Benefit in Impact Reduction***	***Proportionality***	***Control Adopted***
Good Practice				
VSP pre-start visual observations and operating procedures for whale sharks and turtles: • **Pre-start visual observations:** Whale sharks and turtles must be observed visually to the extent of the shutdown zone (500 m from VSP source) by a suitably trained crew member for at least ten minutes before operations commence. • **Operating procedures:** While the VSP acoustic source is operating: – visual observations of the shutdown zone must be maintained continuously to identify if there are any whale sharks or turtles present – if a whale shark or turtle is sighted beyond the shutdown zone, the operator of the acoustic source must be placed on standby to shut down the acoustic source – if a whale shark or turtle is sighted within the shutdown zone, the acoustic source must be shut down. • **Low visibility operating procedures**: During periods of low visibility (where the observation zone cannot be clearly viewed), including night time, the VSP source may be used as described in operating procedures, provided that during the preceding 24-hour period: – a two-hour period of continual observation was undertaken in good visibility and no whale sharks or turtles were sighted in the shutdown zone.	F: Yes. CS: Minimal. Bridge crews already maintain a constant watch during operations (including during VSP activities).	Reduces the likelihood of individuals of cetacean, turtle or whale shark species being within proximity of the acoustic source where behavioural impact could occur.	Benefits outweigh cost/sacrifice.	Yes C 3.2

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS)[15]***	***Benefit in Impact Reduction***	***Proportionality***	***Control Adopted***
The use of additional dedicated Marine Fauna Observers (MFO) on the MODU and/or support vessels during VSP.	F: Yes. However, vessel crews already maintain a constant safety watch during operations (including during VSP activities). CS: Additional cost of MFOs.	Given the constant bridge watch performed as part of the Procedure, additional MFOs would not further reduce the likelihood of an individual being within close proximity of the acoustic source during start-up or during operations.	Disproportionate. The cost/sacrifice outweighs the benefit gained.	No
No concurrent drilling to be performed in the Operational Area during the Petroleum Activities Program.	F: Yes. CS: Minimal cost sacrifice.	By not conducting concurrent drilling activities, only one acoustic source could be operating in the Operational Area at any one time, reducing the likelihood of disturbance to species.	Benefits outweigh cost/sacrifice.	Yes C 4.1
Professional Judgement – Eliminate				
Eliminate VSP from Petroleum Activities Program.	F: Not feasible – VSP required for well logging, considered critical for well safety. CS: Not considered – control not feasible.	Not considered – control not feasible.	Not considered – control not feasible.	No
Application of soft start procedures for VSP.	F: Not feasible. When using lower power sources such as VSP, there is limited ability to ramp up pulses, so doing a soft start at lower sound level is physically not possible. When applying a soft start control to VSP activities, the soft start ends up cumulatively more noise to be emitted into the marine environment. CS: Not considered – control not feasible.	Not considered – control not feasible.	Not considered – control not feasible.	No

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS)[15]***	***Benefit in Impact Reduction***	***Proportionality***	***Control Adopted***
Only conduct VSP activities outside peak sensitivity periods for sound-sensitive marine fauna.	F: Not feasible – Timing of activities is linked to MODU schedule. Timing of all activities is currently not determined, and due to MODU availability and operational requirements, undertaking activities during migration and/or nesting seasons may not be able to be avoided. VSP required for well logging which could take place at any time. VSP is considered critical for well data interpretation. CS: Not considered – control not feasible.	Not considered – control not feasible.	Not considered – control not feasible.	No
Professional Judgement – Substitute				
Substitute VSP with other well logging techniques.	F: Not feasible – no other methods available for capturing required formation information. CS: Not considered – control not feasible.	Not considered – control not feasible.	Not considered – control not feasible.	No
Professional Judgement – Engineered Solution				
No additional controls were identified.				

ALARP Statement

On the basis of the environmental impact assessment outcomes and use of the relevant tools appropriate to the decision type (i.e. Decision Type A), Woodside considers the adopted controls appropriate to manage the impacts of VSP. As no reasonable additional/alternative controls were identified that would further reduce the impacts without grossly disproportionate sacrifice, the impacts and risks are considered ALARP.

Demonstration of Acceptability

Acceptability Statement

The impact assessment has determined that, given the adopted controls, noise emissions from VSP are unlikely to result in a potential impact greater than localised impacts and no lasting effect on species or other communities (zooplankton). Further opportunities to reduce the impacts and risks have been investigated above. The adopted controls are considered good oil-field practice/industry best practice. The potential impacts and risks are considered broadly acceptable if the adopted controls are implemented. Therefore, Woodside considers the adopted controls appropriate to manage the impacts and risks of VSP noise emissions to a level that is broadly acceptable.

<table>
<tr><th colspan="4">Environmental Performance Outcomes, Standards and Measurement Criteria</th></tr>
<tr><th>Outcomes</th><th>Controls</th><th>Standards</th><th>Measurement Criteria</th></tr>
<tr>
<td>EPO 3
No prolonged exposure of whales, whale sharks and turtles to VSP once detected, during the Petroleum Activities Program.</td>
<td>C 3.1
VSP pre-start visual observations and operating procedures for whales. This includes requirements for:
• Pre-start visual observations: Whales must be observed visually to the extent of the observation zone (3 km from VSP source) by a suitably trained crew member for at least 30 minutes before operations commence.
• Operating procedures: While the VSP acoustic source is operating:
– visual observations of the observation zone (3 km from VSP source) must be maintained continuously to identify if there are any whales present
– if a whale is sighted within the caution zone (1 km from VSP source), the operator of the acoustic source must be placed on standby to power down the acoustic source
– if a whale is sighted within the shutdown zone (500 m from the VSP source), the acoustic source must be shut down.
• Low visibility operating procedures: During periods of low visibility (where the observation zone cannot be clearly viewed), including night time, the VSP source may be used as described in operating procedures, provided that during the preceding 24-hour period:
– there have not been three or more instigated shut down situations for the same type of marine fauna
– a two-hour period of continual observation was undertaken in good visibility and no whales were sighted in the observation zone.</td>
<td>PS 3.1
Attenuation buffer established and maintained between VSP source and whales.</td>
<td>MC 3.1.1
Records demonstrate compliance with described prestart visual observations, and operating procedures for whales.</td>
</tr>
</table>

Environmental Performance Outcomes, Standards and Measurement Criteria			
Outcomes	***Controls***	***Standards***	***Measurement Criteria***
	C 3.2 VSP pre-start visual observations and operating procedures for whale sharks and turtles: • **Pre-start visual observations:** Whale sharks and turtles must be observed visually to the extent of the shutdown zone (500 m from VSP source) by a suitably trained crew member for at least ten minutes before operations commence. • **Operating procedures:** While the VSP acoustic source is operating: – visual observations of the shutdown zone must be maintained continuously to identify if there are any whale sharks or turtles present – if a whale shark or turtle is sighted beyond the shutdown zone, the operator of the acoustic source must be placed on standby to shut down the acoustic source – if a whale shark or turtle is sighted within the shutdown zone, the acoustic source must be shut down. • **Low visibility operating procedures**: During periods of low visibility (where the observation zone cannot be clearly viewed), including night time, the VSP source may be used as described in operating procedures, provided that during the preceding 24-hour period: – a two-hour period of continual observation was performed in good visibility and no whale sharks or turtles were sighted in the shutdown zone.	**PS 3.2** Attenuation buffer established and maintained between VSP source and whale sharks and turtles.	**MC 3.2.1** Records demonstrate compliance with described prestart visual observations, and operating procedures for whale sharks and turtles.
EPO 4 No cumulative exposure to whales, turtles and whale sharks from multiple VSP sources as a result of the Petroleum Activities Program.	**C 4.1** No concurrent drilling to be performed in the Operational Area during the Petroleum Activities Program.	**PS 4.1** No cumulative impacts of VSP sources on whales, turtles and whale sharks.	**MC 4.1.1** Records demonstrate no concurrent drilling occurred.

6.6.4 Routine Acoustic Emissions: Generation of Noise from Project Vessels, MODU, Positioning Equipment and Helicopter Transfers

Context	
Project vessels – **Section 3.5** Other support – **Section 3.6** Subsea installation and pre-commissioning activities – **Section 3.10**	Biological environment – **Section 4.5**

Impacts and Risks Evaluation Summary

Source of Impact	*Environmental Value Potentially Impacted*							*Evaluation*						
	Soil and Groundwater	***Marine Sediment***	***Water Quality***	***Air Quality (incl Odour)***	***Ecosystems/Habitat***	***Species***	***Socio-Economic***	***Decision Type***	***Consequence***	***Likelihood***	***Current Risk Rating***	***ALARP Tools***	***Acceptability***	***Outcome[16]***
Generation of acoustic signals from MODU, drilling and project vessels during normal operations						X		A	F	-	-	GP PJ	Broadly Acceptable	N/A
Generation of acoustic signals from dynamic positioning systems on project vessels						X		A	F	-	-	GP PJ		N/A
Generation of airborne noise from helicopter transfers						X		A	F	-	-	GP PJ		N/A

Description of Source of Impact

The MODU, project vessels (including primary installation vessels, pipelay and support vessels), helicopters and positioning transponders will generate noise both in the air and underwater, due to the operation of thrusters, engines, propeller movement, drilling operations, etc. These noises will contribute to and can exceed ambient noise levels which range from around 90 dB re 1 μPa (rms) under very calm, low wind conditions, to 120 dB re 1 μPa (rms) under windy conditions (McCauley, 2005).

MODU Noise

Noise associated with a moored MODU will be restricted to drilling activities, such as drill pipe operations and on-board machinery. A range of broadband values (59 to 185 dB re 1 μPa at 1 m (rms)) have been quoted for various MODUs (Simmonds et al., 2004); with noise likely to be between 100 to 190 dB re 1 μPa at 1 m SPL (rms) during drilling and between 85 to 135 dB re 1 μPa at 1 m SPL (rms) when not actively drilling. McCauley (1998) recorded received noise levels of about 117 dB re 1 μPa at 1 m SPL (rms) at 125 m from a moored MODU while actively drilling (with support vessel on anchor). The MODU will be moored and therefore there will be no additional noise from using DP equipment.

The MODU is expected to be on location for about 70 days for each of the four wells.

Project Vessel Noise

The main source of noise from a DP vessel (such as primary installation vessels) relates to using DP thrusters. There is no applicable sound data available for a typical DP primary installation vessel; however, frequencies and sound levels are expected to be similar to those from a DP drill ship (e.g. MODU). A noise assessment for the Deepwater Millennium (McPherson et al., 2013) estimated the broadband source level for drilling operations at 196 dB re 1 μPa at 1 m, with all six thrusters working at 100%. 196 dB re 1 μPa at 1 m is expected to be the worst case as a primary installation vessel is not expected to operate on 100% DP capacity on a continual basis.

[16] There are no specific controls and EPOs identified for generation of noise from project vessesl, MODU, positioning equipment and helicopter transfers. However, MODU and vessel power generation equipment will be maintained in accordance with preventative maintenance programs to optimise equipment efficiency and thus reduce excess noise generation e.g. MODU and vessel engines to be maintained as per manufacturer's specification.

Support vessels and primary installation vessels will use DP while the vessel is maintaining position. McCauley (1998) measured underwater broadband noise equivalent to about 182 dB re 1 µPa SPL (rms) at 1 m from a support vessel holding station in the Timor Sea. Similar noise levels are expected to be generated by support vessels used for this Petroleum Activities Program.

Note that all project vessels are required to comply with EPBC Regulation 2000 – Part 8 Interacting with Cetaceans to reduce the likelihood of collisions with cetaceans (refer to **Section 6.7.8**). Implementing this control may incidentally reduce the noise generated by vessels in proximity to cetaceans as vessels will be travelling slower; slower vessel speeds may reduce underwater noise from machinery noise (main engines) and propeller cavitation.

Generation of Noise From Helicopter Transfers

Helicopter engines and rotor blades are recognised as a source of noise emissions, which may constitute a source of environmental risk resulting in behavioural disturbance to marine fauna. Activities relevant to the Operational Area will relate to the landing and take-off of helicopters on the MODU or vessel helidecks. Helicopter flights are at their lowest (i.e. closest point to the sea surface) during these periods of take-off and landing from helidecks, which constitutes a relatively short phase of routine flight operations. During these critical stages of helicopter operations, safety takes precedence.

Noise levels for typical helicopters used in offshore operations (Eurocopter Super Puma AS332) at 150 m separation distance have been measured at up to a maximum of 90.6 dB (BMT Asia Pacific, 2005). Unconstrained point source noise in the atmosphere (such as helicopter noise) spreads spherically (Truax, 1978), with noise received at the sea surface decreasing with increasing distance from the aircraft (Nowacek et al., 2007). Based on spherical geometric spreading (and not considering transmission loss from atmospheric absorption), the sound level is expected to decrease by 6 dB for every doubling of the distance from the source (Truax, 1978). Using this model, a maximum sound level of about 90 dB at 150 m would be reduced to about 76 dB directly below a helicopter travelling at an altitude of 500 m.

Generation of Underwater Noise from Positioning Equipment

An array of LBL and/or USBL transponders may be installed on the seabed to help correctly position the flowline and pre-lay structures. Transmissions are not continuous but consist of short ‘chirps’ with a duration that ranges from 3 to 40 milliseconds. Transponders typically emit pulses of medium frequency sound, generally within the range 21 to 31 kHz. The estimated SPL would be 180 to 206 dB re 1 µPa at 1 m (Jiménez-Arranz et al., 2017).

Impact Assessment

Potential Impacts to Protected Species

The Operational Area is located in waters about 130–290 m deep. The fauna associated with this area will be predominantly pelagic and demersal species of fish, with migratory species such as turtles, whale sharks and cetaceans present in the area seasonally.

Elevated underwater noise can affect marine fauna, including cetaceans, fish, turtles, sharks and rays in three main ways (Richardson et al., 1995; Simmonds et al., 2004):

- by causing direct physical effects on hearing or other organs (injury)
- by masking or interfering with other biologically important sounds (including vocal communication, echolocation, signals and sounds produced by predators or prey)
- through disturbance leading to behavioural changes or displacement from important areas.

The thresholds that could result in behavioural response for cetaceans is expected to be 120 dB re 1 µPa SPL (rms) for continuous noise sources, and 160 dB re 1 µPa SPL (rms) for impulsive noise sources. These thresholds are adopted by the US NOAA and are consistent with the levels presented by Southall et al. (2007). Potential for injury to hearing would be expected to occur at 230 dB re 1 µPa (pk) (Southall et al., 2007). Typical noise levels generated by a DP primary installation vessel or support vessel likely to be used for this Petroleum Activities Program does not exceed that level, so injury to protected species is not anticipated.

Listed Threatened and listed Migratory species that could be potentially impacted by underwater noise may be present within the Operational Area, and primarily include cetaceans as well as whale sharks, rays and turtles. The Operational Area overlaps the migration BIA for pygmy blue whales, which are seasonally present in the area from April to August (northbound) and October to December (southbound). The Operational Area also overlaps with the whale shark foraging BIA (with peak numbers expected March to July) and an internesting BIA for flatback turtles nesting at the Montebello Islands (with peak nesting in December and January).

MODU, Primary Installation Vessels and Support Vessels

It is likely that there may be increased numbers of pygmy blue whales (and other whale species such as humpback, sei and fin whales), whale sharks and turtles within the Operational Area during migratory/nesting periods. However, even with an increased likelihood of interaction the potential impacts are considered to be not significant to environmental receptors, given the noise levels associated with routine operations of vessels and the MODU. It is reasonable to expect that fauna may demonstrate avoidance or attraction behaviour to the noise generated by the Petroleum Activities Program. For example, when transiting through the area, pygmy blue whales may deviate slightly from their migration route, but continue on their migration pathway. Note that the Operational Area is surrounded by open water, with no restrictions (e.g. shallow waters, embayments) to an animal’s ability to avoid the activities. Potential impacts from predicted noise levels from the MODU, primary installation vessels and support vessels are not considered to be ecologically significant at a population level.

Other fauna associated with the Operational Area will be predominantly pelagic and demersal species of fish, with migratory species such as whale sharks, rays, marine turtles and other cetacean species migrating through or present in the Operational Area. Therefore, potential impacts from vessel noise are likely to be restricted to temporary avoidance behaviour to individuals transiting through the Operational Area, and are therefore considered localised with no lasting effect. As the wells will not be drilled concurrently, there is no potential for cumulative impacts from drilling concurrent wells.

Helicopter Noise

Water has a very high acoustic impedance contrast compared to air, and the sea surface is a strong reflector of noise energy (i.e. very little noise energy generated above the sea surface crosses into and propagates below the sea surface (and vice versa) – the majority of the noise energy is reflected). The angle at which the sound path meets the surface influences the transmission of noise energy from the atmosphere through the sea surface; angles ±>13° from vertical being almost entirely reflected (Richardson et al., 1995). Given this, and the typical characteristics of helicopter flights within the Operational Area (duration, frequency, altitude and air speed), the opportunity for underwater noise levels that may result in behavioural disturbance are not considered to be credible. Note that helicopter noise during approach, landing and take-off is more likely to propagate through the sea surface due to the reduced air speed and lower altitude. However, helicopter noise during approach, landing and take-off will be mingled with underwater noise generated by the facility hosting the helipad (e.g. thruster noise from vessels, machinery noise from MODU, etc.). Additionally, approach, landing and take-off are relatively short phases of the flight, resulting in little opportunity for underwater noise to be generated.

Given the standard flight profile of a helicopter transfer, maintenance of a >500 m horizontal separation from cetaceans (as per the EPBC Regulations), and the predominantly seasonal presence of whales within the Operational Area, interactions between helicopters and cetaceans resulting in behavioural impacts are considered to be highly unlikely. In the highly unlikely event that cetaceans are disturbed by helicopters, responses are expected to consist of short-term behavioural responses, such as increased swimming speed; the consequence of such disturbance is considered to have no lasting effect and be of no significance.

Turtles may be present in low numbers within the Operational Area, and may be exposed to helicopter noise when on the sea surface (e.g. when basking or breathing). Typical startle responses occur at relatively short ranges (tens of metres) (Hazel et al., 2007) and as such, startle responses during typical helicopter flight profiles are considered to be remote. In the event of a behavioural response to the presence of a helicopter, turtles are expected to exhibit diving behaviour, which is of no lasting effect.

Seabirds within the Operational Area may avoid helicopters. Given the expected low density of seabirds within the Operational Area, the relative infrequency of helicopter flights and lack of lasting effect of potential behavioural responses to helicopter noise, the likelihood and consequence of subsequent impacts are considered to be highly unlikely and result in no lasting effect, respectively.

Positioning Equipment Noise

Due to the short duration chirps, the temporary use and the mid frequencies used by positioning equipment, the acoustic noise from the transponders is unlikely to have an effect on the behavioural patterns of marine fauna, and is below noise injury thresholds. Therefore, no impacts are anticipated from positioning transponders.

Summary of Potential Impacts to Environmental Values

It is considered that noise generated by MODU, drilling activities, project vessels (including primary installation vessels and support vessels), helicopters and positioning transponders will not result in a potential impact greater than localised impacts with no lasting effect, not significant to marine fauna (i.e. Environment Impact – F).

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS)***[17]	***Benefit in Impact Reduction***	***Proportionality***	***Control Adopted***
Legislation, Codes and Standards				
No additional controls identified.				
Good Practice				
The use of dedicated MFOs on support vessels for the duration of the Petroleum Activities Program to watch for whales and provide direction on and monitor compliance with Part 8 of the EPBC Regulations.	F: Yes. However, support vessel bridge crews already maintain a constant watch during operations. CS: Additional cost of MFOs.	Given that support vessel bridge crews already maintain a constant watch during operations, additional MFOs would not further reduce the likelihood or consequence of impact.	Disproportionate. The cost/sacrifice outweighs the benefit gained.	No
Professional Judgement – Eliminate				
Removal of support vessel on standby at the Petroleum Activities Program location.	F: No. Activity support vessel required for safety reasons, particularly for maintaining the 500 m petroleum safety zone around the MODU/ primary installation vessels. CS: Introduces unacceptable safety risk.	Not considered – control not feasible.	Not considered – control not feasible.	No
Elimination of noise from the MODU, primary installation vessels, support vessels or survey positioning equipment.	F: No. The generation of noise from these sources cannot be eliminated due to operating requirements. Note that vessels operating on DP may be a safety-critical requirement. CS: Inability to conduct the Petroleum Activities Program. Loss of project.	Not considered – control not feasible.	Not considered – control not feasible.	No
Professional Judgement – Substitute				
Management of vessel noise by varying the timing of the Petroleum Activities Program to avoid migration periods.	F: Not feasible. Variation of timing of specific activities is not feasible as activity is subject to schedule constraints and vessel availability. CS: Significant cost and schedule impacts if activities avoid specific timeframes.	Not considered – control not feasible.	Not considered – control not feasible.	No
Professional Judgement – Engineered Solution				
No additional controls identified.				

[17] Qualitative measure

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS)[17]***	***Benefit in Impact Reduction***	***Proportionality***	***Control Adopted***
ALARP Statement On the basis of the environmental impact assessment outcomes and use of the relevant tools appropriate to the decision type (i.e. Decision Type A), Woodside considers the potential impacts from MODU drilling activities, project vessels (including primary installation vessels and support vessels), helicopters and positioning transponder noise emissions to be ALARP. As no reasonable additional/alternative controls were identified that would further reduce the impacts without grossly disproportionate sacrifice, the impacts and risks are considered ALARP.				

Demonstration of Acceptability
Acceptability Statement The impact assessment has determined that MODU, drilling activities, project vessels (including primary installation vessels and support vessels), helicopters and positioning transponder noise disturbance is unlikely to result in a potential impact greater than localised impacts not significant to marine fauna, with no lasting effect. Further opportunities to reduce the impacts and risks have been investigated above. The potential impacts and risks are considered broadly acceptable. Therefore, Woodside considers standard operations appropriate to manage the impacts and risks of MODU, drilling activities, project vessels (including primary installation vessels and support vessels), helicopters and positioning transponder noise emissions to a level that is broadly acceptable.

6.6.5 Routine and Non-routine Discharges to the Marine Environment MODU and Project Vessels

Context	
Project vessels – **Section 3.5**	Physical environment – **Section 4.4** Biological environment – **Section 4.5**

Impacts and Risks Evaluation Summary

Source of Impact	*Environmental Value Potentially Impacted*							*Evaluation*						
	Soil and Groundwater	*Marine Sediment*	*Water Quality*	*Air Quality (incl Odour)*	*Ecosystems/Habitat*	*Species*	*Socio-Economic*	*Decision Type*	*Consequence*	*Likelihood*	*Current Risk Rating*	*ALARP Tools*	*Acceptability*	*Outcome*
Routine discharge of sewage, grey water and putrescible wastes to marine environment from MODU and project vessels			X					A	F	-	-	LCS PJ	Broadly Acceptable	EPO 5
Routine discharge of deck and bilge water to marine environment from MODU and project vessels			X					A	F	-	-	LCS PJ		
Routine discharge of cooling water or brine to the marine environment from MODU and project vessels			X					A	F	-	-	LCS PJ		

Description of Source of Impact

The MODU and project vessels (including primary installation vessels and support vessels) routinely generate/discharge the following:

- Small volumes of treated sewage and putrescible wastes to the marine environment – The impact assessment based on a maximum approximate discharge of 15 m³ per MODU/vessel per day, using an average volume of 75 L/person/day and a maximum of 200 persons on board. However, it is noted that vessels such as support vessels will have considerably less persons on board.
- Routine/periodic discharge of relatively small volumes of bilge water – Bilge tanks receive fluids from many parts of a MODU or vessel. Bilge water can contain water, oil, detergents, solvents, chemicals, particles and other liquids, solids or chemicals.
- Variable water discharge from MODU/vessel decks directly overboard or via deck drainage systems – Water sources could include rainfall events and/or deck activities such as cleaning/wash-down of equipment/decks.
- Cooling water from machinery engines or mud cooling units and brine water produced during the desalination process of reverse osmosis to produce potable water on board the MODU and project vessels.

Environmental risk relating to unplanned (non-routine/accidental) disposal/discharge of waste is addressed in **Section 6.7.7**.

Impact Assessment

Potential Impacts to Water Quality and Marine Fauna

The main environmental impact associated with ocean disposal of sewage and other organic wastes (i.e. putrescible waste) is eutrophication. Eutrophication occurs when the addition of nutrients, such as nitrates and phosphates, causes adverse changes to the ecosystem, such as oxygen depletion and phytoplankton blooms. Other contaminants of concern occurring in these discharges may include ammonia, E. coli, faecal coliform, volatile and semi-volatile organic compounds, phenol, hydrogen sulphide, metals, surfactants and phthalates.

Woodside monitored sewage discharges at its Torosa-4 Appraisal Drilling campaign which demonstrated that a 10 m³ sewage discharge reduced to about 1% of its original concentration within 50 m of the discharge location. In addition to this, monitoring at distances of 50, 100 and 200 m downstream of the platform and at five different water depths confirmed that discharges were rapidly diluted and no elevations in water quality monitoring parameters (e.g. total nitrogen, total phosphorous and selected metals) were recorded above background levels at any station (Woodside Energy Limited, 2011). Mixing and dispersion would be further facilitated in deep offshore waters, consistent with the location of the Operational Area, through regional wind and large scale current patterns resulting in the rapid mixing of surface and near surface waters where sewage discharges may occur. Studies investigating the effects of nutrient enrichment from offshore sewage discharges indicate that the influence of nutrients in open marine areas is much less significant than that experienced in enclosed areas (McIntyre and Johnston, 1975).

Furthermore, open marine waters do not typically support areas of increased ecological sensitivity, due to the lack of nutrients in the upper water column and lack of light penetration at depth. Therefore presence of other receptors such as fish, reptiles, birds and cetaceans in significant numbers, and in close proximity to the Operational Area, is unlikely. Research also suggests that zooplankton composition and distribution are not affected in areas associated with sewage dumping grounds (McIntyre and Johnston, 1975). Plankton communities are expected to rapidly recover from any such short-term, localised impact, as they are known to have naturally high levels of mortality and a rapid replacement rate.

Additional discharges outlined, which may include other non-organic contaminants (e.g. bilge water), will be rapidly diluted through the same mechanisms as above and are expected to be in very small quantities and concentrations as to not pose any significant risk to any relevant receptors. As such, no significant impacts from the planned (routine and non-routine) discharges that are listed above are anticipated because of the minor quantities involved, the expected localised mixing zone and high level of dilution into the open water marine environment of the Operational Area. The Operational Area is located more than 12 nm from land, which exceeds the exclusion zones required by Marine Order 96 (Marine pollution prevention – sewage) 2013 and Marine Order 95 (Marine pollution prevention – garbage) 2013.

While the Petroleum Activities Program may extend for several years, vessels will not be continuously in the Operational Area during this time, and will also be moving (i.e. not in a single location for an extended period of time). As a result, these routine and non-routine discharges are expected to be intermittent in nature for the duration of the Petroleum Activities Program. Therefore, cumulative impacts to water quality within the Operational Area are expected to be localised and short-term with no lasting effect.

It is possible that protected marine fauna transiting the localised area may come into contact with these discharges (e.g. pygmy blue whales, whale sharks and turtles as they traverse the Operational Area during their seasonal migrations (**Section 4.5.2**). However, given the localised extent of cumulative impacts from multiple vessel discharges within the Operational Area, significant impacts to marine fauna are not expected.

Summary of Potential Impacts to Environmental Values

Given the adopted controls, it is considered that routine or non-routine discharges described will not result in a potential impact greater than localised contamination not significant to environmental receptors, with no lasting effect (i.e. Environment Impact – F).

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS)[18]***	***Benefit in Impact Reduction***	***Proportionality***	***Control Adopted***
Legislation, Codes and Standards				
Marine Order 95 – pollution prevention – garbage (as appropriate to vessel class) which requires putrescible waste and food scraps to pass through a macerator so it is capable of passing through a screen with no opening wider than 25 mm.	F: Yes. CS: Minimal cost. Standard practice.	No reduction in likelihood or consequence would result.	Controls based on legislative requirements – must be adopted.	Yes C 5.1

[18] Qualitative measure

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS)[18]***	***Benefit in Impact Reduction***	***Proportionality***	***Control Adopted***
Marine Order 96 – pollution prevention – sewage (as appropriate to vessel class) which includes the following requirements: • a valid International Sewage Pollution Prevention Certificate, as required by vessel class • an AMSA-approved sewage treatment plant • a sewage comminuting and disinfecting system • a sewage holding tank sized appropriately to contain all generated waste (black and grey water) • discharge of sewage which is not comminuted or disinfected will only occur at a distance of more than 12 nm from the nearest land • discharge of sewage which is comminuted or disinfected using a certified approved sewage treatment plant will only occur at a distance of more than 3 nm from the nearest land • discharge of sewage will occur at a moderate rate while support vessel is proceeding (> 4 knots), to avoid discharges in environmentally sensitive areas.	F: Yes. CS: Minimal cost. Standard practice.	No reduction in likelihood or consequence would result.	Controls based on legislative requirements – must be adopted.	Yes C 5.2
Where there is potential for loss of primary containment of oil and chemicals on the MODU, deck drainage must be collected via a closed drainage system. E.g. drill floor.	F: Yes. CS: Minimal cost. Standard practice.	Reduces the likelihood of contaminated deck drainage water being discharged to the marine environment. No change in consequence would occur.	Benefits outweigh cost/sacrifice.	Yes C 5.3
Marine Order 91 – oil (as relevant to vessel class) requirements, which includes mandatory measures for processing oily water prior to discharge: • Machinery space bilge/oily water shall have IMO-approved oil filtering equipment (oil/water separator) with an on-line monitoring device to measure Oil in Water (OIW) content to be less than 15 ppm prior to discharge. • IMO-approved oil filtering equipment shall also have an	F: Yes. CS: Minimal cost. Standard practice.	No reduction in likelihood or consequence would result.	Controls based on legislative requirements – must be adopted.	Yes C 5.4

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS)***[18]	***Benefit in Impact Reduction***	***Proportionality***	***Control Adopted***
alarm and an automatic stopping device or be capable of recirculating if OIW concentration exceeds 15 ppm. • A deck drainage system shall be capable of controlling the content of discharges for areas of high risk of fuel/oil/grease or hazardous chemical contamination. • There shall be a waste oil storage tank available, to restrict oil discharges. • If machinery space bilge discharges cannot meet the oil content standard of <15 ppm without dilution or be treated by an IMO-approved oil/water separator, they will be contained on-board and disposed onshore. • Valid International Oil Pollution Prevention Certificate.				
Good Practice				
No additional controls identified.				
Professional Judgement – Eliminate				
No additional controls identified.				
Professional Judgement – Substitute				
Storage, transport & treatment/disposal onshore of sewage, greywater, putrescible and bilge wastes.	F: Not feasible. Would present additional safety and hygiene hazards resulting from the storage, loading and transport of the waste material. Distance of activity offshore also makes implementing this control not feasible. CS: Not considered – control not feasible.	Not considered – control not feasible.	Not considered – control not feasible.	No
Professional Judgement – Engineered Solution				
No additional controls identified.				
ALARP Statement On the basis of the environmental impact assessment outcomes and use of the relevant tools appropriate to the decision type (i.e. Decision Type A), Woodside considers the adopted controls appropriate to manage the impacts of planned (routine and non-routine) discharges. As no reasonable additional/alternative controls were identified that would further reduce the impacts without grossly disproportionate sacrifice, the impacts and risks are considered ALARP.				

Demonstration of Acceptability
Acceptability Statement The impact assessment has determined that, given the adopted controls, planned discharges (routine and non-routine) are unlikely to result in a potential impact greater than localised impacts not significant to environmental receptors and no lasting effect. Further opportunities to reduce the impacts and risks have been investigated above. The adopted controls are considered good oil-field practice/industry best practice and meet legislative requirements under Marine Orders 91, 95 and 96. The potential impacts and risks are considered broadly acceptable if the adopted controls are implemented. Therefore, Woodside considers the adopted controls appropriate to manage the impacts and risks of these discharges to a level that is broadly acceptable.

Environmental Performance Outcomes, Standards and Measurement Criteria

Outcomes	*Controls*	*Standards*	*Measurement Criteria*
EPO 5 No impact to water quality greater than a consequence level of F from discharge of sewage, greywater, putrescible wastes, bilge and deck drainage to the marine environment during the Petroleum Activities Program.	**C 5.1** Marine Order 95 – pollution prevention – garbage (as appropriate to vessel class) which requires putrescible waste and food scraps to pass through a macerator so it is capable of passing through a screen with no opening wider than 25 mm.	**PS 5.1** MODU and project vessels compliant with Marine Order 95 – pollution prevention – garbage.	**MC 5.1.1** Records demonstrate MODU and project vessels are compliant with Marine Order 95 – pollution prevention – garbage (as appropriate to vessel class).
	C 5.2 Marine Order 96 – pollution prevention – sewage (as appropriate to vessel class) which includes the following requirements: • a valid International Sewage Pollution Prevention Certificate, as required by vessel class • an AMSA-approved sewage treatment plant • a sewage comminuting and disinfecting system • a sewage holding tank sized appropriately to contain all generated waste (black and grey water) • discharge of sewage which is not comminuted or disinfected will only occur at a distance of more than 12 nm from the nearest land • discharge of sewage which is comminuted or disinfected using a certified approved sewage treatment plant will only occur at a distance of more than 3 nm from the nearest land • discharge of sewage will occur at a moderate rate while support vessel is proceeding (>4 knots), to avoid discharges in environmentally sensitive areas.	**PS 5.2** MODU and project vessels compliant with Marine Order 96 – pollution prevention – sewage (as appropriate to vessel class).	**MC 5.2.1** Records demonstrate MODU and project vessels are compliant with Marine Order 96 – pollution prevention – sewage (as appropriate to vessel class).

<table>
<tr><th colspan="4">Environmental Performance Outcomes, Standards and Measurement Criteria</th></tr>
<tr><th>Outcomes</th><th>Controls</th><th>Standards</th><th>Measurement Criteria</th></tr>
<tr><td></td><td>C 5.3
Where there is potential for loss of primary containment of oil and chemicals on the MODU, deck drainage must be collected via a closed drainage system. E.g. drill floor.</td><td>PS 5.3
Contaminated drainage contained, treated and/or separated prior to discharge.</td><td>MC 5.3.1
Records demonstrate MODU has a functioning deck drainage water management system.</td></tr>
<tr><td></td><td>C 5.4
Marine Order 91 – oil (as relevant to vessel class) requirements, which includes mandatory measures for processing oily water prior to discharge:
• Machinery space bilge/oily water shall have IMO-approved oil filtering equipment (oil/water separator) with an on-line monitoring device to measure OIW content to be less than 15 ppm prior to discharge.
• IMO-approved oil filtering equipment shall also have an alarm and an automatic stopping device or be capable of recirculating if OIW concentration exceeds 15 ppm.
• A deck drainage system shall be capable of controlling the content of discharges for areas of high risk of fuel/oil/grease or hazardous chemical contamination.
• There shall be a waste oil storage tank available, to restrict oil discharges.
• If machinery space bilge discharges cannot meet the oil content standard of <15 ppm without dilution or be treated by an IMO-approved oil/water separator, they will be contained on-board and disposed onshore.
• Valid International Oil Pollution Prevention Certificate.</td><td>PS 5.4
Discharge of machinery space bilge/oily water will meet oil content standard of <15 ppm without dilution.</td><td>MC 5.4.1
Records demonstrate discharge specification met for MODU and project vessels.</td></tr>
</table>

6.6.6 Routine and Non-routine Discharges to the Marine Environment: Drill Cuttings and Drilling Fluids (WBM and NWBM)

Context	
Drilling and completions activities – **Section 3.9** Project fluids – **Section 3.11**	Physical environment – **Section 4.4** Biological environment – **Section 4.5**

Impacts and Risks Evaluation Summary

Source of Impact	*Environmental Value Potentially Impacted*							*Evaluation*						
	Soil and Groundwater	*Marine Sediment*	*Water Quality*	*Air Quality (incl Odour)*	*Ecosystems/Habitat*	*Species*	*Socio-Economic*	*Decision Type*	*Consequence*	*Likelihood*	*Current Risk Rating*	*ALARP Tools*	*Acceptability*	*Outcome*
Routine discharge of WBM drill cuttings to the seabed and the marine environment		X	X		X			A	E	-	-	LCS GP PJ	Broadly Acceptable	EPO 6
Routine discharge of NWBM drill cuttings to the seabed and the marine environment		X	X		X			A	E	-	-			
Routine discharge of drilling muds (WBM) to the seabed and the marine environment		X	X		X			A	E	-	-			
Non-routine discharge of wash water from mud pits and vessel tank wash fluids		X	X		X			A	E	-	-			
Routine discharge of well clean-up fluids		X	X		X			A	E	-	-			
Discharge of well annular fluids from abandoned well		X	X		X			A	F	-	-			

Description of Source of Impact

Drilling Program

The proposed Petroleum Activities Program includes the drilling of four wells, all at a seabed depth of about 174 m (**Table 3-2**).

Drilling activities are described in **Section 3.9**. Wells will be drilled as a series of sections, as detailed in **Table 6-3**. The top hole sections of each well will be drilled without a riser in place (i.e. riserless drilling). Upon drilling of the top hole sections, casings will be cemented in place, a BOP installed and a riser put in place between the BOP and the MODU. The riser remains in place during drilling of the bottom hole sections and facilitates the circulation of drilling fluids and cuttings between the well bore and the MODU.

The following describes the source of impact with respect to discharge of drill cuttings, mud and clean-up fluids only (see **Section 6.6.7** for cement, cementing fluids and subsea control fluids). The base case (e.g. typical drilling operations) for managing cuttings is to discharge into the marine environment along with WBMs which are used to transport the cuttings out of the well.

For the purposes of this impact assessment, the indicative dimensions, discharge locations and approximate cuttings volumes provided in **Table 6-3** represent the worst case for a single section, taking into account each well to be drilled during the Petroleum Activities Program.

Table 6-3: Estimated discharges of cuttings and volumes of drilling fluids used for the Petroleum Activities Program[19]

	Well section width (inches)	Cuttings volume (m^3)	Drilling fluid type	Drilling fluid ~ volume (m^3)	Hole section	Discharge point
	42	86	Seawater* with pre-hydrated bentonite sweeps/XC polymer	238	Top	Seabed
	26	71	Seawater* with pre-hydrated bentonite sweeps/XC polymer	468	Top	Seabed
	17.5	351	WBM	1179	Top	Surface
	13.5	184	NWBM	37	Bottom	Surface
	9.875	26	WBM	1389	Bottom	Surface
	Total Planned Activities	718 m^3 per well		3311 per well		
Indicative Contingent Activities (two top hole respuds)	42" + 26" + 17.5" sections	1016	Seawater with pre-hydrated bentonite sweeps/XC polymer for 42"/26" sections. WBM for 17.5" sections.	3770	Top	Seabed
Indicative Contingent Activities (sidetrack one section)	13.5" section (indicative)	184	NWBM	37	Bottom	Surface

** Seawater volume not included in the estimated 'Drilling Fluid Volume'*

Drill Cuttings

Indicative drill cuttings generated from each well have been estimated to comprise a total of about 718 m^3 per well. Typically, drilling generates drill cuttings ranging in size from clay-sized particles (~0.002 mm) to coarse gravel (>30 mm) (IOGP, 2016). Cuttings size is determined by TD, lithology, drill bit employed and SCE specifications. Indicative volumes of drill cuttings for the well are outlined in **Table 6-3**.

Cuttings resulting from drilling the top hole section are drilled using a seawater, pre-hydrated bentonite sweeps drilling fluid (WBM) system, discharging the cuttings to the seabed at the well site where they will accumulate near the wellhead (**Section 3.9.2**).

The bottom hole sections will be drilled with a marine riser that enables cuttings and drilling fluid to be circulated back to the MODU, where the cuttings are separated from the drilling fluids by the SCE. The SCE uses shale shakers to remove coarse cuttings from the drilling fluids. After processing by the shale shakers, the recovered fluids from the cuttings may be directed to centrifuges, which are used to remove fine solids (~4.5 to 6 µm). The cuttings with retained fluids are discharged below the water line and the mud is recirculated into the fluid system (**Section 3.9.4**). Cuttings will typically drop out of suspension in the vicinity of the well site (as coarser materials), while the fluids if not flocculated with the cuttings may disperse further, temporarily elevating TSS and sediment deposition.

Where NWBM is needed to drill a well section, the cuttings from the NWBM drilling fluid system will also pass through a cuttings dryer to reduce the average residual oil on cuttings (OOC) for the well (only sections using NWBM) to ALARP, prior to discharge. In the event of SCE failures, cuttings may be discharged without having passed through the dryer; however, this will only occur for a short duration while the drill string is being moved to a safe location in the well and existing cuttings are circulated out of the hole. A decision will then be made on the case for drilling ahead without the failed SCE, while still meeting residual OOC discharge limits. Drilling ahead while SCE breakdown assessment and repairs occur is a contingent activity subject to additional controls (**C 6.7**); however, the standard mode of operation to ensure management of cuttings to ALARP is to treat cuttings through a dryer.

[19] Volumes described are approximate and may be subject to change due to well design and operational requirements.

An OOC discharge limit of <6.9% on wet cuttings will be averaged over the well (for sections drilled with NWBM). The estimated volume of cuttings discharged with residual NWBM is shown in **Table 6-3** for a hypothetical worst case well. Typical NWBM cuttings volumes may be around 184 m³ (per well).

Completion and Well Bore Clean-Out Fluids

As required throughout activities with the riser connected, wells will be displaced from one drilling fluid system to another, or from the drilling fluid system to completion brine. A chemical clean-out pill or fluids train will be circulated between the two fluids. Brine is typically filtered to reduce suspended solids. This will result in a discharge of operational fluids in accordance with the Woodside internal guidelines.

Should there be clean-up fluid or completion brine contaminated with NWBM drilling fluid or base oil, it will be captured and stored on the MODU for discharge or backloading to shore. Discharge may occur if the oil content is <1% hydrocarbon contamination by volume. For initial clean-up fluids (usually returned to the rig within the first few hours of circulation) which are predominantly drilling mud (concentration of mud compared to brine is a higher percentage of mud), fluids will be retained and returned to shore if hydrocarbon contamination is not <1% by volume and WBM will be discharged as per requirements in this EP.

Drilling Fluids

WBM will be operationally discharged to the marine environment at the location of the well being drilled during the Petroleum Activities Program under the following scenarios:

1. at the seabed when drilling the top hole (riser less) sections
2. below sea surface as fluid remaining on drill cuttings, after passing through the SCE (bottom hole sections, drilled with riser in place)
3. from the mud pits from a pipe below the sea surface, if the WBM cannot be re-circulated/re-used through the drilling fluid system (due to deterioration/contamination), re-used on the well or on another well, or stored.

NWBM may be used to drill wells should the offset history, geohazards assessment and borehole stability studies indicate that NWBM is required to manage well stability to safe levels.

Drilling fluids are contained within the drilling fluids circulation system. Mud pits (tanks) within this system provide capacity for storing drilling fluids. The mud pits are cleaned out when drilling operations are complete. Should NWBM be used, mud pit residue may be discharged to the sea where the residue contains <1% oil volume. Where the mud pit residue exceeds 1% by volume, the residue will be retained and disposed onshore.

Base oil and chemicals used in WBM and NWBM are assessed using a defined framework and set of tools to ensure the potential impacts of the chemicals selected are acceptable, ALARP and meet Woodside's expectation for environmental performance. (**Section 3.11.1**).

Contingent Activities

Respud

The requirement to respud a well is overall a low likelihood event. If required, the most likely scenario is that the decision to respud is made when drilling the top hole section of a well. Therefore, the incremental increase in cuttings and fluid discharges are associated with the repeat drilling of the same top hole sections for the respudded well with the same associated discharges. A respud once drilling of the bottom hole sections has commenced is far less likely given the time and effort already committed to the well. However, if this was to occur the associated discharges would also be a repeat of the discharges as per **Table 6-3**, to re-drill the same sections of the respudded well.

Sidetrack

The option of a sidetrack instead of a respud may be determined, if operational issues are encountered. Should a sidetrack be required it will result in an increase in the volume of cuttings generated and a potential increase in the use of WBM. Additional drill cuttings volumes are estimated in **Table 6-3**.

Well Annular Fluids

After drilling is complete, some wellbore fluids will remain in the annular spaces between the casing. Should any well be abandoned during drilling due to the requirement for a respud, upon wellhead removal small volumes (~ 1.5 m³) of fluid exchange between the annular spaces and the ocean may occur. The exchange will not be instantaneous as the annular spaces are small and the fluids are typically heavier than seawater.

Impact Assessment

Potential Impacts to Water Quality, Marine Sediment Quality and Habitats and Communities

The identified potential impacts associated with the discharge of drill cuttings and fluids include a localised and temporary decrease in water quality and localised change in seabed sediment quality as well as localised burial of benthic biota (species) and change to ecosystems/habitat.

A number of direct and indirect impact pathways are identified for drill cuttings and drilling fluids as follows:

- temporary increase in TSS in the water column
- attenuation of light penetration as an indirect consequence of the elevation of TSS and the rate of sedimentation

- sediment deposition to the seabed leading to the alteration of the physico-chemical composition of sediments, and burial and potential smothering effects to sessile benthic biota
- potential contamination and toxicity effects to benthic and in-water biota.

The four development wells will be drilled in Permit Area WA-49-L, situated in offshore waters (~50 km from the nearest coastline at the Montebello Islands) in water depths of ~174 m. The physical habitat in the area comprises deep, soft, unconsolidated sediment which is relatively flat and featureless.

The top hole sections drilled (riser-less) have drill cuttings and unrecoverable fluids discharged at the seabed at the well site and typically result in a localised area of sediment deposition (known as a cuttings pile) close to the well site. Depending on seabed current regimes, a greater spread of cuttings and WBMs may occur downstream from the well site. The spread of cuttings and WBMs is expected to a maximum of approximately 150 m from the discharge location, based on a review of seven studies summarised by IOGP (2016).

The bottom hole sections are drilled after the riser is fitted. Cuttings and unrecoverable fluids are discharged below the water line of the MODU site, resulting in drill cuttings and drilling fluids rapidly dispersing through the water column. The larger cuttings particles will drop out of suspension and deposit in proximity to the well site (tens of metres) with potential for localised spreading downstream, while the finer fluid particles will remain in suspension and will be transported away from the well site, rapidly diluting and eventually depositing over a larger area (hundreds of metres) downstream of the well site. Predicted impacts for bottom hole cuttings are generally confined to a maximum of 500 m from the discharge point (IOGP, 2016), with NWBM cuttings discharges to water less than about 300–400 m depth typically deposited in sediments within about 100 to 200 m of the discharge (IOGP, 2016).

Potential impacts from the discharge of cuttings range from the complete burial of benthic biota in the immediate vicinity of the well site due to sediment deposition (mainly top hole cuttings), smothering effects from raised sedimentation concentrations as a result of elevated TSS, changes to the physico-chemical properties of the seabed sediments (particle size distribution, elevated metals such as Barium and potential for decrease in oxygen levels (anoxic conditions) within the surface sediments due to organic matter degradation by aerobic bacteria) and subsequent changes to the composition of infauna communities to minor sediment loading above background and no associated ecological effects.

The Montebello Australian Marine Park (IUCN Category VI – Multiple Use Zone) is the closest MPA to the Operational Area, at a distance of about 20 km to the east of the well locations. The discharge of drill cuttings is therefore not expected to impact this Marine Park. The Operational Area has a minor overlap with the Ancient Coastline at the 125 m Depth Contour KEF and the Continental Slope Demersal Fish Communities KEF (**Figure 4-18**). However, none of the proposed well locations are within the KEFs. The nearest wells are about 2.4 km from the Continental Slope Demersal Fish Communities KEF and 5 km from the Ancient Coastline KEF. Given the area potentially impacted by drill cuttings discharge (up to 500 m, as described above) and the distances between the well locations and the KEFs, the discharge of drill cuttings is not expected to influence the ecological values of these KEFs.

Habitats and Communities (Physical Impact of Cuttings)

Cuttings discharged at the seabed while drilling wells will result in localised cuttings piles on the seabed surrounding the well head, as discussed above, with a greater spread of cuttings expected to occur downstream from the well site. The cuttings pile will vary in particle size distribution from the surrounding seabed. Benthic organisms below this cuttings pile will be smothered; however, the cuttings piles are expected to be recolonised over time. Ecological impacts to benthic biota is predicted when sediment deposition is equal to or greater than 6.5 mm in thickness (IOGP, 2016). This amount of sediment deposition from top hole and bottom hole cuttings is expected to be confined to within a few hundred metres around the well location. Low levels of sediment deposition away from the immediate area of the well site may occur and would represent a thin layer of settled drill cuttings, which will likely be naturally reworked into surface sediment layers through bioturbation (US Environmental Protection Agency, 2000). Mobile benthic fauna, such as demersal fish, may be temporarily displaced from areas where cuttings discharges accumulate.

Furthermore, ecological impacts are not expected for mobile benthic fauna such as crabs and shrimps or pelagic and demersal fish, given their mobility (IOGP, 2016). Balcom et al. (2012) concluded that impacts associated with discharging cuttings and base fluids (including NWBMs) are minimal, with impacts highly localised to the area of the discharge. Changes to benthic communities are normally not severe. Organic enrichment can occur, leading to anoxic conditions in the surface sediments and a loss of infauna species that have a low tolerance to low oxygen concentrations, and to a lesser extent chemical toxicity near the well location. These impacts are highly localised with short-term recovery that may include changes in community composition with the replacement of infauna species that are hypoxia-tolerant (IOGP, 2016). Recovery of affected benthic infauna, epifauna and demersal communities is expected to occur quickly, given the short duration of sediment deposition and the widely represented benthic and demersal community composition.

Water Quality

The discharge of drill cuttings and unrecoverable fluids is expected to increase turbidity and TSS levels in the water column, leading to an increased sedimentation rate above ambient levels. Drill cuttings discharge is generally intermittent and of short duration (over a total period of about 70 days) during the drilling of a well. Nelson et al. (2016) identified a sedimentation rate of <10 mg/L as having no effect or sub-lethal minimal effect concentration. Given the generally low concentration of TSS (due to rapid dispersion from the well site), the offshore open ocean site in conjunction with rapid dispersion of sediment and the short period of intermittent discharge, the plume is not expected to have more than a very highly localised potential area of ecological impact and it is not predicted to impact productivity of the water column.

Furthermore, there are no likely impacts expected for pelagic fauna. While very high concentrations of suspended sediments have been shown to result in mortality of pelagic animals (>1830 mg/L), such concentrations do not occur as a result of drill cuttings discharges (IOGP, 2016). In addition, fish are likely to move away when elevated TSS concentrations are detected, while air breathing megafauna such as cetaceans and turtles are not expected to be in direct contact with the TSS plume, given its proximity to the MODU. Any potential contact would be of a short duration, given the rapid dispersion of the plume and the expected transient movement of megafauna in this offshore area. Light-dependent benthic primary producer habitats are not located in the Operational Area.

Given the composition and wider representation of the expected benthic communities in the vicinity of the Operational Area, the ecological impacts are considered to be slight and short-term.

Sediment Quality and Habitats and Communities (Contamination and Toxicity Effects from Drilling Fluids)

Indicative components of the WBM system outlined in **Section 3.11.1**, have a low toxicity. Bentonite and chemicals from the family of XC polymers (Xanthan Gum or similar) are listed as ‘E’ category fluids under the OCNS and considered to ‘pose little or no risk to the environment’. Metals such as barium from these additives will be present in the drill cuttings, primarily as insoluble mineralised salts, and consequently are not released in significant amounts to the pore water of marine sediments and have low bioavailability to those benthic fauna which may come into contact with the discharged barite (Crecelius et al., 2007; Neff, 2008).

The XC polymer and bentonite sweeps have very low toxicities and are considered by OSPAR to pose little or no risk to the environment. They may, however, cause physical damage to benthic organisms by abrasion or clogging, or through changes in sediment texture that can inhibit the settlement of planktonic polychaete and mollusc larvae (Swan et al., 1994). However, these impacts are not expected to be significant due to the rapid biodegradation and dispersion of WBM drilling fluids (Terrens et al., 1998) and no significant habitats/biota are considered to be present in the Operational Area. The dilution of solid elements of the WBM into substrate largely depends on the energy level of the local environment and the ‘mixing’ that takes place, but is expected to occur rapidly following release (especially with WBM). The low sensitivity of the benthic communities/habitats combined with the low toxicity of WBM and low physical impacts are unlikely to result in a significant environmental impact.

Base fluids for NWBM are assessed in accordance with Woodside’s Chemical Selection and Assessment Environment Guideline. They are designed to be biodegradable in offshore marine sediments. Biodegradation can result in a low oxygen (anoxic) environment resulting in changes in benthic community structure. Species sensitive to anoxic environments are eliminated and replaced by tolerant and opportunistic species, resulting in decreased species diversity, but the number of individuals often increases (Neff et al., 2000). NWBMs are designed to be low in toxicity and are not readily bioavailable to benthic fauna due to their physical/chemical properties.

Furthermore, the combination of low toxicity and rapid dilution of unrecoverable NWBMs discharged in association with drill cuttings are of little risk of direct toxicity to water-column biota (Neff et al., 2000). A small quantity of WBM and NWBM residue may be discharged at the sea surface while cleaning the mud pit (<1%), typically at the conclusion of drilling activities or when changing between mud types. Nedwed et al. (2006) found that depth is an important factor for concentrations of NWBM on cuttings, where cuttings which had a great distance to reach the seabed (950 m) had significantly lower concentrations, suggesting that loss of base fluid during settling acted to significantly reduce chemical effects from discharges. The study concluded that NWBM discharged in deep water posed very limited environmental impacts (from analysis of difference in benthic fauna between pre- and post-drilling samples (Nedwed et al., 2006). This discharge is expected to dilute rapidly, with a potential impact to the environment considered to be a local, temporary decrease in water quality.

The low sensitivity of the benthic communities/habitats within and in the vicinity of the Operational Area, combined with the low toxicity of WBMs and NWBMs, no bulk discharges of NWBM and the highly localised nature and scale of predicted physical impacts to seabed biota, affirm that any significant impact is considered likely but of a slight environmental consequence.

Cumulative Impacts

Given the Petroleum Activities Program includes drilling four development wells combined with the presence of four historical wells in vicinity of the proposed development wells in the Julimar field (**Figure 3-2**), there is the potential for cumulative disturbance to marine sediment quality and benthic communities. The cuttings and drilling fluids discharges from each well will accumulate within the receiving environment. The most recently drilled wells near the proposed development (<3 km) were drilled approximately four years ago (i.e. 2015). It is expected that the benthic habitat communities have fully recovered since then (aside from the cuttings in the immediate vicinity of the wells, from drilling the tophole section, which can modify the habitat (IOGP, 2016)); therefore, posing no risk for significant cumulative impacts from historical wells. Therefore cumulative impacts are expected to be limited to the Petroleum Activities Program.

When considering deposition of sediments from each drilling activity, deposition at a thickness of greater than 6.5 mm is limited to within a distance of a few hundred metres, although this depends on the nature of the cuttings and the water depth and currents of the receiving environment (IOGP, 2016). If the area of cuttings deposition from the wells from the Petroleum Activities Program overlap, impacts are anticipated to be minimal, considering the observed limited benthic biota within the Operational Area (**Section 4.5.1**).

No cumulative impacts to water quality are expected to occur since discharged sediments are predicted to settle in between the drilling activities for each well and no concurrent drilling will occur.

Well Annular Fluids

The non-instantaneous nature of the release of the well annular fluids is expected to result in rapid dilution to a no-effect concentration within metres of the release location.

Summary of Potential Impacts to Environmental Values

Given the adopted controls, it is considered that the drill cutting and drilling fluids discharges described will not result in a potential impact greater than localised burial and smothering of benthic habitats and slight/short term effects to water quality (e.g. turbidity increase) (i.e. Environment Impact – E).

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS)***[20]	***Benefit in Impact Reduction***	***Proportionality***	***Control Adopted***
Legislation, Codes and Standards				
No additional controls identified.				
Good Practice				
Drilling, completions, cementing, flowline pre-commissioning and subsea control fluids and additives will have an environmental assessment completed prior to use.	F: Yes. CS: Minimal cost. Standard practice.	Environmental assessment of chemicals will reduce the consequence of impacts resulting from discharges to the marine environment by ensuring chemicals have been assessed for environmental acceptability. Planned discharges are required for safely executing activities; therefore, no reduction in likelihood can occur.	Benefits outweigh cost/sacrifice.	Yes C 6.1
For drilling and completions fluids, six-monthly chemical review performed to confirm potential chemical impacts are reduced to ALARP.	F: Yes. CS: Minimal cost. Standard practice.	Regular reviews will ensure chemicals selected for drilling and completions fluids remain ALARP.	Benefits outweigh cost/sacrifice.	Yes C 6.2
Written NWBM justification process followed.	F: Yes. CS: Minimal cost. Standard practice.	The written justification considers the technical need for NWBM use, receiving environment, cost and additional controls that may be required. By performing formal assessment, the potential impacts are well understood, allowing for development of control measures to reduce the consequence of NWBM use. This provides an overall environmental benefit.	Benefits outweigh cost/sacrifice.	Yes C 6.3

[20] Qualitative measure

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS)[20]***	***Benefit in Impact Reduction***	***Proportionality***	***Control Adopted***
No overboard disposal of bulk NWBM.	F: Yes. CS: Minimal cost. Standard practice.	By restricting the volume of NWBM for overboard discharge, the consequence of the release on the environment is reduced. Although no change in likelihood is provided, the decrease in consequence results in an environmental benefit.	Benefits outweigh cost/sacrifice.	Yes C 6.4
Bulk operational discharges conducted under MODU's PTW system (to operate discharge valves/pumps).	F: Yes. CS: Minimal cost. Standard practice.	The MODU's PTW may slightly reduce the likelihood of bulk discharges occurring, but it is unlikely to be significant given bulk discharges are often operationally required and cannot be eliminated.	Benefits outweigh cost/sacrifice.	Yes C 6.5
SCE used to treat NWBM cuttings prior to discharge.	F: Yes. CS: Minimal – more frequent cuttings sampling and testing.	Achieving average oil on cuttings (sections using NWBM only) discharge limit of 6.9% or less oil on wet cuttings will have a small reduction in consequence.	Benefits outweigh cost/sacrifice.	Yes C 6.6
In event of SCE failure (where no redundancy is available) while drilling with NWBM, the initial action will be to cease drilling and determine whether to repair SCE or drill ahead until next practicable opportunity to trip out of the hole. If cuttings are discharged during dryer or auger failure, measurement of OOC to occur more frequently from shakers.	F: Yes. CS: Cost and schedule implications due to cessation of drilling.	Ceasing drilling in the event of equipment failure will allow for time to assess feasibility of drilling ahead while still meeting residual OOC discharge requirements.	Benefits outweigh cost/sacrifice.	Yes C 6.7
Professional Judgement – Eliminate				
None identified				
Professional Judgement – Substitute				
None identified				
Professional Judgement – Engineered Solution				
Mud pit wash residue will be measured for oil content prior to discharge.	F: Yes. CS: Minimal cost. Standard practice.	Ensuring <1% oil content will provide a small reduction in consequence when residue is discharged to the environment.	Benefits outweigh cost/sacrifice.	Yes C 6.8

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS)[20]***	***Benefit in Impact Reduction***	***Proportionality***	***Control Adopted***
Drill cuttings returned to the MODU will be discharged below the water line.	F: Yes. CS: Minimal cost. Standard practice.	Discharging drill cuttings below the water line will reduce carriage and dispersion of cuttings. thereby reducing the consequence of cuttings discharges during the Petroleum Activities Program.	Benefits outweigh cost/sacrifice.	Yes C 6.9
Cuttings reinjection into formation. Cuttings are to be crushed, slurrified and pumped to a desired geological structure with a suitable seal, below the seabed through an annulus or tubing.	F: No. No concurrent drilling or direct sequential drilling planned which would require cuttings to be stored prior to reinjection. CS: Not considered – control not feasible.	Not considered – control not feasible.	Not considered – control not feasible.	No
Riserless mud recovery (RMR) system to return top hole cuttings/mud from the riserless section of the well to the MODU prior to treatment onboard and discharge from the MODU (below the water line) for <u>all wells</u>. Note: RMR may be used for technical reasons if a weighted fluid is required to successfully drill a top hole section (such as mitigating against shallow hazards or unstable formations).	F: Yes. RMR in the water depth where this Petroleum Activities Program will take place (145–174 m) is technically feasible with a specially designed/ engineered solution. RMR may be required for technical reasons during the Petroleum Activities Program. CS: Primary cost/ sacrifice of this option is the installation of RMR equipment including the footprint of equipment onboard the rig, POB for operation/ maintenance and risks associated with operational reliability of the installed system (particularly in the deeper waters of the Petroleum Activities Program).	Potential environmental benefit from disposing top hole cuttings/fluid from the MODU below the surface, instead of directly to seafloor, includes a reduction in the consequence of environmental impacts from smothering surrounding benthic fauna (due to a greater spread of cuttings on the seafloor). The magnitude of this reduction in smothering potential could depend upon metocean factors such as tide at the time of discharge (which impact dispersion efficacy and patterns). Because RMR allows for fluid recovery, mud is able to be reused down-hole, reducing the total volume of mud used for that section. The net environmental benefit for this option is reduced or neutral due to the introduction of suspended sediment impact potential for in-water fauna, which doesn't exist to the same extent for disposal of top hole cuttings/fluids at seafloor.	Disproportionate to implement RMR for environmental reasons. Although use of the RMR system to bring mud/fluids back to the MODU (rather than discharging at seabed) includes a reduction in the likelihood of environmental impacts from smothering of proximate benthic fauna, environmental impact potential is then transferred to in-water fauna from suspended sediment, rather than reduced by applying this control. Considering the already low level of impact from cuttings/fluid discharge predicted, the outcomes of the impact assessment described above which determined no sensitive benthic receptors in the vicinity of the Petroleum Activity Program, and transfer of environmental	No

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS)[20]***	***Benefit in Impact Reduction***	***Proportionality***	***Control Adopted***
		The transfer of environmental consequence from reducing cuttings/mud discharged at each well location (i.e. less potential for smothering benthic fauna at seafloor) to reductions in water quality for in-water fauna by suspended sediment and final sedimentation levels, means the consequence of discharging cuttings to the marine environment during the Petroleum Activities Program is not reduced.	impacts to another receptor, any minor environmental benefits gained from implementing this control are considered disproportionate to the costs and risks associated with RMR system installation and use.	
RMR system to return top hole cuttings from the riserless section of the well to the MODU prior to transport to an alternative discharge location or back to shore for disposal.	F: Yes. RMR in the water depth where this Petroleum Activities Program will take place (145–174 m) is technically feasible with a specially designed/ engineered solution. CS: Primary cost/ sacrifice of this option is the additional handling required to transport mud/cuttings to an alternative disposal location. Particularly the health and safety risks associated with high frequency of support vessel activity alongside the rig and the amount of lifting operations required if a cuttings skip/drilling waste container system were employed. The installation of RMR equipment including the footprint of equipment onboard the rig, POB for operation/ maintenance and risks associated with operational reliability of the installed system (particularly in the deeper waters of the Petroleum Activity Program).	As described above with additional environmental benefits of discharge at an alternative location or transported back to shore. With cuttings removed from the location, possible environment benefit comes from reduced smothering/ burial potential for local benthic habitat in the direct vicinity of the well, where cuttings would normally be discharged on the seafloor. Fluids are still discharged on location (from the MODU) in accordance with requirements in this EP. The net environmental benefit for this option is reduced due to the introduction of suspended sediment impact potential for in-water fauna with the sub-surface discharge of fluids from the top hole, which doesn't exist to the same extent for disposal of top hole fluids at seafloor. Discharging at a different location reduces the consequence to environmental sensitivities in the Operational Area.	Disproportionate. The cost/sacrifice outweighs the benefit gained over the duration of the Petroleum Activities Program. The potential environmental benefits derived from using RMR to bring cuttings/fluids back to the MODU (rather than discharging at seabed) are limited. The potential reduction in likelihood of burial/ smothering due to removing cuttings for one hole section is offset by cuttings/ fluids discharged on location through drilling the rest of the well (i.e. discharges from the other well sections). There is also a transfer of risk and new risks introduced; bringing fluids back to the MODU and disposal at surface has an impact potential for in-water fauna compared to discharge at seabed. Considering the already low level of	No

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS)[20]***	***Benefit in Impact Reduction***	***Proportionality***	***Control Adopted***
	Other cost/sacrifice elements which are considered include: • further treatment of cuttings onshore is required to ensure a standard suitable for landfill: Class II disposed locally (e.g. Karratha); Class III landfill requires transport to Geraldton or Perth • increased risk of unplanned vessel collision or loss of cuttings during transfer activities • environmental impact (suspended sediment/ sedimentation) of discharging cuttings at new location and other regulatory approvals may also be required (e.g. sea dumping permit) • potential halt to drilling activity if transfer operations are delayed due to weather or operational issues • additional environmental impact incurred (air emissions) from vessel use and onshore trucking for transportation of cuttings.	However, the small risk of impact is transferred to an alternate site. Given the relatively low biological significance of sensitivities in the Operational Area, no environmental benefit is gained overall. Transportation of cuttings for onshore disposal eliminates any consequence of discharging cuttings. This only provides a small environmental benefit, given the low consequence of discharging cuttings on location.	impact from cuttings/fluid discharge predicted and the outcomes of the impact assessment described above which determined no sensitive benthic receptors in the vicinity of the Petroleum Activity Program, any environmental benefits gained from implementing this control are considered disproportionate to the costs and risks introduced by onshore cuttings relocation or disposal at alternative offshore location.	
Return riser-in-place cuttings for disposal at another marine location or onshore for processing and land disposal (skip and ship) for whole well to reduce risk of benthic disturbance. OR Return riser-in-place cuttings for all sections drilled with NWBM for disposal onshore (to reduce potential residual OOC to environment).	F: Yes. CS: Primary cost/ sacrifice of this option is the additional handling required to transport cuttings to an alternative disposal location. Particularly the health and safety risks associated with high frequency of support vessel activity alongside the rig and the amount of crane lifting required if a cuttings skip/drilling	Compared to adopted control, return riser-in-place cuttings would reduce cuttings/ mud discharged (although discharge would still occur during riserless drilling on the basis that this control is not adopted) at each well location; however, given current impact assessment and controls adopted, this would not result in a significant	Disproportionate. Given the adopted controls and low current risk rating, the high cost/ sacrifice outweighs the benefit gained over the duration of the Petroleum Activities Program. Impact assessment has determined no sensitive benthic receptors in the vicinity and a low level of impact	No

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS)***[20]	***Benefit in Impact Reduction***	***Proportionality***	***Control Adopted***
	waste container system were employed. Other cost/sacrifice elements which are considered include: • further treatment of cuttings onshore is required to ensure a standard suitable for landfill: Class II disposed locally (e.g. Karratha); Class III landfill requires transport to Geraldton or Perth • increased risk of unplanned vessel collision or loss of cuttings during transfer activities • environmental impact (suspended sediment/ sedimentation) of discharging cuttings at new location and other regulatory approvals may also be required (e.g. sea dumping permit) • potential halt to drilling activity if transfer operations are delayed due to weather or operational issues • additional environmental impact incurred (air emissions) from vessel use and onshore trucking for transporting cuttings • disposal via landfill and/or treatment does not eliminate an environmental impact. These options have their own impacts and therefore disadvantages if implemented.	reduction of consequence.	potential from overall cuttings/mud discharge; therefore, benefit to be gained from cuttings/mud recovery is disproportionate to the risks introduced by relocating cuttings (including if an alternative system which doesn't use transport containers was implemented).	

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS)[20]***	***Benefit in Impact Reduction***	***Proportionality***	***Control Adopted***
Reduce total drill cuttings by implementing slim well design	F: No. Slim well design is not considered feasible based on the following factors: • The wells to be drilled in the Petroleum Activities Program are expected to be deep. Designs have been optimised to minimise the size of hole drilled while still being able to reach the targets and meet development objectives. CS: Not considered – control not feasible.	Not considered – control not feasible.	Not considered – control not feasible.	No
Water quality and/or sediment monitoring of drill cuttings or drilling fluids to verify impact during activity.	F: Yes. CS: • for in-water sampling using ROV – time and logistics for tool change-out from operational tools to specialised scientific sampling tools • additional personnel on board to operate ROV and coordinate sampling program • low ROV availability due to operations can limit time to monitor environment • if additional ROV is required on the MODU, deck space and resources to run/store/service ROV • resources for sample processing (space/equipment/ personnel).	No environmental benefit would be gained by implementing monitoring during the activity. Monitoring could be used to inform additional control measures in future drilling activities; however, there is a considerable body of existing scientific literature on potential impacts of drill cuttings and impacts are generally well understood. Furthermore, it is not guaranteed that additional controls would be feasible, or if they would provide any environmental benefit.	Disproportionate. Cost/sacrifice outweigh benefit to be gained in the context of existing environment (deep water, open ocean communities with no proximity to sensitive benthic communities or receptors). Although adopting this control could be used to verify EPOs associated with drilling mud and cutting discharge, alternative controls identified achieve an appropriate outcome.	No

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS)[20]***	***Benefit in Impact Reduction***	***Proportionality***	***Control Adopted***
Use SCE with secondary treatment for NWBM: Thermomechanical systems (to achieve <1% average oil on cuttings).	F: Yes – with associated infrastructure including vessels for offline storage and delivery to thermomechanical dryer. CS: The primary cost/sacrifice of this option is the monetary outlay for acquisition and implementation which is estimated at $800,000 to mobilise, install and demobilise, along with a running cost of ~$32,000/day. Other factors considered include: • It is estimated that it would take a minimum of seven months to mobilise, install and commission the system on to the MODU. • Complex and unfamiliar system to integrate with the rig systems. • Increased health and safety exposure due to: – crew of nine engineers and technicians required to run the plant – multiple crane lifting operations during installation, operations and demobilisation – rotating machinery – heat illness – deck congestion due to large footprint of the plant.	The consequence would be reduced by reducing the average OOC discharged.	Disproportionate. Cost/sacrifice outweighs benefit to be gained in the context of existing environment and drilling campaign.	No

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS)[20]***	***Benefit in Impact Reduction***	***Proportionality***	***Control Adopted***
Time-restricted discharge of WBM and/or cuttings to align with tide/current or other oceanographic events.	F: Yes. CS: Disruption to drilling operations in having to stop drilling at time when discharge of WBM and/or cuttings might not be permitted. Additional mud storage volume required.	Given the offshore location, oceanographic changes are unlikely to significantly affect the dispersion of cuttings; therefore, no environmental benefit would be gained.	Disproportionate. The cost/sacrifice outweighs the benefit gained – No hard coral or other photo-sensitive benthic communities in the vicinity of wells to rationalise phased/timed discharge.	No

ALARP Statement

On the basis of the environmental impact assessment outcomes and use of the relevant tools appropriate to the decision type (i.e. Decision A type), Woodside considers the adopted, standard 'good practice' controls appropriate to manage the impacts of drill cuttings and drilling fluids discharges. A range of engineered solutions and other elimination options were considered to further reduce the impact of planned discharge of drill cuttings and drilling fluids to ALARP; however, technical and operational challenges, safety and environmental risk and additional financial costs resulted in these options being rejected on the basis that they were grossly disproportionate to the potential environmental benefit gained. As no reasonable additional/alternative controls were identified that would further reduce the impacts and risks, which are already low due to the low sensitivity of the environment, without grossly disproportionate sacrifice, the impacts and risks are considered ALARP.

Demonstration of Acceptability

Acceptability Statement

The impact assessment has determined that, given the adopted controls, cuttings and fluid discharges is unlikely to result in a potential impact greater than slight, short-term impact on habitat (but not affecting ecosystem function), biological and physical attributes. Further opportunities to reduce the impacts and risks have been investigated above.

The adopted controls are considered good oil-field practice/industry best practice to prevent the generation of significant volumes of drill cuttings. Other engineered solutions to manage drill cuttings and fluids were considered; however, these represented costly 'end of pipe' solutions rather than a preventative approach, with additional safety and environmental risks. The potential impacts and risks are considered broadly acceptable if the adopted controls are implemented. Therefore, Woodside considers the adopted controls appropriate to manage the impacts and risks, which due to the low sensitivity of the environment are low, of these discharges to a level that is broadly acceptable.

Environmental Performance Outcomes, Standards and Measurement Criteria			
Outcomes	***Controls***	***Standards***	***Measurement Criteria***
EPO 6 No impact to water quality or marine biota greater than a consequence level of E[21] from discharging drilling cuttings or fluids	**C 6.1** Drilling, completions, cementing, flowline pre-commissioning and subsea control fluids and additives will have an environmental assessment completed prior to use.	**PS 6.1** Reduces to ALARP the impact potential of all chemicals intended or likely to be discharged into the marine environment	**MC 6.1.1** Records demonstrate chemical selection, assessment and approval process for selected chemicals is followed.

[21] Defined as ' Slight and short term impact on species or habitat but not affecting ecosystem function' as in Figure 2-6/Section 2.6.3.

Environmental Performance Outcomes, Standards and Measurement Criteria			
Outcomes	***Controls***	***Standards***	***Measurement Criteria***
during the Petroleum Activities Program.	**C 6.2** For Drilling and Completions fluids, six-monthly chemical review performed to confirm potential chemical impacts are reduced to ALARP.	**PS 6.2** Evaluates ongoing ALARP and acceptability of approved chemicals (including determining whether alternative products are available).	**MC 6.2.1** Records confirm six-monthly reviews have taken place, and any actions/changes are being tracked to closure.
	C 6.3 Written NWBM justification process followed.	**PS 6.3** Ensures the use of NWBM is consistently challenged.	**MC 6.3.1** Records demonstrate a formal justification has been completed prior to using NWBM.
	C 6.4 No overboard disposal of bulk NWBM.	**PS 6.4** Reduces the volume of hydrocarbons discharged to the environment.	**MC 6.4.1** Incident reports of any unplanned discharges of NWBM.
	C 6.5 Bulk operational discharges conducted under MODU's PTW system (to operate discharge valves/pumps).	**PS 6.5** Ensures an increased level of assurance and verification on bulk operational discharges.	**MC 6.5.1** Records demonstrate that bulk discharges are conducted under the MODU PTW system.
	C 6.6 SCE used to treat NWBM cuttings prior to discharge.	**PS 6.6** Achieves average OOC (sections using NWBM only) discharge limit of 6.9% or less oil on wet cuttings.	**MC 6.6.1** Records confirm the average OOC for the entire well (sections using NWBM only) do not exceed limit.
	C 6.7 In event of SCE failure (where no redundancy is available) while drilling with NWBM, the initial action will be to cease drilling and determine whether to repair SCE or drill ahead until the next practicable opportunity to trip out of the hole. If cuttings are discharged during dryer or auger failure, measurement of OOC to occur more frequently from shakers.	**PS 6.7** The decision whether to repair SCE or drill ahead will consider the estimated time for repairs and the amount of drilling until next planned trip out of hole, to ensure the OOC limit is not exceeded.	**MC 6.7.1** Records demonstrate that in the event of auger or cuttings dryer failure (where no redundancy is available), active drilling is initially stopped as soon as safe to do so. Evidence of the decision to drill ahead with failed SCE can be produced. Records confirm the average OOC for the entire well (sections using NWBM only) do not exceed limit.
	C 6.8 Mud pit wash residue will be measured for oil content before discharge.	**PS 6.8** Achieves less than 1% by volume oil content before discharge.	**MC 6.8.1** Records after pit clean-out (for pits potentially contaminated with base oil) demonstrate mud pit wash residue was less than 1% by volume oil content before discharge.
	C 6.9 Drill cuttings returned to the MODU will be discharged below the water line.	**PS 6.9** Reduces carriage and dispersion of cuttings by surface currents.	**MC 6.9.1** Records confirm cuttings discharge chute/line is below the water line.

6.6.7 Routine and Non-routine Discharges to the Marine Environment: Cement, Cementing Fluids, Grout, Subsea Well Fluids, Formation Water and Unused Bulk Products

Context	
Drilling and completions activities – Section 3.9 Project fluids – Section 3.11	Physical environment – **Section 4.4** Biological environment – **Section 4.5**

Impacts and Risks Evaluation Summary

Source of Impact	*Environmental Value Potentially Impacted*							*Evaluation*						
	Soil and Groundwater	***Marine Sediment***	***Water Quality***	***Air Quality (incl Odour)***	***Ecosystems/Habitat***	***Species***	***Socio-Economic***	***Decision Type***	***Consequence***	***Likelihood***	***Current Risk Rating***	***ALARP Tools***	***Acceptability***	***Outcome***
Routine discharge of cement, cementing fluids, grout, subsea well fluids (BOP and well construction activity control fluids; completion fluids and well intervention/workover fluids) and other down-well products to the seabed and the marine environment		X	X		X			A	E	-	-	LCS GP PJ	Broadly Acceptable	EPO 7

Description of Source of Impact

Cementing Fluids, Cement and Grout

Cementing fluids may require discharge to the marine environment under various scenarios. When cementing the conductor and surface casings after top-hole sections of the well have been drilled, cement must be circulated to the seabed to ensure structural integrity of the well. Excess cement is pumped to ensure structural integrity is achieved.

If the hole is completely in-gauge and there are no downhole losses while running the cement, a maximum average volume of 55 m^3 per well is estimated to be circulated to the seafloor at the well location, which forms a thin concrete film on the seabed in close proximity to the well.

After each cement job, left over cement slurry in the cement pump unit and the surface lines is flushed and discharged to the sea to prevent clogging of the lines and equipment. This is estimated at about 35 m^3 per well (based on seven cement jobs per well × 5 m^3 discharged per job).

Cement spacers can be used as part of the cementing process, within the well casing, to assist with cleaning the casing sections prior to cement flow-through. The spacers may consist of either seawater or a mixture of seawater and dye. The dye is used to provide a pre-indicator of cement overflow to the seabed surface, to ensure adequate cement height.

Excess cement (dry bulk, after well operations are completed) will either be: used for subsequent wells; provided to the next operator at the end of the drilling program (as it remains on the rig); or, if these options aren't practicable, discharged to the marine environment as a slurry.

Upon arrival on location at the Operational Area, the rig may be required to perform a cement unit test, or 'dummy cement job'. Discharges from the test are either made through the usual cement unit discharge line, which may be up to 10 m above the sea level or through drill pipe below sea level, and occur as a cement slurry. The slurry is usually a mix of cement and water; however, may sometimes contain stabilisers or chemical additives.

Post-lay span rectification may also be required after flowline installation. This process typically involves placing grout bags under the span section. The empty bag is filled with grout on the seabed supplied from a mixing and pumping spread on the vessel via a downline. Typical grout volumes depend on the size of the span and may vary from about 200 kg to 2000 kg per span. If grout bags are used, the downline recovery time risks exceeding the grout curing time; if grout cures within the downline and pump, the equipment is likely to be rendered unserviceable, as well as the downline not being safely recoverable in the normal way. Therefore, after grouting activities at each span site, the downline and pump will need to be purged using seawater. This results in an amount of grout, approximately equivalent to the downline volume (5 m^3), being discharged to the ocean. This flushing is required once per grout site. The actual number is not known until the line is laid and need for span rectification determined, if any.

Subsea Fluids – BOP and Well Construction Activity Control Fluids

Subsea fluids are likely to be released during drilling, completions and Xmas tree installation, including BOP control fluids. The BOP is required to be regularly function tested when sub-sea, as defined by legislative requirements. The BOP is function-tested during assembly and maintenance and during operation on the seabed. As part of this testing, small volumes of BOP control fluid (generally consisting of water mixed with a glycol based detergent or equivalent water-based anti-corrosive additive) is released to the marine environment. The BOP will be function-tested approximately every seven days (when a pressure test is not occurring) and pressure tested approximately every 21 days as per API 53 (an American Petroleum Institute standard for Well Control Equipment Systems for Drilling Wells). This will result in discharges of about 90 L of BOP control fluids per test.

Functioning and testing of the subsea Xmas trees and subsea landing strings will result in the discharge of small volumes of water glycol based control fluid.

Subsea Fluids – Displacement, Completion and Well Bore Clean-Out Fluids

As required throughout activities with the riser connected, wells will be displaced from one drilling fluid system to another, or from the drilling fluid system to completion brine. A chemical clean-out pill or fluids train will be circulated between the two fluids. Cleanout fluids and completion brine will be captured and stored on the MODU and discharged if oil concentration is <1% by volume, or returned to shore if discharge requirements cannot be met.

During well unloading, base oil will be sent to the flare. Refer to **Section 6.6.9** for an assessment of risk associated with planned flaring during well unloading.

Subsea Fluids – Well Intervention and Workover Fluids

A workover or intervention may be performed on any of the wells in the Petroleum Activities Program. If the well has been flowed previously, or if down-hole hydrocarbons remain in the well (e.g. reservoir fluid or if base oil has been left in the well), there is potential that the intervention/workover fluids will be contaminated with hydrocarbons. If hydrocarbon contamination of the intervention/workover fluids has occurred, the fluid will need to be treated on the MODU, to ensure hydrocarbon content prior to discharge is 1% by volume, or less.

During IMR or workover activities, it may be necessary to remove marine growth from subsea infrastructure using acid (typically sulphamic acid) to aid visual inspection and operation of valves and other mechanisms.

Produced/Formation Water

During well unloading and completion activities, completion and formation fluids will be discharged to the marine environment via the well test package. The well test water treatment package will be used to treat produced/formation water that cannot be flared before discharge. Prior to discharge, the fluids are cycled through a water filtration system consistent with solids and polishing. About 500 bbls of formation water is produced per well and will be discharged via the treatment package.

Other Down-Well Products

Additional products such as barite and bentonite may be discharged in bulk during or at the end of the activity if they cannot be reused or taken back to shore. Use and discharge of all chemicals will be performed in line with Woodside's internal guidelines (**Section 3.11.1**). Discharge may be in the form of dry bulk or as a slurry; however, discharges will not be contaminated with hydrocarbons.

Impact Assessment

Potential Impacts to Water Quality, Sediment Quality and Other Habitats and Communities

Pelagic and benthic habitats in the Operational Area are considered to be of low sensitivity (no known significant benthic habitat or infauna habitat). The Operational Area has a minor overlap with the Ancient Coastline at the 125 m Depth Contour KEF and the Continental Slope Demersal Fish Communities KEF (**Figure 4-18**). However, none of the proposed well locations are within the KEFs. The nearest wells are about 2.4 km from the Continental Slope Demersal Fish Communities KEF and 5 km from the Ancient Coastline KEF. Impacts to the values and sensitivities of these KEFs therefore are not expected. Coupled with the low toxicity of the fluids to be used for the Petroleum Activities Program, the likelihood of any significant impact to marine biota is considered to be low.

Cement and Grout

Impacts of cement on the marine environment are associated mainly with smothering surrounding benthic and/or infauna communities. Cement is the most common material currently used in artificial reefs around the world (OSPAR, 2010) and is not expected to pose any toxicological impacts to receptors from leaching or direct contact. A minimum cement volume is required to be stored on the MODU for use in well control and plug & abandon activities. While cement volumes are calculated prior to use to minimise excess, the requirement for additional volumes on the MODU means some cement may require discharge if options for reuse on other wells is not possible. Discharge of excess cement may occur as dry bulk or as a slurry. Dry bulk has the potential to disperse across a wider area, but at lower concentration, compared to slurry which would have a greater tendency to settle on the seafloor closer to the well location. In either case, discharges are not expected to widely disperse before settling on the seabed.

The impact of cement discharge and grout (if required) at the seabed will therefore be limited to any surrounding benthic and/or infauna communities, in a small localised area immediately around the well and likely within the area previously impacted by drill cuttings (see **Section 6.6.6**).

Cementing Fluids, Subsea Well Fluids (BOP and Well Construction Activity Control Fluids, Completion Fluids and Well Intervention/Workover Fluids) and Other Down-Well Products
All chemicals that may be operationally released or discharged to the marine environment by the Petroleum Activities Program are evaluated using a defined framework and set of tools to ensure the potential impacts of the chemicals selected are acceptable, ALARP and meet Woodside's expectation for environmental performance. Therefore, any chemicals selected and potentially released are expected to be of low toxicity and biodegradable. Additionally, where cements have been mixed in excess and cannot be reused or returned to shore, these will be turned into a slurry. As chemicals have initially been chosen based on the environmental performance and based on an ALARP assessment, additional dilution prior to discharge further reduces the environment impact to water quality, sediment quality and marine benthic and/or infauna communities. Given the minor quantities of routine and non-routine planned discharges, short discharge durations and the low toxicity and high dispersion in the open, offshore environment, any impacts on the marine environment are expected to be slight and localised. Given the highly localised nature of these discharges and potential impacts, cumulative impacts to marine biota, water quality and sediments are not expected.
Summary of Potential Impacts to Environmental Values
Given the adopted controls, it is considered that the routine discharge of cement, cementing fluid, subsea well fluid and other down-well products described will not result in a potential impact greater than localised, slight and short term impacts to infauna and benthic communities, water quality and marine sediment (but not affecting ecosystems function) (i.e. Environment Impact – E).

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS)[22]***	***Benefit in Impact Reduction***	***Proportionality***	***Control Adopted***
Legislation, Codes and Standards				
No additional controls identified.				
Good Practice				
Drilling, completions, cementing, flowline pre-commissioning and subsea control fluids and additives will have an environmental assessment completed prior to use.	F: Yes. CS: Minimal cost. Standard practice.	Environmental assessment of chemicals will reduce the consequence of impacts resulting from discharges to the marine environment by ensuring chemicals have been assessed for environmental acceptability. Planned discharges are required for safely executing activities; therefore, no reduction in likelihood can occur.	Benefits outweigh cost/sacrifice.	Yes C 6.1
For Drilling and Completions fluids, six-monthly chemical review performed to confirm potential chemical impacts are reduced to ALARP.	F: Yes. CS: Minimal cost. Standard practice.	Regular reviews will ensure chemicals selected for Drilling and Completions fluids remain ALARP.	Benefits outweigh cost/sacrifice.	Yes C 6.2
Bulk operational discharges conducted under MODU's PTW system (to operate discharge valves/ pumps).	F: Yes. CS: Minimal cost. Standard practice.	The MODU's PTW may slightly reduce the likelihood of bulk discharges occurring, but it is unlikely to be significant given bulk discharges are often operationally required and cannot be eliminated.	Benefits outweigh cost/sacrifice.	Yes C 6.5

[22] Qualitative measure

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS)[22]***	***Benefit in Impact Reduction***	***Proportionality***	***Control Adopted***
Displacement, brine, workover or intervention fluids contaminated with hydrocarbons will be treated prior to discharge or contained. If discharge specification not met, the fluid will be returned to shore.	F: Yes. CS: Minimal cost. Standard practice.	Ensuring <1% oil content will provide a small reduction in consequence when fluids are discharged to the environment.	Benefits outweigh cost/sacrifice.	Yes C 7.1
Professional Judgement – Eliminate				
Do not use BOP control fluids.	F: No. BOP control fluids are critical to the operation of the BOP. CS: Not considered – control not feasible.	Not considered – control not feasible.	Not considered – control not feasible.	No
Return cement and other down-well products onshore for treatment/disposal.	F: Yes. However, cement slurry may harden during transport, introducing difficulty in handling and transportation. CS: The cost involved in transporting cement for shore-based disposal is significant.	Not discharging cement to the marine environment would eliminate the likelihood and consequence of impacts from such activities.	Disproportionate. Given the non-toxic nature of cement, the cost/sacrifice outweighs the benefit gained.	No
Use excess bulk cement and other down-well products on subsequent wells or pass onto subsequent operator.	F: Yes. However the cement may not meet the required technical specifications and hence not be usable. At the time of EP submission, the drilling schedule is unknown and hence a commitment to reuse cement may not be feasible. CS: Minor.	Using excess bulk cement on subsequent wells would eliminate the bulk discharge of cement to the marine environment and would eliminate the likelihood and consequence of impacts from such activities.	Disproportionate. Given the risk of the cement discharge and other down-well products to the environment is low due to the benign nature of the substance and the low sensitivity of the receiving environment, it is considered a negligible environmental risk. The cost/sacrifice outweighs the benefit gained.	No
Professional Judgement – Substitute				
No additional controls identified.				
Professional Judgement – Engineered Solution				
No additional controls identified.				

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS)***[22]	***Benefit in Impact Reduction***	***Proportionality***	***Control Adopted***
ALARP Statement On the basis of the environmental impact assessment outcomes and use of the relevant tools appropriate to the decision type (i.e. Decision Type A), Woodside considers the adopted controls appropriate to manage the impacts of cement, cementing fluids, subsea well fluids and unused bulk products. As no reasonable additional/alternative controls were identified that would further reduce the impacts without grossly disproportionate sacrifice, the impacts and risks are considered ALARP.				

Demonstration of Acceptability
Acceptability Statement The impact assessment has determined that, given the adopted controls, routine cement, cementing fluids, subsea well fluids and unused bulk products is unlikely to result in a potential impact greater than localised, slight and short term impacts to infauna and benthic communities, water quality and marine sediment (but not affecting ecosystems function). Further opportunities to reduce the impacts and risks have been investigated above. The adopted controls are considered good oil-field practice/industry best practice. The potential impacts and risks are considered broadly acceptable if the adopted controls are implemented. Therefore, Woodside considers the adopted controls appropriate to manage the impacts and risks of these discharges to a level that is broadly acceptable.

Environmental Performance Outcomes, Standards and Measurement Criteria			
Outcomes	***Controls***	***Standards***	***Measurement Criteria***
EPO 7 No impact to water quality or marine biota greater than a consequence level of E[23] from discharging cement, cementing fluids, subsea well fluids and unused bulk products during the Petroleum Activities Program.	**C 6.1** Drilling, completions, cementing, flowline pre-commissioning and subsea control fluids and additives will have an environmental assessment completed prior to use.	**PS 6.1** Reduces to ALARP the impact potential of all chemicals intended or likely to be discharged into the marine environment	**MC 6.1.1** Records demonstrate chemical selection, assessment and approval process for selected chemicals is followed.
	C 6.2 For Drilling and Completions fluids, six-monthly chemical review performed to confirm potential chemical impacts are reduced to ALARP.	**PS 6.2** Evaluates ongoing ALARP and acceptability of approved chemicals (including determining whether alternative products are available).	**MC 6.2.1** Records confirm six-monthly reviews have taken place for drilling and completion fluids, and any actions/changes are being tracked to closure.
	C 6.5 Bulk operational discharges conducted under MODU's PTW system (to operate discharge valves/pumps).	**PS 6.5** Ensures an increased the level of assurance and verification on bulk operational discharges	**MC 6.5.1** Records demonstrate that bulk discharges are conducted under the MODU PTW system.
	C 7.1 Displacement, brine, workover or intervention fluids contaminated with hydrocarbons will be treated prior to discharge or contained. If discharge specification not met, the fluid will be returned to shore.	**PS 7.1** Achieves oil concentration <1% by volume prior to discharge.	**MC 7.1.1** Records demonstrate that discharge criteria was met prior to discharge or contained.

[23] Defined as ' Slight and short term impact on species or habitat but not affecting ecosystem function' as in **Figure 2-6**/**Section 2.6.3**.

6.6.8 Routine and Non-routine Discharges to the Marine Environment: Flowline and Subsea Installation Fluids

Context		
Project fluids – **Section 3.11**	Physical environment – **Section 4.4** Biological environment – **Section 4.5**	Stakeholder consultation – **Section 5**

Impacts and Risks Evaluation Summary

Source of Impact	*Environmental Value Potentially Impacted*							*Evaluation*						
	Soil and Groundwater	*Marine Sediment*	*Water Quality*	*Air Quality (incl Odour)*	*Ecosystems/Habitat*	*Species*	*Socio-Economic*	*Decision Type*	*Consequence*	*Likelihood*	*Current Risk Rating*	*ALARP Tools*	*Acceptability*	*Outcome*
Discharge of flowline and subsea installation fluids to the marine environment		X	X		X			A	E	-	-	GP PJ	Broadly Acceptable	EPO 8

Description of Source of Impact

The following activities will result in the discharge of flowline and subsea installation preservation and pre-commissioning fluids:

- FCGT to clean and preserve the flowline
- hydrotesting to check system integrity
- dewatering
- small leaks from subsea infrastructure hydrotesting.

Flowline Fluids

Water used for the FCGT, hydrotesting and dewatering will be filtered sea water, which is chemically treated with sufficient chemical concentration to provide a minimum protection period of two years. The chemicals will be continuously injected into the flowline resulting in a concentration up to 650 ppm. Note: the amount of chemical (e.g. biocide, oxygen scavenger, etc.) to be injected is dependent on the temperature, pH and the length of time the water will be left in the pipeline (DNVGL-RP-F115), and will be subject to further refinement during detailed engineering.

Injection rates will be monitored and adjusted as necessary to compensate for varying fill rates. The discharges will all occur at the BRU-XOM FLET at about 145 m water depth. The total flowline volume estimated to be discharged for hydrotest is 3505 m³, with a contingency for over-pump of 20% (**Table 6-4**).

All subsea chemicals will have an environmental assessment completed prior to use to demonstrate that the potential impacts of the chemicals selected are acceptable and ALARP (subject to technical and economic constraints).

Table 6-4: Estimated discharges from FCGT and subsea pre-commissioning activities (including contingency)

Action Description	Line Discharge %	Line Volume Discharge (m³)	Water Treatement Chemicals (m³)	Flourescein volume (L)	MEG %	MEG Volume (m³)
FCGT and dewatering of the 22 km flowline	120	3505	2.5	1500	<1	15

During flowline installation, contingency dewatering may be required to remove untreated seawater from the flowline (e.g. a wet buckle event). This would require the flowline to be dewatered with a sufficient amount of treated seawater to ensure the chloride ion concentration in the flowline does not exceed 200 ppm. Seawater will be treated with the same chemicals, in the same concentrations, as for the routine (non-contingent) FCGT process. While the volume of treated seawater required to dewater the flowline could be up to 3505 m^3 for the full flowline length, the dewatering discharge volume would depend on the length of flowline installed prior to the contingency event occurring (e.g. if contingency dewatering occurs halfway through flowline installation, then the volume of treated seawater discharge would be about 1755 m^3).

Subsea Installation Fluids

Small leak tests result in discharges of MEG and hydrotest fluid in very small quantities. The total leak test discharge volume for the Petroleum Activities Program is expected to be about 5 m^3, discharged at the locality of the subsea infrastructure; e.g. each of the well centres.

Impact Assessment

Potential Impacts to Water Quality, Marine Sediment Quality, Other Habitats and Communities and Protected Species

Flowline Fluids

Woodside has previously performed modelling for a pipeline installation campaign to assess the near field dispersion of a dewatering discharge of treated seawater, at a similar location and depth.

The nearfield dispersion modelling indicated that under median current scenarios (50th percentile exceedance – median currents, average dilution and advection using 0.21 m/s), ~900 dilutions are achieved within ~50 m of the release site, while under worst-case mixing (95% exceedance case – slow currents, low dilution and slow advection using 0.04 m/s) ~280 dilutions are achieved within ~25 m of the release site. This indicates that based on an in-pipe chemical concentration of 650 ppm, the plume would dilute to below 1 ppm (based on LC_{50} over 96 hours) in proximity to the discharge location.

While the modelling for the planned dewatering discharges for this EP is not directly comparable with regards to volume (higher), flow rate and discharge velocity (slower), it provides a good indication that potential impacts to benthic communities, fish or pelagic invertebrates would be limited to within the low sensitivity Operational Area (1.5. km) around subsea installation. The higher discharge volume for this EP (3505 m^3) compared to the modelled volume (1449 m^3) is likely to lead to a similar spatial extent due to similar (albeit slower) discharge rates. The duration of exposure may be longer, however the LC_{50} is based on 96 hours, while the duration of dewatering discharge would be much shorter (expected to be about 12–24 hours). Therefore it is not expected that benthic communities, fish or pelagic invertebrates would be exposed to concentrations above the LC_{50} for greater than 96 hours. Furthermore it is expected that motile fish and other marine fauna will adapt their behaviour and move away from the discharge, if exposed. The worst case discharge is expected to result in a localised plume leading to localised and temporary reduction in water quality.

The habitats in the vicinity of the proposed release location are mostly composed of benthic communities typical of the North West Shelf and the seabed is relatively flat and featureless with limited, if any, hard substrate habitat expected in proximity to the release location (**Section 4.4**). It is therefore unlikely for sensitive species to be present. Impacts on benthic communities are predicted to be negligible due to the relatively low biological abundance and wide distribution of similar community types throughout the region. In the event of lethal/sub-lethal stress to infauna, the ecological consequences may include temporary and localised impact to infauna populations with a temporary decline in abundance in the immediate area of the hydrotest discharge; however, populations would recover rapidly through recolonisation by surrounding populations.

Potential impacts to marine fauna such as pelagic fish or invertebrate species and marine mammals are expected to be limited to temporary avoidance of the plume in a localised area. Plankton populations in the upper surface layers may be affected in the immediate discharge plume; however, given the fast population turnover of open water plankton populations, the potential ecological impacts are considered very minor. Therefore, localised, short term and negligible impacts are predicted.

Subsea Installation Fluids

Given the low volume of MEG and hydrotest fluids (5 m^3) discharged during testing, any impact on the marine environment is expected to be highly localised and negligible. Potential impacts to benthic habitats and pelagic fauna are discussed above.

Cumulative Impacts

Given that only localised, short term and negligible impacts are predicted to water quality and marine biota, cumulative impacts affecting marine biota from the discharge of dewatering and small volumes of subsea installation fluids are considered unlikely. If contingency dewatering of the flowline is required as a result of wet buckle, there may be multiple dewatering discharge events. However, due to the short duration of the discharge (maximum of 12–24 hours for the full flowline), full dispersion between discharge events is expected and potential impacts will remain localised, short-term and negligible with no cumulative impacts expected.

Summary of Potential Impacts to Environmental Values
Given the adopted controls, it is considered that the routine discharge of flowline fluids and subsea installation fluids described will not result in an impact greater than localised, slight and short term impacts to infauna and benthic communities, marine sediment, water quality and pelagic marine fauna (but not affecting ecosystems function) (i.e. Environment Impact – E).

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS)***[24]	***Benefit in Impact Reduction***	***Proportionality***	***Control Adopted***
Legislation, Codes and Standards				
No additional controls identified.				
Good Practice				
Drilling, completions, cementing, flowline pre-commissioning and subsea control fluids and additives will have an environmental assessment completed prior to use.	F: Yes. CS: Minimal cost. Standard practice.	Environmental assessment of chemicals will reduce the consequence of impacts resulting from discharges to the marine environment by ensuring chemicals have been assessed for environmental acceptability. Planned discharges are required for safely executing activities; therefore, no reduction in likelihood can occur.	Benefits outweigh cost/sacrifice.	C 6.1
Chemical dosage volume and concentration will be monitored during hydrotest.	F: Yes. CS: Minimal cost. Standard practice.	Monitoring volumes of dosage chemicals during hydrotest will reduce the likelihood of impacts.	Benefits outweigh cost/sacrifice.	C 8.1
ROV inspection during hydrotest test.	F: Yes. CS: Minimal cost. Standard practice.	A procedure for hydrotesting work that includes inspection (including by ROV) during testing to identify leakage and trigger activity to stop will reduce the likelihood of impacts.	Benefits outweigh cost/sacrifice.	C 8.2
Professional Judgement – Eliminate				
Reduce volume or not use preservation and pre-commissioning chemicals.	F: No. Preservation and pre-commissioning fluids are required to verify the structural integrity of the subsea infrastructure. The volumes selected are required to achieve verification. CS: Potential loss of production due to loss of integrity, possibly leading to	Not considered – control not feasible.	Disproportionate. The cost/sacrifice outweighs the benefit gained.	No

[24] Qualitative measure

	a larger environmental incident.			
Do not conduct FCGT activities.	F: No. FCGT activities are required to control the potential for corrosion of the flowlines and to determine if any unacceptable restrictions and/or obstructions exist in the line. CS: Potential loss of production due to loss of integrity, possibly leading to a larger environmental incident.	This would eliminate any potential impacts from the FCGT activities but increases the likelihood of loss of integrity during operation and potentially greater environmental impacts.	Disproportionate The cost/sacrifice outweighs the benefit gained.	No
Professional Judgement – Substitute				
No additional controls identified.				
Professional Judgement – Engineered Solution				
No additional controls identified.				
ALARP Statement On the basis of the environmental impact assessment outcomes and use of the relevant tools appropriate to the decision type (i.e. Decision Type A), Woodside considers the adopted controls appropriate to manage the impacts of flowline and subsea installation fluid discharges. As no reasonable additional/alternative controls were identified that would further reduce the impacts without grossly disproportionate sacrifice, the impacts and risks are considered ALARP.				

Demonstration of Acceptability
Acceptability Statement The impact assessment has determined that, given the adopted controls, flowline and subsea installation fluid discharges are unlikely to result in a potential impact greater than localised, slight and short term impacts to infauna and benthic communities, marine sediment, water quality and pelagic marine fauna (but not affecting ecosystems function). Further opportunities to reduce the impacts and risks have been investigated above. The adopted controls are considered good oil-field practice/industry best practice. The potential impacts and risks are considered broadly acceptable if the adopted controls are implemented. Therefore, Woodside considers the adopted controls appropriate to manage the impacts and risks of these discharges to a level that is broadly acceptable.

Environmental Performance Outcomes, Standards and Measurement Criteria			
Outcomes	***Controls***	***Standards***	***Measurement Criteria***
EPO 8 No impact to water quality or marine biota greater than a consequence level of E[25] from routine discharges of flowline and subsea installation fluids during the Petroleum Activities Program.	**C 6.1** Drilling, completions, cementing, flowline pre-commissioning and subsea control fluids and additives will have an environmental assessment completed prior to use.	**PS 6.1** Reduces to ALARP the impact potential of all chemicals intended or likely to be discharged into the marine environment	**MC 6.1.1** Records demonstrate chemical selection, assessment and approval process for selected chemicals is followed.
	C 8.1 Chemical dosage volume and concentration will be monitored during hydrotest.	**PS 8.1** Chemical dosage concentration to not exceed 650 ppm, and where possible reduced following detailed engineering.	**MC 8.1.1** Records demonstrate compliance with maximum dosage concentration.

[25] Defined as ‘ Slight and short term impact on species or habitat but not affecting ecosystem function’ as in Figure 2-6/Section 2.6.3.

Environmental Performance Outcomes, Standards and Measurement Criteria			
Outcomes	***Controls***	***Standards***	***Measurement Criteria***
	C 8.2 ROV inspection during hydrotest test.	**PS 8.2** ROV inspection during hydrotest to identify leakage and trigger activity to stop.	**MC 8.2.1** Records demonstrate ROV inspection during hydrotest and record any instances of activity required to stop due to identified leak(s).

6.6.9 Routine Atmospheric Emissions: Fuel Combustion, Flaring, Incineration and Venting

Context	
Project vessels – **Section 3.5** Well unloading – **Section 3.9.9**	Physical environment – **Section 4.4**

Impacts and Risks Evaluation Summary

Source of Impact	***Environmental Value Potentially Impacted***							***Evaluation***						
	Soil and Groundwater	***Marine Sediment***	***Water Quality***	***Air Quality (incl Odour)***	***Ecosystems/Habitat***	***Species***	***Socio-Economic***	***Decision Type***	***Consequence***	***Likelihood***	***Current Risk Rating***	***ALARP Tools***	***Acceptability***	***Outcome***
Internal combustion engines and incinerators on MODU and project vessels				X				A	F	-	-	LCS GP PJ	Broadly Acceptable	EPO 9
Flaring during well unloading				X				A	F	-	-			EPO 10
Contingent venting of gas during drilling (i.e. well kick)				X				A	F	-	-			EPO 11

Description of Source of Impact

Atmospheric emissions will be generated by the project vessels from internal combustion engines (including all equipment and generators) and incineration activities (including on-board incinerators) during the Petroleum Activities Program. Emissions will include SO_2, NO_x, ozone-depleting substances, CO_2, particulates and volatile organic compounds (VOCs).

During well unloading for the development wells (four in total), hydrocarbons will flow from the well to the MODU, where they will be flared via the temporary production system. The volumes of hydrocarbons that will be flared are subject to operational requirements. However, to inform the impact assessment, Woodside has estimated that well unloading for the development wells (four in total) may require intermittent flaring for up to 20 days, with up to 900 million standard cubic feet of hydrocarbons flared per well. These estimates are based on Woodside's operational experience and are considered appropriate for the Petroleum Activities Program.

During drilling of each well, a 'kick' may occur in the reservoir. A kick is an undesirable influx of formation fluid into the wellbore. The resultant effect would be a release of a small volume of greenhouse gases via the degasser to the atmosphere during well control operations, known as 'venting'. Venting is required to ensure well integrity is maintained in the event of a kick, thereby avoiding an emergency condition.

Impact Assessment
Potential Impacts to Air Quality
Fuel combustion, flaring and incineration have the potential to result in a localised, temporary reduction in air quality. Potential impacts include a localised reduction in air quality, generation of dark smoke and contribution to greenhouse gas emissions. Given the short duration and exposed location of the MODU and project vessels, which will lead to the rapid dispersion of the low volumes of atmospheric emissions, the potential impacts are expected to have no lasting effect, with no cumulative impacts when considered in the context of existing or future oil and gas operations in the region. Venting may result in a localised and temporary reduction in air quality as the gas vents to the atmosphere, and a localised and temporary contribution to greenhouse gas emissions. There is potential for human health effects for workers in the immediate vicinity of atmospheric emissions. However, the closest sensitive populated receptor is on Barrow Island, about 70 km south-east of the Operational Area; therefore, any risks associated with off-site human health effects are negligible beyond the immediate zone of release and dispersion. Given the short duration and isolated location of the Petroleum Activities Program (which will lead to the rapid dispersion of the low volumes of atmospheric emissions), the potential impacts are expected to be minor.
Summary of Potential Impacts to Environmental Values
Given the adopted controls, it is considered that fuel combustion, flaring, incineration and venting emissions will not result in a potential impact greater than a temporary decrease in local air quality and/or water quality standards, with no lasting effect and no significant impact to environmental receptors (i.e. Environment Impact – F).

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/ Sacrifice (CS)[26]***	***Benefit in Impact Reduction***	***Proportionality***	***Control Adopted***
Legislation, Codes and Standards				
Marine Order 97 (marine pollution prevention – air pollution).	F: Yes. CS: Minimal cost. Standard practice.	Legislative requirements to be followed may slightly reduce the likelihood of air pollution.	Control based on legislative requirements – must be adopted.	Yes C 9.1
Offshore Petroleum and Greenhouse Gas Storage (Resource Management and Administration) Regulations 2011: Accepted WOMP and application to drill.	F: Yes. CS: Minimal cost. Standard practice.	The accepted WOMP will manage the risk of well kicks, reducing the likelihood of occurrence. No reduction in consequence will occur.	Benefits outweigh cost/sacrifice.	Yes C 11.1
As-built checks shall be completed during well operations.	F: Yes. CS: Minimal cost. Standard practice.	Reduces the likelihood of occurrence. No reduction in consequence will occur.	Benefits outweigh cost/sacrifice.	Yes C 11.2
Good Practice				
Burning and flaring during well unloading activities will be conducted using Woodside and Vendor approved TPS (Well Test) Package.	F: Yes. CS: Minimal cost. Standard practice.	Reduces the likelihood of atmospheric emissions impacting air quality. Consequence remains unchanged.	Benefits outweigh cost/sacrifice.	Yes C 10.1.1

[26] Qualitative measure

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/ Sacrifice (CS)[26]***	***Benefit in Impact Reduction***	***Proportionality***	***Control Adopted***
Oil burner will have an independent certified emissions testing certificate.	F: Yes. CS: Minimal cost. Standard practice.	This control results in a reduction on likelihood of atmospheric emissions impacting air quality, consequence remains unchanged.	Benefits outweigh cost/sacrifice.	Yes C 10.1.2
Subsea BOP installed and function tested during drilling operations.	F: Yes. CS: Standard practice. Required by Woodside standards.	BOP testing reduces the volume of gas vented in the event of a well kick.	Benefits outweigh cost/sacrifice.	Yes C 11.3
Process conducted to calculate, update and monitor kick tolerance for use in well design and while drilling.	F: Yes. CS: Minimal cost. Standard practice for Woodside activities.	Processes will reduce the volume of gas vented in the event of a well kick.	Benefits outweigh cost/sacrifice.	Yes C 11.4
Well control bridging document for alignment of Woodside and the MODU Contractor in order to manage the equipment and procedures for preventing and handling a well kick.	F: Yes. CS: Minimal cost. Standard practice for Woodside activities.	Implementing equipment and procedures in the well control bridging document will reduce the volume of gas vented in the event of a well kick.	Benefits outweigh cost/sacrifice.	Yes C 11.5
Professional Judgement – Eliminate				
Do not combust fuel.	F: No. There are no MODUs or vessels that do not use internal combustion engines. CS: Not considered – control not feasible.	Not considered – control not feasible.	Not considered – control not feasible.	No
Do not vent during well kick.	F: No. Venting is a critical safety activity required in the event of a kick to reduce pressure build-up. CS: Not considered – control not feasible.	Not considered – control not feasible.	Not considered – control not feasible.	No
Professional Judgement – Substitute				
No additional controls identified.				
Professional Judgement – Engineered Solution				
No additional controls identified.				
ALARP Statement On the basis of the environmental impact assessment outcomes and use of the relevant tools appropriate to the decision type (i.e. Decision Type A), Woodside considers the adopted controls appropriate to manage the impacts of fuel combustion, flaring and incineration. As no reasonable additional/alternative controls were identified that would further reduce the impacts without grossly disproportionate sacrifice, the impacts and risks are considered ALARP.				

Demonstration of Acceptability
Acceptability Statement The impact assessment has determined that, given the adopted controls, fuel combustion, flaring, incineration and venting are unlikely to result in a potential impact greater than a temporary decrease in local air quality and/or water quality standards, with no lasting effect. Further opportunities to reduce the impacts and risks have been investigated above. The controls adopted meet the legislative requirements within Marine Order 97. The potential impacts and risks are considered broadly acceptable if the adopted controls are implemented. Therefore, Woodside considers the adopted controls appropriate to manage the impacts and risks of the described emissions to a level that is broadly acceptable.

Environmental Performance Outcomes, Standards and Measurement Criteria			
Outcomes	***Controls***	***Standards***	***Measurement Criteria***
EPO 9 Fuel combustion emissions during the Petroleum Activities Program are restricted to those necessary to perform the activity.	**C 9.1** Marine Order 97 (marine pollution prevention – air pollution) which details requirements for: • International Air Pollution Prevention Certificate, required by vessel class • use of low sulphur fuel when available • Ship Energy Efficiency Management Plan, where required by vessel class • onboard incinerator to comply with Marine Order 97.	**PS 9.1** MODU and project vessels compliant with Marine Order 97 (marine pollution prevention – air pollution) to restrict emissions to those necessary to perform the activity. Vessel marine assurance process conducted prior to contracting vessels, to ensure suitability and compliance with vessel combustion certification/ Marine Order requirements.	**MC 9.1.1** Marine Assurance inspection records demonstrate compliance with Marine Order 97.
EPO 10 Maximise efficiency of combustion during flaring and oil-burning.	**C 10.1.1** Burning and flaring during well unloading activities will be conducted using Woodside and Vendor approved TPS (Well Test) Package.	**PS 10.1** Maintain gas flare and oil burner to maximise efficiency of combustion and minimise venting.	**MC 10.1.1** Records demonstrate that a Woodside approved Well Test Package is in use during well unloading/testing.
	C10.1.2 Oil burner will have an independently certified emissions testing certificate.		**MC 10.2.1** Records demonstrate that oil burner is certified and emissions tested.
EPO 11 Emissions to air as a result of venting from well kick are restricted to those necessary to maintain well integrity.	**C 11.1** Offshore Petroleum and Greenhouse Gas Storage (Resource Management and Administration) Regulations 2011: accepted WOMP, which describes the well design and barriers to be used to prevent a loss of well integrity, specifically: • All permeable zones penetrated by the well bore, containing hydrocarbons or over-pressured water, shall be isolated from the surface environment by a minimum of two barriers (primary and secondary) (a single fluid barrier may be implemented during the initial stages of well construction if	**PS 11.1** Wells drilled in compliance with the accepted WOMP, including implementation of barriers to prevent a loss of well integrity.	**MC 11.1.1** Acceptance letter from NOPSEMA demonstrates the WOMP and application to drill were accepted by NOPSEMA prior to the drilling activity commencing.
			MC 11.1.2 Records demonstrate minimum of two verified barriers (a single fluid barrier may be implemented during the initial stages of well construction if appropriateness is confirmed by a shallow hazard study) were in place for all permeable

Environmental Performance Outcomes, Standards and Measurement Criteria			
Outcomes	***Controls***	***Standards***	***Measurement Criteria***
	appropriateness is confirmed by a shallow hazard study). • Discrete hydrocarbon zones shall be isolated from each other (to prevent cross flow) by a minimum of one barrier where deemed required. • All normally pressured permeable water-bearing formations shall be isolated from the surface by a minimum of one barrier. The barriers shall: • be effective over the lifetime of well construction • (fluid barriers) remain monitored and provide sufficient pressure to counter pore pressure during well construction • (cementing barriers including conductor, casing and liners) conform to the relevant minimum standards set out in the Woodside Engineering Standard – Well Cementation. Verification: • Effectiveness of primary and secondary barriers shall be verified (physical evidence of the correct placement and performance) during the drilling of the well.		zones penetrated by the wellbore.
			MC 11.1.3 Records demonstrate composition and weight of drilling fluids were applicable to down hole conditions.
	C 11.2 As-built checks shall be completed during well operations.	**PS 11.2** Achieve a minimum acceptable standard of well integrity.	**MC 11.2.1** Records of as-built checks.
			MC 11.2.2 Records demonstrate Well Acceptance Criteria have been met.
	C 11.3 Subsea BOP installed and function tested during drilling operations. The BOP shall include: • one annular preventer • two pipe rams (excluding the test rams) • a minimum of two sets of shear rams, one of which must be capable of sealing • deadman functionality • the capability of ROV intervention • independent power systems.	**PS 11.3** Subsea BOP specification, installation and function testing compliant with internal Woodside Standards and international requirements (API Standard 53 4th Edition) as agreed by Woodside and MODU Contractor.	**MC 11.3.1** Records demonstrate that BOP and BOP control system specifications and function testing were in accordance with minimum standards for the expected drilling conditions as agreed by Woodside and the MODU Contractor.

Environmental Performance Outcomes, Standards and Measurement Criteria			
Outcomes	***Controls***	***Standards***	***Measurement Criteria***
	C 11.4 Process conducted to calculate, update and monitor kick tolerance for use in well design and while drilling, including: • The BOP shall be closed upon detecting a positive well influx. • The shut-in procedure shall be according to the rig contractor procedures or as the well conditions dictate. • Kick tolerance calculations will be made for drilling all hole sections based on the weakest known point in the well. Kick detection techniques will be adjusted based on the level of kick tolerance through management of change (MOC). • The manual also includes requirements for kick tolerance management in the event of down-hole losses.	**PS 11.4** Kick tolerance is calculated, managed, monitored and updated while drilling.	**MC 11.4.1** Records demonstrate well kick tolerance is calculated, managed, monitored and updated while drilling.
			MC 11.4.2 Records demonstrate shut-in procedures. followed in the event of a potential well kick.
	C 11.5 Well control bridging document for alignment of Woodside and the MODU Contractor in order to manage the equipment and procedures for preventing and handling a well kick.	**PS 11.5** Well is drilled in accordance with an agreed well control bridging document.	**MC 11.5.1** Records demonstrate well drilled in accordance with well control bridging document.

6.6.10 Routine Light Emissions: External Lighting on MODU and Project Vessels

Context														
Project vessels – **Section 3.5**							Physical environment – **Section 4.4**							
Impacts and Risks Evaluation Summary														
Source of Impact	***Environmental Value Potentially Impacted***							***Evaluation***						
	Soil and Groundwater	***Marine Sediment***	***Water Quality***	***Air Quality (incl Odour)***	***Ecosystems/Habitat***	***Species***	***Socio-Economic***	***Decision Type***	***Consequence***	***Likelihood***	***Current Risk Rating***	***ALARP Tools***	***Acceptability***	***Outcome***[27]
External light emissions on-board MODU and project vessels						X		A	F	-	**-**	PJ	Broadly Acceptable	N/A

Description of Source of Impact
The MODU and project vessels will have external lighting to facilitate navigation and safe operations at night throughout the Petroleum Activities Program. External light emissions from the MODU and project vessels are typically managed to maintain good night vision for crew members. Lighting on the MODU is used to allow safe operations during night hours, as well as to communicate the MODU's presence and activities to other marine users (i.e. navigation lights). Lighting is required for safely operating the MODU and cannot reasonably be eliminated. Note that flaring, which is a relatively bright light source, will occur during well unloading. External lighting is located over the entire MODU, with most external lighting directed towards working areas such as the main deck, pipe rack and drill floor. These areas are typically lower than 20 m above sea level when the MODU is on station. The highest point on the MODU is the top of the derrick, which is typically about 50 m above sea level. The distance to the horizon at which components of the MODU will be directly visible can be estimated using the formula of: $$horizon\ distance = 3.57 \times \sqrt{height}$$ Where 'horizon distance' is the distance to the horizon at sea level in kilometres and 'height' is the height above sea level of the light source in metres. Using this formula, the approximate distances at which various MODU components (and associated light sources) will be visible at sea level are: • main deck (~20 m above sea level): about 16 km from MODU • Derrick top (~50 m above sea level): about 25 km from MODU.
Impact Assessment
Potential Impacts to Protected Species
Light emissions can affect fauna in two main ways: • *Behaviour*: Many organisms are adapted to natural levels of lighting and the natural changes associated with the day and night cycle as well as the night time phase of the moon. Artificial lighting has the potential to create a constant level of light at night that can override these natural levels and cycles. • *Orientation*: Organisms such as marine turtles and birds may also use lighting from natural sources to orient themselves in a certain direction at night. In instances where an artificial light source is brighter than a natural source, the artificial light may act to override natural cues, leading to disorientation.

[27] There are no specific controls and EPOs identified for external lighting on MODU and project vessles. However, minimum lighting aboard the MODU and project vessels will be maintained to facilitate safe operations and navigation.

Fauna within the Operational Area are predominantly pelagic fish and zooplankton, with a low abundance of transient species such as marine turtles, whale sharks, whales and migratory sea birds transiting through the Operational Area. There is no known critical habitat within the Operational Area for EPBC listed species, although there is overlap with BIAs for flatback turtle internesting, whale shark foraging, pygmy blue whale migration and wedge-tailed shearwater breeding. Pygmy blue whales and whale sharks are not expected to be impacted by above-surface light emissions beyond opportunistic feeding that may occur as a result of prey aggregations around the light source. Given the fauna expected to occur within the Operational Area, impacts from light emissions are considered to be highly unlikely.

Marine Turtles – Adults

Artificial lighting may affect the location that turtles emerge to the beach, the success of nest construction, whether nesting is abandoned, and even the seaward return of adults (Salmon et al., 1995a, 1995b; Salmon and Witherington, 1995). However, such lighting is typically from residential and industrial development overlapping the coastline, rather than offshore from nesting beaches. While the Operational Area overlaps with the north-west extent of a BIA for flatback turtle internesting (described in **Section 4.5.2**), the nearest landfall for this BIA occurs at North West Island of the Montebello Islands, about 50 km south-east of the Operational Area. Impacts to nesting turtles are therefore not expected. Given the water depth of the Operational Area (at least ~130 m), turtles are unlikely to be foraging. However, it is acknowledged that marine turtles may be present transiting the Operational Area in low densities.

Migratory Birds

The Operational Area may be occasionally visited by migratory and oceanic birds but does not contain any emergent land that could be used as roosting or nesting habitat and contains no known critical habitats (including feeding for any species. A BIA for wedge-tailed shearwater breeding overlaps with the Operational Area, with the breeding period occurring from August to April (**Section 4.5.2**). Seabird surveys over the North West Shelf Province have noted that seabird distributions in tropical waters were generally patchy, except near islands (Dunlop et al., 1988). Given the Operational Area lies offshore with the closest island 47 km away, seabirds are likely to only transit over the Operational Area when travelling between emergent land and important habitats. Migratory shorebirds may be present in or fly through the region between July and December and again between March and April as they complete migrations between Australia and offshore locations (DSEWPaC, 2012d). The risk associated with collision from seabirds attracted to the light is considered to be low, given the low numbers expected to transit the area and that there is no critical habitat for these species within the Operational Area, as well as the slow moving speeds associated with the MODU and project vessels.

Fish

Lighting from the presence of a vessel may result in the localised aggregation of fish below the vessel. These aggregations of fish are considered localised and temporary and any long term changes to fish species composition or abundance is considered highly unlikely. This localised increase in fish extends to those comprising the whale shark's diet. However, given that a large proportion of the diet comprises krill and other planktonic larvae, it is unlikely that a light source will lead to a significant increase in whale shark abundance in the vicinity of the MODU and project vessels.

Summary of Potential Impacts to Environmental Values

Light emissions from the MODU and project vessels will not result in an impact greater than localised and temporary disturbance to fauna in the vicinity of the Operational Area, with no lasting effect (i.e. Environment Impact – F).

Demonstration of ALARP

Control Considered	*Control Feasibility (F) and Cost/Sacrifice (CS)*[28]	*Benefit in Impact Reduction*	*Proportionality*	*Control Adopted*
Legislation, Codes and Standards				
No additional controls identified.				
Good Practice				
No additional controls identified.				
Professional Judgement – Eliminate				
Substitute external lighting with 'turtle friendly' light sources (reduced emissions in turtle visible spectrum).	F: Yes. Replacing external lighting with turtle friendly lighting is technically feasible, although is not considered to be practicable. CS: Significant cost sacrifice. The retrofitting of all external lighting on the MODU, etc.,	Given the potential impacts to turtles during this activity is insignificant, implementing this control would not result in a reduction in consequence.	Grossly disproportionate. Implementation of the control requires considerable cost sacrifice for minimal environmental benefit.	No

[28] Qualitative measure

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS)***[28]	***Benefit in Impact Reduction***	***Proportionality***	***Control Adopted***
	would result in considerable cost and time expenditure. Considerable logistical effort to source sufficient inventory of the range of light types onboard the MODU.		The cost/sacrifice outweighs the benefit gained.	
Vary the timing of the Petroleum Activities Program to avoid peak turtle internesting periods (December to January).	F: No. The Operational Area has a minor overlap with the flatback turtle internesting BIA in an area not known to provide foraging habitat. Given the low potential for internesting turtles to be present within the Operational Area, the risk of potential impacts from vessel light emissions on adult turtles is considered to be low. CS: Significant cost and schedule impacts due to delays in securing vessels/MODU for specific timeframes.	Not considered – control not feasible.	Not considered, control not feasible.	No
Professional Judgement – Engineered Solution				
No additional controls identified.				
ALARP Statement On the basis of the environmental impact assessment outcomes and use of the relevant tools appropriate to the decision type (i.e. Decision Type A), Woodside considers the potential impacts from routine light emissions from the MODU and project vessels to be ALARP in its current risk state. As no reasonable additional/alternative controls were identified that would further reduce the impacts without grossly disproportionate sacrifice, the impacts and risks are considered ALARP.				

Demonstration of Acceptability
Acceptability Statement The impact assessment has determined that, in its current state, routine light emissions from the MODU and project vessels are unlikely to result in a potential impact greater than localised behavioural disturbance to fauna within the Operational Area, with no lasting effect. Further opportunities to reduce the impacts and risks have been investigated above. The potential impacts and risks are consistent with good oil-field practice/industry best practice and are considered to be broadly acceptable in its current state. Therefore, Woodside considers standard operations appropriate to manage the impacts and risks of routine light emissions to a level that is broadly acceptable.

6.7 Unplanned Activities (Accidents, Incidents, Emergency Situations)

6.7.1 Quantitative Spill Risk Assessment Methodology

Quantitative hydrocarbon spill modelling was performed by RPS, on behalf of Woodside, using a three-dimensional hydrocarbon spill trajectory and weathering model, SIMAP (Spill Impact Mapping and Analysis Program). The model is designed to simulate the transport, spreading and weathering of specific hydrocarbon types under different environmental conditions (both meteorological and oceanographic). Near-field subsurface discharge modelling was performed using OILMAP, 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. The OILMAP output parameters were used as input into SIMAP.

The algorithms in the SIMAP model are based on the best available scientific knowledge, and are updated when necessary in response to significant advances in knowledge. Recent improvements have been implemented to the entrainment algorithm, which have been adjusted to implement the findings of published data based on field research performed during the Macondo spill event in the Gulf of Mexico (Spaulding et al., 2017; Li et al., 2017; French-McCay et al., 2018).

Stochastic modelling was conducted for this study, which compiled data from 300 hypothetical spills under different environmental conditions to determine the widest extent of possible oil dispersion. The environmental conditions for each of the hypothetical spills were selected randomly from an historic time-series of wind and current data representative of the study area. Results of the replicate simulations were then statistically analysed and mapped to define contours of percentage probability of contact at identified thresholds around the hydrocarbon release point. The simulations that show something unusual or unexpected make an important contribution to the overall outcomes and fate of the hydrocarbon.

The model simulates surface releases and uses the unique physical and chemical properties of a representative hydrocarbon type to calculate rates of evaporation and viscosity change, including the tendency to form oil-in-water emulsions. Moreover, the unique transport and dispersion of surface slicks and in-water components (entrained and dissolved) are modelled separately. Thus, the model can be used to understand the wider potential consequences of a spill, including direct contact of hydrocarbons due to surface slicks (floating hydrocarbon) and exposure of organisms to entrained and dissolved aromatic hydrocarbons in the water column. The model also calculates the accumulation of hydrocarbon mass that arrives on each section of shoreline over time, taking into account any mass that is lost to evaporation and/or subsequent removal by current and wind forces.

All hydrocarbons spill modelling assessments performed by RPS undergo initial sensitivity modelling to determine appropriate time to add to the simulation after the cessation of the spill. The amount of time following the spill is based on the time required for the modelled concentrations to practically drop below threshold concentrations anywhere in the model domain in the test cases.

In addition to the stochastic modelling, single-trajectory modelling (deterministic) was conducted to assess potential worst-case trajectories based on the stochastic modelling runs. The deterministic simulations are therefore representative of single spill events under certain wind and current conditions. The deterministic simulations were performed to represent the fastest time to shoreline contact and the largest volume ashore from a single model run.

6.7.1.1 Environment that May Be Affected and Hydrocarbon Contact Thresholds

The outputs of the quantitative hydrocarbon spill modelling are used to assess the environmental risk, if a credible hydrocarbon spill scenario occurred, by delineating which areas of the marine environment could be exposed to hydrocarbon levels exceeding hydrocarbon threshold concentrations. The summary of all the locations where hydrocarbon thresholds could be exceeded by any of the simulations modelled is defined as the ‘environment that may be affected’. The EMBA covers a larger area than the area that is likely to be affected during any single spill event, as the model was run for a variety of weather and metocean conditions (300 simulations in total), and the EMBA represents the total extent of all the locations where hydrocarbon thresholds could be exceeded from all modelling runs. Furthermore, as the weathering of different fates of hydrocarbons (surface, entrained and dissolved) differs due to the influence of the metocean mechanism of transportation, a different EMBA is presented for each fate.

The spill modelling outputs are presented as threshold concentrations for surface, entrained and dissolved hydrocarbons for the modelled scenarios. Surface spill concentrations are expressed as grams per square metre (g/m²), with entrained and dissolved aromatic hydrocarbon concentrations expressed as parts per billion (ppb). A conservative approach adopting accepted contact thresholds that are documented to impact the marine environment are used to define the EMBA. These hydrocarbon thresholds are presented in Table 6-5 and described in the following subsections.

Table 6-5: Summary of environmental impact thresholds applied to the quantitative hydrocarbon spill risk modelling results

Surface Hydrocarbon (g/m²)	Entrained hydrocarbon (ppb)	Dissolved aromatic hydrocarbon (ppb)	Accumulated hydrocarbon (g/m²)
10	500	500	100

6.7.1.2 Surface Hydrocarbon Threshold Concentrations

The spill modelling outputs defined the EMBA for surface hydrocarbons resulting from a spill (contact on surface waters) using a threshold of ≥10 g/m² (dull metallic colours based on the relationship between film thickness and appearance (Bonn Agreement, 2015)) (**Table 6-6**). This threshold concentration is geared towards informing potential oiling impacts for wildlife groups and habitats that may break through the surface slick from the water or the air (for example: emergent reefs, vegetation in the littoral zone and air-breathing marine reptiles, cetaceans, seabirds and migratory shorebirds).

Thresholds for registering biological impacts resulting from contact of surface slicks have been estimated by different researchers at about 10–25 g/m² (French et al., 1999; Koops et al., 2004; NOAA, 1996). Potential impacts of surface slick concentrations in this range for floating hydrocarbons may include harm to seabirds through ingestion from preening contaminated feathers, or the loss of the thermal protection of their feathers. The 10 g/m² threshold is the reported level of oiling to instigate impacts to seabirds and is also applied to other wildlife, though it is recognised that ‘unfurred’ animals, where hydrocarbon adherence is less, may be less vulnerable. ‘Oiling’ at this threshold is taken to be of a magnitude that can cause a response to the most vulnerable wildlife such as seabirds. Due to weathering processes, surface hydrocarbons will have a lower toxicity due to change in their composition over time. Potential impacts to shoreline sensitive receptors may be markedly reduced in instances where there is extended duration until contact.

Table 6-6: The Bonn Agreement oil appearance code

Appearance (following Bonn visibility descriptors)	Mass per area (g/m²)	Thickness (µm)	Volume per area (L/km²)
Discontinuous true oil colours	50 to 200	50 to 200	50,000 to 200,000
Dull metallic colours	5 to 50	5 to 50	5000 to 50,000
Rainbow sheen	0.30 to 5.00	0.30 to 5.00	300 to 5000
Silver sheen	0.04 to 0.30	0.04 to 0.30	40 to 300

6.7.1.3 Dissolved Aromatic Hydrocarbon Threshold Concentrations

The threshold concentration value for dissolved aromatic hydrocarbons has been set with reference to results from ecotoxicity tests on Balnaves-3 crude oil (a light crude). Although spill modelling for the credible ‘loss of well containment’ scenario associated with the Petroleum Activities Program is based on the characteristics of Julimar condensate, Balnaves-3 crude ecotoxicity is considered a suitable (albeit conservative) surrogate for Julimar condensate, given both hydrocarbons exhibit similar boiling point (BP) distributions and volatility. This suggests that the potential for toxicity of both hydrocarbons is comparable, although the Julimar condensate is characterised by lower aromatic content, indicating it may be less toxic. **Table 6-7** compares the characteristics of Julimar condensate and Balnaves-3 crude oil (a light crude).

Table 6-7: Comparison of Julimar condensate and Balnaves-3 crude characteristics

Hydrocarbon Type	Initial Density (g/cm³)	Viscosity (cP @ 20˚C)	Component BP (˚C)	Volatiles <180˚C	Semi volatiles 180–265 °C	Low Volatility (%) 265–380 °C	Residual (%) >380 °C	Aromatic (%) of whole oil <380 °C BP
				Non-Persistent			Persistent	
Julimar Condensate	0.7885 at 15 °C	1.248	% of total	48.8	21.3	29.5	0.4	11.5
Balnaves-3 Crude	0.780	1.399	% of total	46	20	23	11	14.2

The purpose of the threshold is to inform the assessment of the potential for toxicity impacts to sensitive marine biota. The ecotoxicity tests were performed on a broad range of taxa of ecological relevance for which accepted standard test protocols are well-established. These ecotoxicology tests are focused on the early life stages of test organisms, when organisms are typically at their most sensitive. The ecotoxicology tests were conducted on six mainly tropical-subtropical species representatives from six major taxonomic groups.

The laboratory-based ecotoxicology tests used a range of water accommodated fraction (WAF) concentrations to expose the different test organisms. For each ecotoxicity test, samples of the WAF were analysed to determine the TPH concentration of the solution. The ecotoxicology testing focused on the total petroleum hydrocarbons (TPH) concentration of the WAF of the hydrocarbon and includes the carbon chains C6 to C36. Typically, C4 to C10 compounds are volatile (BP <180°C), C11 to C15 compounds are semi-volatile (BP 180–265°C), C16 to C20 compounds have low volatility (265–380°C) and C21 compounds and above are residual (BP >380°C) (Ecotox Services Australia, 2013).

Table 6-8 presents the results of no observed effect aromatic concentrations (NOECs) for the crude oil WAFs tested. With the exception of the NOEC value for the amphipod acute toxicity tests, all other toxicity tests indicated NOECs ranged from 610 to 6640 ppb, with a median value of 2695 ppb.

Table 6-8: Summary of total recoverable hydrocarbons NOECs for key life-histories of different biota based on toxicity tests for WAF of Balnaves-3 crude condensate

Biota and Life Stage	Exposure duration	NOEC – TRH concentration of unweathered Balnaves Crude Oil showing no direct biological effect (ppb)
Sea urchin larval development	72 hours	4850
Milky oyster larval development	48 hours	4580
Microalgal growth test	72 hours	810
Copepod acute toxicity test	48 hours	670
Amphipod acute toxicity test	96 hours	123
Larval fish imbalance	96 hours	6640

Source: Ecotox Services Australia, 2013

Based on these ecotoxicology tests, the selected dissolved aromatic hydrocarbon threshold of 500 ppb has been adopted. This 500 ppb threshold is below the NOEC values for five out of the six sensitive organisms tested (**Table 6-8**). These six tests represent six different taxonomic groups which were tested for chronic (function of life) effects of immobilisation, early life stage development/growth and acute toxicity (i.e. mortality). One test with a NOEC below the set threshold was the amphipod acute toxicity test (*Melita plumulosa*). Although tests indicated acute and chronic effects at dissolved aromatic concentrations less than 500 ppb (NOEC: estimated at 126 ppb), toxicity test results on all other test organisms found no observed effects at concentrations well above 500 ppb.

It is considered reasonable that the 500 ppb threshold remains applicable and appropriate for delineating potential chronic and acute effects to ecosystems, with the assessment recognising the potential to impact reproductive success and early life stages of the most sensitive species at the adopted threshold value.

6.7.1.4 Entrained Hydrocarbon Threshold Concentrations

The spill modelling outputs are used to define the EMBA by defining the spatial variability of entrained hydrocarbons above a set concentration threshold contacting sensitive receptors (expressed in ppb).

Entrained hydrocarbons present a number of possible mechanisms for toxic exposure to marine organisms. The entrained hydrocarbon droplets may contain soluble compounds, hence have the potential for generating elevated concentrations of dissolved aromatic hydrocarbons (e.g. if mixed by breaking waves against a shoreline). Physical and chemical effects of the entrained hydrocarbon droplets have also been demonstrated through direct contact with organisms; for example, through physical coating of gills and body surfaces and accidental ingestion (National Research Council, 2005).

The threshold concentration of entrained hydrocarbons that could result in a biological impact cannot be determined directly using available ecotoxicity data for WAF of oil hydrocarbons (**Table 6-8**). However, it is likely this data specific to dissolved oil hydrocarbon represents a worst-case scenario. This is owing to the fact that entrained oil hydrocarbons are less biologically available to organisms through absorption into their tissues than dissolved hydrocarbons. It is therefore expected that the entrained threshold concentration of 500 ppb will represent a potential impact substantially lower than the NOEC concentrations presented in **Table 6-8**.

6.7.1.5 Accumulated Hydrocarbon Threshold Concentrations

Owens and Sergy (1994) define accumulated hydrocarbon <100 g/m² to have an appearance of a stain on shorelines. French-McCay (2009) defines accumulated hydrocarbons ≥100 g/m² to be the threshold that could impact the survival and reproductive capacity of benthic epifaunal invertebrates living in intertidal habitat.

6.7.2 Accidental Hydrocarbon Release: Loss of Well Integrity

Context		
Drilling activities – **Section 3.9**	Physical environment – **Section 4.4** Biological environment – **Section 4.5** Socio-economic environment – **Section 4.6** Values and sensitivities – **Section 4.7**	Stakeholder consultation – **Section 5**

Impacts and Risks Evaluation Summary

Source of Risk	***Environmental Value Potentially Impacted***							***Evaluation***						
	Soil and Groundwater	***Marine Sediment***	***Water Quality***	***Air Quality (incl Odour)***	***Ecosystems/Habitat***	***Species***	***Socio-Economic***	***Decision Type***	***Consequence***	***Likelihood***	***Current Risk Rating***	***ALARP Tools***	***Acceptability***	***Outcome***
Loss of hydrocarbons to marine environment due to loss of well integrity		X	X	X	X	X	X	C	B	2	**H**	LCS GP PJ RBA CV SV	Acceptable if ALARP	EPO 12

Description of Source of Risk

Loss of Well Integrity – Background

Woodside has identified a well blowout as the scenario with the worst case credible environmental outcome as a result of loss of well integrity. A blowout is an incident where formation fluid flows out of the well or between formation layers after all the predefined technical well barriers (e.g. the BOP) or activation of the same have failed.

Industry Experience

A risk assessment by AMSA of oil spills in Australian ports and waters (Det Norske Veritas, 2011) concluded that:

- overall national exceedance frequency for oil spills from offshore drilling in Australia is 0.033 for spills >1 tonne/year decreasing to 0.008 for spills >100 tonnes/year (Det Norske Veritas, 2011)
- the estimated blow-out probability adopted for drilling and completing a development well is 2.5×10^{-4} per well (Det Norske Veritas, 2011). This is based on data from the Gulf of Mexico, United Kingdom and Norway from 1980–2004, including wells that had BOPs installed.

Woodside has a good history of implementing industry standard practice in well design and construction. In the company's 60 year history, it has not experienced any well integrity events that have resulted in significant releases or significant environmental impacts.

Therefore, in accordance with the Woodside Risk Matrix, a loss of well integrity and resulting blowout event corresponds to an 'unlikely' event as it has occurred many times in the industry, but not in the Company.

Drilling Timeframe

Drilling is scheduled to occur throughout the year (all seasons), to provide operational flexibility for requirements and schedule changes and vessel/MODU availability.

Credible Scenario – Loss of Well Integrity

The Petroleum Activities Program consists of drilling four development wells. A loss of well integrity could result in a loss of containment at any of these wells. Woodside identified the worst case credible spill scenario for a well blowout to be an uncontrolled surface release for five days, when the MODU would provide a conduit to the surface for the uncontrolled flow, followed by a 72 day uncontrolled seabed release as the MODU would no longer be present to provide a conduit.

The MODU would no longer be present after five days for the following reasons:

- In a non-explosion scenario, the MODU is likely to be moved off location as soon as is practicable to prevent escalation and further harm to personnel.
- In an explosion scenario, the MODU is expected to sink due to an anticipated compromise in structural integrity and stability after a period of time. The most recent example of a similar scenario is the Deepwater Horizon (DWH) incident, when the semi-submersible MODU sank after 36 hours following the uncontrolled loss of well control in the Gulf of Mexico in April 2010.

Woodside has assessed the DWH (and as a result, five days) to be a suitable blowout scenario because:

- it is the most recent significant event of this nature in the industry
- the DWH is comparable in size, weight and capability to the MODUs that will conduct well construction operations for the Julimar Development Phase 2 drilling
- studies of the North Sea and US Gulf of Mexico Outer Continental Shelf (OCS) events support that the majority of blowout durations are less than five days (Holand, 1997).

The 77-day (11 weeks) release duration assumes the maximum depth of the hydrocarbon reservoir would be open and takes into account the estimated time to drill a relief well under the Mutual Aid Memorandum of Understanding (MoU) (discussed further in **Appendix D**).

For each EP well loss of integrity scenario, Woodside assesses whether the standard 77-day release usually modelled is most appropriate, based on the timeframes of:

- mobilisation of relief MODU: 21 days.
- relief well drill time: 42 days.
- intersect and kill: 14 days.

A number of Woodside procedures were followed to identify credible spill scenarios, including spill duration. The process followed is outlined in **Figure 6-1,** with a breakdown of timeframes and justification for the reduced relief well drill time provided in **Table 6-9**.

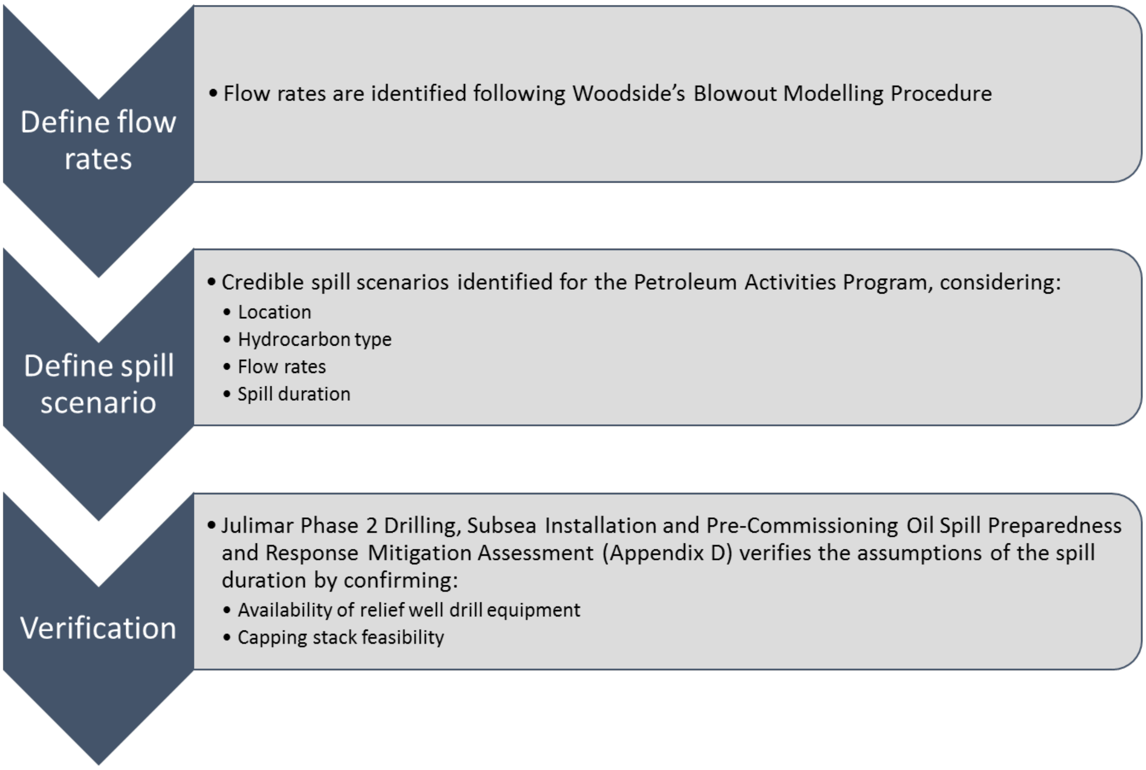

Figure 6-1: Credible oil spill scenario identification process

Table 6-9: Relief well drill times

Phase	Description	Time for completion (days)
Mobilisation	Sourcing a MODU through APPEA MoU and mobilisation	21
Drill relief well	Mooring and drill well to 9-5/8"/10-3/4' shoe	42
Intersect and kill	Relief well intersects uncontrolled well, kills well, ceasing release of hydrocarbons	14
	Total days	**77 days**

Blowout Volume

Woodside has determined that a blowout from the JULA-K location would represent the worst case in terms of volume released, with an estimated volume of about 270,000 m³. This volume is calculated based on an estimated release rate and time to drill a relief well, considering well characteristics including total vertical depth and time to mobilise a relief MODU.

Quantitative Spill Risk Assessment – Well Blowout

Spill modelling was performed by RPS, on behalf of Woodside, to determine the fate of hydrocarbon released for the 77 day blowout scenario at the JULA-K well location, based on the assumptions in **Table 6-10**. RPS performed the modelling based on a volume of ~270,000 m³.

Table 6-10: Summary of modelled credible scenario – well blowout

	Loss of well integrity
Total discharge[29] at surface	5 days 19,203 m³
Total discharge at seabed	72 days 250,496 m³
Water depth	174 m
Fluid	Julimar condensate

Hydrocarbon Characteristics

Julimar condensate was selected as the representative hydrocarbon for wells proposed under this EP (**Section 6.7.1**).

Julimar Condensate (API 47.9) contains a low proportion (0.4% by mass) of hydrocarbon compounds that will not evaporate at atmospheric temperatures. These compounds will persist in the marine environment. The mixture is composed of hydrocarbons that have a wide range of boiling points and volatilities at atmospheric temperatures, and which will begin to evaporate at different rates on exposure to the atmosphere. Evaporation rates will increase with temperature, but in general about 48.8% of the oil mass should evaporate within the first 12 hours (BP <180 °C); a further 21.3% should evaporate within the first 24 hours (180 °C < BP <265 °C); and a further 29.5% should evaporate over several days (265 °C < BP <380 °C). The whole oil has low asphaltene content (<0.5%), indicating a low propensity for the mixture to take up water to form water-in-oil emulsion over the weathering cycle.

Weathering processes under realistic variable wind conditions are illustrated in the example mass balance weathering graph for a discrete spill of 50 m³ of Julimar condensate released at the surface, which is considered informative for this scenario (**Figure 6-2**). The graph demonstrates that the majority of evaporation would take place within the first 24 hours, with about 64% of the released hydrocarbons expected to evaporate after seven days. Under these conditions, a large proportion of remaining hydrocarbons is expected to entrain, with less than 1% persisting on the sea surface after 24 hours. During calm conditions, 74% of hydrocarbons are predicted to evaporate within 24 hours and 92% evaporation after seven days, with negligible levels of entrainment.

[29] The discharge volumes in **Table 6-10** are predicted using reservoir modelling software packages that consider a number of factors (well design, reservoir properties and environmental conditions such as water depth, temperature and pressure) to provide a production profile over the oil spill modelling period.

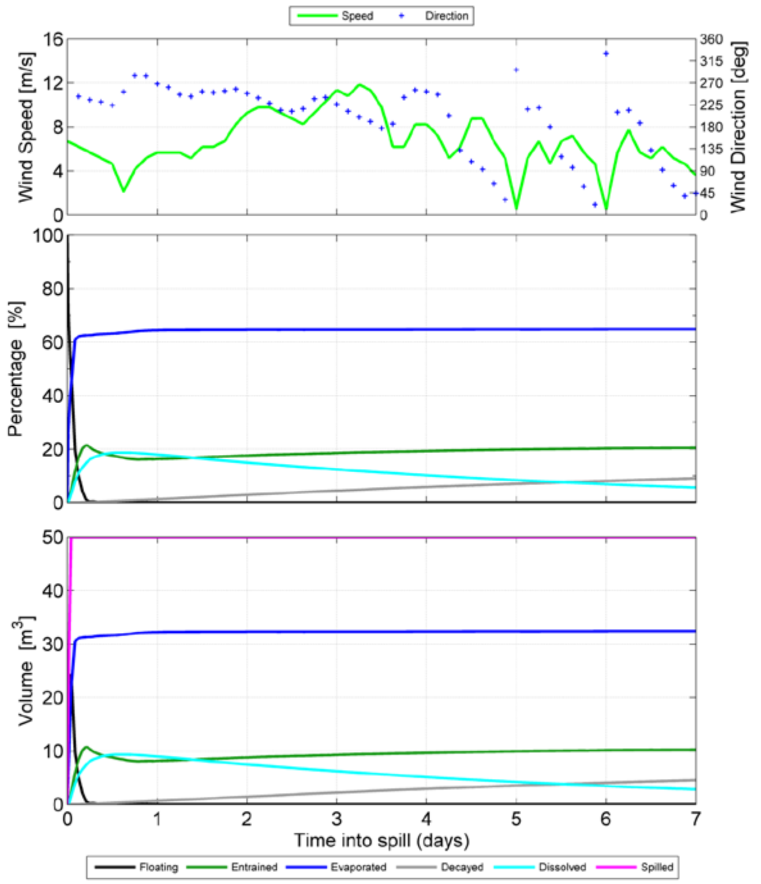

Figure 6-2: Proportional mass balance plot representing the weathering of 50 m³ from a surface spill of Julimar condensate spilled onto the water surface and subject to variable wind at 27 °C water temperature and 25 °C air temperature

Subsea Plume Dynamics

The well blowout surface/subsea release that has been modelled forecasts the size of the hydrocarbon droplets that would be released from the well as determined by the OILMAP model. **Table 6-11** summarises the results of the OILMAP modelling for the well blowout.

Table 6-11: Range of assumed inputs and range of calculated outputs, by OILMAP model for the surface/subsea well loss of containment

	Variable	Julimar condensate
Assumed discharge	Release depth (m) Hydrocarbon temp (C°) Gas:condensate ratio (scf/bbl) Hydrocarbon flow rate (bbl/day) Diameter of exit hole (m)	Surface (initial) 174 m (seabed release phase) 118°C ~ 47,600 20,318–23,983 0.314 m
Calculated gas plume dynamics	Plume diameter (m) Plume trapping height (m ASB)	10.6 m 174 m (surface)
Calculated droplet size distribution	20% droplets of size (µm) 20% droplets of size (µm) 20% droplets of size (µm) 20% droplets of size (µm) 20% droplets of size (µm)	3.9 µm 9.0 µm 11.8 µm 15.6 µm 22.3 µm

The results of the OILMAP simulation predict that the discharge will generate a cone of rising gas that will entrain the oil droplets and ambient sea water up to the water surface. The mixed plume is initially forecast to jet towards the water surface with a vertical velocity of around 14 m/s, gradually slowing and increasing in plume diameter as more ambient water is entrained. The diameter of the central cone of rising water and oil at the point of surfacing is predicted to be about 11 m.

The high discharge velocity and turbulence generated by the expanding gas plume is predicted to generate very small oil droplets (<25 µm). The results suggest that beyond the immediate vicinity of the blowout, the majority of the released hydrocarbons will be present in the upper layers of the ocean, with the potential for oil to form floating slicks under sufficiently calm local wind conditions.

The ongoing nature of the release combined with the potential for the plume to breach the water surface may present other hazards, including conditions that may lead to high local concentrations of atmospheric volatiles. These issues should be considered when evaluating the practicality of the response operations at or near the blowout site.

Impact Assessment

Potential Impacts Overview

Environment that May Be Affected

The overall EMBA for the Petroleum Activities Program is based on stochastic modelling which compiles data from 300 hypothetical worst-case spill simulations under a variety of weather and metocean conditions (as described in **Section 6.7.1**). The EMBA therefore covers a larger area than the area that would be affected during any single spill event, and therefore represents the total extent of all the locations where hydrocarbon thresholds could be exceeded from all modelling runs. The trajectory of a single spill would have a considerably smaller footprint.

As the weathering of different fates of hydrocarbons (surface, entrained and dissolved) differs due to the influence of the metocean mechanism of transportation, a different EMBA is discussed for each fate.

Surface Hydrocarbons: Quantitative hydrocarbon spill modelling result outputs for surface hydrocarbons are shown in **Table 6-14**. If this scenario occurred, a surface hydrocarbon slick would form down-current of the well site, with the trajectory dependent on prevailing wind and current conditions at the time. The slick is likely to drift in north-easterly and south-westerly directions. The modelling indicates the EMBA would be restricted to Commonwealth waters in the open ocean, and may extend for up to 120 km from the release site. The modelling did not predict contact by surface hydrocarbons above 10 g/m² for any sensitive shoreline receptor due to the rapid weathering (evaporation/entrainment) of the hydrocarbon, as shown in **Table 6-13**. Floating oil at the 10 g/m² threshold is predicted to arrive at the surface waters of the Montebello Marine Park receptor with a probability of 14.5% after 68 hours.

Entrained Hydrocarbons: Quantitative hydrocarbon spill modelling results for entrained hydrocarbons are shown in **Table 6-14**. If the loss of well integrity scenario occurred, entrained hydrocarbons are forecast to potentially drift in all directions, with the most likely directions of travel being to the north-east and south-west of the release site. The EMBA is predicted to extend up to a maximum of about 950 km from the release site (<1% probability). Contact by entrained oil at concentrations equal to or greater than 500 ppb is predicted at the Montebello Marine Park (80.5% probability), Gascoyne Marine Park (66% probability) and Rankin Bank (47.5% probability), as well as several other receptors with probabilities lower than 40% (refer to **Table 6-13**). The maximum entrained oil concentration forecast for any receptor is predicted as 82.8 ppm (82,816 ppb) at Montebello Marine Park.

The modelling indicated that the entrained hydrocarbon EMBA above the 500 ppb threshold concerntrations would be expected to contact the Montebello/Barrow/Lowendal Islands Group, Southern Pilbara Islands, Muiron Islands, Ningaloo Coast and Shark Bay (open ocean). There is also the potential to contact the Abrolhos Islands Marine Park and the Argo-Rowley Terrace Marine Park. **Table 6-13** indicates entrained threshold concentrations contact locations for receptors as identified by the modelling.

Dissolved Aromatic Hydrocarbons: Quantitative hydrocarbon spill modelling results for dissolved aromatic hydrocarbons are shown in (**Table 6-14**). If the loss of well integrity scenario occurred, dissolved hydrocarbons are forecast to potentially drift in all directions, with the most likely direction of travel being to the south-west of the release site. The modelling indicates the EMBA may extend for up to about 647 km. Contact by dissolved aromatic hydrocarbons at concentrations equal to or greater than 500 ppb is predicted at Montebello Marine Park (72.5% probability), Gascoyne Marine Park (39.5% probability) and Rankin Bank (32%), as well as several other receptors with probabilities of less than 20% (refer to **Table 6-13**). The maximum dissolved aromatic hydrocarbon concentration forecast for any receptor is predicted as 29.6 ppm (29,557 ppb) at Montebello Marine Park.

Accumulated Hydrocarbons: Quantitative hydrocarbon spill modelling results for local accumulated hydrocarbon concentrations indicates a very low maximum probability of shoreline accumulation occurring above threshold concentrations (100 g/m²) at any location (the maximum probability is 2%). The maximum accumulated volume is predicted to be 38 m³, on the Kimberley Coast, with a maximum local accumulated concentration of 267 g/m² (**Table 6-12**).

Table 6-12: Accumulated shoreline concentration

Receptor Location	Probability (%) of shoreline oil concentration ≥100 g/m²)	Maximum local accumulated concentration (g/m²) in the worst replicate spill	Maximum accumulated volume (m³) along this shoreline, in the worst replicate simulation
Kimberley Coast	2	267	38
Eighty Mile Beach	2	267	36
Eighty Mile Beach MP and Ramsar	2	206	5
Ningaloo Coast Middle	1	170	6
Ningaloo Coast Middle WHA	1	170	6
Montebello Islands	1	140	4
Montebello Marine Park (State)	1	140	4
Ningaloo Coast North	2	124	6
Ningaloo Coast North WHA	2	124	6
Barrow Island	1	109	4

Single-Trajectory (Deterministic) Modelling

In addition to the stochastic modelling, single-trajectory (deterministic) modelling was performed to assess potential worst-case trajectories based on the stochastic modelling runs. Deterministic simulations were performed to represent the fastest time to shoreline contact (**Figure 6-2**) and the largest volume ashore from a single model run (**Figure 6-3**). Full results of the deterministic modelling are presented in **Appendix D**.

Summary of Potential Impacts

Table 6-13 presents the full extent of the EMBA; i.e. the sensitive receptors and their locations that may be exposed to hydrocarbons (surface, entrained, dissolved and accumulated) at or above the set threshold concentrations in the unlikely event of a major hydrocarbon release from a loss of well integrity during the Petroleum Activities Program. Details of these receptors are outlined in **Section 4**. The potential biological and ecological impacts of an unplanned hydrocarbon release as a result of a loss of well integrity during the Petroleum Activities Program are presented in the following sections.

Table 6-13: Probability of hydrocarbon spill contact above impact thresholds within the EMBA with key receptor locations and sensitivities for a 77 day subsea blowout of Julimar condensate

Environmental setting	Location/name	Open water (pristine)	Marine sediment (pristine)	Coral reef	Seagrass beds/macroalgae	Mangroves	Spawning/nursery areas	Open water – productivity/ upwelling	Non-biogenic coral reefs	Offshore filter feeders and/or deepwater benthic communities	Nearshore filter feeders	Sandy shores	Estuaries/tributaries/creeks/ lagoons (including mudflats)	Rocky shores	Cetaceans – migratory whales	Cetaceans – dolphins and porpoises	Dugongs	Pinnipeds (sea lions and fur seals)	Marine turtles (including foraging and internesting areas and significant nesting beaches)	Seasnakes	Whale sharks	Sharks and rays	Sea birds and/or migratory shorebirds	Pelagic fish populations	Resident/demersal fish	Fisheries – commercial	Fisheries – traditional	Tourism and recreation	Protected areas/heritage – European and Indigenous/shipwrecks	Offshore oil & gas infrastructure (topside and subsea)	Surface hydrocarbon (≥10 g/m²)	Entrained hydrocarbon (≥500 ppb)	Dissolved aromatic hydrocarbon (≥500 ppb)	Accumulated hydrocarbons (>100 g/m²)
		Environmental, Social, Cultural, Heritage and Economic Aspects presented as per the Environmental Risk Definitions (Woodside's Risk Management Procedure (WM0000PG10055394))																													Probability of hydrocarbon contact (condensate) (%) Note: the probability is based on stochastic modelling of 300 hypothetical worst-case spills under a variety of weather and metocean conditions			
		Physical		Biological																						Socio-economic and Cultural								
		Water Quality	*Sediment Quality*	*Marine Primary Producers*			*Other Communities/Habitats*								*Protected Species*									*Other Species*										
***Offshore*[30]**	Agro-Rowley Terrace Marine Park	✓						✓							✓	✓			✓			✓	✓	✓		✓			✓			11.5	1	
	Montebello Marine Park	✓	✓	✓			✓	✓							✓	✓			✓	✓	✓	✓	✓	✓	✓	✓		✓	✓*		14.5	80.5	72.5	
	Carnarvon Canyon Marine Park	✓	✓					✓		✓														✓	✓	✓			✓			2		
	Ningaloo Marine Park	✓						✓		✓					✓	✓			✓		✓	✓	✓	✓	✓	✓		✓	✓			36	19	
	Gascoyne Marine Park	✓	✓												✓	✓			✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓		66	39.5	
	Abrolhos Marine Park	✓	✓	✓			✓	✓		✓						✓			✓	✓		✓	✓	✓	✓			✓	✓			1		
Submerged shoals	Rankin Bank	✓	✓	✓			✓	✓		✓						✓				✓		✓		✓	✓	✓		✓				32	47.5	
Islands	Montebello Islands (including State Marine Park)	✓	✓	✓	✓	✓	✓	✓				✓		✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓		✓	✓			16.5	9.5	1
	Barrow Island (including State Nature Reserves, State Marine Park and Marine Management Area)	✓	✓	✓	✓	✓	✓	✓				✓		✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓		15.5	5	1
	Lowendal Islands	✓	✓	✓	✓	✓	✓	✓				✓		✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓			✓	✓			6.5	1	

[30] Note: hydrocarbons cannot accumulate on open ocean, submerged receptors, or receptors not fully emergent

Environmental setting	Location/name	Environmental, Social, Cultural, Heritage and Economic Aspects presented as per the Environmental Risk Definitions (Woodside's Risk Management Procedure (WM0000PG10055394))																													Probability of hydrocarbon contact (condensate) (%) Note: the probability is based on stochastic modelling of 300 hypothetical worst-case spills under a variety of weather and metocean conditions			
		Physical		Biological																						Socio-economic and Cultural								
		Water Quality	*Sediment Quality*	*Marine Primary Producers*			*Other Communities/Habitats*									*Protected Species*									*Other Species*									
		Open water (pristine)	*Marine sediment (pristine)*	*Coral reef*	*Seagrass beds/macroalgae*	*Mangroves*	*Spawning/nursery areas*	*Open water – productivity/ upwelling*	*Non-biogenic coral reefs*	*Offshore filter feeders and/or deepwater benthic communities*	*Nearshore filter feeders*	*Sandy shores*	*Estuaries/tributaries/creeks/ lagoons (including mudflats)*	*Rocky shores*	*Cetaceans – migratory whales*	*Cetaceans – dolphins and porpoises*	*Dugongs*	*Pinnipeds (sea lions and fur seals)*	*Marine turtles (including foraging and internesting areas and significant nesting beaches)*	*Seasnakes*	*Whale sharks*	*Sharks and rays*	*Sea birds and/or migratory shorebirds*	*Pelagic fish populations*	*Resident/demersal fish*	*Fisheries – commercial*	*Fisheries – traditional*	*Tourism and recreation*	*Protected areas/heritage – European and Indigenous/shipwrecks*	*Offshore oil & gas infrastructure (topside and subsea)*	Surface hydrocarbon (≥10 g/m²)	Entrained hydrocarbon (≥500 ppb)	Dissolved aromatic hydrocarbon (≥500 ppb)	Accumulated hydrocarbons (>100 g/m²)
	Muiron Islands (WHA, State Marine Park)	✓	✓	✓	✓		✓	✓		✓		✓		✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓			✓	✓			23	7.5	
	Pilbara Islands – Southern Island Group (Serrurier, Thevenard and Bessieres Islands – State Nature Reserves)	✓	✓		✓		✓		✓			✓		✓		✓	✓		✓	✓		✓	✓	✓	✓	✓		✓	✓			17.5	6	
	Ningaloo Coast (North, Middle, South); WHA and State Marine Park)	✓	✓	✓	✓	✓	✓	✓		✓		✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓		✓	✓			36	19	2
Mainland (nearshore waters)	Shark Bay – Open Ocean Coast (WHA)	✓	✓	✓	✓		✓	✓			✓	✓		✓		✓	✓		✓	✓		✓	✓	✓	✓	✓		✓	✓			1		
	Kimberley Coast											✓	✓	✓					✓				✓					✓	✓					2
	Eighty Mile Beach (including Marine Park and Ramsar wetland) – shoreline only											✓	✓	✓					✓				✓					✓	✓					2

Summary of Potential Impacts to Environmental Values	
Summary of Potential Impacts to Protected Species	
Setting	***Receptor Group***
Offshore, Oceanic Reefs and Islands	**Cetaceans:** Marine mammals that have direct physical contact with surface, entrained or dissolved aromatic hydrocarbons may suffer surface fouling, ingestion of hydrocarbons (from prey, water and sediments), aspiration of oily water or droplets, and inhalation of toxic vapours (DWH Natural Resource Damage Assessment Trustees, 2016). This may result in the irritation of sensitive membranes such as the eyes, mouth, digestive and respiratory tracts and organs, impairment of the immune system, neurological damage (Helm et al., 2015), reproductive failure, adverse health effects (e.g. lung disease, poor body condition) and potentially mortality (DWH Natural Resource Damage Assessment Trustees, 2016). In a review of cetacean observations relating to a number of large scale hydrocarbon spills, Geraci (1988) found little evidence of mortality associated with hydrocarbon spills. However, it was concluded that exposure to oil from the DWH resulted in increased mortality to cetaceans in the Gulf of Mexico (DWH Natural Resource Damage Assessment Trustees, 2016). Geraci (1988) did identify behavioural disturbance (i.e. avoiding spilled hydrocarbons) in some instances for several species of cetacean, suggesting that cetaceans have the ability to detect and avoid surface slicks. However, observations during spills have recorded larger whales (both mysticetes and odontocetes) and smaller delphinids travelling through and feeding in oil slicks. During the DWH spill, cetaceans were routinely seen swimming in surface slicks offshore (and nearshore) (Aichinger Dias et al., 2017). A range of cetaceans were identified as potentially occurring within the Operational Area and wider EMBA (**Section 4.5.2**). In the event of a well blowout, surface, entrained and dissolved hydrocarbons exceeding threshold concentrations may drift across habitat for oceanic cetacean species and the migratory routes and BIAs of cetaceans considered to be MNES (**Section 4.5.2**), including humpback whales and pygmy blue whales (northbound and southbound migrations). Impacts to cetaceans will depend on the exposure pathway; with exposure to entrained oil and surface slicks not expected to result in significant impacts due to the relatively volatile, non-persistent nature of the hydrocarbons. Direct toxic effects from external exposure are not expected to occur, although mucous membranes and eyes may become irritated. Indirect toxic effects, such as hydrocarbon ingestion through accumulation in prey, may occur. This is not expected to occur in migrating baleen whales, such as pygmy blue and humpback whales, which are known to primarily feed in the Southern Ocean (although may opportunistically feed during migrations). Note that baleen whales feeding within entrained hydrocarbon plumes may ingest hydrocarbons, potentially resulting in toxic effects (particularly fresh hydrocarbons near the release location). Cetacean populations that are resident within the potential EMBA may be susceptible to impacts from spilled hydrocarbons if they interact with an area affected by a spill. Such species are more likely to occupy coastal waters (refer to the *Mainland and Islands* section below for more information). Impacts from physical contact with hydrocarbons are likely to be in the form of irritation and sub-lethal biological effects (e.g. skin irritation, reproductive failure) and in rare circumstances, death. Suitable habitat for oceanic toothed whales (e.g. sperm whales) and dolphins (e.g. spinner dolphin) is broadly distributed throughout the region and as such, impacts are unlikely to affect an entire population. Other species identified in **Section 4.5.2** may also have possible transient interactions with the EMBA (refer **Table 6-13** for the list of receptor locations important for cetaceans). Physical contact with hydrocarbons to these species may result in biological consequences (considered unlikely as the spilled hydrocarbon is expected to weather quickly); however, it is unlikely to affect an entire population and not predicted to impact on the overall population viability. Pygmy blue whales and humpback whales are known to migrate seasonally through the potential spill-affected area for surface, dissolved and entrained hydrocarbons (**Section 4.5.2**). A major spill in July to December would coincide with humpback whale migration through the waters off the Pilbara, North West Cape (Ningaloo) and Shark Bay (open ocean). A major spill in April to August or October to December would coincide with pygmy blue whale migration. Double et al. (2014) suggest that pygmy blue whales migrate in offshore waters in the region of the Operational Area in about 200–1000 m of water (**Figure 4-8**). The pygmy blue whale migration BIA overlaps the Operational Area and the humpback whale migration BIA within the wider EMBA and may be overlapped by a worst-case hydrocarbon spill. However, feeding during migrations is low level and opportunistic. As such, the risk of ingesting hydrocarbons is low. Migrations of both pygmy blue whales and humpback whales are protracted through time and space (i.e. the whole population will not be within the EMBA), and as such, a spill from the loss of well integrity is unlikely to affect an entire population. The humpback whale resting area in Exmouth Gulf and the calving area in Camden Sound are not predicted to be contacted by surface, entrained or dissolved hydrocarbons above threshold concentrations. A loss of well integrity resulting in a well blowout could disrupt a significant portion of the humpback or pygmy blue whale populations. Such disruption could include behavioural impacts (e.g. avoidance of impacted areas), sub-lethal biological effects (e.g. skin irritation, irritation from ingestion or inhalation,

	reproductive failure) and, in rare circumstances, death. However, such disruptions or impacts are not predicted to impact on the overall population viability of cetaceans within the EMBA.
	Marine Turtles: Adult sea turtles exhibit no avoidance behaviour when they encounter hydrocarbon slicks (NOAA, 2010). Contact with surface slicks, or entrained hydrocarbon, can therefore result in hydrocarbon adherence to body surfaces (Gagnon and Rawson, 2010) irritating mucous membranes in the nose, throat and eyes leading to inflammation and infection (NOAA, 2010). Oiling can result in ingestion of hydrocarbons; indicators of polycyclic aromatic hydrocarbons (PAH) were higher in tissues, stomach content, colon content and faeces of visibly oiled turtles compared to non-visibly oiled turtles (Ylitalo et al., 2017). A stress response associated with this exposure pathway includes an increase in the production of white blood cells, and even a short exposure to hydrocarbons may affect the functioning of their salt gland (Lutcavage et al., 1995). Oiling can result in mortality depending on the extent of oiling and the size of the marine turtle (DWH Natural Resource Damage Assessment Trustees, 2016). Hydrocarbons in surface waters may also impact turtles when they surface to breathe and inhale toxic vapours. Their breathing pattern, involving large ‘tidal’ volumes and rapid inhalation before diving, results in direct exposure to petroleum vapours which are the most toxic component of the hydrocarbon spill (Milton and Lutz, 2003). This can lead to lung damage and congestion, interstitial emphysema, inhalant pneumonia and neurological impairment (NOAA, 2010). Contact with entrained hydrocarbons can result in hydrocarbon adhering to body surfaces (Gagnon and Rawson, 2010), irritating mucous membranes in the nose, throat and eyes leading to inflammation and infection (Gagnon and Rawson, 2010). Given the nature of the hydrocarbon, which is not expected to form surface slicks in areas where turtles are likely to occur in high densities (e.g. near nesting areas, foraging habitat, etc.), inhalation of harmful concentrations of hydrocarbon vapour by turtles (and other air breathing fauna) is considered to be very unlikely. Due to the absence of potential nesting habitat and location offshore, the Operational Area is unlikely to represent important habitat for marine turtles. However, turtles may be present foraging within the wider EMBA, and the EMBA overlaps the BIAs identified in **Section 4.5.2**, particularly the internesting BIAs for flatback turtles which extend for ~80 km from known nesting locations. It is noted that the Petroleum Activities Program will coincide with nesting season for marine turtles in the region. In the event of a loss of well integrity, there is a potential that surface, entrained and dissolved hydrocarbons exceeding threshold concentrations will be present in offshore waters extending up to 120 km, 950 km and 650 km, respectively, from the release site. Therefore, a hydrocarbon spill may have a minor disruption to a portion of the population; however, there is no threat to overall population viability. Potential impacts to internesting marine turtles are discussed in the *Mainland and Islands (nearshore)* impacts discussion.
	Seasnakes: Impacts to seasnakes from direct contact with hydrocarbons are likely to result in similar physical effects to those recorded for marine turtles and may include potential damage to the dermis and irritation to mucus membranes of the eyes, nose and throat (International Tanker Owners Pollution Federation (ITOPF), 2011). They may also be impacted when they return to the surface to breathe and inhale the toxic vapours associated with the hydrocarbons, damaging their respiratory system. In general, seasnakes frequent the waters of the continental shelf area around offshore islands and potentially submerged shoals (water depths <100 m; see *Submerged Shoals* below). While individuals may be present in the offshore oceanic waters, their abundance is not expected to be high, given the deep water and offshore location of the activity. Therefore, a hydrocarbon spill may have a minor disruption to a portion of the population but there is no threat to overall population viability.
	Sharks (including Whale Sharks) and Rays: Hydrocarbon contact may affect whale sharks through ingestion (entrained/dissolved hydrocarbons), particularly if feeding. Whale sharks may transit offshore open waters, including the Operational Area, when migrating to and from Ningaloo Reef (**Figure 4-11**), where they aggregate for feeding from March to July (see *Mainland and Islands (Nearshore Waters)* below). Whale sharks may also opportunistically feed in offshore waters and the EMBA overlaps the whale shark migration BIA identified in **Section 4.5.2**. Whale sharks are seasonally present within the BIA between April and October and the wider EMBA overlaps an aggregation area at Ningaloo. Whale sharks are versatile feeders, filtering large amounts of water over their gills, catching planktonic and nektonic organisms (Jarman and Wilson, 2004). Therefore, individual whale sharks that have direct contact with hydrocarbons within the spill-affected area may be impacted. Impacts to sharks and rays (including giant manta rays) may occur through direct contact with hydrocarbons and contaminate the tissues and internal organs, either through direct contact or via the food chain (consumption of prey). As gill breathing organisms, sharks and rays may be vulnerable to toxic effects of dissolved hydrocarbons (entering the body via the gills) and entrained hydrocarbons (coating of the gills, inhibiting gas exchange). The potential impacts are expected to vary depending on the weathered state of the hydrocarbon.

	In the offshore environment, it is probable that pelagic shark species are able to detect and avoid surface waters underneath hydrocarbon spills by swimming into deeper water or away from the affected areas. Therefore, any impact on sharks and rays is predicted to be minor and localised.
	Seabirds and/or Migratory Shorebirds: Offshore waters are potential foraging grounds for seabirds associated with coastal roosting and nesting habitat. There are confirmed foraging grounds off Ningaloo and the Barrow/Montebello/Lowendal Island Group. There are a number of BIAs for seabirds and migratory shorebirds that overlap the wider EMBA, as provided in **Section 4.5.2**. Seabirds generally do not exhibit avoidance behaviour to floating hydrocarbons. Physical contact of seabirds with surface slicks is by several exposure pathways, primarily immersion, ingestion and inhalation. Such contact with hydrocarbons may result in plumage fouling and hypothermia (loss of thermoregulation), decreased buoyancy and potential to drown, inability to fly or feed, anaemia, pneumonia and irritation of eyes, skin, nasal cavities and mouths (AMSA, 2013; International Petroleum Industry Environmental Conservation Association (IPIECA), 2004) and result in mortality due to oiling of feathers or the ingestion of hydrocarbons. Longer term exposure effects that may potentially impact seabird populations include a loss of reproductive success (loss of breeding adults) and malformation of eggs or chicks (AMSA, 2013). The extent of the EMBA for surface hydrocarbon concentration of >10 g/m^2, as a result of a loss of well integrity, is simulated by stochastic modelling to extend approximately 100 km from the release location (at 1% probability and above). Therefore, a hydrocarbon spill is unlikely to disrupt a significant portion of the foraging habitat for seabirds.
Submerged Shoals	**Marine Turtles:** There is the potential for marine turtles to be present at submerged shoals such as Rankin Bank and Glomar Shoals. These shoals and banks may, at times, be a foraging habitat for marine turtles, given the coral and filter feeding biota associated with these areas. However, these areas are not known foraging locations and satellite tracking of individual green turtles in the nearshore environment of the NWS did not indicate any overlap of the tracked post-nesting migratory routes and the Operational Area. It is, however, acknowledged that individual marine turtles may be present at Rankin Bank and Glomar Shoals and the surrounding areas. Therefore, a hydrocarbon spill may have a minor disruption to a portion of the population (see *Offshore* section above); however, there is no threat to overall population viability.
	Seasnakes: There is the potential for seasnakes to be present at submerged shoals such as Rankin Bank and Glomar Shoals. The potential impacts of exposure are as discussed previously in *Offshore – Seasnakes*. A hydrocarbon spill may have a minor disruption to a portion of the population but there is no threat to overall population viability.
	Sharks and Rays: There is the potential for resident shark and ray populations to be impacted directly by hydrocarbon contact or indirectly through contaminated prey or loss of habitat. Spill model results indicate potential impacts to the benthic communities of Rankin Bank and Glomar Shoals, which may host shark and ray populations. Pelagic and transient sharks and rays are expected to move away from areas affected by spilled hydrocarbons. Impacts to such species are expected to be limited to behavioural responses/ displacement. Shark and ray species that have associations with submerged shoals and oceanic atolls may not move in response to such habitat being contacted by spilled hydrocarbons. Such species may be more susceptible to a reduction in habitat quality resulting from a hydrocarbon spill. Impacts to sharks and rays at Rankin Bank and Glomar Shoals are likely to be localised as they are comparable to other Australian reefs and the NWMR submerged shoals and banks. It is expected that there will be no impacts at the population level.
Mainland and Islands (Nearshore Waters)	**All Species:** The information provided on protected species in this section is in addition to that provided in the preceding *Offshore, Oceanic Reefs* and *Submerged Shoals* sections. Refer to these preceding sections for additional discussion of protected species.
	Cetaceans and Dugongs: In addition to a number of whale species that may occur in nearshore waters, coastal populations of small cetaceans (such as spotted bottlenose dolphins and Indo-Pacific humpback dolphins) and dugongs are known to reside or frequent nearshore waters, including the Ningaloo Coast, Muiron Islands, Montebello/Barrow/Lowendal Islands, Pilbara Southern Island Groups, Shark Bay and a number of other nearshore and coastal locations including coastal areas of the Indonesian archipelago (see **Table 6-13**), which may be potentially impacted by entrained hydrocarbons exceeding threshold concentrations in the event of a loss of well integrity. Refer to **Section 4.5.2** and **Table 4-2** for the full list of EPBC listed cetacean species identified by the Protected Matters Search Tool with potential to occur within the EMBA. BIAs for dugong and cetaceans that overlap with the wider EMBA are outlined in **Section 4.5.2**. The predicted EMBA for entrained hydrocarbon extends past Exmouth Gulf and down to Shark Bay. These areas are known humpback whale aggregation areas during their annual southern migration (September to December); therefore,

	humpbacks moving into these aggregation areas may be exposed to hydrocarbons above threshold levels. However, surface, entrained and dissolved hydrocarbons concentrations above thresholds are not expected within Exmouth Gulf itself. No hydrocarbon contact at or above threshold concentrations is expected for Camden Sound, an important calving area for humpback whales. The potential impacts of exposure are as discussed previously in *Offshore – Cetaceans*. However, nearshore populations of cetaceans and dugongs are known to exhibit site fidelity and are often resident populations. Therefore, the potential for sustained exposure may be greater; however, hydrocarbons reaching these environments will be highly weathered, with volatile and water soluble (often the most toxic components) expected to have dissipated before reaching nearshore waters. In the Gulf of Mexico, nearshore bottlenose dolphins experienced mortality, reproductive failure and adverse health effects at higher levels than those of oceanic stocks (DWH Natural Resource Damage Assessment Trustees, 2016) during the DWH spill. Additional possible environment impacts may also include the potential for dugongs and dolphins to ingest hydrocarbons when feeding on oiled seagrass stands or contaminated sediments. There are also potential indirect impacts to dugongs due to loss of this food source due to dieback in worse affected areas. Therefore, a hydrocarbon spill may have an impact on feeding habitats and disrupt a significant portion of the local population but it is not predicted to result in impacts on overall population viability of either dugongs or coastal cetaceans.
	Pinnipeds: Australian sea lions are found at the Houtman Abrolhos Islands, which are about 660 km from the Operational Area. There is a minor overlap of the EMBA for entrained hydrocarbons with the Abrolhos AMP, however the overlap is in deep waters (>1000 m) where Australian sea lions are not expected to occur. Further, any entrained hydrocarbons that do reach this area after an extended period (i.e. modelled time to contact is a minimum of 30 days for entrained hydrocarbons) would be heavily weathered and therefore have minor or no impacts on sea lions.
	Marine Turtles: Several marine turtle species use nearshore waters and shorelines for foraging and breeding (including internesting), with significant nesting beaches along the mainland coast and islands in potentially impacted locations such as the Ningaloo Coast, Muiron Islands, Montebello/Barrow/ Lowendal Islands, Pilbara Islands (Southern Island Groups), Shark Bay and Eighty Mile Beach. There are distinct breeding seasons as detailed in **Section 4.5.2**. The nearshore waters of these turtle habitat areas may be exposed to entrained hydrocarbons exceeding threshold concentrations, and accumulated hydrocarbons above threshold concentrations. The potential impacts of exposure are as discussed previously in *Offshore – Marine Turtles*. In the nearshore environment, turtles can ingest hydrocarbons when feeding (e.g. on oiled seagrass stands/macroalgae) or can be indirectly affected by loss of food source (e.g. seagrass due to dieback from hydrocarbon exposure) (Gagnon and Rawson, 2010). In addition, hydrocarbon exposure can impact turtles during the breeding season at nesting beaches. Contact with gravid adult females or hatchlings may occur on nesting beaches (accumulated hydrocarbons) or in nearshore waters (entrained hydrocarbons) where hydrocarbons are predicted to make shoreline contact. If accumulated hydrocarbons (Montebello Islands, Ningaloo Coast and Eighty Mile Beach only) or entrained hydrocarbons reach the shoreline or internesting coastal waters (refer to **Table 6-13** for receptor locations), there is the potential for impacts to turtles using the affected area. Animals that lay eggs have been shown to pass metabolised oil related compounds into their offspring which has the potential to be toxic to the developing embryos. Similarly, adult female turtles can pass metabolised oil and related products to their eggs, thereby potentially exposing developing embryos and impairing the development and survival of embryos (DWH Natural Resource Damage Assessment Trustees, 2016). During the breeding season, turtle aggregations near nesting beaches within the wider EMBA are most vulnerable due to greater turtle densities. Potential impacts may occur at the population level but given the volatile nature of the hydrocarbons and low levels of shoreline accumulation predicted, impact on overall population viability is not expected.
	Seasnakes: As discussed previously (see '*Submerged Shoals – Seasnakes*') impacts to seasnakes for the mainland and island nearshore waters (including the Ningaloo Coast, Muiron Islands, Montebello/Barrow/Lowendal Islands, Southern Pilbara Island Groups and Shark Bay) from direct contact with hydrocarbons may occur but there is expected to be no threat to overall population viability.
	Sharks and Rays: Whale sharks and manta rays are known to frequent the Ningaloo Reef system and the Muiron Islands (and form feeding aggregations in late summer/autumn). Whale sharks and manta rays generally transit along the nearshore coastline and are vulnerable to surface, entrained and dissolved aromatic hydrocarbon spill impacts, with both taxa having similar modes of feeding. Whale sharks are versatile feeders, filtering large amounts of water over their gills, catching planktonic and nektonic organisms (Jarman and Wilson, 2004). Whale sharks at Ningaloo Reef have been observed using two different feeding strategies, including passive sub-surface ram-feeding and active surface feeding (Taylor, 2007). Passive feeding consists of swimming slowly at the surface with the mouth wide open. During active feeding, sharks swim high in the water with the

	upper part of the body above the surface and the mouth partially open (Taylor, 2007). These feeding methods would result in the potential for individuals that are present in worse affected spill areas to ingest potentially toxic amounts of surface, entrained or dissolved aromatic hydrocarbons into their body. Large amounts of ingested hydrocarbons may affect their endocrine and immune system in the longer term. The presence of hydrocarbons may displace whale sharks from the area where they normally feed and rest, and potentially disrupt migration and aggregations to these areas in subsequent seasons. Whale sharks may also be affected indirectly by surface, entrained or dissolved aromatic hydrocarbons through the contamination of their prey. The preferred food of whale sharks are fish eggs and phytoplankton which are abundant in the coastal waters of Ningaloo Reef in late summer/autumn, driving the annual arrival and aggregation of whale sharks in this area. If the spill event were to occur during the spawning season, this important food supply (in worse spill affected areas of the reef) may be diminished or contaminated. The contamination of their food supply and the subsequent ingestion of this prey by the whale shark may also result in long term impacts as a result of bioaccumulation. There is the potential for other resident shark and ray populations (e.g. sawfish species identified in **Table 4-2** and **Section 4.5.2**) to be impacted directly from hydrocarbon contact or indirectly through contaminated prey or loss of habitat. However, it is probable that shark species will move away from the affected areas. **Table 6-13** indicates the receptor locations predicted to be impacted from entrained and/or dissolved aromatic hydrocarbons to the benthic communities of nearshore, subtidal communities, and it is considered that there is the potential for habitat loss to occur. Therefore, the consequences to resident shark and ray populations (if present) from loss of habitat may disrupt a significant portion of the population; however, it is not expected to impact the overall viability of the population.
	Seabirds and/or Migratory Shorebirds: In the unlikely event of a loss of well integrity, there is the potential for seabirds, and resident and non-breeding overwintering shorebirds that use the nearshore waters for foraging and resting, to be exposed to surface, entrained and dissolved hydrocarbons. This could result in lethal or sub-lethal effects. Although breeding oceanic seabird species can travel long distances to forage in offshore waters, most breeding seabirds tend to forage in nearshore waters near their breeding colony, resulting in intensive feeding by higher seabird densities in these areas during the breeding season and making these areas particularly sensitive in the event of a spill. Pathways of biological exposure that can result in impact may occur through ingesting contaminated fish (nearshore waters) or invertebrates (intertidal foraging grounds such as beaches, mudflats and reefs). Ingestion can also lead to internal injury to sensitive membranes and organs (IPIECA, 2004). Whether the toxicity of ingested hydrocarbons is lethal or sub-lethal will depend on the weathering stage and its inherent toxicity (note: the shortest entrained hydrocarbon time to contact with a shoreline is nine days (North Ningaloo Coast)). Exposure to hydrocarbons may have longer term effects, with impacts to population numbers due to decline in reproductive performance and malformed eggs and chicks, affecting survivorship and loss of adult birds. Important areas for foraging seabirds and migratory shorebirds are identified in **Section 4.7**. Refer to **Table 6-13** for locations within the predicted extent of the EMBA that are identified as habitat for seabirds/migratory shorebirds. Suitable habitat or seabirds and shorebirds are broadly distributed along the mainland and nearshore island coasts within the EMBA. Of note are important nesting and resting areas, including (refer to **Section 4.5.2** for additional information, including BIAs within the wider EMBA): • Muiron Islands • Ningaloo Coast • Montebello/Barrow/Lowendal Islands Group (including known nesting habitats on Boodie, Double and Middle Islands) • Pilbara Islands South Island Group • Shark Bay. Therefore, a hydrocarbon spill may impact on key feeding habitat and disrupt a significant portion of the habitat; however, this is not expected to threaten the overall population viability of seabirds or shorebirds.

Summary of Potential Impacts to Marine Primary Producers	
Setting	***Receptor Group***
Submerged Shoals	The waters overlying the submerged Rankin Bank and Glomar Shoals have the potential to be exposed to entrained and dissolved hydrocarbons above threshold concentrations (at or greater than 500 ppb). This permanently submerged habitat represents sensitive open water benthic community receptors, extending from deep depths to relatively shallow water. Given the depth of Rankin Bank and Glomar Shoals, it is likely the potential for biological impact is significantly reduced when compared to the upper water column layers. However, potential biological impacts could include sub-lethal stress and in some instances total or partial mortality of sensitive benthic organisms such as corals and the early life stages of resident fish and invertebrate species. The submerged shoals of Rankin Bank and Glomar Shoals are areas associated with sporadic upwelling and associated primary productivity events. Impacts to plankton communities from exposure to entrained hydrocarbons above threshold concentrations may result in short-term changes in plankton community composition but recovery would occur. Hydrocarbon contact during the spawning seasons for resident shoal community benthos and fish (meroplankton), particularly exposure to in-water toxicity effects to biota, may result in the loss of a discrete cohort population but would not affect the longer term viability of resident populations. Therefore, any impacts to resident shoal community benthos and fish (meroplankton) are likely to be localised at the shoals and temporary. Hydrocarbon exposure to offshore filter-feeding communities (e.g. communities around Rankin Bank in water depths between 80–100 m or other locations as identified in **Table 6-13**) may occur depending on the depth of the entrained/dissolved hydrocarbons. Exposure to entrained (aromatic) hydrocarbons (≥500 ppb) has potential to result in lethal or sub-lethal toxic effects. Sub-lethal impacts, including mucus production and polyp retraction, have been recorded for gorgonians exposed to hydrocarbon (White et al., 2012). Any impacts may result in localised long-term effects to community structure and habitat.
Mainland and Islands (Nearshore Waters)	**Coral Reef:** The quantitative spill risk assessment and EMBA indicate there would be potential for coral reef habitat to be exposed to entrained hydrocarbons (≥500 ppb threshold concentration) to contact shallow nearshore waters and, therefore, exposure of subtidal corals associated with the fringing reefs located at a number of mainland and island locations. Areas that may be contacted by entrained hydrocarbons (≥500 ppb threshold concentration) include the Ningaloo Coast, Muiron Islands, Montebello/Barrow/Lowendal Islands Group, Pilbara Southern Islands Groups and Shark Bay. There is the potential for these reefs to be exposed to entrained hydrocarbons concentrations that are considered to induce toxicity effects, particularly for reproductive and juvenile stages of invertebrate and fish species. Exposure to entrained hydrocarbons (≥500 ppb) has the potential to result in lethal or sub-lethal toxic effects to corals and other sensitive sessile benthos within the upper water column, including upper reef slopes (subtidal corals), reef flat (intertidal corals) and lagoonal (back reef) coral communities (with reference to Ningaloo Coast). Mortality in a number of coral species is possible and would result in the reduction of coral cover and change in the composition of coral communities. Sub-lethal effects to corals may include polyp retraction, changes in feeding, bleaching (loss of zooxanthellae), increased mucous production resulting in reduced growth rates and impaired reproduction (Negri and Heyward, 2000). This could impact the shallow water fringing coral communities/reefs of the offshore islands (e.g. Muiron Islands, Barrow/Montebello/Lowendal Islands and Pilbara Southern Island Groups) and also the mainland coast (e.g. Ningaloo Coast). With reference to Ningaloo Reef, wave-induced water circulation flushes the lagoon and may promote removal of entrained hydrocarbons from this particular reef habitat. Under typical conditions, breaking waves on the reef crest induce a rise in water level in the lagoon, creating a pressure gradient that drives water in a strong outward flow through channels. In the unlikely event of a spill occurring at the time of coral spawning at potentially affected coral locations or in the general peak period of biological productivity, there is potential for a significant reduction in successful fertilisation and coral larval survival due to the sensitivity of coral early life stages to hydrocarbons (Negri and Heyward, 2000). Such impacts are likely to result in the failure of recruitment and settlement of new population cohorts. In addition, some non-coral species may be affected via direct contact with entrained and dissolved aromatic hydrocarbons, resulting in sub-lethal impacts and in some cases mortality. This is with particular reference to the early life stages of coral reef animals (reef attached fishes and reef invertebrates), which can be relatively sensitive to hydrocarbon exposure. Coral reef fish are site-attached, have small home ranges and as reef residents they are at higher risk from hydrocarbon exposure than non-resident, more wide-ranging fish species. The exact impact on resident coral communities (which may include fringing reefs of the offshore islands and/or the Ningaloo reef system) will be entirely dependent on actual hydrocarbon concentration, duration of exposure and water depth of the affected communities. Over the worst affected sections of reef habitat, coral community live cover, structure and composition is predicted to reduce, manifested by loss of corals and associated sessile biota. Recovery of these

	impacted reef areas relies on coral larvae from neighbouring coral communities that have either not been affected or only partially impacted. For example, there is evidence that Ningaloo Reef corals and fish are partly self-seeding (Underwood, 2009), with the supply of larvae from locations within Ningaloo Reef of critical importance to the healthy maintenance of the coral communities. Recovery at other coral reef areas, including Scott Reef, may not be aided by a large supply of larvae from other reefs, with levels of recruits after a disturbance event only returning to previous levels after the numbers of reproductive corals had also recovered (Gilmour et al., 2013). Therefore, a hydrocarbon spill may result in large-scale impacts to coral reefs, with long-term effects (recovery >10 years) possible.
	Seagrass Beds/Macroalgae and Mangroves: Spill modelling has predicted entrained hydrocarbons ≥500 ppb have the potential to contact a number of shoreline sensitive receptors such as those supporting biologically diverse, shallow subtidal and intertidal communities. The variety of habitat and communities types, from the upper subtidal to the intertidal zones, support a high diversity of marine life and are used as important foraging and nursery grounds by a range of invertebrate and vertebrate species. Depending on the trajectory of the entrained plume, macroalgal/seagrass communities including the Ningaloo Coast (patchy and low cover associated with the shallow limestone lagoonal platforms), Muiron Islands (associated with limestone pavements), the Barrow/Montebello/Lowendal Islands Group and the Pilbara Southern Island Group (documented as low and patchy cover) have the potential to be exposed (see **Table 6-13** for a full list of receptors within the EMBA). Seagrass in the subtidal and intertidal zones have different degrees of exposure to hydrocarbon spills. Subtidal seagrass is generally considered much less vulnerable to hydrocarbon spills than intertidal seagrass, primarily because freshly spilled hydrocarbons float under most circumstances. Dean et al. (1998) found that oil mainly affects flowering; therefore, species that are able to spread through apical meristem growth are not as affected (such as *Zostera*, *Halodule* and *Halophila* species). Seagrass and macroalgal beds occurring in the intertidal and subtidal zone may be susceptible to impacts from entrained hydrocarbons. Toxicity effects can also occur due to absorption of soluble fractions of hydrocarbons into tissues (Runcie et al., 2010). The potential for toxicity effects of entrained hydrocarbons may be reduced by weathering processes that should serve to lower the content of soluble aromatic components before contact occurs. Exposure to entrained aromatic hydrocarbons may result in mortality, depending on actual entrained aromatic hydrocarbon concentration received and duration of exposure. Physical contact with entrained hydrocarbon droplets could cause sub-lethal stress, causing reduced growth rates and a reduction in tolerance to other stress factors (Zieman et al., 1984). Impacts on seagrass and macroalgal communities are likely to occur in areas where hydrocarbon threshold concentrations are exceeded. Mangrove habitat and associated mud flats and salt marsh at Ningaloo Coast (small habitat areas) and the Montebello Islands have the potential to be exposed (see **Table 6-13** for the full list of receptors). Mangroves can be impacted by entrained aromatic hydrocarbons that may adhere to the sediment particles. In low energy environments such as in mangroves, deposited sediment-bound hydrocarbons are unlikely to be removed naturally by wave action and may be deposited in layers by successive tides (NOAA, 2014). Given the non-persistent nature of the hydrocarbons, no significant effects to mangroves are expected to occur. Entrained hydrocarbon impacts may include sub-lethal stress and mortality to certain sensitive biota in these habitats, including infauna and epifauna. Larval and juvenile fish, and invertebrates that depend on these shallow subtidal and intertidal habitats as nursery areas, may be directly impacted due to the loss of habitats and/or lethal and sub-lethal in-water toxic effects. This may result in mortality or impairment of growth, survival and reproduction (Heintz et al., 2000). In addition, there is the potential for secondary impacts on shorebirds, fish, sea turtles, rays and crustaceans that use these intertidal habitat areas for breeding, feeding and nursery habitat purposes.
Summary of Potential Impacts to Other Species	
Setting	***Receptor Group***
All Settings	**Pelagic and Demersal Fish:** Fish mortalities are rarely observed to occur as a result of hydrocarbon spills (ITOPF, 2011). This has generally been attributed to the possibility that pelagic fish are able to detect and avoid surface waters underneath hydrocarbon spills by swimming into deeper water or away from the affected areas. Fish that have been exposed to dissolved aromatic hydrocarbons are capable of eliminating the toxicants once placed in clean water, hence individuals exposed to a spill are likely to recover (King et al., 1996). Where fish mortalities have been recorded, the spills (resulting from the groundings of the tankers Amoco Cadiz in 1978 and the Florida in 1969) have occurred in sheltered bays. Laboratory studies have shown that adult fish are able to detect hydrocarbons in water at very low concentrations, and large numbers of dead fish have rarely been reported after oil spills (Hjermann et al., 2007). This suggests that juvenile and adult fish are capable of avoiding water contaminated with high concentrations of hydrocarbons. However, sub-lethal impacts to adult and juvenile fish may be

	possible, given long-term exposure (days to weeks) to PAH concentrations (Hjermann et al., 2007). While modelling of the loss of well integrity indicates the potential EMBA for dissolved hydrocarbons is extensive, no time-integrated exposure metrics were modelled. Given the oceanographic environment within the wider EMBA, PAH exposures in the order of weeks for pelagic fish are not considered credible. The effects of exposure to oil on the metabolism of fish appears to vary according to the organs involved, exposure concentrations and route of exposure (waterborne or food intake). Oil reduces the aerobic capacity of fish exposed to aromatics in the water and to a lesser extent affects fish consuming contaminated food (Cohen et al., 2005). The liver, a major detoxification organ, appears to be the organ where anaerobic activity is most impacted, probably increasing anaerobic activity to facilitate the elimination of ingested oil from the fish (Cohen et al., 2005). Fish are perhaps most susceptible to the effects of spilled oil in their early life stages, particularly during egg and planktonic larval stages, which can become entrained in spilled oil. Contact with oil droplets can mechanically damage feeding and breathing apparatus of embryos and larvae (Fodrie and Heck, 2011). The toxic hydrocarbons in water can result in genetic damage, physical deformities and altered developmental timing for larvae and eggs exposed to even low concentrations over prolonged timeframes (days to weeks) (Fodrie and Heck, 2011). More subtle, chronic effects on the life history of fish as a result of exposing early life stages to hydrocarbons include disruption to complex behaviour such as predator avoidance, reproductive and social behaviour (Hjermann et al., 2007). Prolonged exposure of eggs and larvae to weathered concentrations of hydrocarbons in water has also been shown to cause immunosuppression and allows expression of viral diseases (Hjermann et al., 2007). PAHs have also been linked to increased mortality and stunted growth rates of early life history (pre-settlement) of reef fishes, as well as behavioural impacts that may increase predation of post-settlement larvae (Johansen et al., 2017). However, the effect of a hydrocarbon spill on a population of fish in an area with fish larvae and/or eggs, and the extent to which any of the adverse impacts may occur, depends greatly on prevailing oceanographic and ecological conditions at the time of the spill and its contact with fish eggs or larvae. Demersal fish species are associated with the Continental Slope Demersal Fish Communities KEF and Ancient Coastline at 125 m Depth Contour KEF, which overlap the Operational Area and provide habitat for demersal fish species. Rankin Bank (about 47 km from the Operational Area) also hosts a diverse demersal fish assemblage. Fish associated with these features may be exposed to dissolved and entrained hydrocarbons above impact thresholds. Mortality and sub lethal effects may impact populations located close to the well blowout and within the EMBA for entrained/dissolved aromatic hydrocarbons (≥500 ppb). Additionally, if prey (infauna and epifauna) surrounding the well location and within the EMBA is contaminated, this can result in the absorption of toxic components of the hydrocarbons (PAHs), potentially impacting fish populations that feed on these. These impacts may result in localised medium/long term impacts on demersal fish habitat, such as the sea floor.
Summary of Potential Impacts to Other Habitats and Communities	
Setting	***Receptor Group***
Offshore	**Benthic Fauna Communities:** In the event of a major release at the seabed, the stochastic spill model predicted hydrocarbon droplets would be entrained, transporting them to the sea surface. As a result, the low sensitivity benthic communities associated with the unconsolidated, soft sediment habitat and any epifauna (filter feeders) associated with the consolidated sediment habitat within and outside the Operational Area are not expected to have widespread exposure to released hydrocarbons. A localised area relating to the hydrocarbon plume at the point of release is predicted, which would result in a small area of seabed and associated epifauna and infauna exposed to hydrocarbons.
	Open Water – Productivity/Upwelling: Primary production by plankton (triggered by sporadic upwelling events in the offshore waters of the NWS) is an important component of the primary marine food web. Planktonic communities are generally mixed including phytoplankton (cyanobacteria and other microalgae) and secondary consuming zooplankton (crustaceans (e.g. copepods) and the eggs and larvae of fish and invertebrates (meroplankton)). Exposure to hydrocarbons in the water column can change species composition, with declines or increases in one or more species or taxonomic groups (Batten et al., 1998). Phytoplankton may also experience decreased rates of photosynthesis (Tomajka, 1985). For zooplankton, direct effects of contamination may include suffocation, changes in behaviour, or environmental changes that make them more susceptible to predation. Impacts on plankton communities are likely to occur in areas where surface, entrained or dissolved aromatic hydrocarbon threshold concentrations are exceeded, but communities are expected to recover relatively quickly (within weeks or months). This is due to high population turnover with copious production within short generation times that also buffers the potential for long-term (i.e. years) population declines (ITOPF, 2011). Therefore, any impacts are likely to be on exposed planktonic communities present in the EMBA and temporary.

	Open Water – Physical Displacement of Fauna from Gas Plume: The effect of the physical extent of the gas plume in the environment is expected to have a limited and localised effect on identified receptors such as the physical barrier created by the gas plume, which may displace transient and/or mobile biota such as pelagic fish, megafauna species (migratory whales) and plankton. It is acknowledged that the physical extent of the plume may displace some open water species transiting the offshore waters of this area of the NWS. The extent of the plume is relatively small in comparison to the surrounding offshore environment but the overall impact to the in-water biota and the marine environment in general is expected to be slight to minor short-term impact to communities in the EMBA.
Mainland and Islands (Nearshore Waters)	**Open Water – Productivity/Upwelling:** Nearshore waters and adjacent offshore waters surrounding the offshore islands (e.g. Barrow and Montebello Islands) and to the west of the Ningaloo reef system are known locations of seasonal upwelling events and productivity. The seasonal productivity events are critical to krill production, which supports megafauna aggregations such as whale sharks and manta rays in the region. This has the potential to result in lethal and sub-lethal impacts to a certain portion of plankton in affected areas, depending on concentration and duration of exposure and the inherent toxicity of the hydrocarbon. However, recovery would occur (see *Offshore* description above). Therefore, any impacts are likely to be on exposed planktonic communities present in the EMBA and temporary in nature.
	Spawning/Nursery Areas: Fish (and other commercially targeted taxa) in their early life stages (eggs, larvae and juveniles) are at their most vulnerable to lethal and sub-lethal impacts from exposure to hydrocarbons, particularly if a spill coincides with spawning seasons or if a spill reaches nursery areas close to the shore (e.g. seagrass and mangroves) (ITOPF, 2011). Fish spawning (including for commercially targeted species such as snapper and mackerel) occurs in nearshore waters at certain times of the year. Nearshore waters are also inhabited by higher numbers of juvenile fishes than offshore waters. Modelling indicated that in the unlikely event of a major spill, there is potential for entrained and dissolved hydrocarbons to occur in the surface water layers above threshold concentrations in nearshore waters, including the Muiron Islands, Ningaloo Coast, Montebello/Barrow/Lowendal Islands Group, Pilbara Southern Islands Group and Shark Bay. This has the potential to result in lethal and sub-lethal impacts to a certain portion of fish larvae in affected areas, depending on concentration and duration of exposure and the inherent toxicity of the hydrocarbon. Although there is the potential for spawning/nursery habitat to be impacted (e.g. mangroves and seagrass beds, discussed above), losses of fish larvae in worse affected areas are unlikely to be of major consequence to fish stocks compared with significantly larger losses through natural predation, and the likelihood that most nearshore areas would be exposed is low (i.e. not all areas in the region would be affected). This is supported by a recent study in the Gulf of Mexico which used juvenile abundance data, from shallow-water seagrass meadows, as indices of the acute, population-level responses of young fishes to the DWH spill. Results indicated there was no change to the juvenile cohorts following the DWH spill. Additionally there were no significant post-spill shifts in community composition and structure, nor were there changes in biodiversity measures (Fodrie and Heck, 2011). Any impacts to spawning and nursery areas are expected to be minor and short term, as would flow-on effects to adult fish stocks into which larvae are recruited.
	Reefs: The reef communities fringing the offshore Ningaloo Coast and Pilbara regions (e.g. the Montebello/Barrow/Lowendal Islands Group and the Pilbara Southern Island Group) may be exposed to entrained and dissolved hydrocarbons (at or above 500 ppb) and consequently exhibit lethal or sub-lethal impacts, resulting in partial or total mortality of keystone sessile benthos, particularly hard corals and thus potential community structural changes to these shallow, nearshore benthic communities may occur. If these reefs are exposed to entrained hydrocarbons, impacts are expected to result in localised long-term effects.
	Filter Feeders: Hydrocarbon exposure to offshore, filter-feeding communities (e.g. deepwater communities of Ningaloo Coast and the Muiron Islands in 20–200 m) may occur depending on the depth of the entrained and dissolved aromatic hydrocarbons. See discussion above on potential impacts.
	Sandy Shores/Estuaries/Tributaries/Creeks (including Mudflats)/Rocky Shores: Shoreline exposure for the upper and lower areas differ. The upper shore has the potential to be exposed to surface slicks, while the lower shore is potentially exposed to entrained hydrocarbon. Potential impacts may occur due to hydrocarbon contact with intertidal areas, including sandy shores, mudflats and rocky shores, listed in **Table 6-13**. Hydrocarbon at sandy shores is incorporated into fine sediments through mixing in the surface layers from wave energy, penetration down worm burrows and root pores. Hydrocarbon in the intertidal zone can adhere to sand particles; however, high tide may remove some or most of the hydrocarbon back of the sediments. Typically, hydrocarbon is only incorporated into the surface layers to a maximum of 10 cm. As described earlier, accumulated hydrocarbons ≥100 g/m² could impact the survival and reproductive capacity of benthic epifaunal

	invertebrates living in intertidal habitat (French-McCay, 2009). Note that shoreline accumulation above impact thresholds was identified by the stochastic modelling as potentially occurring at the Montebello Islands, Ningaloo Coast and Eighty Mile Beach, albeit with a low probability. Given the hydrocarbons are non-persistent, long-term impacts to shores are not expected. The impact of hydrocarbon on rocky shores will largely depend on the incline and energy environment. On steep/vertical rock faces on wave exposed coasts, there is likely to be no impact from a spill event. However, a gradually sloping boulder shore in calm water can potentially trap large amounts of hydrocarbon (IPIECA, 2000). The impact of the spill on marine organisms along the rocky coast will depend on the toxicity and weathering of the hydrocarbon. Similar to sandy shores, accumulated hydrocarbons ≥100 g/m² could coat the epifauna along rocky coasts and impact the reproductive capacity and survival. The locations of rocky shores where impacts are predicted are at the Montebello Islands. Intertidal mudflats are susceptible to potential impacts from hydrocarbons, as they are typically low energy environments and therefore trap hydrocarbons. The extent of oiling is influenced by the neap and spring tidal cycle and seasonal highs and lows affecting mean sea level. Potential impacts to tidal flats include heavy accumulations covering the flat at low tide; however, it is unlikely that hydrocarbon will penetrate the water-saturated sediments. However, hydrocarbon can penetrate sediments through animal burrows and root pores. It has been demonstrated that infaunal burrows allow hydrocarbons to access subsurface sediments where it can be retained for months. Potential impacts may occur due to entrained contact with shallow, subtidal and intertidal zones of the Ningaloo Coast and Barrow Island, Montebello Islands and the Muiron Islands, albeit at low probabilities. In-water toxicity of the dissolved and entrained hydrocarbons reaching these shores will determine impacts to the marine biota, such as sessile barnacle species and/or mobile gastropods, and crustaceans such as amphipods. Lethal and sub-lethal impacts may be expected where the entrained hydrocarbon concentration threshold is >500 ppb. Impacts may result in localised changes to the community structure of these shoreline habitats which would be expected to recover in the medium term (2–5 years).
Key Ecological Features	**KEFs** potentially impacted by the hydrocarbon spill from a loss of well integrity are: • ancient coastline at 125 m depth contour • continental slope demersal fish communities • Exmouth Plateau • Glomar Shoals • canyons that link the Cuvier Abyssal Plan with the Cape Range Peninsula • Commonwealth waters adjacent to Ningaloo Reef • canyons linking the Argo Abyssal Plain with the Scott Plateau • Wallaby Saddle • western demersal slope and associated fish communities. Although these KEFs are primarily defined by seabed geomorphological features, they are described to identify the potential for increased biological productivity and, therefore, ecological significance. The consequences of a hydrocarbon spill from a loss of well integrity event are predicted to result in moderate impacts with values of the KEF areas affected (for the values of each KEF see **Section 4.7.11**). Potential impacts include: the contamination of sediments, impacts to benthic fauna/habitats, associated impacts to demersal fish populations, and reduced biodiversity as described above and below. Most of the KEFs within the EMBA have relatively broad-scale distributions and are unlikely to be significantly impacted.
Summary of Potential Impacts to Water Quality	
Setting	***Aspect***
Offshore	**Open Water – Water Quality:** Water quality would be affected due to hydrocarbon contamination which is described in terms of the biological effect concentrations. These are defined by the EMBA descriptions for each of entrained and dissolved hydrocarbon fates and their predicted extent (refer to **Table 6-13**). Furthermore, water quality is predicted to have minor long term and/or significant short term hydrocarbon contamination above background and/or national/international quality standards.
Submerged Shoals	**Open Water – Water Quality:** Water quality would be reduced due to hydrocarbon contamination that is predicted to be at or above biological effect concentrations for the surrounding marine waters over Rankin Bank. The submerged Rankin Bank and Glomar Shoals has the potential to be exposed to entrained hydrocarbons at or greater than 500 ppb. The waters surrounding this permanently submerged habitat would show a reduction in quality due to hydrocarbon contamination above background and/or national/international quality standards.

Mainland and Islands (Nearshore Waters)	**Open Water – Water Quality:** Water quality would be affected/reduced due to hydrocarbon contamination, with modelling predictions indicating that hydrocarbon contact is at or above biological effect concentrations for entrained hydrocarbons in nearshore waters of identified islands and the mainland coast (refer to **Table 6-13**). Such reduction in water quality is predicted to have minor long term or significant short term hydrocarbon contamination above background and/or national/international quality standards.
Summary of Potential Impacts to Marine Sediment Quality	
Setting	***Receptor Group***
Offshore	**Marine Sediment Quality:** In the event of a major hydrocarbon release at the seabed, modelling indicates that a pressurised release of condensate would atomise into droplets that would be rapidly transported into the water column to the surface. As a result, the extent of potential impacts to the seabed area at and surrounding the release site would be confined to a localised footprint. Marine sediment quality would be reduced (contamination above national/international quality standards) as a consequence of hydrocarbon contamination for a small area within the immediate release site for a long to medium term.
Submerged Shoals	**Marine Sediment Quality:** There is potential for the reduction of marine sediment quality due to contact and adherence of entrained hydrocarbons with seabed sediments of the submerged shoals. If this was to occur, marine sediment quality would be reduced (contamination above national/international quality standards) as a consequence of hydrocarbon contamination for a small area within the immediate release site for a long to medium term. However, given the nature of the hydrocarbon, contact with submerged shoals is considered unlikely.
Mainland and Islands (Nearshore Waters)	**Marine Sediment Quality:** Entrained hydrocarbons (at or above the defined thresholds) are predicted to potentially contact shallow, nearshore waters of identified islands and mainland coastlines. Hydrocarbons may accumulate (at or above the ecological threshold) at the Montebello Islands, Ningaloo Coast and Eighty Mile Beach (refer to **Table 6-13**). Such hydrocarbon contact may lead to reduced marine sediment quality by several processes, such as adherence to sediment and deposition shores or seabed habitat.
Summary of Potential Impacts to Air Quality	
A hydrocarbon release during a loss of well integrity has the potential to result in localised, temporary reduction in air quality. Potential impacts are expected to be a slight and temporary localised effect to ecosystems, species and/or habitats in the area. There is potential for human health effects for workers in the immediate vicinity of atmospheric emissions. The ambient concentrations of methane and volatile organic carbons released from diffuse sources is difficult to accurately quantify, although their behaviour and fate is predictable in open offshore environments as it is dispersed rapidly by meteorological factors such as wind and temperature. Methane and VOC emissions from a hydrocarbon release in such environments are rapidly degraded in the atmosphere by reaction with photo-chemically-produced hydroxyl radicals. In the unlikely occurrence of a loss of well integrity, the temporary nature of any methane or VOC emissions (from either gas surfacing or weathering of liquid hydrocarbons); the predicted behaviour and fate of methane and VOCs in open offshore environments; and the significant distance from the Operational Area to the nearest sensitive air shed (town of Dampier about 180 km away), the potential impacts are expected to be minor and temporary.	
Summary of Potential Impacts to Protected Areas	
The quantitative spill risk assessment results indicate that the open water environment protected within the AMPs listed in **Table 6-13** may be affected by the released hydrocarbons. In the unlikely event of a major spill, entrained hydrocarbons and/or dissolved hydrocarbons may contact the identified key receptor locations of islands and mainland coastlines, resulting in the actual or perceived contamination of protected areas, including the Ningaloo WHA and the Ningaloo Commonwealth and State marine reserves, as identified for the EMBA (refer to **Table 6-13**). Objectives in the management plans for the Ningaloo Marine Park (Commonwealth waters), the Ningaloo Marine Park and Muiron Islands Marine Management Area, and for the Montebello/Barrow Islands Marine Conservation Reserves, require consideration of a number of physical, ecological and social values identified in these areas. Impact on the values of these protected areas are discussed in the relevant sections above for ecological and physical (water quality) values and below for social (socio-economic) values. Impact on the protected areas is discussed in the sections above for ecological values and sensitivities and below for socio-economic values. Additionally, such hydrocarbon contact may alter stakeholder understanding and/or perception of the protected marine environment, given these represent areas largely unaffected by anthropogenic influences and contain biological diverse environments.	

Summary of Potential Impacts to Socio-economic Values	
Setting	***Receptor Group***
Offshore	**Fisheries – Commercial:** Spill scenarios modelled are unlikely to cause significant direct impacts on the target species of Commonwealth and offshore State fisheries within the defined EMBA. Further details are provided below (impact assessment relating to spawning is discussed above under *Summary of Potential Impacts to Other Habitats and Communities*). ***General Fisheries*****:** Fish exposure to hydrocarbon can result in 'tainting' of their tissues. Even very low levels of hydrocarbons can impart a taint or 'off' flavour or smell in seafood. Tainting is reversible through the process of depuration which removes hydrocarbons from tissues by metabolic processes, although it is dependent upon the magnitude of the hydrocarbon contamination. Fish have a high capacity to metabolise these hydrocarbons while crustaceans (such as prawns) have a reduced ability (Yender et al., 2002). Seafood safety is a major concern associated with spill incidents. Therefore, actual or potential contamination of seafood can affect commercial and recreational fishing, and can impact seafood markets long after any actual risk to seafood from a spill has subsided (Yender et al., 2002). A major spill would result in establishment of a Petroleum Safety Zone around the spill-affected area. There would be a temporary prohibition on fishing activities for a period of time and subsequent potential for economic impacts to affected commercial fishing operators. Additionally, hydrocarbon can foul fishing equipment such as traps and trawl nets, requiring cleaning or replacement. ***Western Tuna and Billfish, Southern Bluefin Tuna, Western Skipjack and West Australian Mackerel Fisheries:*** The tuna fisheries (Western Tuna and Billfish, Western Skipjack Southern Bluefin Tuna fisheries for which limited fishing activity has occurred in this area in recent years) and the Western Australian Mackerel Fishery target pelagic fish species. Adult fish are highly mobile and able to move away from the spill-affected area or avoid the surface waters; however, hydrocarbon concentrations in the upper water column could lead to potential exposure through direct absorption of hydrocarbons and indirectly by the consumption of contaminated prey (Merkel et al., 2012). Given these pelagic species are distributed over a wide geographical area, the impacts at the population or species level are considered minor in the unlikely event of a spill. ***Western Deep Trawl and Northwest Slope Trawl Fisheries:*** The predicted EMBA resulting from an uncontrolled loss of hydrocarbon from a loss of well integrity may directly impact the species fished by the Northwest Slope Trawl Fishery and Western Deep Trawl Fishery. These fisheries target benthic species (demersal finfish and crustaceans) in greater than 200 m water depth. The Northwest Slope Trawl Fishery targets scampi and deepwater prawns. These species are less mobile and will therefore not be able to easily move away from the spill. Mortality/sub-lethal effects may impact populations located close to the spill location. The Western Deep Trawl Fishery targets over 50 demersal fish species. Mortality and sub-lethal effects may impact localised populations of targeted species located close to the spill and within the EMBA for entrained/dissolved hydrocarbons (≥500 ppb). However, the entrained hydrocarbon is likely to be confined in the upper water column; therefore, the demersal species are less likely to be exposed to hydrocarbons than pelagic species. This is particularly relevant as the majority of fishing effort for both these fisheries is located distant from the location of a potential loss of well integrity. Fish resources exploited by these fisheries are unlikely to be impacted significantly as hydrocarbons at this distance are likely to be confined in the upper water column. A major loss of hydrocarbons from the Petroleum Activities Program may lead to an exclusion of fishing from the spill-affected area for an extended period. ***State Fisheries*****:** The predicted EMBA resulting from a major spill may impact the area fished by a number of State fisheries (refer **Table 4-8**). These fisheries generally use a range of gear types (trawl, trap and line) and operate from shallow inshore water to water depths up to 200 m, targeting demersal and pelagic finfish species and prawns. In the unlikely event of a major hydrocarbon spill, there is the potential for the targeted fish species to be exposed to entrained and/or dissolved aromatic hydrocarbons in the water column. However, the potential for direct impact would be reduced, as target species such as mackerel and snapper are likely to avoid the surface water layer underneath oil slicks. Demersal species (such as finfish and crustaceans) have limited mobility and therefore will not be able to easily move away from a spill. Mortality/sub-lethal effects may impact populations located close to the loss of well integrity location. A major loss of hydrocarbons from the Petroleum Activities Program may lead to an exclusion of fishing from the spill-affected area for an extended period. A number of other State and Commonwealth fisheries, further afield in the EMBA (refer **Table 4-8**), may also be affected by a major spill. However, the impacts to these far field fisheries will be similar to that described above for 'General Fisheries Impacts'.

	Tourism including Recreational Activities: Recreational fishers predominantly target tropical species such as emperor, snapper, grouper, mackerel, trevally and other game fish. Recreational angling activities include shore-based fishing, private boat and charter boat fishing, with the peak in activity between April and October (Smallwood et al., 2011). Limited recreational fishing is expected to take place in the offshore waters of the Operational Area. Impacts on species that are recreationally fished are described above and under '*Summary of Potential Impacts to Other Species*'. A major loss of hydrocarbon from the Petroleum Activities Program may lead to exclusion of marine nature-based tourist activities for an extended period, resulting in a loss of revenue for operators.
	Offshore Oil and Gas Infrastructure: In the unlikely event of a major spill, surface hydrocarbons may affect production from existing petroleum facilities (platforms and floating production, storage and offtake vessels). For example, facility water intakes for cooling and fire hydrants could be shut off which could in turn lead to the temporary cessation of production activities. Spill exclusion zones established to manage the spill could also prohibit support vessel access as well as offtake tankers approaching facilities off the North West Cape. The impact on ongoing operations of regional production facilities would be determined by the nature and scale of the spill and metocean conditions. Furthermore, decisions on the operation of production facilities in the event of a spill would be based primarily on health and safety considerations. The closest production is the Pluto Platform (operated by Woodside). Other nearby facilities include the Chevron-operated Wheatstone Platform. Operation of these facilities is likely to be affected in the event of a loss of well integrity spill.
Submerged Shoals	**Tourism and Recreation:** In the unlikely event of a major spill, a temporary prohibition on charter boat recreational fishing trips and any other marine nature-based tourism trips to Rankin Bank and Glomar Shoals may be put into effect, depending on the trajectory of the plume, resulting in a loss of revenue for operators.
Mainland and Islands (Nearshore Waters)	**Fisheries – Commercial:** ***Nearshore Fisheries and Aquaculture:*** In the unlikely event of a loss of well integrity, there is the possibility that target species in some areas used by a number of State fisheries, prawn fisheries, pearl oyster fisheries and aquarium fisheries in nearshore waters of the mainland coast and islands that are within the EMBA could be affected. Targeted fish, prawn, mollusc and lobster species could experience sub-lethal stress, or in some instances mortality, depending on the concentration and duration of hydrocarbon exposure and its inherent toxicity. ***Prawn Managed Fisheries:*** In a major spill, the modelling indicated the entrained EMBA may extend to nearshore waters closest to the mainland Pilbara and Gascoyne coasts, including the actively fished areas of the designated Onslow Prawn Managed Fishery, Exmouth Gulf Prawn Managed Fishery, Nickol Bay Prawn Managed Fishery and the Shark Bay Prawn and Scallop Managed Fishery, and managed prawn nursery areas. Note that the majority of the demarcated area for the prawn managed fishery in the Exmouth Gulf (proper) is outside the EMBA. Prawn habitat utilisation differs between species in the post-larval, juvenile and adult stages (Dall et al., 1990). Direct impacts to benthic habitat due to a major spill has the potential to impact prawn stocks. For example, juvenile banana prawns are found almost exclusively in mangrove-lined creeks (Rönnbäck et al., 2002), whereas juvenile tiger prawns are most abundant in areas of seagrass (Masel and Smallwood, 2000). Adult prawns also inhabit coastline areas but tend to move to deeper waters to spawn. In a major spill, the model predicted shallow subtidal and intertidal habitats at the Muiron Islands, Montebello Islands, Barrow Island, Lowendal Islands, Pilbara Southern Islands Group, Exmouth Gulf, Shark Bay (open ocean coast), and mangrove and seagrass habitats of the Ningaloo Coast are located within the EMBA and could be exposed to hydrocarbon concentrations above threshold concentrations, depending on the trajectory of the plume. Localised loss of juvenile prawns in worse spill affected areas is possible. Whether lethal or sub-lethal effects occur will depend on duration of exposure, hydrocarbon concentration, weathering stage of the hydrocarbon and its inherent toxicity. Furthermore, seafood consumption safety concerns and a temporary prohibition on fishing activities may lead to subsequent potential for economic impacts to affected commercial fishing operators.
	Fisheries – Traditional: Although no designated traditional fisheries have been identified, it is recognised that Aboriginal communities fish in the shallow coastal and nearshore waters of Barrow Island, Montebello Islands and Ningaloo Reef, and therefore may be potentially impacted if a hydrocarbon spill from a loss of well integrity were to occur. Impacts would be similar to those identified for commercial fishing in the form of a potential exclusion zone and contamination/tainting of fish stocks.

	Tourism and Recreation: In the unlikely event of a major spill, the nearshore waters of island groups including the Muiron Islands, Barrow/Lowendal/Montebellos and the Pilbara islands (Southern Island groups) and mainland coasts (Ningaloo and Shark Bay), could be reached by entrained hydrocarbon, depending on prevailing wind and current conditions. Shoreline accumulation above threshold concentrations is also predicted for the Ningaloo Coast and Shark Bay, albeit with a low probability of occurrence. These locations offer a number of amenities such as fishing and swimming. Utilisation of beaches and surrounds have a recreational value for local residents and visitors (regional, national and international). If a major spill resulted in hydrocarbon contact, there could be restricted access to beaches for a period of days to weeks, until natural weathering or tides and currents remove the hydrocarbons. In a major spill, tourists and recreational users may also avoid areas due to perceived impacts, including after the hydrocarbon spill has dispersed. There is potential for stakeholder perception that this remote environment will be contaminated over a large area and for the longer term, resulting in a prolonged period of tourism decline. Oxford Economics (2010) assessed the duration of hydrocarbon spill related tourism impacts and found that on average, it took 12 to 28 months to return to baseline visitor spending. There is likely to be significant impacts to the tourism industry, wider service industry (hotels, restaurants and their supply chain) and local communities in terms of economic loss as a result of spill impacts to tourism. Recovery and return of tourism to pre-spill levels will depend on the size of the spill, effectiveness of the spill clean-up and change in any public misconceptions regarding the spill (Oxford Economics, 2010).
	Cultural Heritage: There are a number of historic shipwrecks identified in the vicinity of the Operational Area (**Table 4-7**). The closest known wrecks are the four wrecks of the *Curlew*, the *Wild Wave (China*), the *Marietta*, and the *Vianen*, near the Montebello Islands and about 40 km from the Operational Area. The modelling results do not predict surface slicks contacting the identified wrecks, and the majority of entrained hydrocarbons are expected to occur close to the surface. However, shipwrecks in the subtidal zone will be exposed to entrained and dissolved hydrocarbons. Marine life that shelter and take refuge in and around these wrecks may be affected by in-water toxicity of dispersed hydrocarbons. The consequences of such hydrocarbon exposure may include all or some of: large fish species moving away and/or resident fish species and sessile benthos such as hard corals exhibiting sub-lethal and lethal impacts (which may range from physiological issues to mortality). Accumulated hydrocarbons above threshold concentrations (> 100 g/m²) are predicted at the Ningaloo Coast. It is acknowledged that the area contains numerous Aboriginal sites such as burial grounds, middens and fish traps that provide a historical account of the early habitation of the area and a tangible part of the culture of local Aboriginal groups (CALM, 1990). Additionally, artefacts, scatter and rock shelter are contained on Barrow and Montebello islands. Within the wider EMBA, a number of places are designated on the National Heritage List (**Section 4.6.1**). These places are also covered by other designations such as WHA, marine parks and listed shipwrecks. Potential impacts have therefore been discussed in the sections above.

Summary of Potential Impacts to Environmental Values

In the unlikely event of a major hydrocarbon spill due to a loss of well integrity, the EMBA includes the areas listed in **Table 6-13**, including the sensitive marine environments and associated receptors of the Muiron Islands, Ningaloo Coast, Exmouth Gulf, Rankin Bank, Glomar Shoals, Montebello/Barrow/Lowendal Islands Group, the Pilbara Southern Islands Group, Shark Bay, and the Abrolhos Islands and any sensitive receptors in the open waters among these key receptor locations. In summary, long term impacts may occur at sensitive nearshore and shoreline habitats, particularly, areas of the Ningaloo Coast, as a result of a major spill of hydrocarbon from drilling activities within the Operational Area.

The overall environmental consequence is defined as B 'Major, long term impact (10-50 years) on highly valued ecosystem, species, habitat, physical or biological attributes' (**Table 2-3**). The likelihood of the event is defined as a 2 'Unlikely', resulting in a risk rating of high.

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS)***[31]	***Benefit in Impact/Risk Reduction***	***Proportionality***	***Control Adopted***
Legislation, Codes and Standards				
Offshore Petroleum and Greenhouse Gas Storage (Resource Management and Administration) Regulations 2011: accepted WOMP, which describes the well design and barriers to be used to prevent a loss of well integrity, specifically: • all permeable zones penetrated by the well bore, containing hydrocarbons or over-pressured water, shall be isolated from the surface environment by a minimum of two barriers (primary and secondary) (a single fluid barrier may be implemented during the initial stages of well construction if appropriateness is confirmed by a shallow hazard study) • discrete hydrocarbon zones shall be isolated from each other (to prevent cross flow) by a minimum of one barrier where deemed required • all normally pressured permeable water-bearing formations shall be isolated from the surface by a minimum of one barrier. The barriers shall: • be effective over the lifetime of well construction • (fluid barriers) remain monitored and provide sufficient pressure to counter pore pressure during well construction • (cementing barriers, including conductor, casing and liners) conform to the relevant minimum Woodside standards. Verification: • effectiveness of primary and secondary barriers shall be verified (physical evidence of the correct placement and performance) during drilling of the well.	F: Yes. CS: Minimal cost. Standard practice.	Compliance with an accepted WOMP will ensure a number of barriers are in place and verified, reducing the likelihood of loss of well integrity occurring. Although the consequence of a blowout would not be reduced, the reduction in likelihood reduces the overall risk.	Benefits outweigh cost/sacrifice.	Yes C 11.1

[31] Qualitative measure

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS)[31]***	***Benefit in Impact/Risk Reduction***	***Proportionality***	***Control Adopted***
Implement requirements for permanent well abandonment: • well barrier as per the internal Woodside Standard and Procedure • placement, length, material and verification of a permanent barrier.	F: Yes. CS: Minimal cost. Standard practice.	This procedure will reduce the likelihood of a spill occurring from a suspended well. Although changes in consequence would occur, the reduction in likelihood results in a reduction in overall risk.	Benefits outweigh cost/sacrifice.	Yes C 12.1
An approved Blowout Contingency Plan shall exist prior to drilling each well, including feasibility and any specific considerations for relief well kill.	F: Yes. CS: Minimal cost. Standard practice.	Assessment of the feasibility considerations for relief well kill will reduce the duration of a spill, resulting in a reduction in consequence and overall risk.	Benefits outweigh cost/sacrifice.	Yes C 12.2
Good Practice				
Subsea BOP installed and function tested during drilling operations. The BOP shall include: • one annular preventer; • two pipe rams (excluding the test rams); • a minimum of two sets of shear rams, one of which must be capable of sealing; • deadman functionality; • the capability of ROV intervention • independent power systems.	F: Yes. CS: Standard practice. Required by Woodside standards.	Testing of the BOP will reduce the likelihood of a blowout resulting in release of hydrocarbons to the marine environment. In the event of a blowout, this control would not reduce the consequence, although the reduction in likelihood reduces the overall risk ranking.	Benefits outweigh cost/sacrifice.	Yes C 11.3
Project-specific Mooring Design Analysis.	F: Yes. CS: Standard practice. Required by Woodside standards.	Ensure adequate MODU station holding capacity to prevent loss of station. This will reduce the likelihood of a blowout resulting in release of hydrocarbons to the marine environment.	Benefits outweigh cost/sacrifice.	C 2.2

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS)[31]***	***Benefit in Impact/Risk Reduction***	***Proportionality***	***Control Adopted***
Professional Judgement – Eliminate				
Do not drill well.	F: No. CS: Inability to produce hydrocarbons. Loss of the project.	All risk would be eliminated.	Disproportionate. Given the extremely low likelihood of a loss of well integrity due to the systematic implementation of Woodside's policies, standards, procedures and processes relating to drilling activities, the cost/sacrifice outweighs the benefit gained.	No
Professional Judgement – Substitute				
No additional controls identified.				
Professional Judgement – Engineered Solution				
No additional controls identified.				
Risk Based Analysis				
A quantitative spill risk assessment was performed (refer **Section 6.7.1**).				
Company Values				
Corporate values require all personnel at Woodside to comply with appropriate policies, standards, procedures and processes while being accountable for their actions and holding others to account in line with the Woodside Compass. As detailed above, the Petroleum Activities Program will be performed in line with these policies, standards and procedures that include suitable controls to prevent loss of well integrity, and response should a loss of well integrity occur.				
Societal Values				
Due to the Petroleum Activities Program's potential extent of the wider EMBA, the loss of well integrity current risk rating presents a Decision Type C, in accordance with the decision support framework described in **Section 2.6**. Extensive consultation was conducted for this program to identify the views and concerns of relevant stakeholders, as described in **Section 5**. Woodside sent an Activity Factsheet in 2019 to all identified relevant stakeholders regarding the Petroleum Activities Program (**Section 5** and **Appendix F**). Woodside has consulted with AMSA and WA DoT on spill response strategies. In accordance with the MoU between Woodside and AMSA, a copy of the Oil Pollution First Strike Plan was provided to AMSA.				
ALARP Statement On the basis of the environmental risk assessment outcomes and use of the relevant tools appropriate to the decision type (i.e. Decision Type C), Woodside considers the adopted controls appropriate to manage the impacts and risks of an extremely low likelihood unplanned hydrocarbon release as a result of a loss of well integrity. As no reasonable additional/alternative controls were identified that would further reduce the impacts and risks without grossly disproportionate sacrifice, the impacts and risks are considered ALARP.				

Demonstration of Acceptability
Acceptability Statement Loss of well integrity has been evaluated as having a high level of current risk rating due to the scale of potential environmental impacts. However, the likelihood of a loss of well integrity occurring is considered extremely low. As per

Demonstration of Acceptability
Section 2.7, Woodside considers high current risk ratings as acceptable, if ALARP is demonstrated using good industry practice, consideration of company and societal values and risk based analysis, if legislative requirements are met and societal concerns are accounted for, and the alternative control measures are grossly disproportionate to the benefit gained. Acceptability is demonstrated with regard to the following considerations: <u>Principles of Ecological Sustainable Development</u> Woodside is a proud Australian company that is here for the long term. Woodside has a strong history of exploration and development of oil and gas reserves in the North West of Western Australia, with an excellent environmental record, while providing revenue to State and Commonwealth Governments, returns to shareholders, jobs and support to local communities. Titles for oil and gas exploration are released based on commitments to explore with the aim of uncovering and developing resources. It is under the lease agreement that Woodside has determined the potential to develop the hydrocarbon fields for which acceptance of this EP is sought under the Environment Regulations. Woodside has established a number of research projects in order to understand the marine environments in which it operates, notably in the Exmouth Region, Dampier Archipelago and the Kimberley Region, including Rankin Bank and Scott Reef. Where scientific data does not exist, Woodside assumes a pristine natural environment exists and, therefore, implements all practicable steps to prevent damage. Woodside's corporate values (**Appendix A**) require that we consider the environment and communities in which we operate when making decisions. Woodside looks after the communities and environments in which it operates. Risks are inherent in petroleum activities; however through sound management and systematic application of policies, standards, procedures and processes, Woodside considers that despite this risk, the extremely low likelihood of loss of well integrity is acceptable. <u>Internal Context</u> The Petroleum Activities Program is consistent with Woodside corporate policies, standards, procedures, processes and training requirements as outlined in the Demonstration of ALARP and Environmental Performance Outcomes, including: • Woodside Health, Safety, Environment and Quality Policy (**Appendix A**) • Woodside Risk Management Policy (**Appendix A**) Oil spill preparedness and response strategies are considered applicable to the nature and scale of the risk and associated impacts of the response are reduced to ALARP (**Appendix D**). Woodside corporate values include working sustainably with respect to the environment and communities in which we operate, listening to internal and external stakeholders, and considering HSE when making decisions. Stakeholder consultation, outlined below, has been performed prior to the Petroleum Activities Program. <u>External Context – Societal Values (includes environmental consequence and stakeholder expectations)</u> Woodside recognises that its licence to operate from a regulator and societal perspective is based on historical performance, complying with appropriate policies, standards and procedures, and understanding the expectations of external stakeholders. External stakeholder consultation, outlined below, has been undertaken prior to the Petroleum Activities Program: • Woodside has consulted with AMSA and WA DoT on spill response strategies. In accordance with the MoU between Woodside and AMSA, a copy of the Oil Pollution First Strike Plan was provided to AMSA and WA DoT. • Other relevant stakeholders have been consulted (**Section 5**) and their feedback incorporated into this EP where appropriate. • The impact assessment has determined that there is unlikely to be a major long-term environmental impact on the offshore environment or sensitive nearshore and shoreline habitats from a loss of well integrity. • By providing additional measures to prevent loss of well integrity, in addition to oil spill response measures that are commensurate with the current risk rating, location and sensitivity of the receiving environment (including social and aesthetic values), Woodside believes this addresses societal concerns to an acceptable level. <u>Other Requirements (includes laws, policies, standards and conventions)</u> The Petroleum Activities Program is consistent with laws, policies, standards and conventions, including: • subsea BOP function testing in accordance with API Standard 53, 4th Edition • mutual aid MoU in place for relief well drilling: Woodside develops a Well Blowout Contingency Plan for each well, which is signed off by the Drilling Engineering Manager and maintains a list of rigs that are currently operating in Western Australia • Offshore Petroleum and Greenhouse Gas Storage (Resource Management and Administration) Regulations 2011: accepted WOMP and application to drill • the Management Plan for the Ningaloo Marine Park and Muiron Islands Marine Management Areas and the Ningaloo Marine Park (Commonwealth Waters) Management Plan

Demonstration of Acceptability
• considerations to water quality, coral, shoreline and intertidal, macroalgal, seagrass, mangroves, seabirds and social and economic values, consistent with the objectives of the management plans • notification of reportable and recordable incidents to NOPSEMA, if required, in accordance with **Section 7.8**.

Environmental Performance Outcomes, Standards and Measurement Criteria			
Outcomes	***Controls***	***Standards***	***Measurement Criteria***
EPO 12 No loss of well integrity resulting in loss of hydrocarbons to the marine environment during Petroleum. Activities Program.	**C 11.1** Offshore Petroleum and Greenhouse Gas Storage (Resource Management and Administration) Regulations 2011: accepted WOMP, which describes the well design and barriers to be used to prevent a loss of well integrity, specifically: • All permeable zones penetrated by the well bore, containing hydrocarbons or over-pressured water, shall be isolated from the surface environment by a minimum of two barriers (primary and secondary) (a single fluid barrier may be implemented during the initial stages of well construction if appropriateness is confirmed by a shallow hazard study). • Discrete hydrocarbon zones shall be isolated from each other (to prevent cross flow) by a minimum of one barrier where deemed required. • All normally pressured permeable water-bearing formations shall be isolated from the surface by a minimum of one barrier. The barriers shall: • be effective over the lifetime of well construction • (fluid barriers) remain monitored and provide sufficient pressure to counter pore pressure during well construction • (cementing barriers including conductor, casing and liners) conform to the relevant minimum Woodside standards. Verification: • effectiveness of primary and secondary barriers shall be verified (physical evidence of the correct placement and performance) during the drilling of the well.	**PS 11.1** Wells drilled in compliance with the accepted WOMP, including implementation of barriers to prevent a loss of well integrity.	**MC 11.1.1** Acceptance letter from NOPSEMA demonstrates the WOMP and application to drill were accepted by NOPSEMA prior to the drilling activity commencing. **MC 11.1.2** Records demonstrate minimum of two verified barriers (a single fluid barrier may be implemented during the initial stages of well construction if appropriateness is confirmed by a shallow hazard study) were in place for all permeable zones penetrated by the wellbore. **MC 11.1.3** Records demonstrate composition and weight of drilling fluids were applicable to down hole conditions.
	C 11.2 As-built checks shall be completed during well operations.	**PS 11.2**	**MC 11.2.1** Records of as-built checks.

Environmental Performance Outcomes, Standards and Measurement Criteria			
Outcomes	***Controls***	***Standards***	***Measurement Criteria***
		Achieve a minimum acceptable standard of well integrity.	**MC 11.2.2** Records demonstrate well acceptance criteria have been met.
	C 12.1 Implement requirements for permanent well abandonment: • well barrier as per the internal Woodside Standard and Procedure • placement, length, material and verification of a permanent barrier.	**PS 12.1** Woodside abandons the wells according to internal Woodside Procedure.	**MC 11.2.2** Records demonstrate well acceptance criteria have been met.
	C 12.2 An approved Blowout Contingency Plan shall exist prior to drilling each well, including feasibility and any specific considerations for relief well kill.	**PS 12.2** Ensures feasibility of performing a well kill operation.	**MC 12.2.1** An approved Well Blowout Contingency Plan.
	C 11.3 Subsea BOP installed and function tested during drilling operations. The BOP shall include: • one annular preventer • two pipe rams (excluding the test rams) • a minimum of two sets of shear rams, one of which must be capable of sealing • deadman functionality • the capability of ROV intervention • independent power systems.	**PS 11.3** Subsea BOP specification, installation and function-testing compliant with internal Woodside Standards and international requirements (API Standard 53 4th Edition) as agreed between Woodside and MODU Contractor.	**MC 11.3.1** Records demonstrate that BOP and BOP control system specifications and function testing were in accordance with minimum standards for the expected drilling conditions as agreed between Woodside and MODU Contractor.
	C 2.2 Project-specific Mooring Design Analysis.	**PS 2.2** Anchors installed as per Mooring Design Analysis to ensure adequate MODU station holding capacity.	**MC 2.2.1** Records demonstrate Mooring Design Analysis completed and implemented during anchor deployment.
For oil spill response outcomes, standards and measurement criteria refer to **Appendix D**.			

6.7.3 Accidental Hydrocarbon Release: Vessel Collision

Context		
Project vessels – **Section 3.5**	Physical environment – **Section 4.4** Biological environment – **Section 4.5** Socio-economic environment – **Section 4.6** Values and sensitivities – **Section 4.7**	Stakeholder consultation – **Section 5**

Impacts and Risks Evaluation Summary

Source of Risk	***Environmental Value Potentially Impacted***							***Evaluation***						
	Soil and Groundwater	***Marine Sediment***	***Water Quality***	***Air Quality (incl Odour)***	***Ecosystems/Habitat***	***Species***	***Socio-Economic***	***Decision Type***	***Consequence***	***Likelihood***	***Current Risk Rating***	***ALARP Tools***	***Acceptability***	***Outcome***
Loss of hydrocarbons to marine environment due to a vessel collision (e.g. support vessels or other marine users)			X		X	X	X	A	D	1	**M**	LCS GP PJ	Broadly Acceptable	EPO 13

Description of Source of Risk

Background

The temporary presence of the MODU and project vessels in the Operational Area will result in a navigational hazard for commercial shipping within the immediate area (as discussed in **Section 6.6.1**). This navigational hazard could result in a third party vessel colliding with the MODU or a project vessel which could release hydrocarbons (**Section 6.7.2** of this EP). Refuelling of the primary installation vessels may be required at sea, with the possibility of a collision resulting in a hydrocarbon release from the fuel tanker.

The MODU has a total marine diesel capacity of about 966–1400 m^3 that is distributed through a number of isolated tanks. MODU fuel tanks are located in the MODU pontoons, typically located on the inner sides of pontoons, and can be over 10 m below the waterline.

The marine diesel storage capacity of a support vessel can also be in the order of 1000 m^3 (total), distributed through multiple isolated tanks typically located mid-ship, and can range in typical size from 22 to 105 m^3.

A typical primary installation vessel is likely to have multiple isolated fuel tanks distributed throughout the hull of the vessel. Individual fuel tanks are typically 500 to 1000 m^3 in volume. In the unlikely event of a vessel collision involving a primary installation vessel during the Petroleum Activities Program, the vessels will have the capability to pump fuel from a ruptured tank to a tank with spare volume in order to reduce the potential volume of fuel released to the environment.

A fuel tanker, which may be used to refuel a primary installation vessel at sea, would have a maximum single tank inventory of up to 2000 m^3.

Industry Experience

Registered vessels or foreign flag vessels in Australian waters are required to report events to the Australian Transport Safety Bureau (ATSB), AMSA or Australian Search and Rescue (AusSAR).

From a review of the ATSB marine safety and investigation reports relevant to oil and gas industry vessels conducted for this EP, one vessel collision occurred in 2011/12 that resulted in a spill of 25–30 L of oil into the marine environment as a result of a collision between a tug and support vessel off Barrow Island. Two other vessel collisions occurred in 2010, one in the port of Dampier, where a support vessel collided with a barge being towed. Minor damage was reported and no significant injury to personnel or pollution occurred. The second 2010 vessel collision involved a vessel under pilot control in port connecting with a vessel alongside a wharf, causing it to sink. No reported pollution resulted from the sunken vessel. These incidents demonstrate the likelihood of only minor volumes of hydrocarbons being released during the highly unlikely event of a vessel collision.

From 2010 to 2011, the ATSB's annual publication defines the individual safety action factors identified in marine accidents and incidents: 42% related to navigation action (2011). Of those, 15% related to poor communication and 42% related to poor monitoring, checking and documentation. The majority of these related to the grounding instances.

Credible Scenario

For a vessel collision to result in the worst-case scenario of a hydrocarbon spill potentially impacting an environmental receptor, several factors must align as follows:

- The identified causes of vessel interaction must result in a collision.
- The collision must have enough force to penetrate the vessel hull.
- The collision must be in the exact location of the fuel tank.
- The fuel tank must be full, or at least of volume which is higher than the point of penetration.

The probability of the chain of events described above aligning, to result in a breach of fuel tanks resulting in a spill that could potentially affect the marine environment, is considered remote. Given the offshore location of the Operational Area, vessel grounding is not considered a credible risk.

The environmental risk analysis and evaluation identified and assessed a range of potential scenarios that could result in a loss of vessel structural integrity, resulting in damage to fuel storage tank(s) and a loss of marine diesel to the marine environment (**Table 6-14**). The scenarios considered damage to single and multiple fuel storage tanks in the support vessel, primary installation vessel, MODU and fuel tanker due to dropped objects and various combinations of vessel-to-vessel and vessel-to-MODU collisions. In summary:

- It is not a credible scenario that the total storage volume of the MODU would be lost, as fuel is stored in more than one tank.
- It is not a credible scenario that a storage tank on the MODU would be damaged due to the location of the tanks within the hull, behind the bilge tanks, below the waterline.
- It is not a credible scenario that a collision between the support vessel and MODU would damage any storage tanks, due to the location of the tanks on both vessel types and secondary containment.
- It is highly unlikely that the full volume of the largest storage tank on a support vessel or primary installation vessel would be lost.

Two additional scenarios were considered: a collision between the support vessel or primary installation vessel with a third party vessel (i.e. commercial shipping, other petroleum related vessels and commercial fishing vessels); and a collision between a primary installation vessel and a fuel tanker. A collision between the support vessel or primary installation vessel with a third party vessel was assessed as being credible but highly unlikely, given the distance of the Operational Area from the nearest shipping fairway (about 40 km away); standard vessel operations and equipment in place to prevent collision at sea; the short duration of primary installation vessel operations on the Operational Area; the low vessel speed of support vessels and operation in close proximity to the MODU (exclusion areas) when present, as required, to perform standby duties; and the construction and placement of storage tanks. The largest tank of the support vessel is unlikely to exceed 105 m^3; the largest tank volume of a primary installation vessel is unlikely to exceed 500 to 1000 m^3.

A collision between a primary installation vessel and a fuel tanker was also considered credible. A fuel tanker may be used to refuel a primary installation vessel at sea, with maximum single tank inventory of up to 2000 m^3. The maximum volume to be assumed in the assessment is therefore 2000 m^3 of marine diesel, which corresponds to rupture of the largest single tank inventory of the fuel tanker. Given the speed at which the vessels will be moving, it is not considered credible to rupture fuel tanks on both the tanker and installation vessel.

Table 6-14: Summary of hydrocarbon spill scenario as a result of vessel collision

Scenario	Hydrocarbon Volumes	Preventative and Mitigation Controls	Credibility
Breach of support vessel fuel tanks due to support vessel – other vessel collision including commercial shipping/fisheries.	Activity support vessel has multiple marine diesel tanks typically ranging between 22–105 m³ each.	Typically double wall, tanks which are located midship (not bow or stern). Vessels are not anchored and steam at low speeds when relocating within the Operational Area or providing stand-by cover. Normal maritime procedures would apply during such vessel movements.	**Credible** Activity support vessel–other vessel collision could potentially result in the release from a fuel tank.
Breach of primary installation vessel fuel tanks due to collision with another vessel including commercial shipping/fisheries.	Primary installation vessels have multiple isolated tanks, largest volume of a single tank is unlikely to exceed 500 to 1000 m³.	Tank locations midship (not bow or stern). Primary installation vessels will be holding station during installation activities or steaming at low speeds when relocating within the Operational Area.	**Credible** Primary installation vessel–third party vessel collision could potentially result in the release from a fuel tank.
Breach of the largest single tank inventory of a fuel tanker due to collision with a primary installation vessel.	A fuel tanker will have a maximum single inventory tank of 2000 m³.	Refer to **Section 6.7.4** for preventative and mitigation controls.	**Credible** Primary installation vessel–fuel tanker collision could potentially result in the release from a fuel tank. It is noted that this scenario is only credible if refuelling of a Primary installation vessel is required in the field.
Breach of MODU fuel tanks due to support vessel collision.	MODU has a fuel oil storage capacity of about 966–1400 m³ (**Table 3-4**), distributed through multiple tanks.	Fuel tanks are located on the inside of pontoons and protected by location below water line, protection from other tanks e.g. bilge tanks. The draught of vessel and location of tanks in terms of water line prevent the tanks from being breached.	**Not credible** Due to location of tanks.
Breach of support vessel fuel tanks due to collision with MODU.	Activity support vessel has multiple marine diesel tanks typically ranging between 22–105 m³ each.	Typically double wall tanks which are located mid ship (not bow or stern). Slow support vessel speeds when in close proximity to MODU.	**Not credible** Collision with MODU at slow speeds is highly unlikely and if it did occur, is highly unlikely to result in a breach of support vessel (low energy contact from slow moving vessel).
Dropped object from back-loading/ offloading operations rupturing the MODU fuel tanks (e.g. a container or piece of equipment).	MODU has a fuel oil storage capacity of about 966–1400 m³, distributed through multiple tanks.	Fuel tanks are located on the inside of pontoons and protected by location the below water line, protection from other tanks, e.g. bilge tanks. The draught of vessel and location of tanks in terms of water line prevent the tanks from being breached.	**Not credible** No direct pathway to tanks from dropped objects.

Quantitative Hydrocarbon Risk Assessment

Modelling was performed by RPS, on behalf of Woodside, to determine the fate of marine diesel released from a collision at a location within the Operational Area. The modelling assessed the extent of a marine diesel spill volume of 2000 m³ for all seasons, using an historic sample of wind and current data for the region. A total of 100 simulations for each season were modelled.

Hydrocarbon Characteristics

Marine diesel is a mixture of both volatile and persistent hydrocarbons. Predicted weathering of marine diesel, based on typical conditions in the region, indicates that about 35% by mass would be expected to evaporate over the first 24 hours (**Figure 6-3**). After this time the majority of the remaining hydrocarbon is entrained into the upper water column, leaving only a small proportion of the oil floating on the water surface (<1%). Given the large proportion of entrained oil and the tendency for it to remain mixed in the water column, the remaining hydrocarbons will decay and/or evaporate over time scales of several weeks to a few months, thereby extending the area of potential effect.

Given the environmental conditions experienced in the Operational Area, marine diesel is expected to undergo rapid spreading and this, together with evaporative loss, is likely to result in a rapid dissipation of the spill. Marine diesel distillates tend not to form emulsions at the temperatures found in the region. Therefore, there is no potential for the spill to extend to sensitive shorelines or mainland receptors above threshold concentrations. The characteristics of the marine diesel used in the modelling are given in **Table 6-15**.

Table 6-15: Characteristics of the marine diesel used in the modelling

Hydrocarbon Type	Initial Density (g/cm³) at 25 ºC	Viscosity (cP @ 25 ºC)	Component BP (ºC)	Volatiles %<180	Semi volatiles % 180–265	Low Volatility (%) 265-380	Residual (%) >380
				Non-Persistent			Persistent
Marine diesel (surrogate for marine gas oil)	0.829	4.0	% of total	6	34.6	54.4	5

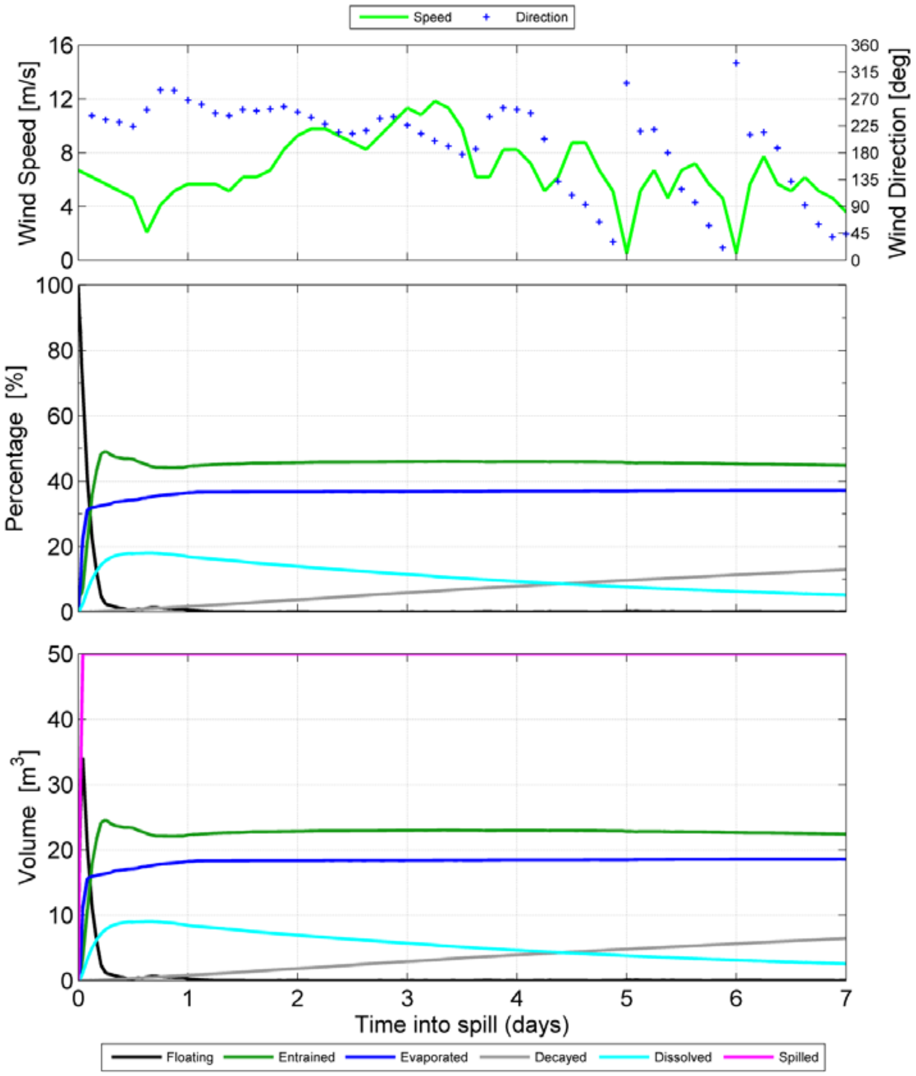

Figure 6-3: Proportional mass balance plot representing weathering of a 2000 m³ surface spill of marine diesel as a one-off release (at a rate of 50 m³/hr) and subject to variable wind at 27 °C water temperature and 25 °C air temperature

Impact Assessment
Potential Impacts Overview
Environment that May Be Affected Surface Hydrocarbons: Quantitative hydrocarbon spill modelling results for surface hydrocarbons are shown in **Table 6-16**. If this scenario occurred, a surface hydrocarbon slick would form down-current of the release location, with the trajectory dependent on prevailing wind and current conditions at the time. The modelling indicates that the EMBA would be confined to open water, with floating oil extending up to about 88 km from the release location at or above the 10 g/m² impact threshold. Entrained Hydrocarbons: Quantitative hydrocarbon spill modelling results are shown in **Table 6-16**. If this vessel collision scenario occurred, a plume of entrained hydrocarbons would form down-current of the release location, with the trajectory dependent on prevailing current conditions at the time. The modelling indicates locations within reach of entrained hydrocarbon at or above the EMBA threshold concentration of 500 ppb are restricted to offshore areas up to about 524 km from the release site. **Table 6-16** provides details of receptors potentially contacted by entrained diesel at 500 ppb. Dissolved Hydrocarbons: Dissolved aromatic hydrocarbons at concentrations equal to or greater than the 500 ppb threshold are predicted to be found up to about 63 km from the spill site and are not expected to reach any sensitive receptor habitats (**Table 6-16**).

Accumulated Hydrocarbons: Accumulated hydrocarbons above threshold concentrations (>100 g/m²) were not predicted by the modelling to occur at any location.

Taking into consideration the EMBA derived from hydrocarbon spill modelling for a marine diesel spill, the environment that may be affected will fall within the EMBA of the crude spill outlined in **Section 6.7.2**.

Table 6-16: Probability of hydrocarbon spill contact above impact thresholds within the EMBA with key receptor locations and sensitivities for a 2000 m³ Instantaneous release of marine diesel

Environmental setting	Location/name	Environmental, Social, Cultural, Heritage and Economic Aspects presented as per the Environmental Risk Definitions (Woodside's Risk Management Procedure (WM0000PG10055394))																													Probability of hydrocarbon contact (diesel) (%) Note: the probability is based on stochastic modelling of 300 hypothetical worst-case spills under a variety of weather and metocean conditions			
		Physical		Biological																						Socio-economic and Cultural								
		Water Quality	Sediment Quality	Marine Primary Producers			Other Communities/Habitats								Protected Species									Other Species										
		Open water (pristine)	Marine sediment (pristine)	Coral reef	Seagrass beds/macroalgae	Mangroves	Spawning/nursery areas	Open water – productivity/ upwelling	Non-biogenic coral reefs	Offshore filter feeders and/or deepwater benthic communities	Nearshore filter feeders	Sandy shores	Estuaries/tributaries/creeks/ lagoons (including mudflats)	Rocky shores	Cetaceans – migratory whales	Cetaceans – dolphins and porpoises	Dugongs	Pinnipeds (sea lions and fur seals)	Marine turtles (including foraging and internesting areas and significant nesting beaches)	Seasnakes	Whale sharks	Sharks and rays	Sea birds and/or migratory shorebirds	Pelagic fish populations	Resident/demersal fish	Fisheries – commercial	Fisheries – traditional	Tourism and recreation	Protected areas/heritage – European and Indigenous/shipwrecks	Offshore oil & gas infrastructure (topside and subsea)	Surface hydrocarbon (≥10 g/m²)	Entrained hydrocarbon (≥500 ppb)	Dissolved aromatic hydrocarbon (≥500 ppb)	Accumulated hydrocarbons (>100 g/m²)
Offshore[32]	Montebello AMP	✓	✓	✓			✓	✓							✓	✓			✓	✓	✓	✓	✓	✓	✓	✓		✓	✓*		2	7.5		
	Ningaloo Middle and North WHA																															1		
	Gascoyne AMP	✓	✓												✓	✓			✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓		4		
	Ningaloo AMP	✓						✓		✓					✓	✓			✓		✓	✓	✓	✓	✓	✓		✓	✓			1		
Islands	Montebello Islands State Marine Park	✓	✓	✓	✓	✓	✓	✓				✓		✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓		✓	✓			0.5		
	Pilbara Islands – Southern Island Group	✓	✓		✓		✓		✓			✓		✓		✓	✓		✓	✓		✓	✓	✓	✓	✓		✓	✓			1		
	Muiron Islands	✓	✓	✓	✓		✓	✓		✓		✓		✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓			✓	✓			0.5		
Mainland (nearshore waters)	WA Coastline	✓	✓	✓	✓	✓	✓		✓		✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓		1		

[32] Note: hydrocarbons cannot accumulate on open ocean, submerged receptors, or receptors not fully emergent.

Summary of Potential Impacts to Protected Species, Other Habitats and Communities, Water Quality and Socio-economic Values
No receptors are contacted by dissolved aromatic hydrocarbons >500 ppb or floating/accumulated oil concentrations equal to or greater than 1 g/m². Entrained hydrocarbons >500 ppb may contact receptors, with the greatest likelihood and concentrations found at the Montebello AMP (7.5% probability of contact at concentrations >500 ppb) and Gascoyne Marine Park (4% probability of contact at concentrations >500 ppb). All other sensitive locations identified in **Table 6-16** are predicted to have a 1% probability or less of contact at concentrations >500 ppb. The potential impacts of entrained hydrocarbons to species (protected and otherwise), marine primary producers, other habitats and communities, water quality, marine sediment quality, air quality, protected areas and socio-economic values are described in **Section 6.7.2**. The loss of well integrity EMBA is larger spatially than the marine diesel EMBA; therefore, the potential impacts of entrained hydrocarbons provided in **Section 6.7.2**, and the scale of impact described, provides a conservative assessment for potential impacts of a 2000 m³ release of marine diesel due to vessel collision. Further detail on impacts specific to a spill of marine diesel are provided below. It is noted that the toxic components in marine diesel include alkylated naphthalenes which can be rapidly accumulated by marine biota including invertebrates such as marine oysters, clams, shrimp, as well as a range of vertebrates, such as finfish. Marine diesel also contains additives that contribute to its toxicity. **_Protected Species_** As identified in **Section 4.5.2**, protected species including pygmy blue whales and marine turtles may be encountered within the Operational Area, and therefore could be impacted by a marine diesel spill. No critical habitats or aggregation areas (feeding, breeding, resting) have been identified within the EMBA. Although the EMBA may spatially overlap with the BIAs identified in **Section 4.5.2**, it is considered that protected species that are present will be predominantly transiting through the area. If marine fauna come into contact with a release, they could suffer fouling, ingestion, inhalation of toxic vapours, irritation of sensitive membranes in the eyes, mouth, digestive and respiratory tracts, and organ or neurological damage. Given the localised area of the potential EMBA and the dilution and weathering of any spill, it is expected that any potential impacts will be low magnitude and temporary in nature. **_Other Habitats, Species and Communities_** Within the EMBA for a marine diesel spill resulting from a vessel collision, there is the potential for plankton communities to potentially be impacted where entrained hydrocarbon threshold concentrations are exceeded. Communities are expected to recover quickly (weeks/months) due to high population turnover (ITOPF, 2011). It is therefore considered that any potential impacts would be low magnitude and temporary in nature. Pelagic fish populations in the open water offshore environment of the EMBA are highly mobile and have the ability to move away from a marine diesel spill. The spill-affected area would likely be confined to the upper surface layers. It is therefore unlikely that fish populations would be exposed to widespread hydrocarbon contamination. Fish populations are likely to be distributed over a wide geographical area so impacts on populations or species level are considered to be negligible. Combined with these factors and the rapid dispersion of marine diesel, it is considered that any potential impacts will be minor. While other communities (e.g. demersal fish, benthic infauna and epifauna) and key sensitivities (e.g. KEFs identified in **Section 4.7.11**) may be within the EMBA, they are unlikely to be directly impacted by a marine diesel spill as hydrocarbons are confined to the upper layers of the water column. **_Water Quality_** It is likely that water quality will be reduced at the release location of the spill; however, such impacts to water quality would be temporary and localised in nature due to the rapid dispersion and weathering of marine diesel. The potential impact is therefore expected to be low. **_Protected Areas_** Entrained hydrocarbons at or exceeding the 500 ppb threshold have a low probability of contacting the Montebello Marine Park, Gascoyne Marine Park and Ningaloo World Heritage Area. However, maximum entrained oil concentration (ppb) averaged over all replicate simulations only exceeded the 500 ppb threshold at Montebello Marine Park (at a concentration of 625 ppb). Entrained hydrocarbons are only predicted within the deep open waters of these protected areas, with no shoreline contact. Potential impacts to water quality and mobile pelagic species in these areas would be temporary and localised in nature due to the rapid dispersion and weathering of the marine diesel. **_Socio-economic_** A marine diesel spill is considered unlikely to cause significant direct impacts on the target species fished by the Commonwealth and State fisheries (see **Section 4.6.3**) which overlap with the EMBA. These fisheries predominantly target demersal fish species (demersal finfish and crustaceans) that inhabit waters in the range of >60–200 m depth or pelagic species which are highly mobile. Therefore, a marine diesel spill due is expected to only result in negligible impacts, considering that hydrocarbons are confined to the upper layers of the water column. However, there is the potential that a fishing exclusion zone would be applied in the area of the spill, which would put a temporary ban on fishing activities and therefore potentially lead to subsequent economic impacts on commercial fishing operators if they were planning to fish within the area of the spill.

Summary of Potential Impacts to Environmental Values
In the unlikely event of an unplanned hydrocarbon release to the marine environment due to vessel collision, combined with the adopted controls, it is considered that any potential impact to water quality would be minor, localised and temporary in nature in comparison to background levels and/or international standards, with localised and temporary impacts to habitats, populations and shipping/fishing concerns. The highest environmental consequence identified for the assessment of an unplanned hydrocarbon release to the marine environment due to vessel collision, as classified in **Figure 2-6**, is defined as D, which equates to minor, short-term impact (1–2 years) on species, habitat (but not affecting ecosystems), physical or biological attributes.

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS)***[33]	***Benefit in Impact/ Risk Reduction***	***Proportionality***	***Control Adopted***
Legislation, Codes and Standards				
Marine Order 30 (prevention of collisions) 2016, including: • adherence to steering and sailing rules including maintaining lookouts (e.g. visual, hearing, radar, etc.), proceeding at safe speeds, assessing risk of collision and taking action to avoid collision (monitoring radar) • adherence to navigation light display requirements, including visibility, light position/shape appropriate to activity • adherence to navigation noise signals as required.	F: Yes. CS: Minimal cost. Standard practice.	Legislative requirements to be followed reduce the likelihood of interference with other marine users resulting in a collision.	Controls based on legislative requirements – must be adopted.	Yes C 13.1
Marine Order 21 (safety of navigation and emergency procedures) 2016, including: • adherence to minimum safe manning levels • maintenance of navigation equipment in efficient working order (compass/radar) • navigational systems and equipment required are those specified in Regulation 19 of Chapter V of *Safety of Life at Sea* • Automatic Identification System (AIS) that provides other users with information about the vessel's identity, type, position, course, speed, navigational status and other safety-related data.	F: Yes. CS: Minimal cost. Standard practice.	Legislative requirements to be followed reduce the likelihood of interference with other marine users and thus the likelihood of a collision.	Controls based on legislative requirements – must be adopted.	Yes C 13.2
Establishment of a 500 m petroleum safety zone around MODU and primary installation vessels and communicated to marine users.	F: Yes. CS: Minimal cost. Standard practice.	Legislative requirements to be followed reduce the likelihood of a	Controls based on legislative requirements – must be adopted.	Yes C 13.3

[33] Qualitative measure

<table>
<tr><th colspan="5">Demonstration of ALARP</th></tr>
<tr><th>Control Considered</th><th>Control Feasibility (F) and Cost/Sacrifice (CS)[33]</th><th>Benefit in Impact/ Risk Reduction</th><th>Proportionality</th><th>Control Adopted</th></tr>
<tr><td></td><td></td><td>collision with a third party vessel.</td><td></td><td></td></tr>
<tr><td colspan="5">Good Practice</td></tr>
<tr><td>A support vessel is on standby as required during drilling activities to assist in third-party vessel interactions (including warning to vessels approaching the 500m petroleum safety zone).</td><td>F: Yes.
CS: Minimal cost – support vessels available routinely in Operational Area during Petroleum Activities Program. Standard practice.</td><td>Provides a small reduction in likelihood of a collision with a third party vessel.</td><td>Benefits outweigh cost/sacrifice.</td><td>Yes
C 13.4</td></tr>
<tr><td>When a support vessel is designated for standby it will undertake actions to prevent unplanned interactions, such as:
• Maintain a 24 hour radio watch on designated radio channel(s).
• Perform continuous surveillance and warn the MODU/primary installation vessels of any approaching vessels reaching 500 m petroleum safety zone. Surveillance shall be conducted by a combination of:
– visual lookout
– radar watch
– other electronic systems available including AIS
– monitoring any additional/agreed radio communications channels
– all other means available.
• While complying with Convention on the International Regulations for Preventing Collisions at Sea, 1972 (COLREGS), approach any vessel attempting to transit through the 500 m zone and contact vessel by all available means.
• Monitor and advise the MODU if:
– MODU navigation signals are defective
– visibility becomes restricted.
• Advise if any buoys in the area are not holding position or are not working as expected.</td><td>F: Yes.
CS: Minimal cost – support vessels available routinely in Operational Area during Petroleum Activities Program. Standard practice.</td><td>Provides a reduction in likelihood of a collision with a third party vessel.</td><td>Benefits outweigh cost/sacrifice.</td><td>Yes
C 13.5</td></tr>
</table>

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS)[33]***	***Benefit in Impact/ Risk Reduction***	***Proportionality***	***Control Adopted***
Notify AHS of activities and movements no less than four working weeks prior to the scheduled activity commencement date.	F: Yes. CS: Minimal cost. Standard practice.	Notification to AHS will enable them to generate navigation warnings (Maritime Safety Information Notifications (MSIN) and Notice to Mariners (NTM) (including AUSCOAST warnings where relevant)).	Benefits outweigh cost/sacrifice. Control is also Standard Practice.	Yes C 1.1
Notify AMSA JRCC of activities and movements of the activity 24–48 hours before operations commence.	F: Yes. CS: Minimal cost. Standard practice.	Communication of the Petroleum Activities Program to other marine users ensures they are informed and aware, thereby reducing the likelihood of a collision with a third party vessel.	Benefits outweigh cost/sacrifice. Control is also Standard Practice.	Yes C 1.3
Mitigation: Oil spill response.	Refer to **Appendix D**.			
Professional Judgement – Eliminate				
Eliminate use of vessels.	F: No. The use of vessels is required to conduct the Petroleum Activities Program. CS: Not considered – control not feasible.	Not considered – control not feasible.	Not considered – control not feasible.	No
Professional Judgement – Substitute				
No additional controls identified.				
Professional Judgement – Engineered Solution				
No additional controls identified.				
Risk Based Analysis				
A quantitative spill risk assessment was performed (see detail above).				
ALARP Statement On the basis of the environmental risk assessment outcomes and use of the relevant tools appropriate to the decision type (i.e. Decision Type A), Woodside considers the adopted controls appropriate to manage the impacts and risks of an unplanned loss of hydrocarbon as a result of vessel collision. As no reasonable additional/alternative controls were identified that would further reduce the impacts and risks without grossly disproportionate sacrifice, the impacts and risks are considered ALARP.				

Demonstration of Acceptability
Acceptability Statement The impact assessment has determined that an unplanned loss of hydrocarbon as a result of a vessel collision represents a low current risk rating that is unlikely to result in potential impact greater than localised, minor and temporary disruption to a small proportion of the population and no impact on critical habitat or activity. Further opportunities to reduce the impacts and risks have been investigated above. The adopted controls are consistent with the most relevant regulatory guidelines, good oil-field practice/industry best practice, and in some cases are above industry best practice and meet legislative requirements of Marine Orders 30 and 21. The potential impacts and risks are considered acceptable if the adopted controls are implemented. Therefore, Woodside considers the adopted controls appropriate to manage the impacts and risks of a loss of vessel structural integrity to a level that is broadly acceptable.

Environmental Performance Outcomes, Standards and Measurement Criteria			
Outcomes	***Controls***	***Standards***	***Measurement Criteria***
EPO 13 No release of hydrocarbons to the marine environment due to a vessel collision during the Petroleum activities Program.	**C 13.1** Marine Order 30 (prevention of collisions) 2016, including: • adherence to steering and sailing rules including maintaining lookouts (e.g. visual, hearing, radar, etc.), proceeding at safe speeds, assessing risk of collision and taking action to avoid collision (monitoring radar) • adherence to navigation light display requirements, including visibility, light position/shape appropriate to activity • adherence to navigation noise signals as required.	**PS 13.1** Support vessels, primary installation vessels and MODU compliant with Marine Order 30 (prevention of collisions) 2016 (which requires vessels to be visible at all times) to prevent unplanned interaction with marine users.	**MC 13.1.1** Marine Assurance inspection records demonstrate compliance with standard maritime safety procedures (Marine Orders 21 and 30).
	C 13.2 Marine Order 21 (safety of navigation and emergency procedures) 2016, including: • adherence to minimum safe manning levels • maintenance of navigation equipment in efficient working order (compass/radar) • navigational systems and equipment required are those specified in Regulation 19 of Chapter V of *Safety of Life at Sea* • AIS that provides other users with information about the vessel's identity, type, position, course, speed, navigational status and other safety-related data.	**PS 13.2** Support vessels, primary installation vessels and MODU compliant with Marine Order 21 (safety of navigation and emergency procedures) 2016 to prevent unplanned interaction with marine users.	
	C 13.3 Establishment of a 500 m petroleum safety zone around MODU and primary installation vessels and communicated to marine users.	**PS 13.3** No entry of unauthorised vessels within the 500 m safety exclusion zone.	**MC 13.3.1** Records demonstrate breaches by unauthorised vessels within the petroleum safety zone are recorded.

Environmental Performance Outcomes, Standards and Measurement Criteria			
Outcomes	***Controls***	***Standards***	***Measurement Criteria***
			MC 13.3.2 Consultation records demonstrate that AHS has been notified before commencing the activity to allow generation of navigation warnings (MSIN and NTM (including AUSCOAST warnings where relevant)), which communicate safety exclusion zones to marine users.
	C 13.4 Support vessel on standby as required during drilling activities to assist in third party vessel interactions (including warning to vessels approaching the 500 m petroleum safety zone).	**PS 13.4** Communicate with third-party vessels, prevent unplanned interaction and assist in emergencies, as required.	**MC 13.4.1** Records demonstrate an activity support vessel was on standby if required.
	C 13.5 When a support vessel is designated for standby it will undertake actions to prevent unplanned interactions, such as: • Maintain a 24 hour radio watch on designated radio channel(s). • Perform continuous surveillance and warn the MODU/primary installation vessels of any approaching vessels reaching the 500 m petroleum safety zone. Surveillance shall be conducted by a combination of: – visual lookout – radar watch – other electronic systems available including AIS – monitoring any additional/agreed radio communications channels – all other means available. • While complying with COLREGS, approach any vessel attempting to transit through the 500 m zone and contact vessel by all available means. • Monitor and advise the MODU if: – MODU navigation signals are defective – visibility becomes restricted. • Advise if any buoys in the area are not holding position or are not working as expected.	**PS 13.5** Define role of support vessels in maintaining petroleum safety zone, preventing unplanned third party vessel interactions, monitoring the effectiveness of navigation controls (e.g. signals), and warning third party vessels of navigation hazards.	**MC 13.5.1** Records of non-conformance against controls maintained.

Environmental Performance Outcomes, Standards and Measurement Criteria			
Outcomes	***Controls***	***Standards***	***Measurement Criteria***
	C 1.1 Notify AHS of activities and movements no less than four working weeks before prior to the scheduled activity commencement date.	**PS 1.1** Notification to AHS of activities and movements to allow generation of navigation warnings (Maritime Safety Information Notifications (MSIN) and Notice to Mariners (NTM) (including AUSCOAST warnings where relevant)).	**MC 1.1.1** Consultation records demonstrate that AHS has been notified before commencing the activity to allow generation of navigation warnings (MSIN and NTM (including AUSCOAST warnings where relevant)), which communicate safety exclusion zones to marine users.
	C 1.3 Notify AMSA JRCC of activities and movements of the activity 24–48 hours before operations commence.	**PS 1.3** Notification to AMSA JRCC to prevent activities interfering with other marine users. AMSA's JRCC will require the MODU's details (including name, callsign and MMSI), satellite communications details (including INMARSAT-C and satellite telephone), area of operation, requested clearance from other vessels and need to be advised when operations start and end.	**MC 1.3.1** Consultation records demonstrate that AMSA JRCC has been notified before commencing the activity within required timeframes.
Detailed preparedness and response performance outcomes, standards and measurement criteria for the Petroleum Activities Program are presented in **Appendix D**.			

6.7.4 Accidental Hydrocarbon Release: Bunkering

Context		
Project vessels – **Section 3.5** Helicopters – **Section 3.8.2**	Physical environment – **Section 4.4** Biological environment – **Section 4.5**	Stakeholder consultation – **Section 5**

Impacts and Risks Evaluation Summary

Source of Risk	*Environmental Value Potentially Impacted*							*Evaluation*						
	Soil and Groundwater	***Marine Sediment***	***Water Quality***	***Air Quality (incl Odour)***	***Ecosystems/Habitat***	***Species***	***Socio-Economic***	***Decision Type***	***Consequence***	***Likelihood***	***Current Risk Rating***	***ALARP Tools***	***Acceptability***	***Outcome***
Loss of hydrocarbons to marine environment from bunkering/refuelling			X			X		A	E	2	M	LCS GP	Broadly Acceptable	EPO 14

Description of Source of Risk

Bunkering of marine diesel between the support vessel(s) and the MODU or installation vessels occurs at the drilling location. Bunkering for a moored MODU is expected to be required about once per month or as required (**Section 3.8.2**). Additionally, refuelling of helicopters using aviation jet fuel may take place onboard the MODU.

Three credible scenarios for the loss of containment of marine diesel during bunkering operations were identified:

- Partial or total failure of a bulk transfer hose or fittings during bunkering, due to operational stress or other integrity issues, could spill marine diesel to the deck and/or into the marine environment. This would be in the order of less than 200 L, based on the likely volume of a bulk transfer hose (assuming a failure of the dry break coupling and complete loss of hose volume).
- Partial or total failure of a bulk transfer hose or fittings during bunkering, combined with a failure in procedure to shutoff fuel pumps, for a period of up to five minutes, could result in about 8 m³ marine diesel loss to the deck and/or into the marine environment.
- Partial or total failure of a bulk transfer hose or fittings during helicopter refuelling could spill aviation jet fuel to the helicopter deck and/or into the marine environment. All helicopter refuelling activities are closely supervised and leaks on the helideck are considered to be easily detectable. In the event of a leak, transfer would cease immediately. The credible volume of such a release during helicopter refuelling would be in the order of <100 L.

Quantitative Spill Risk Assessmentc

Woodside has commissioned RPS to model several small marine diesel spills, including surface spill volumes of 8 m³ in the offshore waters of northwest WA. The results of these models have indicated that exposure to surface hydrocarbons above the 10 g/m² threshold is limited to the immediate vicinity of the release site, with little potential to extend beyond 1 km. Therefore, it is considered that exposure to thresholds concentrations from an 8 m³ surface spill from bunkering activities would be well within the EMBA for the vessel collision scenario detailed in **Section 6.7.3**. Given this, the offshore location of the Operational Area, and the fact that the same hydrocarbon type is involved for both scenarios, specific modelling for an 8 m³ marine diesel release was not performed for this Petroleum Activities Program.

Given the physical and chemical similarities, and the relatively small credible spill volumes, marine diesel is considered to be a suitable substitute for aviation jet fuel for the purposes of this environmental risk assessment.

Hydrocarbon Characteristics

Refer to **Section 6.7.3** for a description of the characteristics of marine diesel, including detail on the predicted fate and weathering of a spill to the marine environment.

Impact Assessment
Potential Impacts Overview
Previous modelling studies for 8 m³ marine diesel releases, spilled at the surface as a result of bunkering activities, indicated that the potential for exposure to surface hydrocarbons exceeding 10 g/m² was confined to within the immediate vicinity (about 1 km) of the release sites. Based on the previous modelling studies and the modelling presented in **Section 6.7.3**, it is considered that there is no potential for contact with sensitive receptor locations above surface (10 g/m²), entrained (500 ppb) or dissolved (500 ppb) threshold concentrations from an 8 m³ spill of marine diesel within the Operational Area. The modelling presented in **Section 6.7.3** for a much larger volume diesel spill (2000 m³) predicted the diesel spill to be restricted to open offshore waters, with a low probability of contacting any protected areas (the highest was a probability of 7.5% for the spill to contact the open waters of the Montebello Marine Park at or above the threshold of 500 ppb).
Summary of Potential Impacts to Protected Species and Water Quality
The potential biological and ecological impacts associated with much larger hydrocarbon spills are presented in **Section 6.7.2** and **Section 6.7.3**; further detail on impacts specific to a spill of marine diesel from a bunkering loss are provided below. The biological consequences of such a small volume spill on identified open water sensitive receptors relate to the potential for minor impacts to megafauna, plankton and fish populations (surface and water column biota) that are within the spill affected area. No impacts to commercial fisheries are expected. Refer to **Section 6.7.3** (potential impacts of unplanned hydrocarbon release to the marine environment from vessel collision) for the detailed potential impacts. However, the extent of the EMBA associated with a marine diesel spill from loss during bunkering will be much reduced in terms of spatial and temporal scales, and hence, potential impacts from bunkering are considered very minor.

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS)[34]***	***Benefit in Impact/ Risk Reduction***	***Proportionality***	***Control Adopted***
Legislation, Codes and Standards				
Marine Order 91 (marine pollution prevention – oil) 2014, requires Ship Oil Pollution Emergency Plan (SOPEP)/Spill Monitoring Programme Execution Plan (SMPEP) (as appropriate to vessel class).	F: Yes. CS: Minimal cost. Standard practice.	Reduces the likelihood of a spill entering the marine environment. Although no significant reduction in consequence could result, the overall risk is reduced.	Controls based on legislative requirements – must be adopted.	Yes C 14.3
Good Practice				
Bunkering equipment controls: • All hoses that have a potential environmental risk following damage or failure shall be linked to the MODU's preventative maintenance system. • All bulk transfer hoses shall be tested for integrity before use (tested in accordance with Original Equipment Manufacturer recommendations) and re-certified annually as a minimum.	F: Yes. CS: Minimal cost. Standard practice.	Reduces the likelihood of a spill occurring. Although no significant reduction in consequence could result, the overall risk is reduced.	Benefits outweigh cost/sacrifice.	Yes C 14.1

[34] Qualitative measure.

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS)[34]***	***Benefit in Impact/ Risk Reduction***	***Proportionality***	***Control Adopted***
• There shall be dry-break couplings and flotation on fuel hoses. • There shall be an adequate number of appropriately stocked, located and maintained spill kits.				
Contractor procedures include requirements to be implemented during bunkering/refuelling operations, including: • A completed PTW and/or Job Safety Analysis (JSA) shall be implemented for the hydrocarbon bunkering/ refuelling operation. • Visual monitoring of gauges, hoses, fittings and the sea surface during the operation. • Hose checks prior to commencement. • Bunkering/refuelling will commence in daylight hours. If the transfer is to continue into darkness, the JSA risk assessment must consider lighting and the ability to determine if a spill has occurred. • Hydrocarbons shall not be transferred in marginal weather conditions.	F: Yes. CS: Minimal cost. Standard practice.	Reduces the likelihood of a spill occurring. Although no significant reduction in consequence could result, the overall risk is reduced.	Benefits outweigh cost/sacrifice.	Yes C 14.2
Mitigation: Oil spill response	Refer to **Appendix D**.			
Professional Judgement – Eliminate				
No refuelling of helicopter on MODU.	F: No. Given the distance of the Operational Area from the airports suitable for helicopter operations, and the endurance of available helicopters, eliminating helicopter refuelling is not feasible. Helicopter flights cannot be eliminated, and may be required in emergency situations. CS: Not assessed, control cannot feasibly be implemented.	Not considered – control not feasible.	Not considered – control not feasible.	No

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS)[34]***	***Benefit in Impact/ Risk Reduction***	***Proportionality***	***Control Adopted***
The MODU brought into port to refuel.	F: No. Does not eliminate the fuel transfer risk. It is not operationally practical to transit MODU back to port for refuelling, based on the frequency of the refuelling requirements and distance from the nearest port (Dampier 180 km). CS: Significant due to schedule delay and vessel transit costs and day rates.	Eliminates the risk in the Operational Area; however, moves risk to another location. Therefore, no overall benefit.	Disproportionate. The cost/sacrifice outweighs the benefit gained.	No
Professional Judgement – Substitute				
No additional controls identified.				
Professional Judgement – Engineered Solution				
No additional controls identified.				
ALARP Statement On the basis of the environmental risk assessment outcomes and use of the relevant tools appropriate to the decision type (i.e. Decision Type A), Woodside considers the adopted controls appropriate to manage the impacts and risks of a bunkering spill. As no reasonable additional/alternative controls were identified that would further reduce the impacts and risks without grossly disproportionate sacrifice, the impacts and risks are considered ALARP.				

Demonstration of Acceptability
Acceptability Statement Loss of hydrocarbons to the marine environment during bunkering has been evaluated as having a low current risk rating that is unlikely to result in potential impact greater than minor impacts to megafauna, plankton and fish populations (surface and water column biota) that are within the spill-affected area, and no impacts to commercial fisheries. Further opportunities to reduce the impacts and risks have been investigated above. The adopted controls are considered good oil-field practice/industry best practice. The potential impacts and risks are considered broadly acceptable if the adopted controls are implemented. Therefore, Woodside considers the adopted controls appropriate to manage the impacts and risks of the described emissions to a level that is broadly acceptable.

Environmental Performance Outcomes, Standards and Measurement Criteria			
Outcomes	***Controls***	***Standards***	***Measurement Criteria***
EPO 14 No unplanned loss of hydrocarbons to the marine environment from bunkering greater than a consequence level of F[35] during the Petroleum Activities Program.	**C 14.1** Bunkering equipment controls: • All hoses that have a potential environmental risk following damage or failure shall be linked to the MODU's preventative maintenance system. • All bulk transfer hoses shall be tested for integrity before use (tested in accordance with Original Equipment Manufacturer recommendations) and re-certified annually as a minimum. • There shall be dry-break couplings and flotation on fuel hoses. • There shall be an adequate number of appropriately stocked, located and maintained spill kits.	**PS 14.1** Ensure damaged equipment is replaced prior to failure.	**MC 14.1.1** Records confirm the MODU bunkering equipment is subject to systematic integrity checks.
		PS 14.2 Minimise inventory loss in the event of a failure.	**MC 14.2.1** Records confirm presence of dry break of couplings and flotation on fuel hoses.
		PS 14.3 Ensure adequate resources are available to allow implementation of SOPEP.	**MC 14.3.1** Records confirm presence of spill kits.
	C 14.2 Contractor procedures include requirements to be implemented during bunkering/refuelling operations, including: • Implement a completed PTW and/or JSA for the hydrocarbon bunkering/refuelling operation. • Visually monitor gauges, hoses, fittings and the sea surface during the operation. • Check hoses prior to commencement. • Commence bunkering/refuelling in daylight hours. If the transfer is to continue into darkness, the JSA risk assessment must consider lighting and the ability to determine if a spill has occurred. • Do not transfer hydrocarbons in marginal weather conditions.	**PS 14.2** Comply with Contractor procedures for managing bunkering/helicopter operations.	**MC 14.2.1** Records demonstrate bunkering/refuelling performed in accordance with contractor bunkering procedures.
	C 14.3 Marine Order 91 (marine pollution prevention – oil) 2014, requires SOPEP/SMPEP (as appropriate to vessel class).	**PS 14.3** Appropriate initial responses prearranged and drilled in case of a hydrocarbon spill, as appropriate to vessel class.	**MC 14.3.1** Marine Assurance inspection records demonstrate compliance with Marine Order 91.
Detailed oil spill preparedness and response performance outcomes, standards and measurement criteria for the Petroleum Activities Program are presented in **Appendix D**.			

[35] Defined as 'Slight, short term local impact (<1 year), on species, habitat but not affecting ecosystem function), physical or biological attributes' as in **Figure 2-6**/**Section 2.6.3**.

6.7.5 Unplanned Discharges: Drilling Fluids

Context														
Project fluids – **Section 3.11**								Physical environment – **Section 4.4** Biological environment – **Section 4.5**						
Impacts and Risks Evaluation Summary														
Source of Risk	***Environmental Value Potentially Impacted***							***Evaluation***						
	Soil and Groundwater	***Marine Sediment***	***Water Quality***	***Air Quality (incl Odour)***	***Ecosystems/Habitat***	***Species***	***Socio-Economic***	***Decision Type***	***Consequence***	***Likelihood***	***Current Risk Rating***	***ALARP Tools***	***Acceptability***	***Outcome***
Accidental discharge of drilling fluids (WBM/NWBM/base oil) to marine environment due to failure of slip joint packers, bulk transfer hose/fitting, emergency disconnect system or from routine MODU operations		X	X		X	X		A	E	1	**L**	LCS GP PJ	Broadly Acceptable	EPO 15

Description of Source of Risk

Transfers

A support vessel will bulk transfer WBM, NWBM or base oil to the MODU, if and when required. Failure of a transfer hose or fittings during a transfer or backload, as a result of an integrity or fatigue issue, could result in a spill of WBM, NWBM or base oil to either the bunded deck or into the marine environment.

Similar to a spill event during refuelling (**Section 6.7.4**), the most likely spill volume of mud is likely to be less than 0.2 m^3, based on the volume of the transfer hose and the immediate shutoff of the pumps by personnel involved in the bulk transfer process. However, the worst-case credible spill scenario could result in up to 8 m^3 of mud being discharged. This scenario represents a complete failure of the bulk transfer hose combined with a failure to follow procedures requiring transfer activities to be monitored, coupled with a failure to immediately shut off pumps (e.g. WBM or NWBM pumped through a failed transfer hose for a period of about five minutes).

Slip Joint Packer Failure

The slip joint packer enables compensation for the dynamic movement of the MODU (heave) in relation to the static location of the BOP. A partial or total failure of the slip joint packer could result in a loss of mud to the marine environment. The likely causes of this failure include a loss of pressure in the pneumatic (primary) system combined with loss of pressure in the back-up (hydraulic) system.

Catastrophic sequential failure of both slip joint packers (pneumatic and hydraulic) would trigger the alarm and result in a loss of the volume of fluid above the slip joint (conservatively 1.5 m^3) plus the volume of fluid lost in the one minute (maximum) taken to shut down the pumps. At a flow rate of 1000 gallons per minute, this volume would equate to an additional 3.8 m^3. In total, it is expected that this catastrophic failure would result in a loss of 5.2 m^3.

Failure of either of the slip joint packers at a rate not large enough to trigger the alarms could result in an undetected loss of 20 bbl (3 m^3) maximum, assuming a loss rate of 10 bbl/hr and that MODU personnel would likely walk past the moon pool at least every two hours.

Activation of the Emergency Disconnect Sequence

The EDS is an emergency system that provides a rapid means of shutting in the well (i.e. BOP closed) and disconnecting the MODU from the BOP. There are two main scenarios where the EDS could be activated: (1) automatic activation of the EDS due to a loss of MODU station keeping from the loss of multiple moorings; and (2) manual activation of the EDS due to an identified threat to the safety of the MODU, including potential collision by a third-party vessel or a loss of well integrity.

The activation of the EDS can result in the release of the entire volume of the marine riser to the marine environment. When drilling, this could result in a subsurface release of a combination of mud and cuttings at the seabed. The volume of material released depends on the water depth and hence the length of the riser (the entire riser volume would be lost). The potential impacts from a hydrocarbon loss of well integrity are discussed in **Section 6.7.2**. For NWBM, it is expected the weight of the NWBM would result in the majority of the release settling to the seabed and/or remaining at depth within the water column. The base oil of the NWBM would remain in an emulsion with the other components of the mud system and drill cuttings.

NWBM Drilling Fluid System

The selection of a NWBM drilling fluid system will be based on Woodside processes (as outlined in **Section 3.11**); however, for the purposes of this risk assessment a base case of base oil (Saraline 185 V) has been used. Saraline 185 V is a mixture of volatile to low volatility hydrocarbons. Predicted weathering of base oil, based on typical conditions in the region, indicates that about 50% by mass is predicted to evaporate over the first day or two (refer to **Table 6-17**). At this time the majority of the remainder could be entrained into the water column. In calm conditions, entrained hydrocarbons are likely to resurface with up to 100% able to evaporate over time.

Table 6-17: Characteristics of the non-water based mud base oil

Oil type	Initial density (kg/m³)	Viscosity (cP @ 20˚C)	Volatiles (%) <180	Semi volatiles (%) 180-265	Low volatility (%) 265-380	Residual (%) >380	Aromatic (%) of whole oil < 380 °C BP
			Non-Persistent		*Persistent*		
Base oil (Saraline 185 V)	0.7760	2.0 @ 40 ºC	8.5	41.1	50.4	0	0

Impact Assessment

Potential Impacts to Water Quality, Other Habitats and Communities and Protected Species

NWBM is made up of a number of components detailed in **Section 3.11.2**, including base oil, which generally has a high volatile to semi-volatile fraction. If released to the marine environment at surface, this generally evaporates within the first 48 hours, with the remaining fraction being on the sea surface and weathering at a slower rate. As a result of this volatility, combined with the worst-case credible spill scenario volumes (8 m³), and based on Woodside's experience of modelling base oil, it is considered there would be an extremely small footprint area associated with any release. Therefore, any surface oil would be confined to open waters with a minor surface slick that would not reach any sensitive receptors. Other components of the NWBM would settle out in the water column and be subject to dilution. Therefore impacts on water quality would be minor and temporary in nature. The safety data sheet for Saraline 185 V indicates that it is readily biodegradable, non-toxic in the water column and has low sediment toxicity (Shell, 2014). Marine fauna may be affected if they come in direct contact with a release (i.e. by traversing the immediate spill area), but due to the small footprint of such a spill, it is anticipated that any impacts would be negligible and temporary in nature.

WBM is made up of a number of components detailed in **Section 3.11.2**, including a variety of chemicals, incorporated into the selected drilling fluid system to meet specific technical requirements. If released to the marine environment at surface, there would be an extremely small impact footprint area associated with a release. Any release would be confined to the open waters of the Petroleum Activities Program Operational Area that would not reach any sensitive receptors. Components of the WBM would settle out in the water column and be subject to dilution. Given the low toxicity of WBM and its planned discharge during drilling, any impacts on water quality would be minor and temporary in nature.

The EMBA associated with the release of NWBM or WBM from the activation of the EDS would be small and limited to deeper water seabed surrounding the well site (the release point). The environmental consequence of such a release would include a highly localised area at the discharge location. Lethal impacts to the underlying infauna may occur from exposure to NWBM but are considered unlikely; recolonisation would occur over time. Elevated hydrocarbon and metal concentrations in the localised area of deposition would also occur, with reduction over time. It is likely that any impacts to water and sediment quality and low-sensitivity deeper water benthos would be short term, localised and a full recovery expected.

Summary of Potential Impacts to Environmental Values

Given the adopted controls, it is considered that accidental discharge of WBM, NWBM or base oil will not result in a potential impact to protected species and water quality greater than slight and short term (<1 year) local impacts (i.e. Environment Impact – E). It is considered that the release of NWBM cuttings from an unplanned discharge will not result in a potential impact greater than slight and/or temporary contamination above background levels, water quality standards, or known effect concentrations.

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/ Sacrifice (CS)[36]***	***Benefit in Impact/Risk Reduction***	***Proportionality***	***Control Adopted***
Legislation, Codes and Standards				
Where there is potential for loss of primary containment of oil and chemicals on the MODU, deck drainage must be collected via a closed drainage system. e.g. drill floor.	F: Yes. CS: Minimal cost. Standard practice.	Reduces the likelihood of contaminated deck drainage water being discharged to the marine environment. No change in consequence would occur.	Benefits outweigh cost/sacrifice.	Yes C 5.3
Marine riser's telescopic joint to be: • comprised of a minimum of two packers (one hydraulic and one pneumatic) • pressure-tested in accordance with manufacturer's recommendations.	F: Yes. CS: Minimal cost. Standard practice.	Reduces the likelihood of equipment failure leading to an unplanned release of drilling fluids. Although the consequence of an unplanned release would be reduced, the reduction in likelihood reduces the overall risk providing an overall environmental benefit.	Benefits outweigh cost/sacrifice.	Yes C 15.1
Good Practice				
Drilling, completions, cementing, flowline pre-commissioning and subsea control fluids and additives will have an environmental assessment completed prior to use.	F: Yes. CS: Minimal cost. Standard practice.	Reduces the consequence of impacts resulting from discharges to the marine environment by ensuring chemicals have been assessed for environmental acceptability. Planned discharges are required for safely executing activities; therefore, no reduction in likelihood can occur.	Benefits outweigh cost/sacrifice.	Yes C 6.1

[36] Qualitative measure.

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/ Sacrifice (CS)[36]***	***Benefit in Impact/Risk Reduction***	***Proportionality***	***Control Adopted***
No overboard disposal of bulk NWBM.	F: Yes. CS: Minimal cost. Standard practice.	Reduces the consequence of the release on the environment. Although no change in likelihood is provided, the decrease in consequence results in an environmental benefit.	Benefits outweigh cost/sacrifice.	Yes C 6.4
Contractor procedure for managing drilling fluids transfers onto, around and off the MODU, which requires: • emergency shutdown systems for stopping losses of containment (e.g. burst hoses) • break-away dry-break couplings for oil based mud hoses • transfer hoses to have floatation devised to allow detection of a leak • the valve line-up will be checked prior to commencing mud transfers • constant monitoring of the transfer process • direct radio communications • completed PTW and JSA showing contractor procedures are implemented • recording and verification of volumes moved to identify any losses • mud pit dump valves locked closed when not in use for mud transfers and operated under a PTW.	F: Yes. CS: Minimal cost. Standard practice for Woodside to review contractor systems prior to performing activity.	Reduces the likelihood of an unplanned release occurring. Although no change in consequence would occur, the reduction in likelihood decreases the overall risk, providing environmental benefit.	Benefits outweigh cost/sacrifice.	Yes C 15.2
Check for the presence and functionality of: • additional SCE (augers and cuttings dryers) • mud tanks • mud tank room • transfer hoses • NWBM base fluid transfer lines • NWBM base fluid transfer station • base fluid storage.	F: Yes. CS: Minimal cost. Standard practice	Reduces the likelihood of an event occurring and reduces the potential consequences (by limiting volume released).	Benefits outweigh cost/sacrifice.	Yes C 15.3
Professional Judgement – Eliminate				
No additional controls identified.				

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/ Sacrifice (CS)[36]***	***Benefit in Impact/Risk Reduction***	***Proportionality***	***Control Adopted***
Professional Judgement – Substitute				
Only use WBM during drilling.	F: Not feasible. A NWBM drilling fluid system is required for safety and technical reasons; therefore option to use must be maintained. CS: Not considered – control not feasible.	Not considered – control not feasible.	Not considered – control not feasible.	No
Professional Judgement – Engineered Solution				
Use a MODU which may have a larger tank storage capacity for WBM. As such, there would be fewer bulk transfer movements.	F: Not feasible. The use of a MODU with greater storage capacity cannot be confirmed. CS: Significant cost and schedule delay would occur if the MODU was limited to greater storage capacity.	Not considered – control not feasible.	Not considered – control not feasible.	No

ALARP Statement

On the basis of the environmental risk assessment outcomes and use of the relevant tools appropriate to the decision type (i.e. Decision Type A), Woodside considers the adopted controls appropriate to manage the impacts and risks of the accidental discharge of drilling fluids, described above. As no reasonable additional/alternative controls were identified that would further reduce the impacts and risks without grossly disproportionate sacrifice, the impacts and risks are considered ALARP.

Demonstration of Acceptability

Acceptability Statement

The impact assessment has determined that, given the adopted controls, unplanned discharges of drilling fluids represent a low current risk rating that is unlikely to result in a potential impact greater than minor and/or temporary contamination above background levels and/or national/international quality standards and/or known biological effect concentrations on a localised scale. Further opportunities to reduce the impacts and risks have been investigated above. The adopted controls are considered good oil-field practice/industry best practice. The potential impacts and risks are considered broadly acceptable if the adopted controls are implemented. Therefore, Woodside considers the adopted controls appropriate to manage the impacts and risks of an unplanned discharge of WBM, NWBM or base oil to a broadly acceptable level.

Environmental Performance Outcomes, Standards and Measurement Criteria			
Outcomes	***Controls***	***Standards***	***Measurement Criteria***
EPO 15 No unplanned loss of WBM/ NWBM/base oil greater than a consequence level of F[37] during the Petroleum Activities Program.	**C 5.3** Where there is potential for loss of primary containment of oil and chemicals on the MODU, deck drainage must be collected via a closed drainage system. E.g. drill floor.	**PS 5.3** Contaminated drainage contained, treated and/or separated prior to discharge.	**MC 5.3.1** Records demonstrate MODU has a functioning deck drainage management system**.**
	C 6.1 Drilling, completions, cementing, flowline pre-commissioning and subsea control fluids and additives will have an environmental assessment completed prior to use.	**PS 6.1** Reduces to ALARP the impact potential of all chemicals intended or likely to be discharged into the marine environment.	**MC 6.1.1** Records demonstrate chemical selection, assessment and approval process for selected chemicals is followed.
	C 6.4 No overboard disposal of bulk NWBM.	**PS 6.4** Reduces the volume of hydrocarbons discharged to the marine environment.	**MC 6.4.1** Incident reports of any unplanned discharges of NWBM.
	C 15.1 Marine riser's telescopic joint to be: • comprised of a minimum of two packers (one hydraulic and one pneumatic) • pressure tested in accordance with manufacturer's recommendations.	**PS 15.1** MODU's joint packer designed and maintained to reduce hydrocarbons discharged to the environment.	**MC 15.1.1** Records demonstrate that MODU's joint packer is compliant.
	C 15.2 Contractor procedure for managing drilling fluids transfers onto, around and off the MODU, which requires: • emergency shutdown systems for stopping losses of containment (e.g. burst hoses) • break-away dry-break couplings for oil based mud hoses • transfer hoses to have flotation devised to allow detection of a leak • the valve line-up will be checked prior to	**PS 15.2** Compliance with Contractor procedures to limit accidental loss to the marine environment.	**MC 15.2.1** Records demonstrate drilling fluid transfers are performed in accordance with the applicable contractor procedures.

[37] Defined as 'Slight, short term local impact (<1 year), on species, habitat but not affecting ecosystem function), physical or biological attributes' as in **Figure 2-6/Section 2.6.3**.

Environmental Performance Outcomes, Standards and Measurement Criteria			
Outcomes	***Controls***	***Standards***	***Measurement Criteria***
	commencing mud transfers • constant monitoring of the transfer process • direct radio communications • completed PTW and JSA showing contractor procedures are implemented • recording and verification of volumes moved to identify any losses • mud pit dump valves locked closed when not in use for mud transfers and operated under a PTW.		
	C 15.3 Check for the presence and functionality of: • additional SCE (augers and cuttings dryers) • mud tanks • mud tank room • transfer hoses • NWBM base fluid transfer lines • NWBM base fluid transfer station • base fluid storage.	**PS 15.3** Prevents unacceptable use or discharge of NWBM/base oil.	**MC 15.3.1** Records demonstrate the presence and functionality of the specified equipment.

6.7.6 Unplanned Discharges: Deck and Subsea Spills

Context	
Project fluids – **Section 3.11**	Physical environment – **Section 4.4** Biological environment – **Section 4.5**

Impacts and Risks Evaluation Summary

Source of Risk	*Environmental Value Potentially Impacted*							*Evaluation*						
	Soil and Groundwater	***Marine Sediment***	***Water Quality***	***Air Quality (incl Odour)***	***Ecosystems/Habitat***	***Species***	***Socio-Economic***	***Decision Type***	***Consequence***	***Likelihood***	***Current Risk Rating***	***ALARP Tools***	***Acceptability***	***Outcome***
Accidental discharge to the ocean of other hydrocarbons/ chemicals from MODU or project vessel deck activities and equipment (e.g. cranes), including helicopter refuelling and subsea spills			X		X	X		A	F	2	**L**	LCS GP PJ	Broadly Acceptable	EPO 16

Description of Source of Risk

Deck spills can result from spills from stored hydrocarbons/chemicals or equipment. The MODU and project vessels will typically store hydrocarbon/chemicals in various volumes (20 L, 205 L; up to about 4000–6000 L). Storage areas are typically set up with effective primary and secondary bunding to contain any deck spills. Releases from equipment are predominantly from the failure of hydraulic hoses, which can either be located within bunded areas or outside of bunded or deck areas (e.g. over water on cranes or subsea during installation activities). Helicopter refuelling may also take place within the Operational Area, on the helipad of the MODU.

Subsea spills can result from a loss of containment of fluids from subsea equipment including the BOP or ROVs. The ROV hydraulic fluid is supplied through hoses containing about 20 L of fluid. Hydraulic lines to the ROV arms and other tooling may become caught, resulting in minor leaks to the marine environment. Small volume hydraulic leaks may occur from equipment operating via hydraulic controls subsea (subsea control fluid). These include the diamond wire cutter, bolt tensioning equipment, ROV tooling, etc.

Minor leaks during wireline activities (a contingent activity) with a live well are described to include leaks such as:

- leaks from the lubricator, stuffing box and hose or fitting failure, which are expected to be less than 10 L (0.01 m^3)
- loss of containment – fluids – surface holding tanks
- backloading of raw slop fluids in an intermediate bulk container(s)
- stuffing box leak/under pressure
- draining of lubricator contents
- lubricant used to lubricate hole
- excess grease/lubricant leaking from the grease injection head. Wind-blown lubricant dripping from cable/on deck.

Woodside's operational experience demonstrates that spills are most likely to originate from hydraulic hoses and have been less than 100 L, with an average volume <10 L.

Impact Assessment
Potential Impacts to Water Quality, Other Habitats and Communities and Protected Species
Accidental spills of hydrocarbons or chemicals from the MODU, project vessels would decrease the water quality in the immediate area of the spill; however, the impacts would be expected to be temporary and very localised due to dispersion and dilution in the open ocean environment. Given the offshore/open water location, receptors such as marine fauna may only be affected if they come in direct contact with a release (i.e. by traversing the immediate spill area). If marine fauna come into contact with a release they could suffer fouling, ingestion, inhalation of toxic vapours, irritation of sensitive membranes in the eyes, mouth, digestive and respiratory tracts and organ or neurological damage. Cetaceans may exhibit avoidance behaviour patterns and given they are smooth skinned, hydrocarbons and other chemicals are not expected to adhere. Given the small area of the potential spill and the dilution and weathering of any spill, the likelihood of ecological impacts to marine fauna (protected species), other communities and habitats is likely to be negligible to very minor. No impacts on socio-economic receptors are expected due to the low levels of fishing activity in the Operational Area, the small volumes of hydrocarbons/chemicals that could be accidentally spilled, and the localised and temporary nature of the impacts.
Summary of Potential Impacts to Environmental Values
Given the adopted controls, it is considered that other hydrocarbon/chemical spills to the marine environment will not result in a potential impact greater than slight, short term local impacts on species, habitat (but not affecting ecosystems function), physical and biological attributes (i.e. Environment Impact – E).

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/ Sacrifice (CS)[38]***	***Benefit in Impact/Risk Reduction***	***Proportionality***	***Control Adopted***
Legislation, Codes and Standards				
Marine Order 91 (marine pollution prevention – oil) 2014, requires SOPEP/SMPEP (as appropriate to vessel class).	F: Yes. CS: Minimal cost. Standard practice.	Legislative requirements to be followed reduce the likelihood of an unplanned release. The consequence is unchanged.	Controls based on legislative requirements – must be adopted.	Yes C 14.3
Liquid chemical and fuel storage areas are bunded or secondarily contained when they are not being handled/moved temporarily.	F: Yes. CS: Minimal cost. Standard practice.	Reduces the likelihood of contaminated deck drainage water being discharged to the marine environment.	Controls based on legislative requirements – must be adopted.	Yes C 16.1
Good Practice				
Where there is potential for loss of primary containment of oil and chemicals on the MODU, deck drainage must be collected via a closed drainage system. E.g. drill floor.	F: Yes. CS: Minimal cost. Standard practice.	Reduces the likelihood of contaminated deck drainage water being discharged to the marine environment.	Benefits outweigh cost/sacrifice.	Yes C 5.3
Spill kits positioned in high risk locations around the rig (near potential spill points such as transfer stations).	F: Yes. CS: Minimal cost. Standard practice.	Reduces the likelihood of a deck spill from entering the marine environment. The consequence is unchanged.	Benefits outweigh cost/sacrifice.	Yes C 16.2
Primary installation vessels have self-containing hydraulic oil drip tray management system.	F: Yes. CS: Minimal cost. Standard practice.	Reduces the likelihood of a deck spill from entering the marine environment. The consequence is unchanged.	Benefits outweigh cost/sacrifice.	Yes C 16.3

[38] Qualitative measure

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/ Sacrifice (CS)[38]***	***Benefit in Impact/Risk Reduction***	***Proportionality***	***Control Adopted***
Detailed oil spill preparedness and response performance outcomes, standards and measurement criteria for the Petroleum Activities Program are presented in **Appendix D**.				
Professional Judgement – Eliminate				
No additional controls identified.				
Professional Judgement – Substitute				
No additional controls identified.				
Professional Judgement – Engineered Solution				
Below-deck storage of all hydrocarbons and chemicals.	F: Not feasible. During operations there is a need to keep small volumes near activities and within equipment requiring use of hydrocarbons and chemicals and can result in increased risk of leaks from transfers via hose or smaller containers. CS: Not considered – control not feasible.	Not considered – control not feasible.	Not considered – control not feasible.	No
A reduction in the volumes of chemicals and hydrocarbons stored onboard the vessel.	F: Yes. Increases the risks associated with transportation and lifting operations. CS: Project delays if required chemicals not on board. Increases the risks associated with transportation and lifting operations.	No reduction in likelihood or consequence since chemicals will still be required to enable drilling activities to occur.	Disproportionate. The cost/sacrifice outweighs the benefit gained.	No
ALARP Statement On the basis of the environmental risk assessment outcomes and use of the relevant tools appropriate to the decision type (i.e. Decision Type A), Woodside considers the adopted controls appropriate to manage the impacts and risks of the potential unplanned accidental deck and subsea spills described above. As no reasonable additional/alternative controls were identified that would further reduce the impacts and risks without grossly disproportionate sacrifice, the impacts and risks are considered ALARP.				

Demonstration of Acceptability
Acceptability Statement The impact assessment has determined that an unplanned minor discharge of hydrocarbons as a result of minor deck and subsea spills represents a low current risk rating that is unlikely to result in potential impact greater than localised, minor and temporary disruption to a small proportion of the population and no impact on critical habitat or activity. Further opportunities to reduce the impacts and risks have been investigated above. The adopted controls are consistent with the most relevant regulatory guidelines and good oil-field practice/industry best practice. The potential impacts and risks are considered acceptable if the adopted controls are implemented. Therefore, Woodside considers the adopted controls appropriate to manage the impacts and risks of minor unplanned deck and subsea spills to a level that is broadly acceptable.

Environmental Performance Outcomes, Standards and Measurement Criteria			
Outcomes	***Controls***	***Standards***	***Measurement Criteria***
EPO 16 No unplanned spills to the marine environment from deck activities greater than a consequence level of F[39] during the Petroleum Activities Program.	**C 5.3** Where there is potential for loss of primary containment of oil and chemicals on the MODU, deck drainage must be collected via a closed drainage system. E.g. drill floor.	**PS 5.3** Contaminated drainage contained, treated and/or separated prior to discharge.	**MC 5.3.1** Records demonstrate MODU has a functioning deck drainage management system.
	C 14.5 Marine Order 91 (marine pollution prevention – oil) 2014, requires SOPEP/SMPEP (as appropriate to vessel class).	**PS 14.5** Appropriate initial responses prearranged and drilled in case of a hydrocarbon spill, as appropriate to vessel class.	**MC 14.3** Marine assurance inspection records demonstrate compliance with Marine Order 91.
	C 16.1 Liquid chemical and fuel storage areas are bunded or secondarily contained when they are not being handled/ moved temporarily.	**PS 16.1** Failure of primary containment in storage areas does not result in loss to the marine environment.	**MC 16.1.1** Records confirms all liquid chemicals and fuel are stored in bunded/ secondarily contained areas when not being handled/moved temporarily.
	C 16.2 Spill kits positioned in high risk locations around the rig (near potential spill points such as transfer stations).	**PS 16.2** Spill kits to be available for use to clean up deck spills.	**MC 16.2.1** Records confirms spill kits are present, maintained and suitably stocked.
	C 16.3 Primary installation vessels have self-containing hydraulic oil drip tray management system.	**PS 16.3** Contain any on-deck spills of hydraulic oil.	**MC 16.3.1** Records demonstrate project installation vessels are equipped with self-containing hydraulic oil drip tray management system.

[39] Defined as 'Slight, short term local impact (< 1 year), on species, habitat but not affecting ecosystem function), physical or biological attributes' as in **Figure 2-6**/**Section 2.6.3**.

6.7.7 Unplanned Discharges: Loss of Solid Hazardous and Non-hazardous Wastes/Equipment

Context	
Project vessels – **Section 3.5**	Physical environment – **Section 4.4** Biological environment – **Section 4.5**

Impacts and Risks Evaluation Summary

Source of Risk	***Environmental Value Potentially Impacted***							***Evaluation***						
	Soil and Groundwater	***Marine Sediment***	***Water Quality***	***Air Quality (incl Odour)***	***Ecosystems/Habitat***	***Species***	***Socio-Economic***	***Decision Type***	***Consequence***	***Likelihood***	***Current Risk Rating***	***ALARP Tools***	***Acceptability***	***Outcome***
Accidental loss of hazardous or non-hazardous wastes/ equipment to the marine environment (excludes sewage, grey water, putrescible waste and bilge water)			X		X	X		A	F	2	**L**	LCS GP PJ	Broadly Acceptable	EPO 17

Description of Source of Risk

The project vessels will generate a variety of solid wastes including packaging and domestic wastes such as aluminium cans, bottles, paper and cardboard. Hence, there is the potential for solid wastes to be lost overboard to the marine environment. Equipment that has been recorded as being lost on previous vessel campaigns (primarily windblown or dropped overboard) has included the loss of a metal pole and hardhat. Loss of solid wastes has potential to occur during backloading activities, periods of adverse weather and incorrect waste storage.

Impact Assessment

Potential Impacts to Water Quality, Other Habitats and Communities and Protected Species

The potential impacts of solid wastes accidentally discharged to the marine environment include direct pollution and contamination of the environment and secondary impacts relating to potential contact of marine fauna with wastes, resulting in entanglement or ingestion and leading to injury and death of individual animals. The temporary or permanent loss of waste materials into the marine environment is not likely to have a significant environmental impact, based on the location of the Operational Area, the types, size and frequency of wastes that could occur and species present.

Summary of Potential Impacts to Environmental Values

Given the adopted controls, it is considered that the accidental discharge of solid waste described will result in localised impacts not significant to environmental receptors (i.e. Environment Impact – F).

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS)***[40]	***Benefit in Impact/Risk Reduction***	***Proportionality***	***Control Adopted***
Legislation, Codes and Standards				
Marine Order 95 – pollution prevention – garbage (as appropriate to vessel class), which requires putrescible waste and food scraps to pass through a macerator so it is capable of passing through a screen with no opening wider than 25 mm.	F: Yes. CS: Minimal cost. Standard practice.	Legislative requirements to be followed reduces the likelihood of an unplanned release. The consequence is unchanged.	Controls based on legislative requirements – must be adopted.	Yes C 5.1
Good Practice				
Drilling and Completions waste arrangements, which require: • dedicated space for waste segregation bins and skips to be provided on the MODU • records of all waste to be disposed, treated or recycled • waste streams to be handled and managed according to their hazard and recyclability class • all non-putrescible waste (excludes all food, greywater or sewage waste) to be transported from the MODU and disposed onshore.	F: Yes. CS: Minimal cost. Standard practice.	Reduces the likelihood of an unplanned release. The consequence is unchanged.	Benefit outweighs cost sacrifice.	Yes C 17.1
Installation vessel waste arrangements, which require: • dedicated waste segregation bins • records of all waste to be disposed, treated or recycled • waste streams to be handled and managed according to their hazard and recyclability class.	F: Yes. CS: Minimal cost. Standard practice.	Reduces the likelihood of an unplanned release. The consequence is unchanged.	Benefit outweighs cost sacrifice.	Yes C 17.2

[40] Qualitative measure.

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS)***[40]	***Benefit in Impact/Risk Reduction***	***Proportionality***	***Control Adopted***
MODU/project vessel ROV, crane or support vessel may be used to attempt recovery of hazardous solid wastes lost overboard. Where safe and practicable, this activity will consider: • risk to personnel to retrieve object • whether the location of the object is in recoverable water depths • object's proximity to subsea infrastructure • ability to recover the object (i.e. nature of object, lifting equipment or, ROV availability and suitable weather).	F: Yes. CS: Minimal cost. Standard practice.	Occurs after an unplanned release of solid waste and therefore no change to the likelihood. Since the waste objects may be recovered, a reduction in consequence is possible.	Benefit outweighs cost sacrifice.	Yes C 17.3
Professional Judgement – Eliminate				
No additional controls identified.				
Professional Judgement – Substitute				
No additional controls identified.				
Professional Judgement – Engineered Solution				
No additional controls identified.				
ALARP Statement On the basis of the environmental risk assessment outcomes and use of the relevant tools appropriate to the decision type (i.e. Decision Type A), Woodside considers the adopted controls appropriate to manage the impacts and risks of accidental discharges of waste. As no reasonable additional/alternative controls were identified that would further reduce the impacts and risks without grossly disproportionate sacrifice, the impacts and risks are considered ALARP.				

Demonstration of Acceptability
Acceptability Statement The impact assessment has determined that, given the adopted controls, accidental discharge of solid waste represents a low current risk rating that is unlikely to result in a potential impact above slight, short term impacts on species, habitat (but not affecting ecosystems function), physical and biological attributes. Further opportunities to reduce the impacts and risks have been investigated above. The adopted controls are considered good oil-field practice/industry best practice and meet legislative requirements (Marine Orders 95 and 94). The potential impacts and risks are considered broadly acceptable if the adopted controls are implemented. Therefore, Woodside considers the adopted controls appropriate to manage the impacts and risks of these discharges to a level that is broadly acceptable.

Environmental Performance Outcomes, Standards and Measurement Criteria			
Outcomes	***Controls***	***Standards***	***Measurement Criteria***
EPO 17 No unplanned releases of solid hazardous or non-hazardous waste to the marine environment greater than a consequence level of F during the Petroleum Activities Program.	**C 5.1** Marine Order 95 – pollution prevention – garbage (as appropriate to vessel class), which requires putrescible waste and food scraps to pass through a macerator so it is capable of passing through a screen with no opening wider than 25 mm.	**PS 5.1** MODU and project vessels compliant with Marine Order 95 – pollution prevention – garbage.	**MC 5.1** Records demonstrate MODU and project vessels are compliant with Marine Order 95 – pollution prevention (as appropriate to vessel class).
	C 17.1 Drilling and Completions waste arrangements, which require: • dedicated space for waste segregation bins and skips to be provided on the MODU • records of all waste to be disposed, treated or recycled • waste streams to be handled and managed according to their hazard and recyclability class • all non-putrescible waste (excludes all food, greywater or sewage waste) to be transported from the MODU and disposed onshore.	**PS 17.1** Hazardous and non-hazardous waste will be managed in accordance with the Drilling and Completions waste arrangements.	**MC 17.1.1** Records demonstrate compliance against Drilling and Completions waste arrangements.
	C 17.2 Installation vessel waste arrangements, which require: • dedicated waste segregation bins • records of all waste to be disposed, treated or recycled • waste streams to be handled and managed according to their hazard and recyclability class.	**PS 17.2** Hazardous and non-hazardous waste will be managed in accordance with the Installation Vessel waste arrangements.	**MC 17.2.1** Records demonstrate compliance against Installation Vessel waste arrangements.

Environmental Performance Outcomes, Standards and Measurement Criteria			
Outcomes	***Controls***	***Standards***	***Measurement Criteria***
	C 17.3 MODU/project vessel ROV, crane or support vessel may be used to attempt recovery of hazardous solid wastes lost overboard. Where safe and practicable, this activity will consider: • risk to personnel to retrieve object • whether the location of the object is in recoverable water depths • object's proximity to subsea infrastructure • ability to recover the object (i.e. nature of object, lifting equipment or, ROV availability and suitable weather).	**PS 17.3** Any hazardous solid waste dropped to the marine environment will be recovered where safe and practicable to do so.	**MC 17.3.1** Records detail the recovery attempt consideration and status of any hazardous waste lost to marine environment.

6.7.8 Physical Presence: Vessel Collision with Marine Fauna

Context	
Project vessels – **Section 3.5**	Biological environment – **Section 4.5**

Impacts and Risks Evaluation Summary

Source of Risk	*Environmental Value Potentially Impacted*							*Evaluation*						
	Soil and Groundwater	***Marine Sediment***	***Water Quality***	***Air Quality (incl Odour)***	***Ecosystems/Habitat***	***Species***	***Socio-Economic***	***Decision Type***	***Consequence***	***Likelihood***	***Current Risk Rating***	***ALARP Tools***	***Acceptability***	***Outcome***
Accidental collision between project vessels and protected marine fauna						X		A	E	1	**L**	LCS GP PJ	Broadly Acceptable	EPO 18

Description of Source of Risk

The MODU and project vessels operating in and around the Operational Area may present a potential hazard to protected marine fauna, including cetaceans (e.g. pygmy blue whales), whale sharks and marine turtles. Vessel movements can result in collisions between the vessel (hull and propellers) and marine fauna, potentially resulting in superficial injury, serious injury that may affect life functions (e.g. movement and reproduction) and mortality. The factors that contribute to the frequency and severity of impacts due to collisions vary greatly due to vessel type, vessel operation (specific activity, speed), physical environment (e.g. water depth), the type of animal potentially present and their behaviours. Support vessels are typically stationary or moving at low speeds when supporting drilling operations; support vessels typically transit to and from the Operational Area between two and four trips per week (e.g. to port) when the MODU is present in the Operational Area. Primary installation vessels will also typically move at low speeds in the Operational Area.

Impact Assessment

Potential Impacts to protected species

The likelihood of vessel/whale collision being lethal is influenced by vessel speed; the greater the speed at impact, the greater the risk of mortality (Jensen and Silber, 2004; Laist et al., 2001). Vanderlaan and Taggart (2007) found that the chance of lethal injury to a large whale as a result of a vessel strike increases from about 20% at 8.6 knots to 80% at 15 knots. At a speed of four knots, the risk was estimated to be less than 10%. Vessel–whale collisions at this speed are uncommon and, based on reported data contained in the US NOAA database (Jensen and Silber, 2004), there are only two known instances of collisions when the vessel was travelling at less than six knots. Both of these were from whale watching vessels that were deliberately placed among whales.

Project vessels in the Operational Area are likely to be travelling less than eight knots; therefore, the chance of a vessel collision with protected species resulting in a lethal outcome is significantly reduced versus faster moving vessels. No known key aggregation areas (resting, breeding or feeding) for protected species are located within or immediately adjacent to the Operational Area; however, the following BIAs overlap with the Operational Area (refer to **Table 4-4** for more detail of seasonal timings):

- Pygmy blue whale distribution BIA (and partial overlap with the migration BIA) (**Figure 4-8**). Seasonally present April to August (north bound migration) and October to December (south bound migration).
- Whale shark foraging BIA (**Figure 4-11**). Seasonally present between March and July during migrations to and from Ningaloo Reef. Occasionally individuals may occur at other times of the year.

- Flatback turtle internesting BIA (**Figure 4-10**). Seasonally present during the nesting season between October and March. Occasionally individuals may occur at other times of the year.

Additionally, an area designated as habitat critical to the survival of flatback turtles is located about 8 km to the south-east of the Operational Area (**Figure 4-7**).

The timing of the activity could occur at any time throughout the year (all seasons); therefore, it is possible that activity will overlap with the migration seasons or seasonal presence of the species above and it is likely that there may be increased numbers of individuals of these species within the Operational Area during the seasonal periods described above.

Whale sharks are at risk from vessel strikes when feeding at the surface or in shallow waters (where there is limited option to dive). Whale sharks may traverse offshore NWS waters including the Operational Area during their migrations to and from Ningaloo Reef and whale sharks have been tracked moving across the Operational Area. However, it is expected that whale shark presence within the Operational Area would not comprise significant numbers, given there is no main aggregation area within the vicinity of the Operational Area, and their presence would be transitory and of a short duration.

With consideration of the absence of potential nesting or foraging habitat (i.e. no emergent islands, reef habitat or shallow shoals) and the water depth (at least 130 m), it is considered that the Operational Area is unlikely to represent important habitat for marine turtles. However, individuals may transit the area, particularly during internesting periods (October to March). It is acknowledged that there are significant nesting sites along the mainland coast and islands of the region.

It is unlikely that vessel movement associated with the Petroleum Activities Program will have a significant impact on marine fauna populations, given: (1) the low presence of transiting individuals; (2) avoidance behaviour commonly displayed by whales, whale sharks and turtles; and (3) low operating speed of the MODU and project vessels (generally less than eight knots or stationary in the Operational Area, unless operating in an emergency).

Summary of Potential Impacts to Environmental Values

Given the adopted controls, it is considered that a collision, were it to occur, will not result in a potential impact greater than slight, short term impact on species (i.e. Environment Impact – E).

Demonstration of ALARP

Control Considered	***Control Feasibility (F) and Cost/ Sacrifice (CS)[41]***	***Benefit in Impact/Risk Reduction***	***Proportionality***	***Control Adopted***
Legislation, Codes and Standards				
EPBC Regulations 2000 – Part 8 Division 8.1 Interacting with cetaceans, including the following measures[42]: • Project vessels will not travel faster than six knots within 300 m of a cetacean or turtle (caution zone) and not approach closer than 100 m from a whale. • Project vessels will not approach closer than 50 m for a dolphin or turtle and/or 100 m for a whale (with the exception of animals bow-riding). • If the cetacean or turtle shows signs of being disturbed, project vessels will immediately withdraw from the caution zone at a constant speed of less than six knots.	F: Yes. CS: Minimal cost. Standard practice.	Implementation of these controls will reduce the likelihood of a collision between a cetacean, whale shark or turtle occurring. The consequence of a collision is unchanged.	Controls based on legislative requirements – must be adopted.	Yes C 18.1

[41] Qualitative measure.

[42]For safety reasons, the distance requirements below are not applied for a vessel holding station or with limited manoeuvrability; e.g. anchor handling, loading, back-loading, bunkering, close standby cover for overside working and emergency situations.

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/ Sacrifice (CS)***[41]	***Benefit in Impact/Risk Reduction***	***Proportionality***	***Control Adopted***
• Vessels will not travel faster than eight knots within 250 m of a whale shark and not allow the vessel to approach closer than 30 m of a whale shark.				
Good Practice				
Variation of the timing of the Petroleum Activities Program to avoid whale migration periods.	F: Not feasible. Timing of activities is linked to MODU schedule. Timing of all activities is currently not determined, and due to MODU availability and operational requirements, conducting activities during migration/ nesting seasons may not be able to be avoided. CS: Not considered – control not feasible.	Not considered – control not feasible.	Not considered – control not feasible.	No
Professional Judgement – Eliminate				
No additional controls identified.				
Professional Judgement – Substitute				
No additional controls identified.				
Professional Judgement – Engineered Solution				
The use of dedicated MFOs on support vessels for the duration of each activity to watch for whales and provide direction on and monitor compliance with Part 8 of the EPBC Regulations.	F: Yes, however vessel bridge crews already maintain a constant watch during operations, and crew complete specific cetacean observation training. CS: Additional cost of MFOs considered unnecessary.	Given support vessel bridge crews already maintain a constant watch during operations, additional MFOs would not significantly further reduce the risk.	Disproportionate. The cost/sacrifice outweighs the benefit gained.	No
ALARP Statement On the basis of the environmental risk assessment outcomes and use of the relevant tools appropriate to the decision type (i.e. Decision Type A), Woodside considers the adopted controls appropriate to manage the impacts and risks of potential vessel collision with protected marine fauna. As no reasonable additional/alternative controls were identified that would further reduce the impacts and risks without grossly disproportionate sacrifice, the impacts and risks are considered ALARP.				

Demonstration of Acceptability
Acceptability Statement   The impact assessment has determined that, given the adopted controls, vessel collision with marine fauna represents a low current risk rating that is unlikely to result in a potential impact greater than minor and temporary disruption to a small proportion of the population and no impact on critical habitat or activity. Further opportunities to reduce the impacts and risks have been investigated above. The adopted controls are considered good oil-field practice/industry best practice and meet the requirements of Part 8 (Division 8.1) of the EPBC Regulations 2000. The potential impacts and risks are considered broadly acceptable if the adopted controls are implemented. Therefore, Woodside considers the adopted controls appropriate to manage the impacts and risks of vessel collision with marine fauna to a level that is broadly acceptable.

Environmental Performance Outcomes, Standards and Measurement Criteria			
Outcomes	***Controls***	***Standards***	***Measurement Criteria***
EPO 18 No vessel strikes with protected marine fauna (whales, whale sharks, turtles) during the Petroleum Activities Program.	**C 18.1** EPBC Regulations 2000 – Part 8 Division 8.1 Interacting with cetaceans, including the following measures[43]: • Project vessels will not travel faster than six knots within 300 m of a cetacean or turtle (caution zone) and not approach closer than 100 m from a whale. • Project vessels will not approach closer than 50 m for a dolphin or turtle and/or 100 m for a whale (with the exception of animals bow-riding). • If the cetacean or turtle shows signs of being disturbed, project vessels will immediately withdraw from the caution zone at a constant speed of less than six knots. • Vessels will not travel faster than eight knots within 250 m of a whale shark and not allow the vessel to approach closer than 30 m of a whale shark.	**PS 18.1** Compliance with EPBC Regulations 2000 – Part 8 Division 8.1 (Regulation 8.05 and 8.06) Interacting with cetaceans to minimise potential for vessel strike.	**MC 18.1.1** Records demonstrate no breaches of EPBC Regulations 2000 – Part 8 Division 8.1 Interacting with cetaceans.
		PS 18.2 All vessel strike incidents with cetaceans will be reported in the National Ship Strike Database (as outlined in the Conservation Management Plan for the Blue Whale—A Recovery Plan under the EPBC Act 1999, Commonwealth of Australia, 2015).	**MC 18.2.1** Records demonstrate reporting cetacean ship strike incidents to the National Ship Strike Database.

[43]For safety reasons, the distance requirements below are not applied for a vessel holding station or with limited manoeuvrability; e.g. anchor handling, loading, back-loading, bunkering, close standby cover for overside working and emergency situations.

6.7.9 Physical Presence: Disturbance to Seabed from Loss of Station Keeping

Context	
Project vessels – **Section 3.5**	Physical environment – **Section 4.4** Biological environment – **Section 4.5**

Impacts and Risks Evaluation Summary

Source of Risk	*Environmental Value Potentially Impacted*							*Evaluation*						
	Soil and Groundwater	*Marine Sediment*	*Water Quality*	*Air Quality (incl Odour)*	*Ecosystems/Habitat*	*Species*	*Socio-Economic*	*Decision Type*	*Consequence*	*Likelihood*	*Current Risk Rating*	*ALARP Tools*	*Acceptability*	*Outcome*
Loss of station keeping of MODU leading to seabed disturbance					X			A	E	2	M	GP PJ RBA	Broadly Acceptable	EPO 19

Description of Source of Risk

A moored MODU is planned to be used for drilling the wells. The rig will be secured on station by a number of mooring lines, as dictated by the mooring analysis, which are held in place by anchors deployed to the seabed (**Section 3.5.1**). High energy weather events such as cyclones, while the MODU is on station, can lead to excessive loads on the mooring lines resulting in failure (either anchor(s) dragging or mooring lines parting). A failure of mooring integrity may lead to the MODU losing station, which may lead to the mooring lines and anchors attached to the MODU being trailed across the seabed.

For a moored MODU, personnel on-board the MODU are typically evacuated during cyclones. Woodside implements a risk-based assessment process to aid in decision-making for cyclone evacuations, with the well suspended prior to MODU evacuation. Support vessels also demobilise from the Operational Area during the passage of a cyclone. While the MODU is temporarily abandoned, the position of the MODU is monitored remotely for any deviation. Support vessels and MODU personnel return to the Operational Area as soon as safe to do so after a cyclone evacuation. Operational experience indicates cyclone evacuations typically last for seven days.

Industry statistics from the North Sea show that a single mooring line failure for MODUs is the most common failure mechanism (33×10^{-4} per line per year), followed by a double mooring line failure (11×10^{-4} per line per year) (Petroleumstilsynet, 2014). Note that single and double mooring line failures do not typically result in the loss of station keeping. In the event of partial or complete mooring failures that are sufficient to result in a loss of station keeping, industry experience indicates that MODUs may drift considerable distances from their initial position (Offshore: Risk & Technology Consulting Inc., 2002). Partial mooring failures leading to a loss of station keeping resulted in smaller MODU displacements due to the remaining anchors dragging along the seabed when compared to complete mooring failures; complete mooring failures resulted in a freely drifting MODU (Offshore: Risk & Technology Consulting Inc., 2002).

NOPSEMA recorded four cases of anchor drag due to loss of MODU holding station during cyclone activity between 2004 and 2015 (NOPSEMA, 2015).

Impact Assessment
Potential Impacts to Other Benthic Communities
Benthic habitats in the Operational Area are expected to largely consist of fine grained muddy sands and silts with an absence of hard substrate. In the unlikely event of a cyclone resulting in the MODU breaking its moorings, the anchors could cause physical damage to soft sediment and potentially limited hard bottom habitats (including in the Continental Slope and Demersal Fish Communities KEF and the Ancient Coastline at 125 m Depth Contour KEF, which have minor overlaps with the Operational Area) and associated benthic communities (e.g. epifauna and infauna). This would result in localised short-term impacts to habitat and biological attributes. Given the low abundance, diversity and broad-scale distribution of the benthic habitat types within and adjacent to the Operational Area, the scale of impact will not be significant.
Summary of Potential Impacts to Environmental Values
Given the adopted controls, seabed disturbance from a loss of station keeping would result in only slight, short-term local impacts to soft sediment benthic communities (i.e. Environment Impact – E).

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS)[44]***	***Benefit in Impact/Risk Reduction***	***Proportionality***	***Control Adopted***
Legislation, Codes and Standards				
No additional controls identified.				
Good Practice				
Specifications and requirements for station keeping equipment (mooring systems) require that: • systems are tested and inspected in accordance with API RP 21 • systems have sufficient capability such that a failure of any single component will not cause progressive failure of the remaining anchoring arrangement.	F: Yes. CS: Minimal cost. Standard practice.	Reduces the likelihood of mooring failure leading to loss of station keeping. Should mooring failure occur, no significant reduction in consequence could occur.	Benefit outweighs cost sacrifice.	Yes C 19.1
Professional Judgement – Eliminate				
Only use a DP MODU (no anchoring required).	F: No. CS: It is not technically feasible for the MODU to use DP in the water depth of the well locations (about 174 m). Woodside has a demonstrated capacity to manage the environmental risks and impacts from mooring to a level that is ALARP and acceptable.	Eliminates the risk.	Disproportionate. The cost/sacrifice associated with only using a DP-capable MODU outweighs the benefit gained.	No
Professional Judgement – Substitute				
No additional controls identified.				

[44] Qualitative measure

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS)[44]***	***Benefit in Impact/Risk Reduction***	***Proportionality***	***Control Adopted***
Professional Judgement – Engineered Solution				
MODU tracking equipment operational when the MODU unmanned.	F: Yes. CS: Minimal cost. Standard practice.	Reduces the likelihood of a loss of station keeping occurring. Although no reduction in consequence could occur, the overall risk is reduced.	Benefit outweighs cost sacrifice.	Yes C 19.2
Risk Based Analysis				
Project-specific Mooring Design Analysis.	F: Yes. CS: Minimal cost. Standard practice.	Reduces the likelihood of mooring failure occurring. Although no reduction in consequence would occur, the overall risk is reduced.	Benefit outweighs cost sacrifice.	Yes C 2.2
Mooring system is tested to recommended tension as per API RP 2SK.	F: Yes. CS: Minimal cost. Standard practice	Reduces the likelihood of anchor drag leading to seabed disturbance.	Benefit outweighs cost sacrifice.	C 19.3
ALARP Statement On the basis of the environmental risk assessment outcomes and use of the relevant tools appropriate to the decision type (i.e. Decision Type A), Woodside considers the adopted controls appropriate to manage the impacts and risks of seabed disturbance from a loss of station holding. As no reasonable additional/alternative controls were identified that would further reduce the impacts and risks without grossly disproportionate sacrifice, the impacts and risks are considered ALARP.				

Demonstration of Acceptability
Acceptability Statement The impact assessment has determined that, given the adopted controls, seabed disturbance from a loss of station keeping will not result in a potential impact greater than localised effects to benthic habitat, with impacts to soft sediment benthic communities expected to be localised and short-term with no significant impacts to environmental receptors. Further opportunities to reduce impacts and risks have been investigated above. The adopted controls are considered good oil-field practice/industry best practice. The potential impacts and risks are considered broadly acceptable if the adopted controls are implemented. Therefore, Woodside considers the adopted controls appropriate to manage the impacts and risks of seabed disturbance from a loss of station keeping to an acceptable level.

Environmental Performance Outcomes, Standards and Measurement Criteria			
Outcomes	***Controls***	***Standards***	***Measurement Criteria***
EPO 19 No mooring failure for the MODU during the Petroleum Activities Program.	**C 19.1** Specification and requirements for station keeping equipment (mooring systems) require that: • systems are tested and inspected in accordance with API RP 21 • systems have sufficient capability such that a failure of any single component will not cause progressive failure of the remaining anchoring arrangement.	**PS 19.1** MODU mooring system tested and in place to ensure no complete mooring failure.	**MC 19.1.1** Records demonstrate mooring system tests and inspection.
	C 19.2 MODU tracking equipment operational when the MODU unmanned.	**PS 19.2** Tracking of the MODU is possible when the MODU is unmanned.	**MC 19.2.1** Records show the MODU has functional tracking equipment for instances when MODU is unmanned.
	C 2.2 Project-specific Mooring Design Analysis.	**PS 2.2** Anchors installed as per Mooring Design Analysis to ensure adequate MODU station holding capacity.	**MC 2.2.1** Records demonstrate Mooring Design Analysis completed and implemented during anchor deployment.
	C 19.3 Mooring system is tested to recommended tension as per API RP 2SK.	**PS 19.3** Monitoring compliant with ISO 19901-7:2013.	**MC 19.3.1** Records confirm mooring system is tested to recommended tension as per API RP 2SK.

6.7.10 Physical Presence: Dropped Object Resulting in Seabed Disturbance

Context	
Project vessels – **Section 3.5** Drilling and completions activities – **Section 3.9** Subsea installation and pre-commissioning activities – **Section 3.10**	Biological environment – **Section 4.5**

Impacts and Risks Evaluation Summary

Source of Risk	***Environmental Value Potentially Impacted***							***Evaluation***						
	Soil and Groundwater	***Marine Sediment***	***Water Quality***	***Air Quality (incl Odour)***	***Ecosystems/Habitat***	***Species***	***Socio-Economic***	***Decision Type***	***Consequence***	***Likelihood***	***Current Risk Rating***	***ALARP Tools***	***Acceptability***	***Outcome***
Dropped objects resulting in seabed disturbance		X			X			A	F	2	**L**	LCS GP PJ	Broadly Acceptable	EPO 20

Description of Source of Risk

There is the potential for objects to be dropped overboard from the MODU and project vessels to the marine environment. Objects that have been dropped during previous offshore projects include small numbers of personnel protective gear (e.g. glasses, gloves, hard hats), small tools (e.g. spanners) hardware fixtures (e.g. riser hose clamp) and drill equipment (e.g. drill pipe).

Impact Assessment

Potential Impacts to Other Benthic Communities

In the unlikely event of loss of equipment or materials to the marine environment, potential environmental effects would be limited to localised physical impacts on benthic communities. As a result of recovery of any dropped objects, this impact will be temporary in nature. However, if the object cannot be recovered due to health and safety, operational constraints and other factors (locating dropped objects at depth) then the impact will be long term.

The temporary or permanent loss of dropped objects into the marine environment is not likely to have a significant environmental impact, as the benthic communities associated with the Operational Area are of low sensitivity and are broadly represented throughout the NWMR (**Section 4.4.4**). Two KEFs – the Ancient Coastline at 125 m Depth Contour and Continental Slope Demersal Fish Communities – have been identified as overlapping the Operational Area, as described in **Section 4.7.1**. Given only a small proportion of the KEFs are overlapping the Operational Area, and the nature and scale of impacts and risks from dropped objects, seabed sensitivities associated with this KEF will not be significantly impacted. Further, considering the types, size and frequency of dropped objects that could occur, it is unlikely that a dropped object would have a significant impact on any benthic community.

Summary of Potential Impacts to Environmental Values

Given the adopted controls and the predicted small footprint of a dropped object, it is considered that a dropped object will result in only localised impacts to a small area of the seabed and a small proportion of the benthic population; however, no significant impact to environmental receptors and with no lasting effect (i.e. Environment Impact – F).

<table>
<tr><th colspan="5">Demonstration of ALARP</th></tr>
<tr><th>Control Considered</th><th>Control Feasibility (F) and Cost/ Sacrifice (CS)[45]</th><th>Benefit in Impact/Risk Reduction</th><th>Proportionality</th><th>Control Adopted</th></tr>
<tr><td colspan="5">Legislation, Codes and Standards</td></tr>
<tr><td colspan="5">No additional controls identified.</td></tr>
<tr><td colspan="5">Good Practice</td></tr>
<tr><td>The MODU/primary installation vessels work procedures for lifts, bulk transfers and cargo loading, which require:
• the security of loads to be checked prior to commencing lifts
• loads to be covered if there is a risk of losing loose materials
• lifting operations to be conducted using the PTW and JSA systems to manage the specific risks of that lift, including consideration of weather and sea state.</td><td>F: Yes.
CS: Minimal cost. Standard practice.</td><td>Occurs after a dropped object event and therefore no change to the likelihood. Since the object may be recovered, a reduction in consequence is possible.</td><td>Benefits outweigh cost/sacrifice.</td><td>Yes
C 20.1</td></tr>
<tr><td>MODU/primary installation vessel inductions include control measures and training for crew in dropped object prevention.</td><td>F: Yes.
CS: Minimal cost. Standard practice.</td><td>By ensuring crew are appropriately trained in dropped object prevention, the likelihood of a dropped object event is reduced. No change in consequence will occur.</td><td>Benefits outweigh cost/sacrifice.</td><td>Yes
C 20.2</td></tr>
<tr><td colspan="5">Professional Judgement – Eliminate</td></tr>
<tr><td colspan="5">No additional controls identified.</td></tr>
<tr><td colspan="5">Professional Judgement – Substitute</td></tr>
<tr><td colspan="5">No additional controls identified.</td></tr>
<tr><td colspan="5">Professional Judgement – Engineered Solution</td></tr>
<tr><td colspan="5">No additional controls identified.</td></tr>
<tr><td colspan="5">ALARP Statement
On the basis of the environmental risk assessment outcomes and use of the relevant tools appropriate to the decision type (i.e. Decision Type A), Woodside considers the adopted controls appropriate to manage the impacts and risks of seabed disturbance from dropped objects. As no reasonable additional/alternative controls were identified that would further reduce the impacts and risks without grossly disproportionate sacrifice, the impacts and risks are considered ALARP.</td></tr>
</table>

[45] Qualitative measure

Demonstration of Acceptability
Acceptability Statement The impact assessment has determined that, given the adopted controls, dropped objects will not result in a potential impact greater than minor and temporary disruption to a small area of the seabed, a small proportion of the benthic population and no impact on critical habitat or activity. Further opportunities to reduce the impacts and risks have been investigated above. The adopted controls are considered good oil-field practice/industry best practice. The potential impacts and risks are considered broadly acceptable if the adopted controls are implemented. Therefore, Woodside considers the adopted controls appropriate to manage the impacts and risks of seabed disturbance from dropped objects to an acceptable level.

Environmental Performance Outcomes, Standards and Measurement Criteria			
Outcomes	***Controls***	***Standards***	***Measurement Criteria***
EPO 20 No incidents of dropped objects to the marine environment greater than a consequence level of F[46] during the Petroleum Activities Program.	**C 20.1** The MODU/primary installation vessels work procedures for lifts, bulk transfers and cargo loading, which require: • the security of loads to be checked prior to commencing lifts • loads to be covered if there is a risk of losing loose materials • lifting operations to be conducted using the PTW and JSA systems to manage the specific risks of that lift, including consideration of weather and sea state.	**PS 20.1** All lifts conducted in accordance with applicable MODU/ primary installation vessel work procedures to limit potential for dropped objects.	**MC 20.1.1** Records show lifts conducted in accordance with the applicable MODU/primary installation vessel work procedures.
	C 20.2 MODU/primary installation vessel inductions include control measures and training for crew in dropped object prevention.	**PS 20.2** Awareness of requirements for dropped object prevention.	**MC 20.2.1** Records show dropped object prevention training is provided to the MODU/primary installation vessels.

[46] Defined as 'Slight, short term local impact (<1 year), on species, habitat but not affecting ecosystem function), physical or biological attributes' as in **Figure 2-6/Section 2.6.3**.

6.7.11 Physical Presence: Accidental Introduction and Establishment of Invasive Marine Species

Context		
Project vessels – **Section 3.5**	Physical environment – **Section 4.4** Biological environment – **Section 4.5**	Stakeholder consultation – **Section 5**

Impacts and Risks Evaluation Summary														
Source of Risk	***Environmental Value Potentially Impacted***							***Evaluation***						
	Soil and Groundwater	***Marine Sediment***	***Water Quality***	***Air Quality (incl Odour)***	***Ecosystems/Habitat***	***Species***	***Socio-Economic***	***Decision Type***	***Consequence***	***Likelihood***	***Current Risk Rating***	***ALARP Tools***	***Acceptability***	***Outcome***
Introduction of invasive marine species (IMS)					X	X	X	A	D	0	L	LCS	Broadly Acceptable	EPO 21

Description of Source of Risk
IMS are a subset of Non-indigenous Marine Species (NIMS) that have been introduced into a region beyond their natural biogeographic range, resulting in impacts to social/cultural, human health, economic and/or environmental values. NIMS are species that have the ability to survive, reproduce and establish founder populations. However, not all NIMS introduced into an area will thrive or cause demonstrable impacts. The majority of NIMS around the world are relatively benign and few have spread widely beyond sheltered ports and harbours. During the Petroleum Activities Program, vessels will be transiting to and from the Operational Area, potentially including traffic mobilising from beyond Australian waters. These project vessels may include the MODU, primary installation vessels and activity support vessels (**Section 3.6**). There is therefore the potential for the MODU and project vessels to transfer IMS from either international waters or Australian waters into the Operational Area. All vessels are subject to some level of marine fouling. Organisms attach to the vessel hull, particularly in areas where organisms can find a good attachment surface (e.g. seams, strainers and unpainted surfaces) or where turbulence is lowest (e.g. niches, sea chests, etc.). Commercial vessels typically maintain anti-fouling coatings to reduce the build-up of fouling organisms. Organisms can also be drawn into ballast tanks during onboarding of ballast water required to maintain safe operating conditions. During the Petroleum Activities Program, project vessels have the potential to introduce IMS to the Operational Area through biofouling (containing IMS) on vessels, as well as ballast water exchange (as described above). Cross-contamination between vessels can also occur (e.g. IMS translocated between project vessels).

Impact Assessment
Potential Impacts to Ecosystems/Habitats, Species and Socio-economic Values
Potential IMS have historically been introduced and translocated around Australia by a variety of natural and human means including biofouling and ballast water. Potential IMS vary from one region to another depending on various environmental factors such as water temperature, salinity, nutrient levels and habitat type, which dictate their survival and invasive capabilities. IMS typically require hard substrate in the photic zone, therefore requiring shallow waters to become established. Highly-disturbed, shallow-water environments such as shallow coastal waters, ports and marinas are more susceptible to IMS colonisation, whereas IMS are generally unable to successfully establish in deep water ecosystems and open-water environments where the rate of dilution and the degree of dispersal are high (Williamson and Fitter, 1996; Paulay et al., 2002; Geiling, 2014). The undisturbed, deep water, offshore location of the Operational Area is therefore unlikely to represent suitable habitat for the establishment of IMS.

Once introduced, IMS may pose a considerable threat to the Australian marine environment, including commercial fisheries. IMS may prey on local species (which had previously not been subject to this kind of predation and therefore have not evolved protective measures), they may outcompete indigenous species for food, space or light, and can also interbreed with local species, creating hybrids such that the endemic species is lost. These changes to the local marine environment result in changes to the natural ecosystem.

IMS have also proven economically damaging to areas where they have been introduced and established. Such impacts include direct damage to assets (fouling of vessel hulls and infrastructure) and depletion of commercially harvested marine life (e.g. shellfish stocks). IMS have proven particularly difficult to eradicate from areas once established. If the introduction is detected early, eradication may be effective but is likely to be expensive, disruptive and, depending on the method of eradication, harmful to other local marine life.

While project vessels (i.e. MODU, primary installation vessels, activity support vessels) have the potential to introduce IMS into the Operational Area, the deep offshore open waters of the Operational Area (130–180 m) are not conducive to the settlement and establishment of IMS. Furthermore, the Operational Area is away from shorelines and/or critical habitat. The nearest sensitive receptor is the Montebello Marine Park located 3.7 km to the east of the Operational Area at its nearest point. The northern portion of the Montebello AMP closest to the Operational Area is in water depths greater than 50 m, with the shallower nearshore waters of the Montebello Islands about 50 km from the Operational Area. It is therefore not expected that settlement and establishment of IMS within the Marine Park could occur as a result of the Petroleum Activities Program. The likelihood of IMS being introduced and establishing viable populations within the Operational Area or surrounds is considered remote.

Summary of Potential Impacts to Environmental Values

In support of Woodside's assessment of the impacts and risks of IMS introduction associated with the Petroleum Activities Program, Woodside conducted a risk and impact evaluation of the different aspects of a marine pest translocation. The results of this assessment are presented in **Table 6-18**.

As a result of this assessment, Woodside has presented the highest potential consequence as a D and likelihood as Remote (0), resulting in an overall low risk following the implementation of identified controls.

Table 6-18: Evaluation of risks and impacts from marine pest translocation

IMS Introduction Location	Credibility of Introduction	Consequence of Introduction	Likelihood
Introduced to Operational Area and establishment on the seafloor or subsea structures.	**Not Credible** The deep offshore open waters of the Operational Area are located away from shorelines and/or critical habitat, more than 25 nm from a shore and in waters 130–180 m deep; they are therefore not conducive to the settlement and establishment of IMS.		
Introduced to Operational Area and establishment on a project vessel (i.e. MODU, primary installation vessels, activity support vessels).	**Credible** There is potential for the transfer of marine pests between project vessels within the Operational Area.	**Environment – Not Credible** The translocation of IMS from a colonised MODU or project vessel to shallower environments via natural dispersion is not considered credible, given the distances of the Operational Area from nearshore environments (i.e. greater than 12 nm/50 m water depth). There is therefore no credible environmental risk and the assessment is limited to Woodside's reputation and brand. **Reputation – D** If IMS were to establish on a project vessel (i.e. MODU, primary installation vessels, activity support vessels) this could potentially impact the vessel operationally through the fouling of intakes, result in translocation of an IMS into the Operational Area and, depending on the species, potentially transfer of an IMS to other support vessels, which would likely result in the quarantine of the vessel until eradication could occur (through cleaning and treatment of infected areas), which would be costly to perform. Such introduction would be expected to have minor impact to Woodside's reputation, particularly with Woodside's contractors, and would likely have a reputational impact on future proposals.	**Remote (0)** Interactions between project vessels will be limited during the Petroleum Activities Program, with 500 m safety exclusion zones being adhered to around the MODU, and interactions limited to short periods of time alongside (i.e. during backloading, bunkering activities). There is also no direct contact (i.e. they are not tied up alongside) during these activities. Spread of marine pests via ballast water in these open ocean environments is also considered remote due to lack of suitable habitat for settlement and establishment.

Transfer between project vessels and by extension from project vessels to other marine environments beyond the Operational Area (i.e. transfer of IMS from offshore MODU, primary installation vessel to an activity support vessel and then to another environment).	**Not Credible** This risk is considered so remote that it is not credible for the purposes of the activity. The transfer of a marine pest between project vessels was already considered remote, given the offshore open ocean environment (i.e. transfer pathway discussed above). For a marine pest to then establish into a mature spawning population on the new project vessel (which would have been through Woodside's risk assessment process) and then transfer to another environment is not considered credible (i.e. beyond the Woodside risk matrix). Project vessels will be located in an offshore, open ocean, deep environment, where IMS survival is implausible. Furthermore this marine pest once transferred would need to survive on a new vessel with good vessel hygiene (i.e. has been through Woodside's risk assessment process), and survive the transport back from the Operational Area to shore. In the event it was to survive this trip, it would then need to establish a viable population in nearshore waters.

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS)[47]***	***Benefit in Impact/ Risk Reduction***	***Proportionality***	***Control Adopted***
Legislation, Codes and Standards				
Project vessels will manage their ballast water using one of the approved ballast water management options, as specified in the Australian Ballast Water Management Requirements.	F: Yes. CS: Minimal cost. Standard practice.	Reduces the likelihood of transferring marine pests between project vessels within the Operational Area. No change in consequence would occur.	Controls based on legislative requirements under the *Biosecurity Act 2015* – must be adopted.	Yes C 21.1
Good Practice				
IMS risk assessment process applied to project vessels which enter the Operational Area. Based on the outcomes of each IMS risk assessment, management measures commensurate with the risk (such as the treatment of internal systems, IMS inspections or cleaning) will be implemented to minimise the likelihood of IMS being introduced.	F: Yes. CS: Minimal cost. Good practice implemented across all Woodside Operations.	Identifies potential risks and additional controls implemented accordingly. In doing so, the likelihood of transferring marine pests between project vessels within the Operational Area is reduced. No change in consequence would occur.	Benefits outweigh cost/sacrifice.	Yes C 21.2

[47] Qualitative measure.

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS)[47]***	***Benefit in Impact/ Risk Reduction***	***Proportionality***	***Control Adopted***
Professional Judgement – Eliminate				
No discharge of ballast water during the Petroleum Activities Program.	F: No. Ballast water discharges are critical for maintaining vessel stability. Given the nature of the Petroleum Activities Program, the use of ballast (including the potential discharge of ballast water) is considered to be a safety-critical requirement. CS: Not assessed, control not feasible.	Not assessed, control not feasible.	Not assessed, control not feasible.	No
Eliminate use of MODU/vessels.	F: No. Given vessels must be used to implement the project, there is no feasible means to eliminate the source of risk. CS: Loss of the project.	Not assessed, control not feasible.	Not assessed, control not feasible.	No
Professional Judgement – Substitute				
Source project vessels based in Australia only.	F: Potentially. Limiting activities to only use local project vessels could potentially pose a significant risk in terms of time and duration of sourcing a vessel, as well as the ability of the local vessels to perform the required tasks. For example there are limited primary installation vessels based in Australian waters. While the project will attempt to source support vessels locally, it is not always possible. Availability cannot always be guaranteed when considering competing oil and gas activities in the region. In addition, sourcing Australian based vessels only will cause increases in cost due to pressures of vessel availability. CS: Significant cost and schedule impacts due to restrictions of vessel hire opportunities.	Sourcing vessels from within Australia will reduce the likelihood of IMS from outside Australian waters; however, it does not reduce the likelihood of translocation of species native to Australia but alien to the Operational Area and NWMR, or of IMS that have established elsewhere in Australia. The consequence is unchanged.	Disproportionate. Sourcing vessels from Australian waters may result in a reduction in the likelihood of IMS introduction to the Operational Area; however, the potential cost of implementing this control is grossly disproportionate to the minor environmental gain (or reducing an already remote likelihood of IMS introduction) potentially achieved by using only Australian based vessels. Consequently, this risk is considered not reasonably practicable.	No

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS)[47]***	***Benefit in Impact/ Risk Reduction***	***Proportionality***	***Control Adopted***
IMS Inspection of all vessels.	F: Yes. Approach to inspect vessels could be a feasible option. CS: Significant cost and schedule impacts. In addition, the IMS risk assessment process (C 21.2) is seen to be more cost effective, as this control allows Woodside to manage the introduction of marine pests through biofouling, while targeting its efforts and resources to areas of greatest concern.	Inspection of all vessels for IMS would reduce the likelihood of IMS being introduced to the Operational Area. However, this reduction is unlikely to be significant given the other control measures implemented. No change in consequence would occur.	Disproportionate. The cost outweighs the benefit gained, as other controls will be implemented to achieve an ALARP position.	No
Professional Judgement – Engineered Solution				
None identified.				
ALARP Statement On the basis of the environmental risk assessment outcomes and use of the relevant tools appropriate to the decision type (e.g. Decision Type A), Woodside considers the adopted controls appropriate to manage the impacts and risks of IMS introduction. As no reasonable additional/alternative controls were identified that would further reduce the impacts and risks without grossly disproportionate sacrifice, the impacts and risks are considered ALARP.				

Demonstration of Acceptability
Acceptability Statement The impact assessment has determined that, given the adopted controls, translocation of IMS may result in a minor, short-term (1–2 years) impact with no lasting effect and the likelihood of introducing IMS to the Operational Area is considered remote[48]. Further opportunities to reduce the impacts and risks have been investigated above. The adopted controls are considered good oil-field practice/industry best practice. The potential impacts and risks are considered broadly acceptable if the adopted controls are implemented. Therefore, Woodside considers the adopted controls appropriate to manage the impacts and risks of invasive marine species to an acceptable level.

Environmental Performance Outcomes, Standards and Measurement Criteria			
Outcomes	***Controls***	***Standards***	***Measurement Criteria***
EPO 21 No introduction and establishment of invasive marine species into the Operational Area as a result of the	**C 21.1** Project vessels will manage their ballast water using one of the approved ballast water management options, as specified in the Australian Ballast Water Management Requirements.	**PS 21.1** Prevents the translocation of IMS within the vessel's ballast water from high risk locations to the Operational Area.	**MC 21.1.1** Ballast Water Records System maintained by vessels which verifies compliance against Australian Ballast Water Management Requirements.

[48] All project vessels including the MODU will undergo Woodside's IMS risk assessment process; therefore, the risk of introducing IMS to the Operational Area and then onto nearshore or coastal areas was considered not credible.

Environmental Performance Outcomes, Standards and Measurement Criteria			
Outcomes	***Controls***	***Standards***	***Measurement Criteria***
Petroleum Activities Program.	**C 21.2** IMS risk assessment process applied to project vessels which enter the Operational Area. Based on the outcomes of each IMS risk assessment, management measures commensurate with the risk (such as the treatment of internal systems, IMS inspections or cleaning) will be implemented to minimise the likelihood of IMS being introduced.	**PS 21.2** Minimise the likelihood of translocating IMS within a vessel's biofouling to the Operational Area.	**MC 21.2.1** Records of IMS risk assessments maintained for all project vessels conducting the Petroleum Activities Program.
			MC 21.2.2 Records of management measures which have been implemented where identified through the IMS vessel risk assessment process are maintained.

7. IMPLEMENTATION STRATEGY

7.1 Overview

Regulation 14 of the Environment Regulations requires an EP to contain an implementation strategy for the activity. The Implementation Strategy for the Petroleum Activities Program confirms fit-for-purpose systems, practices and procedures are in place to direct, review and manage the activities so environmental risks and impacts are continually being reduced to ALARP and are Acceptable, and that environmental performance outcomes and standards outlined in this EP are achieved.

Woodside, as nominated titleholder, is responsible for ensuring the Petroleum Activities Program is managed in accordance with this Implementation Strategy and the WMS (see **Section 1.8**).

7.2 Systems, Practice and Procedures

All operational activities are planned and performed in accordance with relevant legislation, standards and management measures identified in this EP, and internal environment standards and procedures (**Section 4**).

Processes are implemented to verify that:

- controls to manage environmental impacts and risks to ALARP and Acceptable are effective
- environmental performance outcomes are met
- standards defined in this EP are complied with.

The systems, practices and procedures that will be implemented are listed in the Performance Standards (PS) contained in this EP. Document names and reference numbers may be subject to change during the statutory duration of this EP and is managed through a changes register and update process.

7.3 Roles and Responsibilities

Key roles and responsibilities for Woodside and Contractor personnel relating to implementing, managing and reviewing this EP are described in **Table 7-1**. Roles and responsibilities for oil spill preparation and response are outlined in **Appendix D** and the *Woodside Oil Pollution Emergency Arrangements (Australia)*.

Table 7-1: Roles and responsibilities

Title (role)	Environmental Responsibilities
Office-based Personnel	
Woodside Project Manager	• Monitor and manage the activity so it is conducted as per the relevant standards and commitments in this EP. • Notify the Woodside Environmental Adviser of any scope changes in a timely manner. • Liaise with regulatory authorities as required. • Review this EP as necessary and manage change requests. • Ensure all project and support vessel crew members complete an HSE induction. • Verify that contractors meet environmental-related contractual obligations. • Confirm environmental incident reporting meets regulatory requirements (as outlined in this EP) and Woodside internal event recording, investigation and learning requirements. • Monitor and close out corrective actions identified during environmental monitoring or audits.

Title (role)	Environmental Responsibilities
Woodside Well Delivery Manager	• Ensure drilling operations are conducted as per this EP and approval conditions. • Provide sufficient resources to implement the drilling-related management measures (i.e. controls, EPOs, PSs and MC) in this EP. • Ensure MODU and support vessel personnel are given an Environmental Induction as per **Section 7.4.2** of this EP at the start of the drilling programs. • Confirm controls and performance standards in this EP are actioned, as required, before drilling commences. • Ensure the MODU start-up meets the requirements of Woodside's drilling and managing rig operations process.
Subsea Delivery Manager	• Ensure the subsea installation activities are conducted as per this EP and approval conditions. • Provide sufficient resources to implement the subsea installation-related management measures (i.e. controls, EPOs, PSs and MC) in this EP. • Ensure installation vessel personnel are given an Environmental Induction as per **Section 7.4.2** of this EP at the start of the installation activities. • Confirm controls and performance standards in this EP are actioned, as required, before installation activities commence. • Ensure relevant vessels meet the requirements of Woodside's marine operations process. • Manage change requests for the activity and notify the Woodside Environmental Adviser of any scope changes in a timely manner. • Confirm that site-based personnel are given an Environmental Induction as per **Section 7.4.2** of this EP at the start of the activity. • Communicate changes to the subsea and pipeline instillation program to the Woodside Environmental Adviser in a timely manner. • Ensure all chemicals and drill fluids proposed to be discharged are assessed and approved as per the requirements of the EP.
Woodside Drilling Superintendent	• Ensure the drilling program meets the requirements detailed in this EP. • Ensure changes to the drilling program are communicated to the Woodside Environmental Adviser. • Ensure Woodside's Well Site Manager is provided with the resources required to ensure the management measures (i.e. controls, EPOs, EPs and MC) in this EP are implemented. • Confirm environmental incident reporting meets regulatory requirements (as outlined in this EP) and Woodside internal Event recording, investigation and learning requirements. • Monitor and close out corrective actions identified during environmental monitoring or audits.
Woodside Drilling Engineers	• Ensure changes to the drilling program are communicated to the Woodside Environmental Adviser. • Ensure all drill and completions fluid chemical components and other fluids that may be used downhole have been reviewed by the Woodside Environmental Adviser.
Woodside Environmental Adviser	• Verify relevant Environmental Approvals for the activities exist prior to commencing activity. • Track compliance with performance outcomes and performance standards as per the requirements of this EP. • Prepare environmental component of relevant Induction Package. • Assist with reviewing, investigating and reporting environmental incidents. • Ensure environmental monitoring and inspections/audits are conducted as per the requirements of this EP. • Liaise with relevant regulatory authorities as required. • Assist in preparing external regulatory reports required, in line with environmental approval requirements and Woodside external regulatory reporting obligations.

Title (role)	Environmental Responsibilities
	• Monitor and close out corrective actions (Campaign Action Register) identified during environmental monitoring or audits. • Provide advice to relevant Woodside personnel and contractors to assist them to understand their environment responsibilities. • Liaise with primary installation contractors to ensure communication and understanding of environment requirements as outlined in this EP and in line with Woodside's Compass values and management systems.
Woodside Corporate Affairs Adviser	• Prepare and implement the Stakeholder Consultation Plan for the Petroleum Activities Program. • Report on stakeholder consultation. • Perform ongoing liaison and notification as outlined in the EP.
Woodside Marine Assurance Superintendent	• Conduct relevant audit and inspection to confirm vessels are in compliance with relevant Marine Orders and Woodside requirements to meet safety, navigation and emergency response requirements.
Woodside Corporate Incident Coordination Centre (CICC) Duty Manager	On receiving notification of an incident: • Establish and take control of the Incident Management Team (IMT) and establish an appropriate command structure for the incident. • Assess the situation and identify risks and actions to minimise the risk. • Communicate impact, risk and progress to the Crisis Management Team and stakeholders. • Develop the incident action plan, including setting objectives for action. • Approve, implement and manage the incident action plan. • Communicate within and beyond the incident management structure. • Manage and review safety of responders. • Address the broader public safety considerations. • Conclude and review activities.
MODU-based Personnel	
MODU Offshore Installation Manager	• Ensure the MODU's management system and procedures are implemented. • Ensure the personnel starting work on the MODU receive an environmental induction that meets the requirements specified in this EP. • Ensure personnel are competent to perform the work they have been assigned. • Ensure emergency drills are conducted as per the MODU's schedule. • Ensure the MODU's Emergency Response Team has been given sufficient training to implement the MODU's SOPEP. • Ensure any environmental incidents or breaches of outcomes or standards are reported immediately to the Well Site Manager. • Ensure corrective actions for incidents or breaches are developed, communicated to the Well Site Manager, and tracked to close-out in a timely manner. Close-out of actions is communicated to the Well Site Manager.
Woodside Well Site Manager	• Ensure the drilling program is conducted as detailed in this EP. • Ensure the management measures (i.e. controls, EPOs, PSs and MC) detailed in this EP (relevant to offshore activities) are implemented on the MODU (other controls will be implemented onshore). • Ensure environmental incidents or breaches of outcomes or standards are reported as per the Woodside event notification requirements. Corrective actions for incidents and breaches must be developed, tracked and closed out in a timely manner. • Ensure actions in the Drilling and Completions HSE Improvement Plan are performed. • Ensure periodic environmental inspections/reviews are completed. Corrective actions from inspections must be developed, tracked and closed out in a timely manner.

Title (role)	Environmental Responsibilities
Woodside Offshore HSE Adviser	• Support the Well Site Manager to ensure the controls detailed in this EP relevant to offshore activities are implemented on the MODU, and assist in collecting and recording evidence of implementation (other controls are implemented and evidence collected onshore). • Support the Well Site Manager to ensure the environmental performance outcomes are met and the performance standards detailed in this EP are implemented on the MODU. • Confirm actions in the Drilling and Completions HSE Improvement Plan are performed. • Support the Well Site Manager to ensure environmental incidents or breaches of outcomes or standards outlined in this EP are reported, and corrective actions for incidents and breaches are developed, tracked and closed out in a timely manner. • Ensure periodic environmental inspections/reviews are completed and corrective actions from inspections are developed, tracked and closed out in a timely manner. • Review Contractors' procedures, input into Toolbox talks and JSAs. • Provide day-to-day environmental support for activities in consultation with the Woodside Environmental Adviser.
Drilling Logistics Coordinator	• Ensure waste is managed on the MODU and sent to shore as per relevant Waste Management Plan.
Vessel-based Personnel	
Primary Installation Vessels Activity Support Vessel Master	• Ensure the vessel management system and procedures are implemented. • Ensure personnel commencing work on the vessel receive an environmental induction that meets the relevant requirements specified in this EP. • Ensure personnel are competent to perform the work they have been assigned. • Ensure SOPEP drills are conducted as per the vessel's schedule. • Ensure the vessel Emergency Response Team has been given sufficient training to implement the SOPEP. • Ensure any environmental incidents or breaches of relevant environmental performance outcomes or performance standards detailed in this EP are reported immediately to the Woodside Well Site Manager. Corrective actions for incidents or breaches must be developed, communicated to the Well Site Manager, and tracked to close-out in a timely manner. Close-out of actions must be communicated to the Well Site Manager.
Vessel Logistics Coordinators	• Ensure waste is managed on the relevant support vessels or primary installation vessels and sent to shore as per the relevant Waste Management Plan.
Vessel HSE Advisers	Refer to Woodside HSE Offshore Adviser responsibilities detailed above under MODU-based personnel.
Contractor Project Manager	• Confirm that activities are conducted in accordance with this EP, as detailed in the Woodside-approved Contactor environmental management plan (or equivalent). • Ensure personnel commencing work on the project receive a relevant environmental induction that meets the requirements specified in this EP. • Ensure personnel are competent to perform the work they have been assigned. • Ensure any environmental incidents or breaches of objectives, standards or criteria outlined in this EP are reported immediately to the Woodside Responsible Engineer or Vessel Master.

It is the responsibility of all Woodside employees and contractors to implement the *Woodside Corporate Health, Safety, Environment and Quality Policy* (**Appendix A**) in their areas of responsibility and that the personnel are suitably trained and competent in their respective roles.

7.4 Training and Competency

7.4.1 Overview

Woodside as part of its contracting process assesses a proposed Contractor's environmental management system to determine the level of consistency with the standard AS/NZ ISO 14001. This assessment is conducted for the Petroleum Activities Program as part of the pre-mobilisation process. The assessment determines whether there is an organisational structure that clearly defines the roles and responsibilities for key positions. The assessment also determines whether there is an up-to-date training matrix that defines any corporate and site/activity-specific environmental training and competency requirements.

As a minimum, environmental awareness training is required for all personnel, detailing awareness and compliance with the Contractor's environmental policy and environmental management system.

7.4.2 Inductions

Inductions are provided to all relevant personnel (e.g. Contractors and Company representatives) before mobilising to or on arrival at the activity location. The induction covers the HSE requirements and environmental information specific to the activity location. Attendance records will be maintained.

The Petroleum Activities Program induction may cover information about:

- description of the activity
- ecological and socio-economic values of the activity location
- Regulations relevant to the activity
- Woodside's Environmental Management System – Health Safety, Environment and Quality Policy
- EP importance/structure/implementation/roles and responsibilities
- main environmental aspects/hazards and potential environmental impacts and related performance outcomes
- oil spill preparedness and response
- monitoring and reporting on performance outcomes and standards using measurement criteria
- incident reporting.

7.4.3 Petroleum Activity Specific Environmental Awareness

Before commencing drilling and subsea installation campaigns associated with the Petroleum Activities Program, a pre-activity meeting will be held on the MODU/primary installation vessels with all relevant personnel. The pre-activity meeting provides an opportunity to reiterate specific environmental sensitivities or commitments associated with the activity. Relevant sections of the pre-activity meeting will also be communicated to the support vessel personnel. Attendance lists are recorded and retained.

During operations, regular HSE meetings will be held on the MODU and project vessels. During these meetings, recent environmental incidents are reviewed and awareness material presented regularly.

7.4.4 Management of Training Requirements

All personnel on the MODU and project vessels are required to be competent to perform their assigned positions. This may be in the form of external or 'on-the-job' training. The vessel Safety Training Coordinator (or equivalent) is responsible for identifying training needs, keeping records of training undertaken, and identifying minimum training requirements.

7.5 Monitoring, Auditing, Management of Non-Conformance and Review

7.5.1 Monitoring

Woodside and its Contractors will conduct a program of periodic monitoring during the Petroleum Activities Program – starting at mobilisation of each activity and continuing through the duration of each activity to activity completion. This information will be collected using the tools and systems outlined below, developed based on the environmental performance outcomes, controls, standards and measurement criteria in this EP. The tools and systems will collect, as a minimum, the data (evidence) referred to in the measurement criteria in **Section 6.6** and **Section 6.7** and **Appendix D**.

The collection of this data (against the measurement criteria) will form part of the permanent record of compliance maintained by Woodside. It will form the basis for demonstrating that the environmental performance outcomes and standards are met, which will be summarised in a series of routine reporting documents.

7.5.1.1 Source-Based Impacts and Risks

The tools and systems to monitor environmental performance, where relevant, will include:

- daily reports, which include leading indicator compliance
- periodic review of waste management and recycling records
- use of Contractor's risk identification program that requires personnel to record and submit safety and environment risk observation cards on a routine basis (frequency varies with contractor)
- collection of evidence of compliance with the controls detailed in the EP relevant to offshore activities by the Woodside/Contractor Offshore HSE Adviser (other compliance evidence is collected onshore)
- environmental discharge reports that record volumes of planned and unplanned discharges downhole (in the well), to ocean and atmosphere
- monitoring of progress against the Drilling and Completions function scorecard for key performance indicators
- internal auditing and assurance program as described in **Section 7.5.2**.

Throughout this activity, Woodside will continuously identify new source-based risks and impacts through the Monitoring and Auditing systems and tools described above and in **Section 7.5.2**.

7.5.1.2 Receptor-Based Knowledge Updates

Under the Woodside Environmental Knowledge Management System, regular monitoring to maintain currency of receptor knowledge is performed as follows:

- Quarterly review of DoEE EPBC Act listed species status, listed species Recovery/Management and Conservation plans, and other environmental matters is completed and recorded by the Environment Science Team. The outcome of each review is summarised and issued to the relevant Environment personnel responsible for EP implementation for their consideration.

- Under the Oil Spill Scientific Monitoring Programme preparedness, an annual review and update to the environmental baseline studies database is completed and documented.
- Periodic location-focused environmental studies and baseline data gap analyses are completed and documented. Any subsequent studies scoped and executed as a result of such gap analysis are managed by the Environment Science Team and tracked via the Corporate Environment Baseline Database.

7.5.2 Auditing

Environmental performance auditing will be performed to:

- identify changes to existing or potential new environmental impacts and risk, and methods for reducing those to ALARP
- confirm that mitigation measures detailed in this EP are effectively reducing environmental impacts and risk, that mitigation measures proposed are practicable, and provide appropriate information to verify compliance
- confirm compliance with the commitments (performance outcomes, controls and standards) detailed in this EP.

Internal auditing will be performed to cover each key project activity as summarised below.

7.5.2.1 MODU Activities

Internal auditing is performed on a MODU-specific schedule, rather than a schedule to align with each well. This enables continuous review and improvement of environmental performance over the term of the MODU contract. The following internal audits, inspections and reviews will be performed to review the environmental performance of the activities:

- Survey environment rig equipment for a newly contracted MODU (if not previously contracted to Woodside within the last two years) against the Woodside Engineering Standard – Rig Equipment, which covers functional and technical requirements for Woodside-contracted rigs and their associated equipment. An environment rig equipment survey scope typically includes mud and solids control systems, environmental discharge control (including drainage management), and loss of containment management.
- Complete a minimum of monthly environmental inspection (conducted by offshore Woodside personnel or delegate), which may include verifying
  - bunkering/transfers between support vessels and MODU/project vessels
  - environment containment including chemical storage, spill response equipment and housekeeping
  - general MODU environment risks including waste management, drilling fluids oil/water separation and inspection of subsea and moonpool areas.
- Perform at least one environment audit during the Petroleum Activities Program, while the MODU is on location (by a Woodside Environmental Adviser or delegate), which may include:
  - operational compliance audits relevant to environmental risk of activities which may include compliance with training commitments, discharge requirements, bunkering activities verification of use of approved chemicals, and satisfactory close-out of items from previous audits
  - inspection of selected risk areas/activities (which may include shaker house, drill floor and mud management during commencement of riser drilling or reservoir

interception) during routine MODU visits throughout the MODU campaign, determined by risk, previous incidents or operation specification requirements.

7.5.2.2 Subsea Scope Activities

The following internal auditing will be performed for the subsea installation and pre-commissioning scopes:

- Pre-mobilisation inspection/audit report will be conducted by a relevant person (prior to the commencement). The scope of the audits are risk-based and specific to the relevant activity, but will generally focus on aspects relating to ensuring appropriate understanding of environmental commitments and the operational readiness of the activity scope, including appropriate environmental controls in place. All primary vessels associated with the above scopes will be audited by Woodside, including the primary installation vessels. Support or transport vessels will be assessed on a risk-based approach, but will be audited via the primary subsea installation contractor's process.
- At least one operational compliance audit relevant to applicable EP commitments will be conducted by a Woodside environment adviser for the subsea campaign. The audit may be conducted offshore or office-based, subject to the duration of the activity and logistics of performing the audit offshore for short duration scopes (e.g. pipelay).
- Contractor-specific HSE audits will also be conducted of the primary installation vessels and associated support vessels. The audits will consider the implementation of HSE management, risk management, as well as pre-mobilisation and offshore readiness.
- Vessel based HSE inspections will be conducted fortnightly by vessel HSE personnel. Each inspection will focus on a specific risk area relevant to the project activity and a formal report will be issued (for example, bunkering controls, chemical and discharge management, cetacean reporting, etc.).

The internal audits/inspections and reviews, combined with the ongoing monitoring described in **Section 7.5.1**, and collection of evidence for measurement criteria are used to assess environmental performance outcomes and standards.

As part of Woodside's EMS and/or assurances processes, activities may also be periodically selected for environmental audits as per Woodside's internal auditing process.

Audit, inspection and review findings relevant to continuous improvement of environmental performance are tracked through the Environmental Commitments and Actions Register (eCAR). This eCAR is used to track subsea support vessel and subsea activity compliance with EP commitments, including any findings and corrective actions.

Non-conformances identified will be reported and/or tracked in accordance with **Section 7.5.4**.

7.5.3 Marine Assurance

Woodside's marine assurance process is managed by the Marine Assurance Team of the Marine Services Group. The Woodside process is based on industry standards and consideration of guidelines and recommendations from recognised industry organisations such as Oil Companies International Marine Forum and International Maritime Contractors Association.

The process is mandatory for all vessels hired for Woodside operations, including for short term hires (i.e. <3 months in duration). It defines applicable marine offshore assurance activities, ensuring that all vessel operators operate seaworthy vessels that meet the requirements for a defined scope of work and are managed with a robust safety management system.

The process is multi-faceted and encompasses the following marine assurance activities:

- Offshore Vessel Safety Management System Assessment (OVMSA)

- DP system verification
- offshore vessel inspection (OVID)
- project support for tender review, evaluation, pre/post contract award.

OVID inspections are objective in nature and reflect what was observed by the Inspector while conducting the inspection. The inspection provides observations as opposed to non-conformities.

Where an OVID inspection and/or OVMSA Verification Review is not available and all reasonable efforts based on time and resource availability to complete an OVID inspection and/or OVMSA Verification Review are performed (i.e. short term vessel hire), the Marine Assurance Specialist Offshore may approve the use of an alternate means of inspection, known as a risk assessment.

7.5.3.1 Risk Assessment

Woodside conducts a risk assessment of vessels where either an OVMSA Verification Review and/or an OVID inspection cannot be completed. This is not a regular occurrence and is typically used when the requirements of the assurance process are unable to be met or the processes detailed are not applicable to a proposed vessel(s).

The risk assessment is a semi-quantitative method of determining what further assurance process activity, if any, is required to assure a vessel for a particular task or role. The process compares the level of management control a vessel is subject to, against the risk factors associated with the activity or role.

Several factors are assessed as part of a vessel risk assessment, including:

- management control factors:
  - Company audit score (i.e. management system)
  - vessel HSE incidents
  - vessel Port State Control deficiencies
  - instances of Port State Control vessel detainment
  - years since previous satisfactory vessel inspection
  - age of vessel
  - contractors' prior experience operating for Woodside.
- activity risk factors:
  - people health and safety risks (a function of the nature of the work and the area of operation)
  - environmental risks (a function of environmental sensitivity, activity type and magnitude of potential environment damage (e.g. largest credible oil spill scenario))
  - value risk (likely time and cost consequence to Woodside if the vessel becomes unusable)
  - reputation risk
  - exposure (i.e. exposure to risk based on duration of project)
  - industrial relations risk.

The acceptability of the vessel or requirement for further vessel inspections or audits is based on the ratio of vessel score to activity risk. If the vessel management control is not deemed to appropriately manage activity risk, then a satisfactory company audit and/or vessel inspection may be required before awarding work.

The risk assessment is valid for the period a vessel is on hire and for the defined scope of work.

7.5.4 Management of Non-conformance

Woodside classifies non-conformances with environmental performance outcomes and standards in this EP as environmental incidents. Woodside employees and Contractors are required to report all environmental incidents, and these are managed as per Woodside's internal event recording, investigation and learning requirements.

An internal computerised database called First Priority is used for the recording and reporting of these incidents. Details of the event, immediate action taken to control the situation, investigation outcomes and corrective actions to prevent reoccurrence are all recorded. Corrective actions are monitored using First Priority and closed out in a timely manner.

Woodside uses a consequence matrix for classification of environmental incidents, with the significant categories being A, B and C (as detailed in **Section 2.6**). Detailed investigations are completed for all categories A, B, C and high potential environmental incidents.

7.5.5 Review

7.5.5.1 Management Review

Within the Environment function, senior management regularly monitors and reviews environmental performance and the effectiveness of managing environmental risks and performance. Within each Function and Business Unit Leadership Team (e.g. Drilling and Completions, Subsea and Developments/Projects), managers review environmental performance regularly, including through quarterly HSE review meetings.

Woodside's Drilling and Completions Environment Team will perform six-monthly reviews of the effectiveness of the implementation strategy and associated tools. This will involve reviewing the:

- Drilling and Completions environment key performance indicators (leading and lagging)
- tools and systems to monitor environmental performance (detailed in **Section 7.5.1**)
- lessons learned about implementation tools and throughout each campaign.

Reviews of oil spill arrangements and testing are performed in accordance with **Section 7.9**.

7.5.5.2 Learning and Knowledge Sharing

Learning and knowledge sharing occurs via a number of different methods including:

- event investigations
- event bulletins
- after action review conducted at the end of each well, including review of environmental incidents as relevant
- ongoing communication with MODU operators
- formal and informal industry benchmarking
- cross-asset learnings
- Engineering and Technical Authorities discipline communications and sharing.

7.5.5.3 Review of Impacts, Risks and Controls Across the Life of the EP

In the unlikely case that activities described in this EP do not occur continuously or sequentially, before recommencing activities after a cessation period greater than 12 months, impacts, risks and controls will be reviewed.

The process will identify or review impacts and risks associated with the newly-commencing activity, and will identify or review controls to ensure impacts and risks remain/are reduced to ALARP and acceptable levels. Information learned from previous activities conducted under this EP will be considered. Controls which have previously been excluded on the basis of proportionality will be reconsidered. Any required changes will be managed by the MOC process outlined below (**Section 7.6**).

7.6 Environment Plan Management of Change and Revision

Management of changes relevant to this EP concerning the scope of the activity description (**Section 3**), including review of advances in technology at stages where new equipment may be selected such as vessel contracting, changes in understanding of the environment, including all current advice from DoEE on species protected under EPBC Act and current requirements for Australian Marine Parks (**Section 4**), and potential new advice from external stakeholders (**Section 7**), will be managed in accordance with Regulation 17 of the Environment Regulations.

Risk will be assessed in accordance with the Environmental Risk Management Methodology (**Section 2.2**) to determine the significance of any potential new environmental impacts or risks not provided for in this EP. Risk assessment outcomes are reviewed in compliance with Regulation 17 of the Environment Regulations.

Minor changes where a review of the activity and the environmental risks and impacts of the activity do not trigger a requirement for a revision, under Regulation 17 of the Environment Regulations, will be considered a 'minor revision'. Minor administrative changes to this EP, where an assessment of the environmental risks and impacts is not required (e.g. document references, phone numbers), will also be considered a 'minor revision'. Minor revisions as defined above will be made to this EP using Woodside's document control process. Minor revisions will be tracked in an MOC register to ensure visibility of cumulative risk changes, as well as enable internal EP updates/reissuing as required. This document will be made available to NOPSEMA during regulator environment inspections.

7.7 Record Keeping

Compliance records (outlined in Measurement Criteria in **Section 5.1**) will be maintained.

Record keeping will be in accordance with Regulation 14(7) which addresses maintaining records of emissions and discharges.

7.8 Reporting

To meet the environmental performance outcomes and standards outlined in this EP, Woodside reports at a number of levels, as outlined in the next sections.

7.8.1 Routine Reporting (Internal)

7.8.1.1 Daily Progress Reports and Meetings

Daily reports for project activities are prepared and issued to key support personnel and stakeholders, by relevant managers responsible for the project. The report provides performance information on project activities, HSE, and current and planned work activities.

Meetings between key personnel are used to transfer information, discuss incidents, agree plans for future activities and develop plans and accountabilities for issue resolution.

7.8.1.2 Regular HSE Meetings

Regular dedicated HSE meetings are held with the offshore and Perth-based management and advisers to address targeted HSE incidents and initiatives. Minutes of these meetings are produced and distributed as appropriate.

7.8.1.3 Performance Reporting

Monthly and quarterly performance reports are developed and reviewed by the Function and Business Unit Leadership Teams (e.g. Drilling and Completions). These reports cover a number of subjects, including:

- HSE incidents (including high potential incidents and those related to this EP) and recent activities
- Corporate Key Performance Indicator targets, which include environmental metrics
- outstanding actions as a result of audits or incident investigations
- technical high and low lights.

7.8.2 Routine Reporting (External)

7.8.2.1 Start and End Notifications of the Petroleum Activities Program

In accordance with Regulation 29, Woodside will notify NOPSEMA and DMIRS of the commencement of the Petroleum Activities Program at least ten days before the activity commences and will notify NOPSEMA and DMIRS within ten days of completing the activity.

7.8.2.2 Environmental Performance Review and Reporting

In accordance with applicable environmental legislation for the activity, Woodside is required to report information on environmental performance to the appropriate regulator. Regulatory reporting requirements are summarised in **Table 7-2**.

Table 7-2: Routine external reporting requirements

Report	Recipient	Frequency	Content
Monthly Recordable Incident Reports (**Appendix E**)	NOPSEMA	Monthly, by the 15th of each month.	Details of recordable incidents that have occurred during the Petroleum Activities Program for the previous month (if applicable).
Environmental Performance Report	NOPSEMA	Annually, with the first report submitted within 12 months of commencing the Petroleum Activities Program covered by this EP, as per the requirements of Regulation 14(2).	Compliance with environmental performance outcomes, controls and standards outlined in this EP, in accordance with the Environment Regulations.

7.8.2.3 End of the Environment Plan

The EP will end when Woodside notifies NOPSEMA that the Petroleum Activities Program has ended and all of the obligations identified in this EP have been fulfilled, and NOPSEMA has accepted the notification, in accordance with Regulation 25A of the Environment Regulations.

7.8.3 Incident Reporting (Internal)

Woodside has a defined process for the internal reporting of incidents. It is the responsibility of the Woodside Project Manager to ensure that reporting of environmental incidents meets the internal reporting requirements as defined in the Woodside HSE event notification matrix.

7.8.4 Incident Reporting (External) – Reportable and Recordable

7.8.4.1 Reportable Incidents

Definition

A reportable incident is defined under Regulation 4 of the Environment Regulations as:

- *'an incident relating to the activity that has caused, or has the potential to cause, moderate to significant environmental damage'.*

A reportable incident for the Petroleum Activities Program is:

- an incident that has caused environmental damage with a Consequence Level of Moderate (C) or above, as defined under Woodside's Risk Table (refer to **Figure 2-6**)
- an incident that has the potential to cause environmental damage with a Consequence Level of Moderate (C) or above, as defined under Woodside's Risk Table (refer to **Figure 2-6**).

The environmental risk assessment (**Section 6**) for the Petroleum Activities Program identifies those risks with a potential consequence level of Moderate (C) or above for environment. The only incident identified that has the potential to cause this level of impact is hydrocarbon loss of containment to the marine environment resulting from a loss of well integrity.

Any such incidents represent potential events which would be reportable incidents. Incidents are reporting with consideration of NOPSEMA (2014) guidance stating, 'if in doubt, notify NOPSEMA', and assessed case-by-case to determine if they trigger a reportable incident as defined in this EP and by the Regulations.

Notification

NOPSEMA will be notified of all reportable incidents, according to the requirements of Regulations 26, 26A and 26AA of the Environment Regulations. Woodside will:

- report all reportable incidents to the regulator (orally) as soon as practicable, but within two hours of the incident or of its detection by Woodside
- provide a written record of the reported incident to NOPSEMA, the National Offshore Petroleum Titles Administrator and the Department of the responsible State Minister (DMIRS) as soon as practicable after the oral reporting of the incident
- complete a written report for all reportable incidents using a format consistent with the NOPSEMA Form FM0831 – Reportable Environmental Incident which must be submitted to NOPSEMA as soon as practicable, but within three days of the incident or of its detection by Woodside
- provide a copy of the written report to the National Offshore Petroleum Titles Administrator and DMIRS, within seven days of the written report being provided to NOPSEMA.

AMSA will be notified of oil spill incidents as soon as practicable following their occurrence, and DoEE if MNES are to be affected by the oil spill incident.

7.8.4.2 Recordable Incidents

Definition

A recordable incident is defined under Regulation 4 of the Environment Regulations as an incident arising from the activity that:

- *'breaches an environmental performance outcome or environmental performance standard, in the EP that applies to the activity, that is not a reportable incident'*.

Notification

NOPSEMA will be notified of all recordable incidents, according to the requirements of Regulation 26B(4), not later than 15 days after the end of the calendar month using the NOPSEMA Form – Recordable Environmental Incident Monthly Summary Report (**Appendix E**) detailing:

- a record of all recordable incidents that occurred during the calendar month
- all material facts and circumstances concerning the recordable incidents that the operator knows or is able, by reasonable search or enquiry, to find out
- any action taken to avoid or mitigate any adverse environment impacts of the recordable incidents
- the corrective action that has been taken, or is proposed to be taken, to prevent similar recordable incidents
- the action that has been taken, or is proposed to be taken, to prevent a similar incident occurring in the future.

7.8.4.3 Other External Incident Reporting Requirements

In addition to the notification and reporting of environmental incidents defined under the Environment Regulations and Woodside requirements, **Table 7-3** describes the incident reporting requirements that also apply in the Permit Area.

Table 7-3: External incident reporting requirements

Incident	Responsible	Notifiable party	Notification Requirements	Contact	Contact Details
Any marine incidents during Petroleum Activities Program, as per AMSA requirements	Vessel Master	AMSA	Incident Alert Form 18 as soon as reasonably practicable* Within 72 hours after becoming aware of the incident, submit Incident Report Form 19	AMSA	reports@amsa.gov.au
Oil pollution incidents in Commonwealth waters	Vessel Master	AMSA RCC	As per Article 8 and Protocol I of MARPOL within two hours via the national emergency 24-hour notification contacts and a written report within 24 hours of the request by AMSA	AMSA RCC	If the ship is at sea, reports are to be made to: Free call: 1800 641 792 Phone: 08 9430 2100 (Fremantle)
Oil pollution incident in Commonwealth waters	Vessel Master	AMSA	Without delay as per protection of the *Sea Act*, part II, section 11(1), verbally notify AMSA RCC via the national emergency 24-hour notification contact of the hydrocarbon spill Follow up with a written Pollution Report as soon as practicable following verbal notification	Rescue Coordination Centre (RCC) Australia	Phone: 1800 641 792 or +61 2 6230 6811 AFTN: YSARYCYX
Any oil pollution incident which has the potential to enter a National Park or requires oil spill response activities to be conducted within a National Park		Department of Environment and Energy	Reported verbally, as soon as practicable	Director of National Parks	Phone: 02 6274 2220
Activity causes unintentional death of or injury to fauna species listed as Threatened or Migratory under the EPBC Act	Vessel Master	Department of Environment and Energy	Within seven days of becoming aware	Secretary of the DoEE	Phone: 1800 803 772 Email: protected.species@environment.gov.au

Additionally, the following pollution activity should also be reported to AMSA via RCC Australia by the Vessel Master:

- any loss of plastic material
- garbage disposed of in the sea within 12 nm of land (garbage includes food, paper, bottles, etc.)
- any loss of hazardous materials.

For oil spill incidents, other agencies and organisations will be notified as appropriate to the nature and scale of the incident as per procedures and contact lists in the Oil Pollution Emergency Arrangements (Australia) and the Julimar Phase 2 Drilling and Subsea Installation Oil Pollution First Strike Plan.

7.9 Emergency Preparedness and Response

7.9.1 Overview

Under Regulation 14(8), the implementation strategy must contain an oil pollution emergency plan (OPEP) and provide for updating the OPEP. Regulation 14(8AA) outlines the requirements for the OPEP which must include adequate arrangements for responding to and monitoring oil pollution.

A summary of how this EP and supporting documents address the various requirements of Environment Regulations relating to oil pollution response arrangements is shown in **Table 7-4**.

Table 7-4: Oil pollution and preparedness and response overview

Content	Environment Regulations Reference	Document/Section Reference
Details of (oil pollution response) control measures that will be used to reduce the impacts and risks of the activity to ALARP and an acceptable level	Regulation 13(5), (6), 14(3)	Oil Spill Preparedness and Response Mitigation Assessment for Julimar Phase 2 Drilling and Subsea Installation EP (**Appendix D**)
Description of the OPEP	Regulation 14(8)	Environment Plan: Woodside's OPEP has the following components: • Woodside Oil Pollution Emergency Arrangements (Australia) • Julimar Phase 2 Drilling and Subsea Installation Oil Pollution First Strike Plan • Oil Spill Preparedness and Response Mitigation Assessment for Julimar Phase 2 Drilling and Subsea Installation EP (**Appendix D**).
Details of the arrangements for responding to and monitoring oil pollution (to inform response activities), including control measures	Regulation 14(8AA)	Oil Spill Preparedness and Response Mitigation Assessment for Julimar Phase 2 Drilling and Subsea Installation EP (**Appendix D**) Julimar Phase 2 Drilling and Subsea Installation Oil Pollution First Strike Plan
Details of the arrangements for updating and testing the oil pollution response arrangements	Regulation 14(8), (8A), (8B), (8C)	Environment Plan: **Section 7.9.3** Oil Spill Preparedness and Response Mitigation Assessment for Julimar Phase 2 Drilling and Subsea Installation EP (**Appendix D)**
Details of provision, monitoring impacts to the environment from oil pollution and response activities	Regulation 14(8D)	Oil Spill Preparedness and Response Mitigation Assessment for Julimar Phase 2 Drilling and Subsea Installation EP (**Appendix D**)
Demonstration that the oil pollution response arrangements are consistent with the national system for oil pollution preparedness and control	Regulation 14(8E)	Woodside's Oil Pollution Emergency Arrangements (Australia)

7.9.2 Emergency Response Preparation

The Corporate Incident Coordination Centre, based in Woodside's head office in Perth, is the onshore coordination point for an offshore emergency. The CICC is staffed by a roster of appropriately skilled personnel available on call 24 hours a day. The CICC, under the leadership of the CICC Duty Manager, supports the site-based IMT by providing, operations, logistics, planning, people management and public information (corporate affairs) support. A description of Woodside's Incident Command Structure and arrangements is further detailed in the Woodside Oil Pollution Emergency Arrangements (Australia).

An Emergency Response Plan (ERP) will be drafted for the Petroleum Activities Program covered by this EP. The ERP provides procedural guidance specific to the rig and location of operations to control, coordinate and respond to an emergency or incident. For a drilling activity, the ERP will be a bridging document to the contracted rigs' emergency documentation. This document summarises the emergency command, control and communications processes for the integrated operation and management of an emergency. It is developed in collaboration with the contracted rig and ensures roles and responsibilities between the contracted rig and Woodside personnel are identified and understood. The ERP will contain instructions for vessel emergency, medical emergency, search and rescue, reportable incidents, incident notification, contact information and activation of the Contractor's emergency centre and Woodside Communication Centre (WCC).

In the event of an emergency of any type:

- On the MODU, the Offshore Installation Manager will assume overall onsite command and act as the Incident Controller (IC). All persons aboard the MODU/activity support vessels will be required to act under the IC's directions. The MODU/activity support vessels will maintain communications with the onshore Drilling Superintendent and/or other emergency services in the event of an emergency. Emergency response support can be provided by the Contractor's emergency centre or WCC if requested by the IC.
- The Vessel Master (depending on the location of the emergency) will assume overall onsite command and act as the IC. All persons will be required to act under the IC's directions. The vessels will maintain communications with the onshore project manager and/or other emergency services in the event of an emergency. Emergency response support can be provided by the Contractor's emergency centre or WCC if requested by the IC.
- The MODU and project vessels will have on-board equipment for responding to emergencies including medical, fire-fighting and oil spill response equipment.

7.9.3 Oil and Other Hazardous Materials Spill

A significant hydrocarbon spill during the proposed Petroleum Activities Program is unlikely, but should such an event occur, it has the potential to cause a serious safety incident, environmental, asset and reputational damage if not managed properly. The Woodside Oil Pollution Emergency Arrangements (Australia) document, supported by the Julimar Phase 2 Drilling and Subsea Installation – Oil Pollution First Strike Plan which provides tactical response guidance to the activity/area and **Appendix D** of this EP, cover spill response for this Petroleum Activities Program.

The Oil Spill Preparedness Manager is responsible for managing Woodside's oil spill response equipment, and for maintaining oil spill preparedness and response documentation. In the event of a major spill, Woodside will request that AMSA (administrator of the National Plan) provides support to Woodside through advice and access to equipment, people and liaison. The interface and responsibilities, as defined under the National Plan, are described in the Woodside Oil Pollution Emergency Arrangements (Australia). AMSA and Woodside have an MoU in place to support Woodside in the event of an oil spill.

The Julimar Phase 2 Drilling and Subsea Installation – Oil Pollution First Strike Plan provides immediate actions required to commence a response.

The MODU and project vessels will have SOPEPs in accordance with the requirements of MARPOL 73/78 Annex I. These plans outline responsibilities, specify procedures and identify resources available in the event of a hydrocarbon or chemical spill from vessel activities. The Oil Pollution First Strike Plan is intended to work in conjunction with the SOPEPs, if hydrocarbons are released to the marine environment from a vessel.

Woodside has established environmental performance outcomes, performance standards and measurement criteria to be used for oil spill response during the Petroleum Activities Program, as detailed in **Appendix D**.

7.9.4 Emergency and Spill Response Drills and Exercises

Woodside categorises incidents and emergencies in relation to response requirements as follows:

7.9.4.1 Level 1

Level 1 incidents are those that can be resolved using existing resources, equipment and personnel. A Level 1 incident is contained, controlled and resolved by site/regionally based teams using existing resources and functional support services.

7.9.4.2 Level 2

Level 2 incidents are characterised by a response that requires external operational support to manage the incident. It is triggered if the capabilities of the tactical level response are exceeded. This support is provided to the activity via the activation of all, or part of, the responsible CICC.

7.9.4.3 Level 3

A Level 3 incident or crisis is identified as a critical event that seriously threatens the organisation's people, the environment, company assets, reputation, livelihood or essential services. At Woodside, the Crisis Management Team manages the strategic impacts in order to respond to and recover from the threat to the Company (material impacts, litigation, legal & commercial, reputation, etc.). The CICC may also be activated as required to manage the operational response to the Level 3 Incident.

7.9.5 Emergency and Spill Response Drills and Exercises

Woodside's capability to respond to incidents will be tested, with the frequency of these tests conducted as prescribed in **Table 7-5**. The company emergency response testing regime is aligned to existing or developing risks associated with Woodside's operations and activities. Corporate hazards/risks outlined in the corporate risk register, respective Safety Cases or project Risk Registers, are the key reference point for developing emergency management and crisis management exercises. External participants may be invited to attend crisis exercises and may include government agencies, specialist service providers, oil spill response organisations or industry members with which Woodside has mutual aid arrangements.

The objective is to exercise procedures, skills and teamwork of the Emergency Response and Command Teams in their ability to respond to Major Accident Events and Major Environment Events. After each exercise, the team holds a debrief session, during which the exercise is reviewed. Any lessons learned or areas for improvement are identified and incorporated into emergency procedures where appropriate.

Table 7-5: Testing of response capability to incidents

Level 1 Response	One Level 1 oil spill response exercise to be conducted within two weeks of new well commencement. This drill should test elements of the recommended response identified in the Julimar Phase 2 Drilling and Subsea Installation – Oil Pollution First Strike Plan in relation to the level of the incident.
Level 2 Response	Minimum of one Emergency Management exercise per MODU per year; and one within one month of commencing a new activity in a new region.
Level 3 Response	The number of Crisis Management Team exercises conducted each year is determined by the CEO, in consultation with the General Manager Security and Emergency Management.

7.9.5.1 Testing of Oil Spill Response Arrangements

There are a number of arrangements which in the event of a spill will underpin Woodside's ability to implement a response across its petroleum activities. To ensure each of these arrangements is adequately tested, the Security and Emergency Management Capability and Development Team ensures tests are conducted in alignment with Woodside's testing schedule.

Woodside's testing schedule aligns with international good practice for spill preparedness and response management. The testing is compatible with the IPIECA Good Practice Guide and the Australian Emergency Management Institute Handbook.

Woodside's testing schedule identifies the type of test which will be conducted annually for each arrangement, and how this type will vary over a five year rolling schedule. Testing methods may include audits, drills, field exercises, functional workshops, assurance reporting, assurance monitoring and reviews of key external dependencies.

Activity-specific Oil Spill Pollution First Strike Plans are developed to meet the response needs of that particular activity's Worst Credible Spill Scenario (WCCS). The ability to implement these plans may rely on specific arrangements or those common to other Woodside activities. Regardless of their commonality, each arrangement will be tested in at least one of the methods annually. The activity-specific Hydrocarbon Pollution First Strike Plan will be tested in alignment with **Table 7-5**. This ensures personnel are familiar with spill response procedures, reporting requirements and roles/responsibilities.

At the completion of testing, a report is produced to demonstrate the outcomes achieved against the tested objectives. The report will include the lessons learned, any improvement actions and a list of the participants. Alternatively an assurance report, assurance records or audit report may be produced. These reports record findings and include any recommendations for improvement. Improvement actions and their close-out are actively recorded and managed.

7.9.6 Cyclone and Dangerous Weather Preparation

As the timing of some activities associated with the Petroleum Activities Program are not yet determined, it is possible drilling and subsea installation activities will overlap with the cyclone season (November to April, with most cyclones occurring between January and March). If drilling in cyclone season, the MODU Contractor and vessel contractors must have a Cyclone Contingency Plan (CCP) in place outlining the processes and procedures that would be implemented during a cyclone event, which will be reviewed and accepted by Woodside.

The MODU and project vessels will receive daily forecasts from the BoM. If a cyclone (or severe weather event) is forecast, the path and its development will be plotted and monitored using the BoM data. If there is the potential for the cyclone (severe weather event) to affect the Petroleum Activities Program, the CCP will be actioned. If required, vessels can transit from the proposed track of the cyclone (severe weather event).

7.9.7 Implementation Strategy and Reporting Commitments Summary

Table 7-6 summarises key components within the implementation strategy.

Table 7-6: Implementation strategy and reporting commitments summary

Implementation Strategy (IS) Performance Outcome	Implementation Strategy Performance Standard	Implementation Strategy Measurement Criteria
PO IS-1 All crew will be aware of their roles and responsibilities regarding environmental risks throughout the Petroleum Activities Program.	**PS IS-1.1** All personnel are required to attend an induction before commencing work. These inductions cover health, safety and environmental requirements for the MODU and project vessels, and environmental information specific to the Petroleum Activities Program location.	**MC IS-1.1.1** Induction attendance records.

Implementation Strategy (IS) Performance Outcome	Implementation Strategy Performance Standard	Implementation Strategy Measurement Criteria
	PS IS-1.2 A pre-activity meeting will be held on the MODU and Primary Installation Vessels with relevant personnel before conducting the Petroleum Activities Program, focusing on any specific environmental sensitivities associated with the activity.	**MC IS-1.1.2** Pre-activity meeting attendance records and minutes.
	PS IS-1.3 During operations, regular HSE meetings will be held on the MODU and project vessels which cover all crew. Recent environmental incidents will be reviewed and awareness material presented regularly.	**MC IS-1.3.1** Attendance is recorded and lists retained on the MODU/project vessels.
	PS IS-1.4 The Rig Contractor and vessel contractors must have a CCP accepted by Woodside, outlining the processes and procedures that would be implemented during a cyclone event, if drilling is to take place during cyclone season.	**MC IS-1.4.1** Record of Woodside-approved Contractor CCP in place prior to activities commencing.
PO IS-2 Woodside and its Contractors will perform a program of periodic monitoring during the Petroleum Activities Program – starting at mobilisation of each activity and continuing through the duration of each activity to activity completion.	**PS IS-2.1** This information will be collected using the tools and systems outlined in **Section 7.5**, developed based on the environmental performance outcomes, standards and measurement criteria in this EP.	**MC-IS 2.1.1** Monitoring reports.
PO IS-3 Woodside will audit environmental performance.	**PS IS-3.1** Any newly contracted MODU will have a start-up or pre-mobilisation audit performed, if not previously contracted to Woodside within the last two years.	**MC IS-3.1.1** Woodside's start up or pre-mobilisation report for the MODU.
	PS IS-3.2 Offshore Woodside personnel must conduct a minimum of monthly environmental inspections as detailed in **Section 7.5.2**.	**MC IS-3.2.1** Completed environmental inspection checklists.
	PS IS-3.3 Woodside Environmental Adviser (or delegate) must complete at least one quarterly environment audit during the Petroleum Activities Program.	**MC IS-3.3.1** Quarterly Environment Audit report.
	PS IS-3.4 Audit findings relevant to continuous improvement of environmental performance will be tracked through the MODU or vessel compliance action register, a contractor register between the MODU operator or vessel contractor and Woodside.	**MC IS-3.4.1** MODU or vessel compliance action register records that demonstrate tracking of audit findings.

Implementation Strategy (IS) Performance Outcome	Implementation Strategy Performance Standard	Implementation Strategy Measurement Criteria
	PS IS-3.5 Marine assurance will be undertaken in accordance with Woodside's internal assurance process and is mandatory for all vessels hired for Woodside operations as detailed in **Section 7.5.2**. The process defines the marine offshore assurance activities applicable for all vessels chartered directly by or on behalf of Woodside.	**MC IS-3.5.1** Records demonstrate marine assurance reviews conducted as required.
PO IS-4 Woodside employees and Contractors will report all environmental incidents and non-conformance with environmental performance outcomes and standards in this EP.	**PS IS-4.1** Non-conformances to be notified, investigated and reported in accordance with Woodside's event recording, investigation and learnings requirements.	**PS IS-4.1.1** Records demonstrate Non-conformances are notified, investigated and reported in accordance with Woodside's event recording, investigation and learnings requirements.
PO IS-5 Woodside will perform regular reviews to monitor environmental performance.	**PS IS-5.1** Woodside is to hold quarterly HSE Review meetings.	**PS IS-5.1.1** Records demonstrate meetings reviewed HSE performance.
	PS IS-4.2 Woodside's Drilling and Completions Environment Team is to perform six-monthly reviews of the effectiveness of the implementation strategy and associated tools as detailed in **Section 7.5.4**.	**PS IS-4.2.1** Records demonstrate six-monthly reviews of the effectiveness of the implementation strategy.
PO IS-6 Changes in activity scope, understanding of the environment and potential new advice from external stakeholders will be tracked and the EP updated as required.	**PS IS-6.2** Management of changes relevant to this EP to be managed in accordance with Regulation 17 of the Environment Regulations detailed in **Section 7.6**.	**PS IS-6.2.1** Records of minor revisions to the EP tracked in an MOC Register. Revision and resubmission of the EP as required.
PO IS-7 All external reporting requirements relevant to this EP will be met.	**PS IS-7.1** Woodside will submit an environmental performance report to NOPSEMA (annually, with the first report submitted within 12 months of commencing the activity) .	**MC IS-7.1.1** Record of submission of environmental performance reports to NOPSEMA.
PO IS-8 All external notification requirements, as applicable to this EP, will be met.	**PS IS-8.1** Woodside will notify NOPSEMA and DMIRS of the commencement of the Petroleum Activities Program at least ten days before the activity commences. Woodside will notify NOPSEMA and DMIRS within ten days of completing the activity.	**MC IS-8.1.1** Record of notification to NOPSEMA. Record of notification to DMIRS.
	PS IS-8.2 The EP will end when Woodside notifies NOPSEMA that the Petroleum Activities Program has ended and all of the obligations identified in this EP have been completed, and NOPSEMA has accepted the notification, in accordance with Regulation 25A.	**MC IS-8.2.1** Record of notification to NOPSEMA.

Implementation Strategy (IS) Performance Outcome	Implementation Strategy Performance Standard	Implementation Strategy Measurement Criteria
	PS IS-8.3 NOPSEMA will be notified of all reportable incidents, according to the requirements of Regulations 26, 26A and 26AA of the Environment Regulations.	**MC IS-8.3.1** Record of notifications to NOPSEMA
	PS IS-8.4 DoEE (if MNES affected) will be notified of oil spill incidents as soon as practicable following the occurrence.	**MC IS-8.4.1** Record of notification to DoEE if MNES is affected.
	PS IS-8.5 DPIRD (formerly DoF), peak fishing bodies and known regional commercial fishing operators identified in this EP will be notified prior to and upon completing the proposed activity, including rig and support vessel details.	**MC IS-8.5.1** Records of notification to the Department, peak fishing bodies and known commercial regional fishing operators identified in this EP.
	PS IS-8.6 Any oil pollution incidents in Commonwealth waters will be reported without delay (by the vessel master) to AMSA RCC as per the *Protection of the Sea (Prevention of Pollution from Ships) Act*, Part II, Section 11(1). The verbal report shall be made via the national emergency 24-hour notification contact, and if AMSA requests a written report, it should be provided within 24 hours of the request.	**MC IS 8.6.1** Records of notification to AMSA.
PO IS-9 Unplanned emissions and discharges will be documented and records maintained.	**PS IS-9.1** The volumes of unplanned emissions and discharges that could result from the risks described in **Section 6.7** are documented in the daily drilling, pipeline or subsea reports.	**MC IS-9.1.1** Records of unplanned emissions and discharges are maintained in daily drilling, pipeline or subsea reports.
PO IS-10 Personnel holding responsibilities in a response will test the arrangements supporting the activities OPEP to ensure they are effective and communicated.	**PS IS-10.1** Exercises will be conducted in alignment with the frequency identified in **Table 7-4**. These arrangements are conducted in accordance with Regulation 14(8B) of the *Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009.* • Arrangements are tested when introduced. • Arrangements are tested in accordance with Woodside's Hydrocarbon Spill Arrangements Testing Schedule as per the frequency identified in **Table 7-5**. • Arrangements will be tested when the OPEP is significantly amended, and further testing will occur if a new activity location is added to the EP.	**MC IS-10.1.1** Spill response exercise reports and key participants maintained in the Woodside IMS system. Records managed in Hydrocarbon Spill Preparedness Unit (HSPU) Testing of Arrangements Register.
	PS IS-10.2 Post exercise reports will be developed for each exercise to measure performance against the objectives, and the learnings from the plan updated in the OPEP following these learnings.	**MC IS-10.2.1** Spill response exercise reports and key participants maintained in the Woodside IMS system. Records managed in HSPU Testing of Arrangements Register.

Implementation Strategy (IS) Performance Outcome	Implementation Strategy Performance Standard	Implementation Strategy Measurement Criteria
	PS IS-10.3 Close-out of HSPU actions from exercising are managed in the HSPU Testing of Arrangements Register.	**MC IS-10.3.1** Records managed in HSPU Testing of Arrangements Register.
PO IS-11 Woodside will ensure that the arrangements supporting the activities OPEP are validated.	**PS IS-11.1** Activity OPEPs will be revised at a minimum every five years.	**MC IS-11.1.1** OPEP current and available.
PO IS-12 The OPEP will only be updated under specific circumstances to ensure the information is current.	**PS IS-12.1** Relevant documents from the OPEP will be reviewed when: • implementing an improved preparedness measure • the availability of equipment stockpiles changes • the availability of personnel changes that reduces or improves preparedness and the capacity to respond • a new or improved technology is introduced that may be considered in a response for this activity • incorporating, where relevant, lessons learned from exercises or events • national or state response frameworks and Woodside's integration with these frameworks changes.	**MC IS-12.1.1** The following records will be maintained: • Woodside's HSPU Testing of arrangements register • Woodside's Internal Equipment Maintenance Register • OPEP current and available.
PO IS-13 Woodside will perform a vessel risk assessment where an OVID inspection and/or OVMSA Verification Review is not available (i.e. short term vessel hire).	**PS IS-13.1** The Marine Vessel Risk Assessment will be conducted by the Marine Assurance Superintendent, or the nominated deputy, where the vessel meets the short term hire prerequisites.	**MC IS-13.1.1** Marine Vessel Risk Assessment sheet demonstrates the assessment has been conducted.
PO IS-14 Prior to recommencing activities after a cessation period greater than 12 months, Woodside will review impacts, risks and controls.	**PS IS-14.1** Impacts and risks associated with recommencing activities (if commencing after a cessation period greater than 12 months) must remain/be reduced to ALARP and acceptable levels.	**MC IS-14.1.1** Records demonstrate impacts, risks and controls are reviewed before recommencing activities (if commencing after a cessation period greater than 12 months).

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8.1 Glossary

Term	Meaning
(the) Regulator	The Government Agency (State or Commonwealth) that is the decision maker for approvals and undertakes ongoing regulation of the approval once granted.
Acceptability	The EP must demonstrate that the environmental impacts and risks of an activity will be of an acceptable level as per Regulation 10A(c).
ALARP	A legal term in Australian safety legislation, it is taken here to mean that all contributory elements and stakeholdings have been considered by assessing costs and benefits, and which identifies a preferred course of action.
API (gravity)	A measure of how heavy or light a petroleum liquid is compared to water.
Australian Standard	An Australian Standard which provides criteria and guidance on design, materials, fabrication, installation, testing, commissioning, operation, maintenance, re-qualification and abandonment.
Ballast	Extra weight taken on to increase a ship's stability to prevent rolling and pitching. Most ships use seawater as ballast. Empty tank space is filled with inert (non-combustible) gas to prevent the possibility of fire or explosion.
Bathymetry	Related to water depth – a bathymetry map shows the depth of water at a given location on the map.
Benthos/Benthic	Relating to the seabed, and includes organisms living in or on sediments/rocks on the seabed.
Biodiversity	Relates to the level of biological diversity of the environment. The EPBC Act defines biodiversity as: "the variability among living organisms from all sources (including terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part) and includes: (a) diversity within species and between species; and (b) diversity of ecosystems".
Biota	The animal and plant life of a particular region, habitat or geological period.
Cetacean	Whale and dolphin species.
Consequence	The worst-case credible outcome associated with the selected event, assuming some controls (prevention and mitigation) have failed. Where more than one impact applies (e.g. environmental and legal/compliance), the consequence level for the highest severity impact is selected.
Coral	Anthozoa that are characterised by stone-like, horny or leathery skeletons (external or internal). The skeletons of these animals are also called coral.
Coral Reef	A wave-resistant structure resulting from skeletal deposition and cementation of hermatypic corals, calcareous algae, and other calcium carbonate-secreting organisms.
Crustacean	A large and variable group of mostly aquatic invertebrates which have a hard external skeleton (shell), segmented bodies, with a pair of often very modified appendages on each segment, and two pairs of antennae (e.g. crabs, crayfish, shrimps, wood lice, water fleas and barnacles).
Cyclone	A rapidly-rotating storm system characterised by a low-pressure centre, strong winds, and a spiral arrangement of thunderstorms that produce heavy rain.
Datum	A reference location or elevation which is used as a starting point for subsequent measurements.
dB	Decibel – a measure of the overall noise level of sound across the audible spectrum with a frequency weighting (that is, 'A' weighting) to compensate for the varying sensitivity of the human ear to sound at different frequencies.

Term	Meaning
dB re 1 µPa²	Measure of underwater noise, in terms of sound pressure. Because the dB is a relative measure, rather than an absolute measure, it must be referenced to a standard "reference intensity", in this case 1 micro Pascal (1 mPa), which is the standard reference that is used. The dB is also measured over a specified frequency, which is usually either a one Hertz bandwidth (expressed as dB re 1 m Pa2/Hz), or over a broadband which has not been filtered. Where a frequency is not specified, it can be assumed that the measurement is a broadband measurement.
dB re 1 µPa².s	Normal unit for sound exposure level.
Demersal	Living close to the floor of the sea (typically of fish).
Drill casing	Tubing that is set inside the drilled well to protect and support the well stream.
Drilling fluids	The main functions of drilling fluids include providing hydrostatic pressure to prevent formation fluids from entering into the well bore, keeping the drill bit cool and clean during drilling, performing drill cuttings, and suspending the drill cuttings while drilling is paused and when the drilling assembly is brought in and out of the hole. The drilling fluid used for a particular job is selected to avoid formation damage and to limit corrosion. The three main categories of drilling fluids are water based muds (which can be dispersed and non-dispersed), non-aqueous muds, usually called oil-based mud, and gaseous drilling fluid, in which a wide range of gases can be used.
DRIMS	Woodside's internal document management system.
Dynamic positioning	In reference to a marine vessel that uses satellite navigation and radio transponders in conjunction with thrusters to maintain its position.
EC_{50}	The concentration of a drug, antibody or toxicant which induces a response halfway between the baseline and maximum after a specified exposure time.
Echinoderms	Any of numerous radially symmetrical marine invertebrates of the phylum *Echinodermata*, which includes starfishes, sea urchins and sea cucumbers, which have an internal calcareous skeleton and are often covered with spines.
Endemic	A species that is native to or confined to a certain region.
Environment	The surroundings in which an organisation operates, including air, water, land, natural resources, flora, fauna, humans and their interrelations (Source: ISO 14001).
Environment Plan	Prepared in accordance with the Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009, which must be assessed and accepted by the Designated Authority (NOPSEMA) before any petroleum-related activity can be conducted.
Environment Regulations	OPGGS (Environment) Regulation 2009.
Environmental approval	The action of approving something, which has the potential to adversely impact the environment. Environmental impact assessment is generally required before environmental approval is granted.
Environmental Hazard	The characteristic of an activity or event that could potentially cause damage, harm or adverse effects on the environment .
Environmental impact	Any change to the environment, whether adverse or beneficial, wholly or partially resulting from an organisation's activities, products or services (Source: HB 203:2006).
Environmental impact assessment	An orderly and systematic process for evaluating a proposal or scheme (including its alternatives), and its effects on the environment, and mitigation and management of those effects (Source: Western Australian *Environmental Impact Assessment Administrative Procedures 2010*).
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*. Commonwealth legislation designed to promote the conservation of biodiversity and protection of the environment.
Epifauna	Benthic animals that live on the surface of a substrate.
Fauna	Collectively, the animal life of a particular region.
Flora	Collectively the plant life of a particular region.

Term	Meaning
IC_{50}	A measure of the effectiveness of a compound in inhibiting biological or biochemical function.
Infauna	Aquatic animals that live in the substrate of a body of water, especially in a soft sea bottom.
ISO 14001	ISO 14001 is an international standard that specifies a process (called an Environmental Management System or EMS) for controlling and improving a company's environmental performance. An EMS provides a framework for managing environmental responsibilities so they become more efficient and more integrated into overall business operations.
Jig fishing	Fishing with a jig, which is a type of fishing lure. A jig consists of a lead sinker with a hook moulded into it and usually covered by a soft body to attract fish.
LC_{50}	The concentration of a substance that is lethal to 50% of the population exposed to it for a specified time.
Likelihood	The description that best fits the chance of the selected consequence actually occurring, assuming reasonable effectiveness of the prevention and mitigation controls.
MARPOL (73/78)	The International Convention for the Prevention of Pollution from Ships 1973, as modified by the Protocol of 1978. MARPOL 73/78 is one of the most important international marine environmental conventions. It was designed to minimise pollution of the seas, including dumping, oil and exhaust pollution. Its stated object is to preserve the marine environment through the complete elimination of pollution by oil and other harmful substances and the minimisation of accidental discharge of such substances.
Meteorology	The study of the physics, chemistry and dynamics of the earth's atmosphere, including the related effects at the air–earth boundary over both land and the oceans.
Mitigation	Management measures which minimise and manage undesirable consequences.
Oligotrophic	Low in plant nutrients and having a large amount of dissolved oxygen throughout.
pH	Measure of the acidity or basicity of an aqueous solution.
Protected Species	Threatened, vulnerable or endangered species which are protected from extinction by preventive measures. Often governed by special Federal or State laws.
Putrescible	Refers to food scraps and other organic waste associated with food preparation that will be subject to decay and rot (putrefaction).
Risk	The combination of the consequences of an event and its associated likelihood. For guidance see Environmental Guidance on Application of Risk Management Procedure.
Sessile	Organism that is fixed in one place; immobile.
Teleost	A fish belonging to the Teleostei or Teleostomi, a large group of fishes with bony skeletons, including most common fishes. The teleosts are distinct from the cartilaginous fishes such as sharks, rays and skates.
Thermocline	A temperature gradient in a thermally stratified body of water.
Zooplankton	Plankton consisting of small animals and the immature stages of larger animals.

Abbreviation	Meaning
µm	Micrometer
ABARES	Australian Bureau of Agricultural and Resource Economics and Sciences
AFMA	Australian Fisheries Management Authority
AHO	Australian Hydrographic Office
AHS	Australian Hydrographic Service
AHV	Anchor Handling Vessel
AIMS	Australian Institute of Marine Science
AIS	Automatic Identification System
ALARP	As Low As Reasonably Practicable
AMP	Australian Marine Park
AMSA	Australian Maritime Safety Authority
APPEA	Australian Petroleum Production and Exploration Association
AS/NZS	Australian/New Zealand Standard
ATSB	Australian Transport Safety Bureau
AusSAR	Australian Search and Rescue
bbl	Oil barrel
BIA	Biologically Important Area
BoM	Bureau of Meteorology
BOP	Blow-Out Preventer
BP	Boiling Point
BRUVS	Baited Remote Underwater Video System
BRU-XOM	Brunello Crossover Manifold
CALM	Department of Conservation and Land Management
CCP	Cyclone Contingency Plan
CEFAS	Centre for Environment, Fisheries and Aquaculture Science
CICC	Corporate Incident Communication Centre
COLREGS	Convention on the International Regulations for Preventing Collisions at Sea, 1972
CRA	Corrosion-Resistant Alloy
CS	Cost/Sacrifice
Cth	Commonwealth
CV	Company Values
DAA	Department of Aboriginal Affairs
DAFF	Department of Agriculture, Fisheries and Forestry
DEC	Department of Environment and Conservation
DEH	Department of Environment and Heritage
DEWHA	Department of the Environment, Water, Heritage and the Arts
DMIRS	Department of Mines, Industry Regulation and Safety
DMP	Department of Mine and Petroleum
DNP	Director of National Parks

Abbreviation	Meaning
DNV	Det Norsk Veritas
DoD	Department of Defence
DoEE	Department of the Environment and Energy
DoF	Department of Fisheries
DoT	WA Department of Transport
DP	Dynamic Positioning
DPaW	Department of Parks and Wildlife
DPIRD	Department of Primary Industries and Regional Development
DSEWPaC	Department of Sustainability, Environment, Water, Population and Communities
DWH	Deepwater Horizon
EC_{50}	Half maximal effective concentration
eCAR	Environmental Commitments and Actions Register
EDS	Emergency Disconnect Sequence
EHU	Electrical Hydraulic Umbilical
EMS	Environmental Management System
ENVID	Environmental Hazard Identification
EP	Environment Plan
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
EPO	Environmental Performance Outcome
ERP	Emergency Response Plan
F	Feasibility
FBE	Fusion Bonded Epoxy
FCGT	Flood, Clean and Gauge Testing
FEWD	Formation Evaluation While Drilling
FLET	Flowline End Termination
GDSF	Gascoyne Demersal Scalefish Fishery
GP	Good Practice
g/m^2	Grams per square metre
HAZID	Hazard Identification
HOCNF	Harmonised Offshore Chemical Notification Format
HQ	Hazard Quotient
HSE	Health, Safety and Environment
HSPU	Hydrocarbon Spill Preparedness Unit
Hz	Hertz
IC	Incident Controller
ILI	In Line Inspection
ILTA	Inline Tee Assembly
IMO	International Maritime Organization
IMR	Inspection, Maintenance and Repair

Abbreviation	Meaning
IMS	Invasive Marine Species
IMT	Incident Management Team
IC_{50}	Half maximal inhibitory concentration
IOGP	International Association of Oil and Gas Producers
IPIECA	International Petroleum Industry Environmental Conservation Association
ISO	International Standards Organization
ITF	Indonesian Throughflow
ITOPF	International Tanker Owners Pollution Federation
IUCN	International Union for Conservation of Nature
JRCC	Joint Rescue Coordination Centre
JULA	Julimar Six-Slot Manifold
KEF	Key Ecological Feature
kHz	Kilohertz
km	Kilometre
kPa	Kilopascal
L	Litres
LBL	Long Base Line
LC_{50}	Lethal Concentration, 50%
LCS	Legislation, Codes and Standards
LNG	Liquefied Natural Gas
m/s	Metres per second
MAF	Marine Aquarium Fishery
MC	Measurement Criteria
MEG	Monoethylene Glycol
MFO	Marine Fauna Observer
MMscf	Million Standard Cubic Feet
MMSI	Maritime Mobile Service Identity
MNES	Matters of National Environmental Significance
MOC	Management of Change
MODU	Mobile Offshore Drilling Unit
MoU	Memorandum of Understanding
MPA	Marine Protected Areas
MPRA	Marine Parks and Reserves Authority
MSIN	Maritime Safety Information Notifications
NIMS	Non-indigenous Marine Species
nm	Nautical mile (1852 m) a unit of distance on the sea
NMFS	US National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NOEC	No Observed Effect Concentration

Abbreviation	Meaning
NOPSEMA	National Offshore Petroleum Safety and Environmental Management Authority
NPS	Non-Pressure Seal
NTM	Notice to Mariners
NWBM	Non-Water Based Mud
NWMR	North West Marine Region
NWS	North West Shelf
NWSTF	North West Slope Trawl Fishery
OCNS	Offshore Chemical Notification Scheme
OCS	Outer Continental Shelf
OIW	Oil in Water
OMR	Opportunity to Modify Request
OOC	Oil On Cuttings
OPEP	Oil Pollution Emergency Plan
OPGGS Act	*Offshore Petroleum and Greenhouse Gas Storage Act 1999*
OSPAR Convention	Convention for the Protection of the Marine Environment of the North-east Atlantic
OVID	Offshore Vessel Inspection Database
OVMSA	Offshore Vessel Safety Management System Assessment
PAH	Polycyclic Aromatic Hydrocarbon
PJ	Professional Judgement
PLRs	Pig Launcher and Receiver
Pow	Octanol-Water Partition
PPA	Pearl Producers Association
ppb	Parts per Billion
ppm	Parts per Million
PS	Performance Standard
psi	Pounds per square inch
PSU	Practical Salinity Unit
PTS	Permanent Threshold Shift
PTW	Permit to Work
RBA	Risk Based Analysis
RCC	Rescue Coordination Centre
RFI	Request for Information
RMR	Riserless Mud Recovery
rms	Root Mean Square
ROV	Remotely Operated Vehicle
SCA	Spool Connector Assembly
SCE	Solids Control Equipment
SDU	Subsea Distribution Units
SEL	Sound Exposure Level

Abbreviation	Meaning
SIMAP	Spill Impact Mapping and Analysis Program
SIMOPS	Simultaneous Operations
SMPEP	Spill Monitoring Programme Execution Plan
SOPEP	Ship Oil Pollution Emergency Plan
SPL	Sound Pressure Level
SV	Societal Values
Stb	Stock tank barrel
TD	Total Depth
TL	Transmission Loss
TPH	Total Petroleum Hydrocarbons
TPS	Well Test Package
TTS	Temporary Threshold Shift
UK	United Kingdom
US	United States of America
USBL	Ultra-Short Baseline
UTA	Umbilical Termination Assemblies
VOC	Volatile Organic Compound
VSP	Vertical Seismic Profiling
WA	Western Australia
WAF	Water Accommodated Fraction
WAFIC	Western Australian Fishing Industry Council
WBM	Water-Based Mud
WCBD	Well Control Bridging Document
WCC	Woodside Communication Centre
WCSS	Worst Credible Spill Scenario
WSTF	Western Skipjack Tuna Fishery
WHA	World Heritage Area
WMS	Woodside Management System
WOMP	Well Operations Management Plan
Woodside	Woodside Energy Limited

APPENDIX A: WOODSIDE ENVIRONMENT & RISK MANAGEMENT POLICIES

WOODSIDE POLICY

Woodside

Health, Safety, Environment and Quality Policy

OBJECTIVES

Strong health, safety, environment and quality (HSEQ) performance is essential for the success and growth of our business. Our aim is to be recognised as an industry leader in HSEQ through managing our activities in a sustainable manner with respect to our workforce, our communities and the environment.

At Woodside we believe that process and personal safety related incidents, and occupational illnesses, are preventable. We are committed to managing our activities to minimise adverse health, safety or environmental impacts, incorporating a right first time approach to quality.

PRINCIPLES

Woodside will achieve this by:

- implementing a systematic approach to HSEQ risk management
- complying with relevant laws and regulations and applying responsible standards where laws do not exist
- setting, measuring and reviewing objectives and targets that will drive continuous improvement in HSEQ performance
- embedding HSEQ considerations in our business planning and decision making processes
- integrating HSEQ requirements when designing, purchasing, constructing and modifying equipment and facilities
- maintaining a culture in which everybody is aware of their HSEQ obligations and feels empowered to speak up and intervene on HSEQ issues
- undertaking and supporting research to improve our understanding of HSEQ and using science to support impact assessments and evidence based decision making
- taking a collaborative and pro-active approach with our stakeholders
- requiring contractors to comply with our HSEQ expectations in a mutually beneficial manner
- publicly reporting on HSEQ performance

APPLICATION

Responsibility for the application of this policy rests with all Woodside employees, contractors and joint venturers engaged in activities under Woodside operational control. Woodside managers are also responsible for promotion of this policy in non-operated joint ventures.

This policy will be reviewed regularly and updated as required.

Reviewed by the Woodside Petroleum Ltd Board on 7 December 2018

WOODSIDE POLICY

Risk Management Policy

OBJECTIVES

Woodside recognises that risk is inherent to its business and that effective management of risk is vital to delivering on our objectives, our success and our continued growth. We are committed to managing all risk in a proactive and effective manner.

Our approach to risk enhances opportunities, reduces threats and sustains Woodside's competitive advantage.

The objective of our risk management system is to provide a consistent process for the recognition and management of risks across Woodside's business. The success of our risk management system lies in the responsibility placed on everyone at all levels to proactively identify, manage, review and report on risks relating to the objectives they are accountable for delivering.

PRINCIPLES

Woodside achieves these objectives by:

- Applying a structured and comprehensive risk management system across Woodside which establishes common risk management understanding, language and methodology
- Identifying, assessing, monitoring and reporting risks to provide management and the Board with the assurance that risks are being effectively identified and managed
- Ensuring risks consider impacts across the following key areas of exposure: health and safety, environment, finance, reputation and brand, legal and compliance, and social and cultural
- Understanding our exposure to risk and applying this to our decision making
- Embedding risk management into our critical business activities and processes
- Assuring the effectiveness of risk controls and of the risk management process
- Building our internal resilience to the effects of adverse business impacts in order to sustain performance.

APPLICATION

The Managing Director of Woodside is accountable to the Board of Directors for ensuring this policy is effectively implemented.

Managers are responsible for promoting and applying the Risk Management Policy. Responsibility for the effective application of this policy rests with all Woodside employees, contractors and joint venturers engaged in activities under Woodside operational control.

This policy will be reviewed regularly and updated as required.

December 2012

APPENDIX B: RELEVANT REQUIREMENTS

This appendix refers to Commonwealth Legislation related to the project. Western Australian State Legislation relevant to an accidental release of hydrocarbons in WA State waters is outlined in the Julimar Phase 2 Drilling and Subsea Installation Oil Pollution Emergency Plan.

Commonwealth Legislation	Legislation Summary
Air Navigation Act 1920 • *Air Navigation Regulations 1947* • *Air Navigation (Aerodrome Flight* • *Corridors) Regulations 1994* • *Air Navigation (Aircraft Engine* • *Emissions) Regulations 1995* • *Air Navigation (Aircraft Noise)* • *Regulations 1984* • *Air Navigation (Fuel Spillage) Regulations 1999*	This Act relates to the management of air navigation.
Australian Maritime Safety Authority Act 1990	This Act establishes a legal framework for the Australian Maritime Safety Authority (AMSA), which represents the Australian Government and international forums in the development, implementation and enforcement of international standards including those governing ship safety and marine environment protection. AMSA is responsible for administering the Marine Orders in Commonwealth waters.
Australian Radiation Protection and Nuclear Safety Act 1998	This Act relates to the protection of the health and safety of people, and the protection of the environment from the harmful effects of radiation.
Biosecurity Act 2015 • *Quarantine Regulations 2000* • *Biosecurity Regulation 2016* • *Australian Ballast Water Management Requirements 2017*	This Act provides the Commonwealth with powers to take measures of quarantine, and implement related programs as are necessary, to prevent the introduction of any plant, animal, organism or matter that could contain anything that could threaten Australia's native flora and fauna or natural environment. The Commonwealth's powers include powers of entry, seizure, detention and disposal. This Act includes mandatory controls on the use of seawater as ballast in ships and the declaration of sea vessels voyaging out of and into Commonwealth waters. The Regulations stipulate that all information regarding the voyage of the vessel and the ballast water is declared correctly to the quarantine officers.
Environment Protection and Biodiversity Conservation Act 1999 • *Environment Protection and Biodiversity Conservation Regulations 2000*	This Act protects matters of national environmental significance (NES). It streamlines the national environmental assessment and approvals process, protects Australian biodiversity and integrates management of important natural and culturally significant places. Under this Act, actions that may be likely to have a significant impact on matters of NES must be referred to the Commonwealth Environment Minister.
Environment Protection (Sea Dumping) Act 1981 • *Environment Protection (Sea Dumping) Regulations 1983*	This Act provides for the protection of the environment by regulating dumping matter into the sea, incineration of waste at sea and placement of artificial reefs.
Industrial Chemicals (Notification and Assessment Act) 1989 • *Industrial Chemicals (Notification and Assessment) Regulations 1990*	This Act creates a national register of industrial chemicals. The Act also provides for restrictions on the use of certain chemicals which could have harmful effects on the environment or health.

Commonwealth Legislation	Legislation Summary
National Environment Protection Measures (Implementation) Act 1998 • *National Environment Protection Measures (Implementation) Regulations 1999*	This Act and Regulations provide for the implementation of National Environment Protection Measures (NEPMs) to protect, restore and enhance the quality of the environment in Australia and ensure that the community has access to relevant and meaningful information about pollution. The National Environment Protection Council has made NEPMs relating to ambient air quality, the movement of controlled waste between states and territories, the national pollutant inventory, and used packaging materials.
National Greenhouse and Energy Reporting Act 2007 • *National Greenhouse and Energy Reporting (Safeguard Mechanism) Rule 2015*	This Act and associated Rule establishes the legislative framework for the NGER scheme for reporting greenhouse gas emissions and energy consumption and production by corporations in Australia.
Navigation Act 2012 • *Marine order 12 – Construction – subdivision and stability, machinery and electrical installations* • *Marine order 30 - Prevention of collisions* • *Marine order 47 - Mobile offshore drilling units* • *Marine order 57 - Helicopter operations* • *Marine order 60 - Floating offshore facilities* • *Marine order 91 - Marine pollution prevention—oil* • *Marine order 93 - Marine pollution prevention—noxious liquid substances* • *Marine order 94 - Marine pollution prevention—packaged harmful substances* • *Marine order 96 - Marine pollution prevention—sewage* • *Marine order 97 - Marine pollution prevention—air pollution*	This Act regulates navigation and shipping including Safety of Life at Sea (SOLAS). The Act will apply to some activities of the MODU and project vessels. This Act is the primary legislation that regulates ship and seafarer safety, shipboard aspects of marine environment protection and pollution prevention.
Offshore Petroleum and Greenhouse Gas Storage Act 2006 • *Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009* • *Offshore Petroleum and Greenhouse Gas Storage (Resource Management and Administration) Regulations 2011* • *Offshore Petroleum and Greenhouse Gas Storage (Safety) Regulations 2009*	This Act is the principal Act governing offshore petroleum exploration and production in Commonwealth waters. Specific environmental, resource management and safety obligations are set out in the Regulations listed.
Ozone Protection and Synthetic Greenhouse Gas Management Act 1989 • *Ozone Protection and Synthetic Greenhouse Gas Management Regulations 1995*	This Act provides for measures to protect ozone in the atmosphere by controlling and ultimately reducing the manufacture, import and export of ozone depleting substances (ODS) and synthetic greenhouse gases, and replacing them with suitable alternatives. The Act will only apply to Woodside if it manufactures, imports or exports ozone depleting substances.

Commonwealth Legislation	Legislation Summary
Protection of the Sea (Powers of Intervention) Act 1981	This Act authorises the Commonwealth to take measures for the purpose of protecting the sea from pollution by oil and other noxious substances discharged from ships and provides legal immunity for persons acting under an AMSA direction.
Protection of the Sea (Prevention of Pollution from Ships) Act 1983 *Protection of the Sea (Prevention of Pollution from Ships) (Orders) Regulations 1994* • *Marine order 91 - Marine pollution prevention—oil* • *Marine order 93 - Marine pollution prevention—noxious liquid substances* • *Marine order 94 - Marine pollution prevention—packaged harmful substances* • *Marine order 95 - Marine pollution prevention—garbage* • *Marine order 96 - Marine pollution prevention—sewage* *Maritime Legislation Amendment (Prevention of Air Pollution from Ships) Act 2007* MARPOL Convention	This Act relates to the protection of the sea from pollution by oil and other harmful substances discharged from ships. Under this Act, discharge of oil or other harmful substances from ships into the sea is an offence. There is also a requirement to keep records of the ships dealing with such substances. The Act applies to all Australian ships, regardless of their location. It applies to foreign ships operating between 3 nautical miles (nm) off the coast out to the end of the Australian Exclusive Economic Zone (200 nm). It also applies within the 3 nm of the coast where the State/Northern Territory does not have complementary legislation. All the Marine Orders listed, except for Marine Order 95, are enacted under both the *Navigation Act 2012* and the *Protection of the Sea (Prevention of Pollution from Ships) Act 1983*. This Act is an amendment to the *Protection of the Sea (Prevention of Pollution from Ships) Act 1983*. This amended Act provides the protection of the sea from pollution by oil and other harmful substances discharged from ships.
Protection of the Sea (Harmful Antifouling Systems) Act 2006 • *Marine order 98—(Marine pollution prevention—anti-fouling systems)*	This Act relates to the protection of the sea from the effects of harmful anti-fouling systems. It prohibits the application or reapplication of harmful anti-fouling compounds on Australian ships or foreign ships that are in an Australian shipping facility.

APPENDIX C: EPBC ACT PROTECTED MATTERS SEARCH

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.

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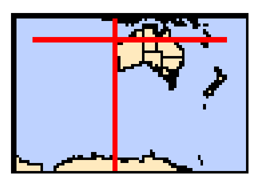
Coordinates
Buffer: 1.0Km



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:	2
National Heritage Places:	3
Wetlands of International Importance:	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	2
Listed Threatened Ecological Communities:	None
Listed Threatened Species:	51
Listed Migratory Species:	64

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:	2
Listed Marine Species:	120
Whales and Other Cetaceans:	33
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	12

Extra Information

This part of the report provides information that may also be relevant to the area you have nominated.

State and Territory Reserves:	14
Regional Forest Agreements:	None
Invasive Species:	6
Nationally Important Wetlands:	None
Key Ecological Features (Marine)	10

Details

Matters of National Environmental Significance

World Heritage Properties [Resource Information]

Name	State	Status
Shark Bay, Western Australia	WA	Declared property
The Ningaloo Coast	WA	Declared property

National Heritage Properties [Resource Information]

Name	State	Status
Natural		
Shark Bay, Western Australia	WA	Listed place
The Ningaloo Coast	WA	Listed place
Historic		
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 Species [Resource Information]

Name	Status	Type of Presence
Birds		
Anous tenuirostris melanops Australian Lesser Noddy [26000]	Vulnerable	Species or species habitat may 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
Diomedea amsterdamensis Amsterdam Albatross [64405]	Endangered	Species or species habitat likely to occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Species or species habitat may occur within area
Limosa lapponica baueri Bar-tailed Godwit (baueri), Western Alaskan Bar-tailed Godwit [86380]	Vulnerable	Species or species habitat may occur within

Name	Status	Type of Presence
		area
Limosa lapponica menzbieri Northern Siberian Bar-tailed Godwit, Bar-tailed Godwit (menzbieri) [86432]	Critically Endangered	Species or species habitat may occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Malurus leucopterus edouardi White-winged Fairy-wren (Barrow Island), Barrow Island Black-and-white Fairy-wren [26194]	Vulnerable	Species or species habitat likely to occur within area
Malurus leucopterus leucopterus White-winged Fairy-wren (Dirk Hartog Island), Dirk Hartog Black-and-White Fairy-wren [26004]	Vulnerable	Species or species habitat likely to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area
Papasula abbotti Abbott's Booby [59297]	Endangered	Species or species habitat may occur within area
Pezoporus occidentalis Night Parrot [59350]	Endangered	Species or species habitat may occur within area
Pterodroma mollis Soft-plumaged Petrel [1036]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Sternula nereis nereis Australian Fairy Tern [82950]	Vulnerable	Breeding known to occur within area
Thalassarche carteri Indian Yellow-nosed Albatross [64464]	Vulnerable	Foraging, feeding or related behaviour may occur within area
Thalassarche cauta cauta Shy Albatross, Tasmanian Shy Albatross [82345]	Vulnerable	Species or species habitat may occur within area
Thalassarche cauta steadi White-capped Albatross [82344]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Species or species habitat may occur within area
Fish		
Milyeringa veritas Blind Gudgeon [66676]	Vulnerable	Species or species habitat may occur within area
Mammals		
Balaenoptera borealis Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Migration route known to occur within area

Name	Status	Type of Presence
Balaenoptera physalus		
Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Bettongia lesueur Barrow and Boodie Islands subspecies		
Boodie, Burrowing Bettong (Barrow and Boodie Islands) [88021]	Vulnerable	Species or species habitat known to occur within area
Bettongia penicillata ogilbyi		
Woylie [66844]	Endangered	Species or species habitat likely to occur within area
Eubalaena australis		
Southern Right Whale [40]	Endangered	Species or species habitat likely to occur within area
Isoodon auratus barrowensis		
Golden Bandicoot (Barrow Island) [66666]	Vulnerable	Species or species habitat known to occur within area
Lagorchestes conspicillatus conspicillatus		
Spectacled Hare-wallaby (Barrow Island) [66661]	Vulnerable	Species or species habitat known to occur within area
Lagorchestes hirsutus Central Australian subspecies		
Mala, Rufous Hare-Wallaby (Central Australia) [88019]	Endangered	Translocated population known to occur within area
Megaptera novaeangliae		
Humpback Whale [38]	Vulnerable	Congregation or aggregation known to occur within area
Osphranter robustus isabellinus		
Barrow Island Wallaroo, Barrow Island Euro [89262]	Vulnerable	Species or species habitat likely to occur within area
Petrogale lateralis lateralis		
Black-flanked Rock-wallaby, Moororong, Black-footed Rock Wallaby [66647]	Endangered	Species or species habitat known to occur within area
Rhinonicteris aurantia (Pilbara form)		
Pilbara Leaf-nosed Bat [82790]	Vulnerable	Species or species habitat known to occur within area
Reptiles		
Aipysurus apraefrontalis		
Short-nosed Seasnake [1115]	Critically Endangered	Species or species habitat known to occur within area
Aprasia rostrata rostrata		
Monte Bello Worm-lizard, Hermite Island Worm-lizard [64481]	Vulnerable	Species or species habitat known to occur within area
Caretta caretta		
Loggerhead Turtle [1763]	Endangered	Breeding known to occur within area
Chelonia mydas		
Green Turtle [1765]	Vulnerable	Breeding known to occur within area
Ctenotus angusticeps		
Northwestern Coastal Ctenotus, Airlie Island Ctenotus [25937]	Vulnerable	Species or species habitat known to occur within area
Ctenotus zastictus		
Hamelin Ctenotus [25570]	Vulnerable	Species or species habitat known to occur within area
Dermochelys coriacea		
Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat known to occur within area
Egernia stokesii badia		
Western Spiny-tailed Skink, Baudin Island Spiny-	Endangered	Species or species

Name	Status	Type of Presence
tailed Skink [64483]		habitat likely to occur within area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Breeding known to occur within area
Lepidochelys olivacea Olive Ridley Turtle, Pacific Ridley Turtle [1767]	Endangered	Species or species habitat likely to occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Breeding known to occur within area
Sharks		
Carcharias taurus (west coast population) Grey Nurse Shark (west coast population) [68752]	Vulnerable	Species or species habitat known to occur within area
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat known to occur within area
Pristis clavata Dwarf Sawfish, Queensland Sawfish [68447]	Vulnerable	Species or species habitat known to occur within area
Pristis zijsron Green Sawfish, Dindagubba, Narrowsnout Sawfish [68442]	Vulnerable	Species or species habitat known to occur within area
Rhincodon typus 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 Common Noddy [825]		Species or species habitat likely to occur within area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardenna carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [82404]		Foraging, feeding or related behaviour likely to occur within area
Ardenna pacifica Wedge-tailed Shearwater [84292]		Breeding known to occur within area
Calonectris leucomelas Streaked Shearwater [1077]		Species or species habitat likely to occur within area
Diomedea amsterdamensis Amsterdam Albatross [64405]	Endangered	Species or species habitat likely to occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Species or species habitat may occur within area
Fregata ariel Lesser Frigatebird, Least Frigatebird [1012]		Species or species habitat likely to occur within area
Fregata minor Great Frigatebird, Greater Frigatebird [1013]		Species or species habitat may occur within

Name	Threatened	Type of Presence
		area
Hydroprogne caspia Caspian Tern [808]		Breeding known to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Onychoprion anaethetus Bridled Tern [82845]		Breeding known to occur within area
Phaethon lepturus White-tailed Tropicbird [1014]		Foraging, feeding or related behaviour likely to occur within area
Sterna dougallii Roseate Tern [817]		Breeding known to occur within area
Sternula albifrons Little Tern [82849]		Congregation or aggregation known to occur within area
Thalassarche carteri Indian Yellow-nosed Albatross [64464]	Vulnerable	Foraging, feeding or related behaviour may occur within area
Thalassarche cauta Tasmanian Shy Albatross [89224]	Vulnerable*	Species or species habitat may occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Species or species habitat may occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable*	Foraging, feeding or related behaviour likely to occur within area
Migratory Marine Species		
Anoxypristis cuspidata Narrow Sawfish, Knifetooth Sawfish [68448]		Species or species habitat known to occur within area
Balaena glacialis australis Southern Right Whale [75529]	Endangered*	Species or species habitat likely to occur within area
Balaenoptera bonaerensis Antarctic Minke Whale, Dark-shoulder Minke Whale [67812]		Species or species habitat likely to occur within area
Balaenoptera borealis Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Balaenoptera edeni Bryde's Whale [35]		Species or species habitat likely to occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Migration route known to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour likely

Name	Threatened	Type of Presence
		to occur within area
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat known to occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Breeding known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Breeding known to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat known to occur within area
Dugong dugon Dugong [28]		Breeding known to occur within area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Breeding known to occur within area
Isurus oxyrinchus Shortfin Mako, Mako Shark [79073]		Species or species habitat likely to occur within area
Isurus paucus Longfin Mako [82947]		Species or species habitat likely to occur within area
Lamna nasus Porbeagle, Mackerel Shark [83288]		Species or species habitat may occur within area
Lepidochelys olivacea Olive Ridley Turtle, Pacific Ridley Turtle [1767]	Endangered	Species or species habitat likely to occur within area
Manta alfredi 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 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 Humpback Whale [38]	Vulnerable	Congregation or aggregation known to occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Breeding known to occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat may occur within area
Physeter macrocephalus Sperm Whale [59]		Species or species habitat may occur within area
Pristis clavata Dwarf Sawfish, Queensland Sawfish [68447]	Vulnerable	Species or species habitat known to occur within area
Pristis zijsron Green Sawfish, Dindagubba, Narrowsnout Sawfish [68442]	Vulnerable	Species or species habitat known to occur within area
Rhincodon typus Whale Shark [66680]	Vulnerable	Foraging, feeding or related behaviour known to occur within area

Name	Threatened	Type of Presence
Sousa chinensis Indo-Pacific Humpback Dolphin [50]		Species or species habitat known to occur within area
Tursiops aduncus (Arafura/Timor Sea populations) Spotted Bottlenose Dolphin (Arafura/Timor Sea populations) [78900]		Species or species habitat known to occur within area
Migratory Terrestrial Species		
Hirundo rustica Barn Swallow [662]		Species or species habitat may occur within area
Motacilla cinerea Grey Wagtail [642]		Species or species habitat may occur within area
Motacilla flava Yellow Wagtail [644]		Species or species habitat may occur within area
Migratory Wetlands Species		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat known to 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
Charadrius veredus Oriental Plover, Oriental Dotterel [882]		Species or species habitat may occur within area
Glareola maldivarum Oriental Pratincole [840]		Species or species habitat may occur within area
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat known to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area
Pandion haliaetus Osprey [952]		Breeding known to occur within area
Thalasseus bergii Crested Tern [83000]		Breeding known to occur within area
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat likely 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
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	Species or species habitat may occur within area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardea alba Great Egret, White Egret [59541]		Species or species habitat likely to 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 likely 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
Diomedea amsterdamensis Amsterdam Albatross [64405]	Endangered	Species or species habitat likely to occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Species or species habitat may occur within area

Name	Threatened	Type of Presence
Fregata ariel Lesser Frigatebird, Least Frigatebird [1012]		Species or species habitat likely to occur within area
Fregata minor Great Frigatebird, Greater Frigatebird [1013]		Species or species habitat may occur within area
Glareola maldivarum Oriental Pratincole [840]		Species or species habitat may occur within area
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat likely to occur within area
Hirundo rustica Barn Swallow [662]		Species or species habitat may occur within area
Larus novaehollandiae Silver Gull [810]		Breeding known to occur within area
Larus pacificus Pacific Gull [811]		Foraging, feeding or related behaviour known to occur within area
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat known to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area
Motacilla cinerea Grey Wagtail [642]		Species or species habitat may occur within area
Motacilla flava Yellow Wagtail [644]		Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area
Pandion haliaetus Osprey [952]		Breeding known to occur within area
Papasula abbotti Abbott's Booby [59297]	Endangered	Species or species habitat may occur within area
Phaethon lepturus White-tailed Tropicbird [1014]		Foraging, feeding or related behaviour likely to occur within area
Pterodroma macroptera Great-winged Petrel [1035]		Foraging, feeding or related behaviour known to occur within area
Pterodroma mollis Soft-plumaged Petrel [1036]	Vulnerable	Foraging, feeding or related behaviour likely

Name	Threatened	Type of Presence
		to occur within area
Puffinus assimilis Little Shearwater [59363]		Foraging, feeding or related behaviour likely to occur within area
Puffinus carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [1043]		Foraging, feeding or related behaviour likely to occur within area
Puffinus pacificus Wedge-tailed Shearwater [1027]		Breeding known to occur within area
Sterna albifrons Little Tern [813]		Congregation or aggregation known to occur within area
Sterna anaethetus Bridled Tern [814]		Breeding known to occur within area
Sterna bengalensis Lesser Crested Tern [815]		Breeding known to occur within area
Sterna bergii Crested Tern [816]		Breeding known to occur within area
Sterna caspia Caspian Tern [59467]		Breeding known to occur within area
Sterna dougallii Roseate Tern [817]		Breeding known to occur within area
Sterna fuscata Sooty Tern [794]		Breeding known to occur within area
Sterna nereis Fairy Tern [796]		Breeding known to occur within area
Thalassarche carteri Indian Yellow-nosed Albatross [64464]	Vulnerable	Foraging, feeding or related behaviour may occur within area
Thalassarche cauta Tasmanian Shy Albatross [89224]	Vulnerable*	Species or species habitat may occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Species or species habitat may occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable*	Foraging, feeding or related behaviour likely to occur within area
Thinornis rubricollis Hooded Plover [59510]		Species or species habitat known to occur within area
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat likely to occur within area
Fish		
Acentronura larsonae Helen's Pygmy Pipehorse [66186]		Species or species habitat may occur within area
Bhanotia fasciolata Corrugated Pipefish, Barbed Pipefish [66188]		Species or species

Name	Threatened	Type of Presence
		habitat may occur within area
Bulbonaricus brauni Braun's Pughead Pipefish, Pug-headed Pipefish [66189]		Species or species habitat may occur within area
Campichthys galei Gale's Pipefish [66191]		Species or species habitat may occur within area
Campichthys tricarinatus Three-keel Pipefish [66192]		Species or species habitat may occur within area
Choeroichthys brachysoma Pacific Short-bodied Pipefish, Short-bodied Pipefish [66194]		Species or species habitat may occur within area
Choeroichthys latispinosus Muiron Island Pipefish [66196]		Species or species habitat may occur within area
Choeroichthys suillus Pig-snouted Pipefish [66198]		Species or species habitat may occur within area
Corythoichthys amplexus Fijian Banded Pipefish, Brown-banded Pipefish [66199]		Species or species habitat may occur within area
Corythoichthys flavofasciatus Reticulate Pipefish, Yellow-banded Pipefish, Network Pipefish [66200]		Species or species habitat may occur within area
Corythoichthys intestinalis Australian Messmate Pipefish, Banded Pipefish [66202]		Species or species habitat may occur within area
Corythoichthys schultzi Schultz's Pipefish [66205]		Species or species habitat may occur within area
Cosmocampus banneri Roughridge Pipefish [66206]		Species or species habitat may occur within area
Doryrhamphus dactyliophorus Banded Pipefish, Ringed Pipefish [66210]		Species or species habitat may occur within area
Doryrhamphus excisus Bluestripe Pipefish, Indian Blue-stripe Pipefish, Pacific Blue-stripe Pipefish [66211]		Species or species habitat may occur within area
Doryrhamphus janssi Cleaner Pipefish, Janss' Pipefish [66212]		Species or species habitat may occur within area
Doryrhamphus multiannulatus Many-banded Pipefish [66717]		Species or species habitat may occur within area
Doryrhamphus negrosensis Flagtail Pipefish, Masthead Island Pipefish [66213]		Species or species habitat may occur within area
Festucalex scalaris Ladder Pipefish [66216]		Species or species habitat may occur within area
Filicampus tigris Tiger Pipefish [66217]		Species or species habitat may occur within

Name	Threatened	Type of Presence
		area
Halicampus brocki Brock's Pipefish [66219]		Species or species habitat may occur within area
Halicampus dunckeri Red-hair Pipefish, Duncker's Pipefish [66220]		Species or species habitat may occur within area
Halicampus grayi Mud Pipefish, Gray's Pipefish [66221]		Species or species habitat may occur within area
Halicampus nitidus Glittering Pipefish [66224]		Species or species habitat may occur within area
Halicampus spinirostris Spiny-snout Pipefish [66225]		Species or species habitat may occur within area
Haliichthys taeniophorus Ribboned Pipehorse, Ribboned Seadragon [66226]		Species or species habitat may occur within area
Hippichthys penicillus Beady Pipefish, Steep-nosed Pipefish [66231]		Species or species habitat may occur within area
Hippocampus angustus Western Spiny Seahorse, Narrow-bellied Seahorse [66234]		Species or species habitat may occur within area
Hippocampus histrix Spiny Seahorse, Thorny Seahorse [66236]		Species or species habitat may occur within area
Hippocampus kuda Spotted Seahorse, Yellow Seahorse [66237]		Species or species habitat may occur within area
Hippocampus planifrons Flat-face Seahorse [66238]		Species or species habitat may occur within area
Hippocampus spinosissimus Hedgehog Seahorse [66239]		Species or species habitat may occur within area
Hippocampus trimaculatus Three-spot Seahorse, Low-crowned Seahorse, Flat-faced Seahorse [66720]		Species or species habitat may occur within area
Lissocampus fatiloquus Prophet's Pipefish [66250]		Species or species habitat may occur within area
Micrognathus micronotopterus Tidepool Pipefish [66255]		Species or species habitat may occur within area
Nannocampus subosseus Bonyhead Pipefish, Bony-headed Pipefish [66264]		Species or species habitat may occur within area
Phoxocampus belcheri Black Rock Pipefish [66719]		Species or species habitat may occur within area
Solegnathus hardwickii Pallid Pipehorse, Hardwick's Pipehorse [66272]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
Solegnathus lettiensis Gunther's Pipehorse, Indonesian Pipefish [66273]		Species or species habitat may occur within area
Solenostomus cyanopterus Robust Ghostpipefish, Blue-finned Ghost Pipefish, [66183]		Species or species habitat may occur within area
Stigmatopora argus Spotted Pipefish, Gulf Pipefish, Peacock Pipefish [66276]		Species or species habitat may occur within area
Syngnathoides biaculeatus Double-end Pipehorse, Double-ended Pipehorse, Alligator Pipefish [66279]		Species or species habitat may occur within area
Trachyrhamphus bicoarctatus Bentstick Pipefish, Bend Stick Pipefish, Short-tailed Pipefish [66280]		Species or species habitat may occur within area
Trachyrhamphus longirostris Straightstick Pipefish, Long-nosed Pipefish, Straight Stick Pipefish [66281]		Species or species habitat may occur within area
Mammals		
Dugong dugon Dugong [28]		Breeding known to occur within area
Reptiles		
Acalyptophis peronii Horned Seasnake [1114]		Species or species habitat may occur within area
Aipysurus apraefrontalis Short-nosed Seasnake [1115]	Critically Endangered	Species or species habitat known to occur within area
Aipysurus duboisii Dubois' Seasnake [1116]		Species or species habitat may occur within area
Aipysurus eydouxii Spine-tailed Seasnake [1117]		Species or species habitat may occur within area
Aipysurus laevis Olive Seasnake [1120]		Species or species habitat may occur within area
Aipysurus pooleorum Shark Bay Seasnake [66061]		Species or species habitat may occur within area
Aipysurus tenuis Brown-lined Seasnake [1121]		Species or species habitat may occur within area
Astrotia stokesii Stokes' Seasnake [1122]		Species or species habitat may occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Breeding known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Breeding known to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat known to occur within area
Disteira kingii Spectacled Seasnake [1123]		Species or species

Name	Threatened	Type of Presence
		habitat may occur within area
Disteira major Olive-headed Seasnake [1124]		Species or species habitat may occur within area
Emydocephalus annulatus Turtle-headed Seasnake [1125]		Species or species habitat may occur within area
Ephalophis greyi North-western Mangrove Seasnake [1127]		Species or species habitat may occur within area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Breeding known to occur within area
Hydrelaps darwiniensis Black-ringed Seasnake [1100]		Species or species habitat may occur within area
Hydrophis czeblukovi Fine-spined Seasnake [59233]		Species or species habitat may occur within area
Hydrophis elegans Elegant Seasnake [1104]		Species or species habitat may occur within area
Hydrophis mcdowelli null [25926]		Species or species habitat may occur within area
Hydrophis ornatus Spotted Seasnake, Ornate Reef Seasnake [1111]		Species or species habitat may occur within area
Lepidochelys olivacea Olive Ridley Turtle, Pacific Ridley Turtle [1767]	Endangered	Species or species habitat likely to occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Breeding known to occur within area
Pelamis platurus 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 Minke Whale [33]		Species or species habitat may occur within area
Balaenoptera bonaerensis Antarctic Minke Whale, Dark-shoulder Minke Whale [67812]		Species or species habitat likely to occur within area
Balaenoptera borealis Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Balaenoptera edeni Bryde's Whale [35]		Species or species habitat likely to occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Migration route known to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Foraging, feeding or

Name	Status	Type of Presence
		related behaviour likely to occur within area
Delphinus delphis Common Dophin, Short-beaked Common Dolphin [60]		Species or species habitat may occur within area
Eubalaena australis Southern Right Whale [40]	Endangered	Species or species habitat likely to occur within area
Feresa attenuata Pygmy Killer Whale [61]		Species or species habitat may occur within area
Globicephala macrorhynchus Short-finned Pilot Whale [62]		Species or species habitat may occur within area
Globicephala melas Long-finned Pilot Whale [59282]		Species or species habitat may occur within area
Grampus griseus Risso's Dolphin, Grampus [64]		Species or species habitat may occur within area
Indopacetus pacificus Longman's Beaked Whale [72]		Species or species habitat may occur within area
Kogia breviceps Pygmy Sperm Whale [57]		Species or species habitat may occur within area
Kogia simus Dwarf Sperm Whale [58]		Species or species habitat may occur within area
Lagenodelphis hosei Fraser's Dolphin, Sarawak Dolphin [41]		Species or species habitat may occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Congregation or aggregation known to occur within area
Mesoplodon densirostris Blainville's Beaked Whale, Dense-beaked Whale [74]		Species or species habitat may occur within area
Mesoplodon ginkgodens Gingko-toothed Beaked Whale, Gingko-toothed Whale, Gingko Beaked Whale [59564]		Species or species habitat may occur within area
Mesoplodon grayi Gray's Beaked Whale, Scamperdown Whale [75]		Species or species habitat may occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat may occur within area
Peponocephala electra Melon-headed Whale [47]		Species or species habitat may occur within area
Physeter macrocephalus Sperm Whale [59]		Species or species habitat may occur within area
Pseudorca crassidens False Killer Whale [48]		Species or species habitat likely to occur

Name	Status	Type of Presence
		within area
Sousa chinensis Indo-Pacific Humpback Dolphin [50]		Species or species habitat known to occur within area
Stenella attenuata Spotted Dolphin, Pantropical Spotted Dolphin [51]		Species or species habitat may occur within area
Stenella coeruleoalba Striped Dolphin, Euphrosyne Dolphin [52]		Species or species habitat may occur within area
Stenella longirostris Long-snouted Spinner Dolphin [29]		Species or species habitat may occur within area
Steno bredanensis Rough-toothed Dolphin [30]		Species or species habitat may occur within area
Tursiops aduncus Indian Ocean Bottlenose Dolphin, Spotted Bottlenose Dolphin [68418]		Species or species habitat likely to occur within area
Tursiops aduncus (Arafura/Timor Sea populations) Spotted Bottlenose Dolphin (Arafura/Timor Sea populations) [78900]		Species or species habitat known to occur within area
Tursiops truncatus s. str. Bottlenose Dolphin [68417]		Species or species habitat may occur within area
Ziphius cavirostris 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)
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)
Montebello	Multiple Use Zone (IUCN VI)
Ningaloo	National Park Zone (IUCN II)
Ningaloo	Recreational Use Zone (IUCN IV)
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
Dirk Hartog Island	WA
Lowendal Islands	WA
Montebello Islands	WA
Muiron Islands	WA
Round Island	WA

Name	State
Serrurier Island	WA
Unnamed WA40322	WA
Unnamed WA40828	WA
Unnamed WA41080	WA
Unnamed WA44665	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		
Rock Pigeon, Rock Dove, Domestic Pigeon [803]		Species or species habitat likely to occur within area
Streptopelia senegalensis		
Laughing Turtle-dove, Laughing Dove [781]		Species or species habitat likely to occur within area
Mammals		
Capra hircus		
Goat [2]		Species or species habitat likely to occur within area
Felis catus		
Cat, House Cat, Domestic Cat [19]		Species or species habitat likely to occur within area
Mus musculus		
House Mouse [120]		Species or species habitat likely to occur within area
Plants		
Cenchrus ciliaris		
Buffel-grass, Black Buffel-grass [20213]		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
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

-19.212 117.3673,-18.5783 118.257,-18.2602 118.8439,-18.2016 118.7201,-18.2568 118.5226,-18.5132 118.172,-18.3015 117.8473,-17.9447 118.0173,-17.4219 118.9212,-16.3734 119.234,-15.7513 119.2452,-15.2398 119.6765,-15.0714 119.7355,-14.6061 119.37,-14.1978 119.3263,-13.6538 119.8054,-13.3472 120.3832,-13.2046 119.9771,-13.8841 119.4491,-13.7067 119.1544,-13.5974 119.1695,-14.6168 118.5766,-14.9119 118.2531,-14.9246 117.4695,-15.6802 117.1756,-16.2213 117.2741,-16.391 116.9846,-16.1425 116.6489,-15.9174 116.5577,-15.0549 116.0259,-14.668 115.9346,-15.1387 115.9286,-15.9018 116.2146,-16.1703 116.179,-16.4502 115.6139,-16.4011 115.2165,-16.4353 115.0163,-16.0627 114.3878,-15.7902 114.1782,-16.1599 114.308,-16.3851 114.2912,-16.5195 113.9235,-16.1878 113.6882,-15.997 113.1528,-15.5066 112.8122,-15.9555 112.718,-16.6017 113.0573,-16.9425 112.8064,-16.6877 112.5275,-16.3516 112.2583,-16.3565 111.7974,-16.3088 111.3227,-16.4389 111.5861,-16.8485 111.6039,-17.1557 111.2827,-18.2962 110.6843,-18.5511 110.2876,-18.4066 109.8435,-18.3968 109.5794,-18.708 109.3586,-19.0895 109.4221,-19.2736 110.2316,-19.6385 110.958,-20.0167 111.0854,-20.2367 110.6506,-20.6184 110.4091,-21.1895 110.2195,-21.3204 109.6777,-21.674 109.4133,-21.2404 108.9868,-21.0325 108.6704,-20.6631 108.6789,-20.1712 108.67,-19.78 108.5772,-19.7786 108.4573,-20.1773 108.4122,-21.0987 108.4882,-21.5414 108.6592,-21.8115 108.9399,-21.8857 109.6183,-22.3963 109.9338,-22.846 110.2653,-23.1691 109.8176,-23.2534 109.2061,-23.5743 109.0052,-23.9292 108.9689,-24.5149 109.6119,-24.6056 110.5416,-25.023 110.5799,-25.2404 110.31,-25.463 110.1151,-25.2259 110.5264,-25.166 111.0147,-25.2965 111.2928,-25.5223 111.5456,-25.9116 111.4652,-26.0993 111.2013,-26.375 110.9081,-26.5825 110.7706,-26.8892 110.7142,-27.698 110.973,-27.8255 111.1102,-27.9326 111.3258,-27.9212 111.7208,-27.8952 111.3267,-27.7218 111.0672,-27.2609 110.901,-26.7501 110.8662,-26.3645 111.0504,-26.1236 111.3655,-26.0205 111.5693,-26.0536 111.9266,-26.3362 112.2729,-26.6715 112.5153,-26.4217 112.9563,-26.1977 113.0647,-25.8586 113.0212,-25.6652 112.5223,-25.2003 112.4534,-24.7083 112.7063,-24.3523 113.0364,-24.1724 113.4144,-24.0429 113.3925,-23.8683 113.4425,-23.3849 113.7214,-23.1204 113.714,-22.9217 113.7416,-22.7064 113.6118,-22.5966 113.6051,-22.4033 113.7181,-21.8691 113.9539,-21.7641 114.1367,-21.7691 114.2243,-21.9218 114.2744,-21.3299 115.2015,-20.91 115.4245,-20.1583 116.4056,-19.212 117.3673

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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APPENDIX D: OIL SPILL PREPAREDNESS AND RESPONSE MITIGATION ASSESSMENT

Oil Spill Preparedness & Response Mitigation Assessment for Julimar Phase 2 Drilling & Subsea Installation Environment Plan

Security & Emergency Management
Hydrocarbon Spill Preparedness Unit

June 2019

Revision: 0

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FIGURES

TABLES

EXECUTIVE SUMMARY

Woodside Energy (Julimar) Pty Ltd (Woodside) has developed its oil spill preparedness and response position for the Julimar Phase 2 Drilling and Subsea Installation, hereafter known as the Petroleum Activities Program (PAP).

This document demonstrates that the risks and impacts from an unplanned hydrocarbon release, and the associated response operations, are controlled to As Low as Reasonably Practicable (ALARP) and Acceptable levels. It achieves this by evaluating response options to address the potential environmental impacts resulting from an unplanned loss of hydrocarbon containment associated with the PAP described in the Environment Plan (EP). This document then outlines Woodside's decisions and techniques for responding to a hydrocarbon release event and the process for determining its level of hydrocarbon spill preparedness.

A summary of the key facts and references to additional detail within this document are presented below.

Table 0-1: Summary of the key details for assessment

Key details of assessment	Summary	Reference to additional detail
Worst Case Credible Scenario	Hydrocarbon release caused by loss of well containment – JULA-K well. 269,858 m^3 of Julimar Condensate over 77 days comprising a 5-day surface release of 19,203 m^3 followed by a 72-day subsurface release of 250,496 m^3. 0.4% residual component of 1,079 m^3.	Section 2.2
Hydrocarbon Properties	**Julimar Condensate** (API 47.9) contains a low proportion (0.4% by mass) of hydrocarbon compounds that will not evaporate at atmospheric temperatures. These compounds will persist in the marine environment. The un-weathered mixture has a dynamic viscosity of 1.248 cP. The pour point of the whole oil (minus 24 °C) ensures that it will remain in a liquid state over the annual temperature range observed on the North West Shelf. The mixture is composed of hydrocarbons that have a wide range of boiling points and volatilities at atmospheric temperatures, and which will begin to evaporate at different rates on exposure to the atmosphere. Evaporation rates will increase with temperature, but in general about 48.8% of the oil mass should evaporate within the first 12 hours (BP < 180 °C); a further 21.3% should evaporate within the first 24 hours (180 °C < BP < 265 °C); and a further 29.5% should evaporate over several days (265 °C < BP < 380 °C).	Section 2.2.1 Section 6.7 of the EP Appendix A of the First Strike Plan
Modelling Results	**Stochastic modelling** A quantitative, stochastic assessment has been undertaken for credible spill scenarios MEE-01 and MEE-05 (Table 2-1) to help assess the environmental risk of a hydrocarbon spill. A total of 100 replicate simulations were completed for the scenarios to test for trends and variations in the trajectory and weathering of the spilled oil, with an even number of replicates completed using samples of metocean data that commenced within each calendar quarter (25 simulations per quarter).	Section 2.3
	Deterministic modelling	

	Deterministic modelling was then undertaken for scenario MEE-01 (Table 2-1) as the worst-case credible scenario (WCCS) to establish the following for response planning purposes: • Minimum time to commencement of oil accumulation at any shoreline receptor (at a threshold of 100 g/m^2) • Maximum cumulative oil volume accumulated across all shoreline receptors (at concentrations in excess of 100 g/m^2) • Maximum cumulative oil volume accumulated at any individual shoreline receptor (at concentrations in excess of 100 g/m^2) Results as follows:		
	Model 14, Q4 Minimum time to commencement of oil accumulation at any shoreline receptor (at a threshold of 100 g/m^2)	**Hydrocarbon release caused by loss of well containment** 18.4 days (Ningaloo Coast Middle World Heritage Area [WHA])	
	Model 22, Q4 Maximum cumulative oil volume accumulated across all shoreline receptors (at concentrations in excess of 100 g/m^2)	**Hydrocarbon release caused by loss of well containment** 38 m^3 (Kimberly Coast & Northern Coast)	
	Model 22, Q4 Maximum cumulative oil volume accumulated at any individual shoreline receptor (at concentrations in excess of 100 g/m^2)	**Hydrocarbon release caused by loss of well containment** 38 m^3 (Kimberly Coast & Northern Coast)	
Net Environmental Benefit Assessment	Monitor and Evaluate, Source Control (relief well drilling), Protection and Deflection, Shoreline Clean-up, and Oiled Wildlife Response are all identified as potentially having a net environmental benefit (dependent on the actual spill scenario) and carried forward for further assessment.		Section 4
ALARP evaluation of selected response techniques	The evaluation of the selected response techniques shows the proposed controls reduced the risk to an ALARP and Acceptable level for the risks and impacts presented in Section 2 and Section 3, without the implementation of considered additional, alternative or improved control measures.		Section 7

1 INTRODUCTION

1.1 Overview

Woodside Energy Ltd (Woodside) has developed its oil spill preparedness and response position for the Julimar Phase 2 Drilling and Subsea Installation, hereafter known as the Petroleum Activities Program (PAP). This document outlines Woodside's decisions and techniques for responding to a hydrocarbon loss of containment event and the process for determining its level of hydrocarbon spill preparedness.

1.2 Purpose

This document, together with the documents listed below, meet the requirements of the *Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009* (Environment Regulations) relating to hydrocarbon spill response arrangements.

- The Julimar Phase 2 Drilling and Subsea Installation Environment Plan (EP)
- Oil Pollution Emergency Arrangements (OPEA) (Australia)
- The Julimar Phase 2 Drilling and Subsea Installation Oil Pollution Emergency Plan (OPEP) including:
  - First Strike Response Plan (FSRP)
  - relevant Operations Plans
  - relevant Tactical Response Plans (TRPs)
  - relevant Supporting Plans
  - Data Directory.

1.3 Scope

This document demonstrates that the risks and impacts from an unplanned hydrocarbon release, and the associated response operations, are controlled to As Low as Reasonably Practicable (ALARP) and Acceptable levels. It achieves this by evaluating response options to address the potential environmental risks and impacts resulting from an unplanned loss of hydrocarbon containment associated with the PAP described in the EP. This content of this document then outlines Woodside's decisions and techniques for responding to a hydrocarbon release event and the process for determining its level of hydrocarbon spill preparedness. It should be read in conjunction with the documents listed in. The location of the PAP is shown in Figure 3.2 of the EP.

1.4 Oil spill response document overview

The documents outlined in and Figure 1-1 are collectively used to manage the preparedness and response for a hydrocarbon release.

The FSRP (contains a pre-operational Net Environmental Benefit Analysis (NEBA) summary, outlining the selected response techniques for this PAP. Relevant Operational Plans to be initiated for associated response techniques are identified in the FSRP and relevant forms to initiate a response are appended to the FSRP.

The process to develop an Incident Action Plan (IAP) begins once the FSRP is underway. The IAP includes inputs from the Monitor and Evaluate (MES) operations and the operational NEBA (Section 4). Planning, coordination and resource management are initiated by the Incident Management Team (IMT). In some instances, technical specialists may be utilised to provide expert advice. The planning may also involve liaison officers from supporting government agencies.

During each operational period, field reports are continually reviewed to evaluate the effectiveness of response operations. In addition, the operational NEBA is continually reviewed and updated to ensure the response techniques implemented continue to result in a net environmental benefit (see Section 4).

The response will continue as described in Section 5 until the response termination criteria have been met as set out in ANNEX B: Operational Monitoring Activation and Termination Criteria..

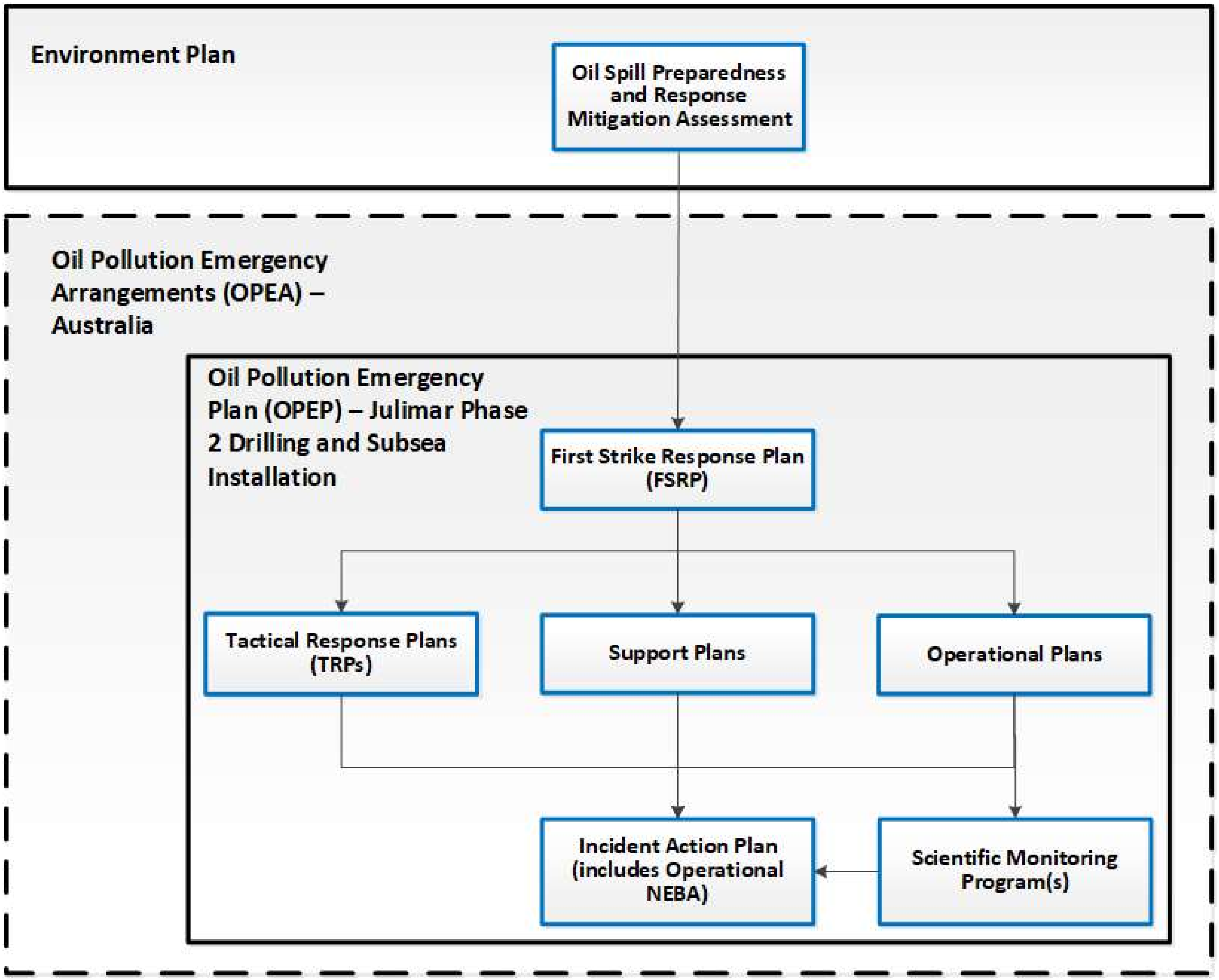

Figure 1-1: Woodside hydrocarbon spill document structure

Table 1-1: Hydrocarbon spill preparedness and response – document references

Document	Document overview	Stakeholders	Relevant information	Document subsections (if applicable)
Julimar Phase 2 Drilling and Subsea Installation Environment Plan (EP)	Demonstrates that potential adverse impacts on the environment associated with the Julimar Phase 2 Drilling and Subsea Installation (during both routine and non-routine operations) are mitigated and managed to As Low As Reasonably Practicable (ALARP) and will be of an acceptable level.	NOPSEMA Woodside internal		EP Section 6 (Environmental Risk Assessment, Performance Outcomes, Standards and Measurement Criteria). EP Section 7 (Implementation strategy – including emergency preparedness and response). EP Section 7 (Reporting and compliance).
Oil Pollution Emergency Arrangements (OPEA) Australia	Describes the arrangements and processes adopted by Woodside when responding to a hydrocarbon spill from a petroleum activity.	Regulatory agencies Woodside internal	All	
Oil Spill Preparedness and Response Mitigation Assessment (OSPRMA) for the Julimar Phase 2 Drilling and Subsea Installation (this document)	Evaluates response options to address the potential environmental impacts resulting from an unplanned loss of hydrocarbon containment associated with the PAP described in the EP.	Regulatory agencies Corporate Incident Control Centre (CICC): Control function in an ongoing spill response for activity-specific response information.	All performance outcomes, standards and measurement criteria related to hydrocarbon spill preparedness and response are included in this document.	
Julimar Phase 2 Drilling and Subsea Installation Oil Pollution First Strike Response Plan (FSRP)	Facility specific document providing details and tasks required to mobilise a first strike response. Primarily applied to the first 24 hours of a response until a full Incident Action Plan (IAP) specific to the event is developed.	Site-based IMT for initial response, activation and notification. CICC for initial response, activation and notification.	Initial notifications and reporting required within the first 24 hours of a spill event. Relevant spill response options that could be initiated for mobilisation in the event of a spill. Recommended pre-planned tactics.	

Document	Document overview	Stakeholders	Relevant information	Document subsections (if applicable)
	Oil Pollution First Strike Response Plans are intended to be the first document used to provide immediate guidance to the responding Incident Management Team (IMT).	CICC: Control function in an ongoing spill response for activity-specific response information.	Details and forms for use in immediate response. Activation process for oil spill trajectory modelling, aerial surveillance and oil spill tracking buoy details.	
Operational Plans	Lists the actions required to activate, mobilise and deploy personnel and resources to commence response operations. Includes details on access to equipment and personnel (available immediately) and steps to mobilise additional resources depending on the nature and scale of a release. Relevant operational plans will be initially selected based on the Oil Pollution First Strike Plan; additional operational plans will be activated depending on the nature and scale of the release.	CICC: Operations and Logistics functions for first strike activities. CICC: Planning Function to help inform the IAP on resources available.	Locations from where resources may be mobilised. How resources will be mobilised. Details of where resources may be mobilised to and what facilities are required once the resources arrive. Details on how to implement resources to undertake a response.	Operational Monitoring Plan Source Control & Well Intervention Protection & Deflection Shoreline clean Up Oiled Wildlife Scientific Monitoring
Tactical Response Plans	Provides options for response techniques in selected Response Protection Areas (RPAs). Provides site, access and deployment information to support a response at the location.	CICC: Planning Function to help develop IAPs, and Logistics function to assist with determining resources required.	Indicative response techniques. Access requirements and/or permissions. Relevant information for undertaking a response at that site. Where applicable, may include equipment deployment locations and site layouts.	Mangrove Bay Turquoise Bay Yardie Creek Ningaloo Reef - Refer to Mangrove/Turquoise bay and Yardie Creek Rankin Bank & Glomar Shoals Barrow and Lowendal Islands Montebello Is - Stephenson Channel Nth Montebello Is Champagne Bay & Chippendale channel Montebello Is - Claret Bay

Document	Document overview	Stakeholders	Relevant information	Document subsections (if applicable)
				Montebello Is - Hermite/Delta Is Channel Montebello Is - Hock Bay Montebello Is - North & Kelvin Channel Montebello Is - Sherry Lagoon Entrance
Support Plans	Support Plans detail Woodside's approach to resourcing and the provision of services during a hydrocarbon spill response.	CICC: Operations, Logistics and Planning functions.	Strategy for mobilising and managing additional resources outside of Woodside's immediate preparedness arrangements.	Marine Logistics People & Global Capability Surge Labour Requirement Plan Health & Safety Aviation IT (First Strike Response) IT (Extended Response) Communications (First Strike Response) Communications (Extended Response) Stakeholder Engagement Accommodation & Catering Waste Management Guidance for Oil Spill Claims Management (Land based) Security Support Plan Hydrocarbon Spill Responder Health Monitoring Guideline

2 RESPONSE PLANNING PROCESS

This document details Woodside's process for identifying potential response options for the hydrocarbon release scenarios, identified in the EP. Figure 2-1 outlines the interaction between Woodside's response, planning/preparedness and selection process.

This structure has been used because it shows how the planning and preparedness activities inform a response and provides indicative guidance on what activities would be undertaken, in sequential order, if a real event were to occur. The process also evaluates alternative, additional and/or improved control measures specific to the PAP.

The Julimar Phase 2 Drilling and Subsea Installation FSRP then summarises the outcome of the response planning process and provides initial response guidance and a summary of ongoing response activities, if an incident were to occur.

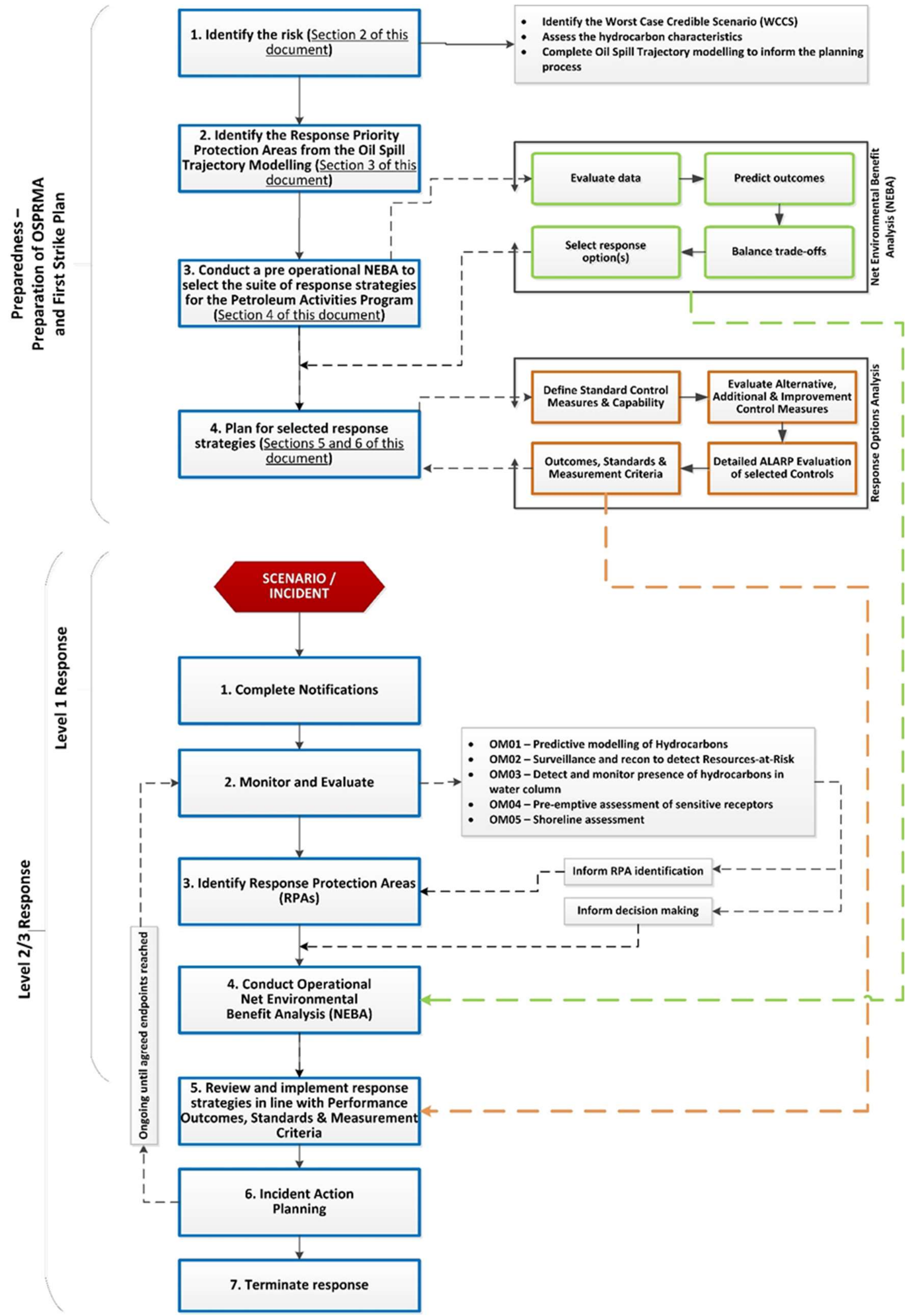

Figure 2-1: Response planning and selection process

2.1 Response planning process outline

This document is expanded below to provide additional context on the key steps in determining capability, evaluating ALARP and hydrocarbon spill response requirements.

Section 1. INTRODUCTION

Section 2. RESPONSE PLANNING PROCESS

- Identification of worst-case credible scenario(s) (WCCS)
- Spill modelling for WCCS

Section 3. IDENTIFY RESPONSE PROTECTION AREAS (RPAs)

- Areas predicted to be contacted at concentration >100 g/m^2.

Section 4. NET ENVIRONMENTAL BENEFIT ANALYSIS (NEBA)

- Pre-operational NEBA (during planning/ALARP evaluation): this must be reviewed during the initial response to an incident to ensure its accuracy
- Selected response techniques prioritised and carried forward for ALARP assessment

Section 5. HYDROCARBON SPILL ALARP PROCESS

- Determines the response need based on predicted consequence parameters.
- Details the environmental performance of the selected response options based on the need.
- Sets the environmental performance outcomes, environmental performance standards and measurement criteria.

Section 6. ALARP EVALUATION

- Evaluates alternative, additional, and improved options for each response technique to demonstrate the risk has been reduced to ALARP.
- Provides a detailed ALARP assessment of selected control measure options against:
    - predicted cost associated with implementing the option
    - predicted change to environmental benefit
    - predicted effectiveness / feasibility of the control measure

Section 7. ENVIRONMENTAL RISK ASSESSMENT OF SELECTED RESPONSE TECHNIQUES

- Evaluation of impacts and risks from implementing selected response options

Section 8. ALARP CONCLUSION

Section 9. ACCEPTABILITY CONCLUSION

2.1.1 Response Planning Assumptions – Timing, Resourcing and Effectiveness

IMT Call-out/ Notification	Contract Activation	Response Option Mobilisation	Response Option Deployment	Response Option Effectiveness
This is the time taken from call-out to mobilise the IMT to the designated Incident Control Centre	This is the time taken once the IMT has been mobilised to activate specific contracts for resources (SFRT, FWADC, AMOSC, AMSA, OSRL, etc)	This is the time taken to mobilise resources from home location to laydown/staging area (expected to be airport or sea port) close to response area	This is the time taken to deploy resources from laydown/staging area (expected to be airport or sea port) to response area/field	This relates to the performance of equipment/response option as well as required personnel resourcing (Specialists/Supervisors + support personnel)
Approx 2-4 hours	Approx 2-4 hours	Response Technique specific	Field/Location specific	Response Strategy specific

Figure 2-2: Response Planning Assumptions – Timing, Resourcing and Effectiveness

For the purpose of defining terms related to response planning and timing, the following definitions have been developed;

- Activation - Is the time taken to activate the appropriate contract and/or arrangements by the IMT once the IMT has mobilised to the Incident Control Centre (ICC). For planning purposes, this is expected to be 2-4 hours post IMT mobilisation to ICC (where the IMT mobilisation is 2-4 hours).
- Mobilisation - Is the time taken following contract activation to mobilise the resources/equipment from its home location (e.g., Dampier, Singapore, Perth, etc.) to the staging area/laydown area (expected to be a nearby seaport or airport). Mobilisation time includes movement of resources from primary storage location to designated deployment location/staging airfields, seaports etc. inclusive of all required access, loading, permits/approvals, transit and unloading activities. If a resource is comprised of multiple components (i.e., vessel with fuel, crew, supplies, hoses, pumps, powerpacks, etc.), the mobilisation time is calculated from the longest lead time item that must be present for the resource to be safely and effectively deployed.
- Deployment - Is the time taken to deploy the required resource(s) from the staging area/laydown area (expected to be a nearby seaport or airport) to the required location in the field (offshore, nearshore, shoreline) where the resource will be utilised

2.2 Environment plan risk assessment (credible spill scenarios)

Potential hydrocarbon release scenarios from the PAP have been identified during the risk assessment process (presented in Section 6 of the EP). Further descriptions of risk, impacts and mitigation measures (which are not related to hydrocarbon preparedness and response) are provided in Section 6 of the EP. Five unplanned events or credible spill scenarios for the PAP have been selected as representative across types, sources and incident/response levels, up to and including the WCCS. The WCCS for the activity is then used for response planning purposes, as all other scenarios are of a lesser scale and extent. By demonstrating capability to manage the response to the WCCS, Woodside assumes other scenarios that are smaller in nature and scale can also be managed by the same capability. Response performance measures have been defined based on a response to the WCCS.

Table 2-1 presents the credible scenarios for the PAP. The loss of well containment scenario (MEE-01) and the hydrocarbon release caused by installation vessel and fuel tanker collision (MEE-005) were both stochastically modelled. MEE-01 was taken forward as the overall WCCS for response planning purposes and modelled deterministically.

Table 2-1: Petroleum Activities Program credible spill scenarios

MEE No.	Scenario selected for planning	Scenario description	Maximum credible volume released (liquid m^3)[1]	Incident Level	Hydrocarbon (HC) type	Residual proportion	Residual volume (liquid m^3)	Key credible scenarios informing response planning
MEE-01 WCCS	Yes	Hydrocarbon release caused by loss of well containment	Surface (5 days): ~120,783 stb ~19,203 m^3 Subsea (72 days): ~1,575,572 stb ~250,496 m^3 Total Volume (77 days): ~1,697,356 stb ~269,858m^3	3	Julimar condensate	0.4%	1,079 m^3	Loss of well control during drilling of development well JULA-K (single zone well).
MEE-02	No	Hydrocarbon release due to diesel bunkering loss of containment	8 m^3	1	Marine diesel	5 %	0.4 m^3	Partial or total failure of a bulk transfer hose or fittings during bunkering, combined with a failure in procedure to shutoff fuel pumps, for a period of up to five minutes.
MEE-03	No	Hydrocarbon release caused by vessel collision: support vessel and third-party vessel	105 m^3	1	Marine diesel	5 %	5.25 m^3	Breach of activity support vessel fuel tanks due to support vessel – third party vessel collision including commercial shipping/fisheries.
MEE-04	No	Hydrocarbon release caused by vessel collision: installation vessel and third-party vessel	500 m^3	2	Marine diesel	5 %	25 m^3	Breach of installation vessel fuel tanks due to collision with third party vessel, including commercial shipping/fisheries.
MEE-05	Yes	Hydrocarbon release caused by vessel collision: installation vessel and fuel tanker	2,000 m^3	3	Marine diesel	5 %	100 m^3	Rupture of the largest single tank inventory of the fuel tanker due to collision with installation vessel.

2.2.1 Hydrocarbon characteristics

More detailed hydrocarbon characteristics, including modelled weathering data and ecotoxicity, are included in Section 6 of the EP.

Julimar condensate

Julimar Condensate (API 47.9) (reference oil Julimar 1, 2010) contains a low proportion (0.4% by mass) of hydrocarbon compounds that will not evaporate at atmospheric temperatures. These compounds will persist in the marine environment.

The unweathered mixture has a dynamic viscosity of 1.248 cP. The pour point of the whole oil (~minus 24°C) ensures that it will remain in a liquid state over the annual temperature range observed on the North West Shelf.

The mixture is composed of hydrocarbons that have a wide range of boiling points and volatilities at atmospheric temperatures, and which will begin to evaporate at different rates on exposure to the atmosphere. Evaporation rates will increase with temperature, but in general about 48.8% of the oil mass should evaporate within the first 12 hours (BP < 180 °C); a further 21.3% should evaporate within the first 24 hours (180 °C < BP < 265 °C); and a further 29.5% should evaporate over several days (265 °C < BP < 380 °C).

Soluble aromatic hydrocarbons contribute approximately 11.5% by mass of the whole oil, with a significant proportion (7.4%) in the C4-C10 range of hydrocarbons. These compounds will evaporate rapidly, reducing the potential for dissolution of a proportion of them into the water.

Diesel

Marine Diesel Oil is typically classed as an International Tanker Owners Pollution Federation (ITOPF) Group I/II oil. Marine diesel is a mixture of volatile and persistent hydrocarbons with low proportions of highly volatile and residual components. In general, about 6% of the oil mass should evaporate within the first 12 hours (BP < 180 °C); a further 35% should evaporate within the first 24 hours (180 °C < BP < 265 °C); and a further 54% should evaporate over several days (265 °C < BP < 380 °C). Approximately 5% of the oil is shown to be persistent. The aromatic content of the oil is approximately 3%.

If released in the marine environment and in contact with the atmosphere (i.e. a surface spill), approximately 41% by mass of this oil is predicted to evaporate over the first couple of days depending upon the prevailing conditions, with further evaporation slowing over time. The heavier (low volatility) components of the oil have a tendency to entrain into the upper water column due to wind-generated waves but can subsequently resurface if wind-waves abate. Therefore, the heavier components of this oil can remain entrained or on the sea surface for an extended period, with associated potential for dissolution of the soluble aromatic fraction.

2.3 Hydrocarbon spill modelling

Oil spill trajectory modelling tools are used for environmental impact assessment and during response planning to understand spatial scale and timeframes for response operations. Woodside recognises that there is a degree of uncertainty related to the use of modelling data and has subsequently utilised conservative approaches to volumes, weathering, spatial areas, timing and response effectiveness to scale capability to need.

The Oil Spill Model and Response System (OILMAP) and Integrated Oil Spill Impact Model System (SIMAP) models are both used for stochastic and deterministic trajectory modelling have been developed over three decades of planning, exercises, actual responses, several peer reviews, and validation studies. OILMAP was originally derived from the United States Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Type A model (French et al. 1996), for assessing marine transport, biological impact and economic damage that was also used under the United States Oil Pollution Act 1990 Natural Resource Damage Assessment (NRDA) regulations. Notable spills where the model has been used and validated against actual field observations include, Exxon Valdez (French McCay 2004), North Cape Oil Spill (French McCay 2003), along with an assessment of 20 other spills (French McCay and Rowe, 2004). In addition, test spills designed to verify fate, weathering and movement algorithms have been conducted regularly and in a range of climate conditions (French and Rines 1997; French et al. 1997; Payne et al. 2007; French McCay et al. 2007).

Further to this, the algorithms have been updated using the latest findings from the Macondo/Deepwater Horizon well blowout in the Gulf of Mexico and validated according to the Deepwater Horizon (DWH) oil spill in support of the Natural Resource Damage Assessment (NRDA) (Spaulding et al. 2015; French McCay et al. 2015, 2016). Finally, the OILMAP and SIMAP models have been used extensively in Australia to prosecute pollution offences, predict discharge locations and likely spill volumes based on weathering and surveillance observations, and has been used as expert witness evidence in Australian court proceedings, aiding the prosecution to determine spill quantum estimates.

2.3.1 Stochastic modelling

Quantitative, stochastic assessments have been undertaken for credible spill scenarios MEE-1 and MEE-05 (Table 2-1) to help assess the environmental consequences of a hydrocarbon spill.

A total of 100 replicate simulations were completed for the scenarios to test for trends and variations in the trajectory and weathering of the spilled oil, with an even number of replicates completed using samples of metocean data that commenced within each calendar quarter (25 simulations per quarter). Further details relating to the assessments for the scenarios can be found in Section 6 of the EP.

2.3.1.1 Environmental impact thresholds – Environment that May Be Affected (EMBA) and hydrocarbon exposure

The outputs of the stochastic spill modelling are used to assess the potential environmental impact from the credible scenarios. The stochastic modelling results are used to delineate areas of the marine and shoreline environment that could be exposed to hydrocarbon levels exceeding environmental impact threshold concentrations. The summary of all the locations where hydrocarbon thresholds could be exceeded by any of the simulations modelled is defined as the EMBA and is discussed further in Section 6 of the EP. As the weathering of different fates of hydrocarbons (surface, entrained and dissolved) differs due to the influence of the metocean mechanism of transportation, a different EMBA is presented for each fate within the EP.

A conservative approach – adopting accepted contact thresholds for impacts on the marine environment – is used to define the EMBA. These hydrocarbon thresholds are presented in Table 2-2 below and described in Section 6 of the EP.

Table 2-2: Summary of thresholds applied to the stochastic hydrocarbon spill modelling to determine zone of consequence and environmental impacts

Threshold	Description
10 g/m^2	Surface hydrocarbon
500 ppb	Entrained hydrocarbon (ppb)
500 ppb	Dissolved aromatic hydrocarbon (ppb)
100 g/m^2	Shoreline accumulation

2.3.2 Deterministic modelling

Woodside uses deterministic modelling results to evaluate risks and impacts and response capability requirements. These results are provided in both shapefile and data table format with each row of the data table representing a 1 km^2 cell. This cell size has been used as it represents the approximate area that a single containment and recovery operation or surface dispersant operation (single sortie or vessel spraying) can effectively treat in one ten (10) hour day. Smaller cell sizes have been considered but would not change the response need as the potential distance between cells would not allow multiple cells to be treated per day by response operations. Additionally, a 1 km^2 cell is expected to allow averaging of threshold concentrations and mass across the spatial extent to represent a conservative approach (patches of oil and windrows) to response planning that simulates operational monitoring feedback in a real event.

Deterministic modelling was carried out on Scenario MEE-01 (loss of well containment) as it was determined to be the overall WCCS and thus used for response planning purposes. A sample of these deterministic results is provided below as an indication of the data format and content.

- Column A and B provide the latitude and longitude of the cell
- Column C is the elapsed time since the release occurred
- Column D represents the average thickness across the cell in g/m²
- Column E represents the viscosity of the hydrocarbon in cSt at sea surface temperature
- Column F and G represents the mass of hydrocarbon across the entire cell in kg and tons respectively.

Table 2-3: Example Deterministic modelling data

Latitude	Longitude	Time_hour	Conc_gm²	Visc_cSt	Mass_kg	Mass_tons
A	B	C	D	E	F	G
-20.1448	115.0404	6	545.1855	3.627244	545066.1	545
-20.1448	115.05	6	268.7345	18.71164	268675.3	269
-20.1448	115.0595	6	108.3504	29.3838	108326.4	108
-20.1357	115.0691	6	62.36282	33.33411	62352.58	624
-20.1538	115.0404	12	121.3684	7.848801	121334.8	121
-20.1448	115.0404	12	673.1097	10.38606	672962.3	673
-20.1448	115.05	12	59.35671	28.86992	59343.64	593

The deterministic modelling data provides an indication of the response need by displaying the potential surface area and volume that may be treated or recovered by response operations. Existing capability is reviewed to approximate the surface area and volumes that can be treated or removed and a range of alternate, improved and additional options to reduce risks and impacts to as low as reasonably practical (ALARP) are considered.

Woodside recognises that no single response technique will treat all available subsea or surface oil and that a combination of response techniques will be required for the identified scenario. Even with the significant resources available to Woodside through existing capability and third-party resources, the primary offshore response techniques of surface dispersant application and containment and recovery will only treat or recover a minor proportion (<30%) of the available surface hydrocarbons based on previous response experience.

Woodside is committed to a realistic, scalable response capability that is commensurate to the level of risk and able to be practically implemented and feasibly sustained.

2.3.2.1 Response planning thresholds for surface and shoreline hydrocarbon exposure

Thresholds to determine the EMBA are used to predict and assess environmental impacts and inform the Scientific Monitoring Program (SMP), however they do not appropriately represent the thresholds at which an effective response can be implemented. Additional response thresholds are used for response planning and to determine areas where response techniques would be most effective. The deterministic modelling is then used to assess the nature and scale of a response.

In the event of an actual response, existing deterministic modelling would be reviewed for suitability and additional modelling would be conducted using real-time data and field information to inform Incident Management Team decisions.

The deterministic spill modelling outputs are presented at response planning thresholds for surface hydrocarbons for the WCCS. Surface spill concentrations are expressed as grams per square metre (g/m²) (Section 2.2). The thresholds used are derived from oil spill response planning literature and industry guidance and are summarised below.

2.3.2.1.1 Surface hydrocarbon concentrations

Table 2-4: Surface hydrocarbon thresholds for response planning

Surface hydrocarbon threshold (g/m^2)	Description	Bonn Agreement Oil Appearance Code (BAOAC)	Mass per area (m^3/km^2)
>10	Predicted minimum threshold for commencing operational monitoring	Code 3 – Dull metallic colours	5 to 50
50	Predicted minimum floating oil threshold for containment and recovery and surface dispersant application [1]	Code 4 – Discontinuous true oil colour	50 to 200
100	Predicted optimum floating oil threshold for containment and recovery and surface dispersant application	Code 5 – Continuous true oil colour	>200
Shoreline hydrocarbon threshold (g/m^2)	**Description**	**National Plan Guidance on Oil Contaminated Foreshores**	**Mass per area (m^3/km^2)**
100	Predicted minimum shoreline accumulation threshold for shoreline assessment operations	Stain	>100
250	Predicted minimum threshold for commencing shoreline cleanup operations	Level 3 – Thin Coating	200 to 1000

The surface thickness of oil at which dispersants are typically effective is approximately 100 g/m^2. However, substantial variations occur in the thickness of the oil within the slick, and most fresh crude oils spread within a few hours, so that overall the average thickness is 0.1 mm (or approx. 100 g/m^2) (International Tanker Owners Pollution Federation [ITOPF] 2011). Additionally, the recommended rate of application for surface dispersant is typically 1-part dispersant to 20 or 25 parts of spilled oil. These figures assume a 0.1 mm slick thickness, averaged over the thickest part of the spill, to calculate a litres/hectare application rate from vessels and aircraft. In practice this can be difficult to achieve as it is not possible to accurately assess the thickness of the floating oil.

Some degree of localised over-dosage and under-dosage is inevitable in dispersant response. An average oil layer thickness of 0.1 mm is often assumed, although the actual thickness can vary over a wide range (from less than 0.0001 mm to more than 1 mm) over short distances (International Petroleum Industry Environment Conservation Association [IPIECA] 2015).

Guidance from the Australian Maritime Safety Authority (AMSA, 2015) indicates that spreading of spills of Group II or III products will rapidly decrease slick thickness over the first 24 hours of a spill resulting in the potential requirement of up to a ten (10) fold increase in capability on day 2 to achieve the same level of performance.

Further guidance from the European Maritime Safety Authority (EMSA) states that spraying the ‘metallic’ looking area of an oil slick (Bonn Agreement Oil Appearance Code [BAOAC] 3, approx. 5 – 50 µm) with dispersant from spraying gear designed to treat an oil layer 0.1 mm (100 µm) thick, will inevitably cause dispersant over-treatment by a factor of 2 to 20 times (EMSA 2012).

Therefore, dispersant application should be concentrated on the thickest areas of an oil slick and Woodside intends on applying surface dispersants to only BAOAC 4 and 5. Spraying areas of oil designated as BAOAC Code 4 (Discontinuous true oil colour) with dispersant will, on average, deliver approximately the recommended treatment rate of dispersant.

Spraying areas of oil designated as BAOAC Code 5 with dispersant (Continuous true oil colour and more than 0.2 mm thick) will, on average, deliver approximately half the recommended treatment rate

[1] At 50g/m^2, containment and recovery and surface dispersant application operations are not expected to be particularly effective. This threshold represents a conservative approach to planning response capability and containing the spread of surface oil.

of dispersant. Repeated application of these areas of thicker oil, or increased dosage ratios, will be required to achieve the recommended treatment rate of dispersant (EMSA 2012).

Guidance from the National Oceanic and Atmospheric Administration (NOAA) in the United States is found in the document: *Characteristics of Response Strategies: A Guide for Spill Response Planning in Marine Environments 2013 (NOAA 2013).* This guide outlines advice for response planning across all common techniques, including surface dispersant spraying and containment and recovery. It states that oil thickness can vary by orders of magnitude within distinct areas of a slick, thus the actual slick thickness and oil distribution of target areas are crucial for determining response method feasibility. Further to this, ITOPF also states that in terms of oil spill response, sheen can be disregarded as it represents a negligible quantity of oil, cannot be recovered or otherwise dealt with to a significant degree by existing response techniques, and is likely to dissipate readily and naturally (ITOPF, 2014).

Figure 2-3 below from AMSA's Identification of Oil on Water – Aerial Observation and Identification Guide (AMSA, 2014) shows expected percent coverage of surface hydrocarbons as a proportion of total surface area. Wind-rows, heavy oil patches and tar balls, for example, must be considered, as they influence oil encounter rates, chemical dosages and ignition potential. Each method has different thickness thresholds for effective response.

From this information and other relevant sources (Allen and Dale, 1996, EMSA, 2012, Spence, 2018) the surface threshold of 50g/m^2 was chosen as an average/equilibrium thickness for offshore response operations (50 g/m^2 is an average is 50% coverage of 0.1mm Bonn Agreement Code 4 - discontinuous true oil colour, or 25% coverage of 0.2mm Bonn Agreement Code 5 – continuous true oil colour which would represent small patches of thick oil or wind-rows).

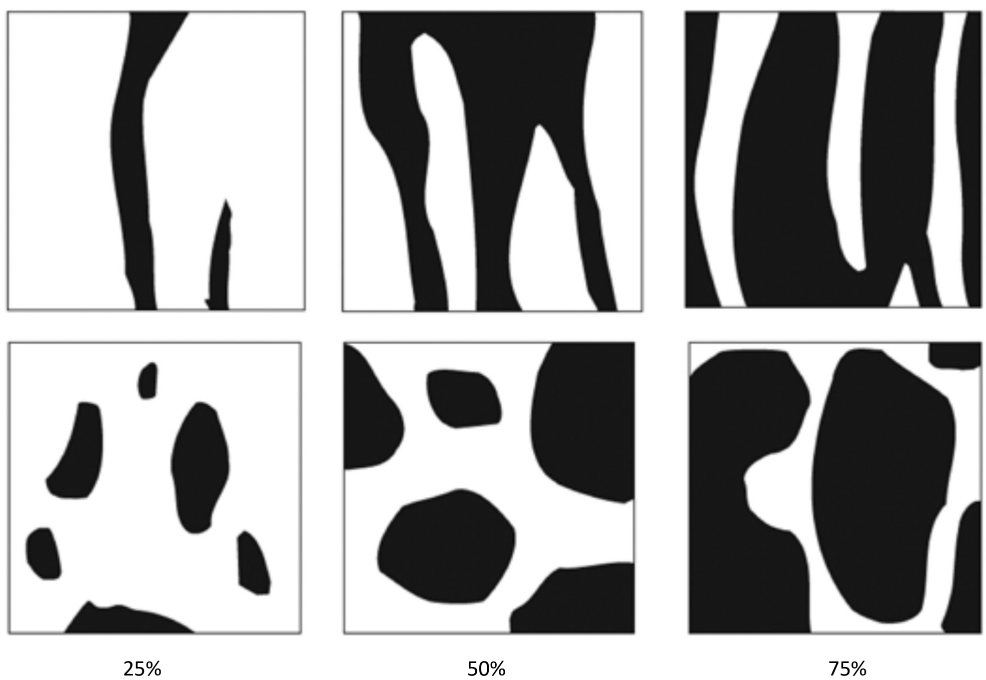

Figure 2-3: Proportion of total area coverage (AMSA, 2014)

Figure 2-4 illustrates the general relationships between on-water response techniques and slick thickness. Wind-rows, heavy oil patches and tar balls, for example, must be considered, as they influence oil encounter rates, chemical dosages and ignition potential. Each method has different thickness thresholds for effective response.

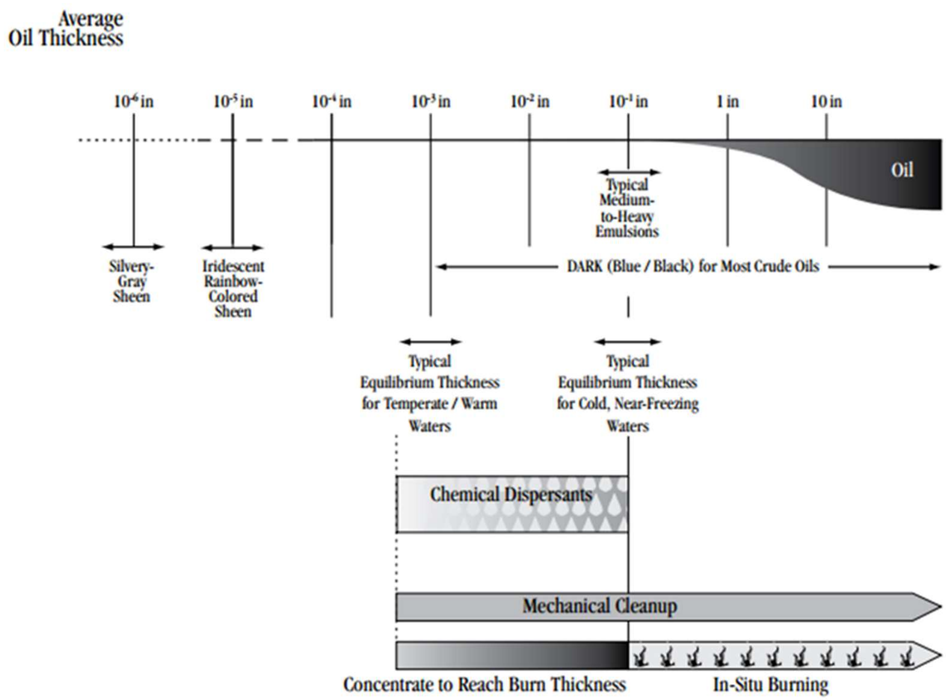

Figure 2-4: Oil thickness versus potential response options (from Allen & Dale 1996)

Wind and wave influence on the feasibility of mechanical clean-up operations and drops the effectiveness significantly because of entrainment and/or splash-over as short period waves develop beyond 2–3 ft (0.6–0.9m) in height. Waves and wind can also be limiting factors for the safe operation of vessels and aircraft.

2.3.2.1.2 Surface hydrocarbon viscosity

Table 2-5: Surface hydrocarbon viscosity thresholds

Surface viscosity threshold (cSt)	Description	European Maritime Safety Authority (EMSA)	Viscosity at sea temperature (cSt)
5,000*	Predicted optimum viscosity for surface dispersant operations	Generally possible to disperse	500-5,000
10,000*	Predicted maximum viscosity for effective surface dispersant operations	Sometimes possible to disperse	5,000-10,000

*Measured at sea surface temperature

Further to the required thickness for surface dispersant application and containment and recovery to be deployed effectively as outlined above, changes to viscosity will also limit the treatment of offshore response techniques. As outlined in the EMSA Manual on the Applicability of Oil Spill Dispersants (EMSA, 2012), guidance around changes to viscosity and likely effectiveness of surface dispersant application is provided.

This includes the following statements; ”It has been known for many years that it is more difficult to disperse a high viscosity oil than a low or medium viscosity oil. Laboratory testing had shown that the effectiveness of dispersants is related to oil viscosity, being highest for modern “Concentrate, UK Type 2/3” dispersants at an oil viscosity of about 1,000 or 2,000 mPa (1,000 – 2,000 cSt) and then declining to a low level with an oil viscosity of 10,000 mPa (10,000 cSt). It was considered that some generally applicable viscosity limit, such as 2,000 or 5,000 mPa (2,000 – 5,000 cSt), could be applied to all oils.”

However, modern oil spill dispersants are generally effective up to an oil viscosity of 5,000 mPa (5,000 cSt) or more, and their performance gradually decreases with increasing viscosity; oils with a viscosity of more than 10,000 are in most cases, no longer dispersible. Guidance from CEDRE (EMSA, 2012) also indicates that products with a range of 500 – 5,000 cSt at sea temperature are generally possible to disperse, while 5,000 – 10,000 cSt at sea temperature above pour point are sometimes possible to disperse, with products beyond 10,000 cSt at sea temperature below pour point are generally impossible to disperse.

To support decision making and response planning, a threshold of 10,000 cSt at sea temperature was chosen as a conservative estimate of maximum viscosity for surface dispersant spraying operations.

The thresholds described above are compared with the modelling results for the WCCS (Table 2-6).

2.3.3 Spill modelling results

Scenario MEE-01 (*Hydrocarbon release caused by loss of well containment – Julimar condensate*) as the WCCS was selected for deterministic analysis and response planning purposes. Details of the scenario and modelling inputs are included along with deterministic results in Table 2-6.

The selected deterministic runs used to represent the WCCS are:

- Model 14, Q4: fastest time to shoreline contact (above 100 g/m^2);
- Model 22, Q4: largest volume ashore at any single RPA (above 100 g/m^2); and
- Model 22, Q4: largest volume ashore on all shorelines from a single model run (above 100 g/m^2).

Table 2-6: Worst case credible scenario modelling results

Scenario description	Results
Worst-case credible scenario(s) (WCCS) Total volume released (m^3 in days)	**Hydrocarbon release caused by loss of well containment – Julimar condensate** Surface – 19,203 m^3 over 5 days Subsurface – 250,496 m^3 over 72 days
Worst-case credible scenario(s) (WCCS) Residual volume remaining post-weathering (m^3)	**Hydrocarbon release caused by loss of well containment – Julimar condensate** Surface/subsurface – 1,079 m^3
Deterministic modelling results	
Model 14, Q4 Minimum time to commencement of oil accumulation at any shoreline receptor (at a threshold of 100 g/m^2)	**Hydrocarbon release caused by loss of well containment** 18.4 days (Ningaloo Coast Middle WHA)
Model 22, Q4 Maximum cumulative oil volume accumulated across all shoreline receptors (at concentrations in excess of 100 g/m^2)	**Hydrocarbon release caused by loss of well containment** 38 m^3 (Kimberly Coast & Northern Coast)

Model 22, Q4 Maximum cumulative oil volume accumulated at any individual shoreline receptor (at concentrations in excess of 100 g/m^2)	**Hydrocarbon release caused by loss of well containment** 38 m^3 (Kimberly Coast & Northern Coast)

From the above modelling results, model runs 14 (Q4) and 22 (Q4) have been used as the basis for response planning and are included in Section 4.2.

The map below displays the predicted surface concentration of oil at 0-50 g/m^2 (BAOAC Code 1-3, sheen – light grey), 50–200 g/m^2 (BAOAC Code 4, discontinuous true oil colour – brown) and 200 g/m^2 and above (BAOAC Code 5, continuous true oil colour – black) over the initial seven (7) days of a loss of well containment and have been chosen for response planning purposes.

As shown in figure Figure 2-5 below and from analysis of the deterministic results, modelling predicts the following:

- The loss of well containment results in surface concentrations above threshold for containment and recovery operations for the initial 7 days during the surface release phase and following days. However, there are very minor volumes and surface area available for recovery from day 7 to day 13 and no recoverable surface hydrocarbons beyond day 13.
- The associated gas from a loss of well containment may also limit opportunities for recovery or treatment of surface hydrocarbons. Response operations cannot be implemented if the safety of response personnel cannot be guaranteed. Safety circumstances that limit the execution of this control measure include volatile concentrations of hydrocarbons in the atmosphere, high winds (>20 knots), waves and/or sea states (>1.5m waves) and high ambient temperatures.

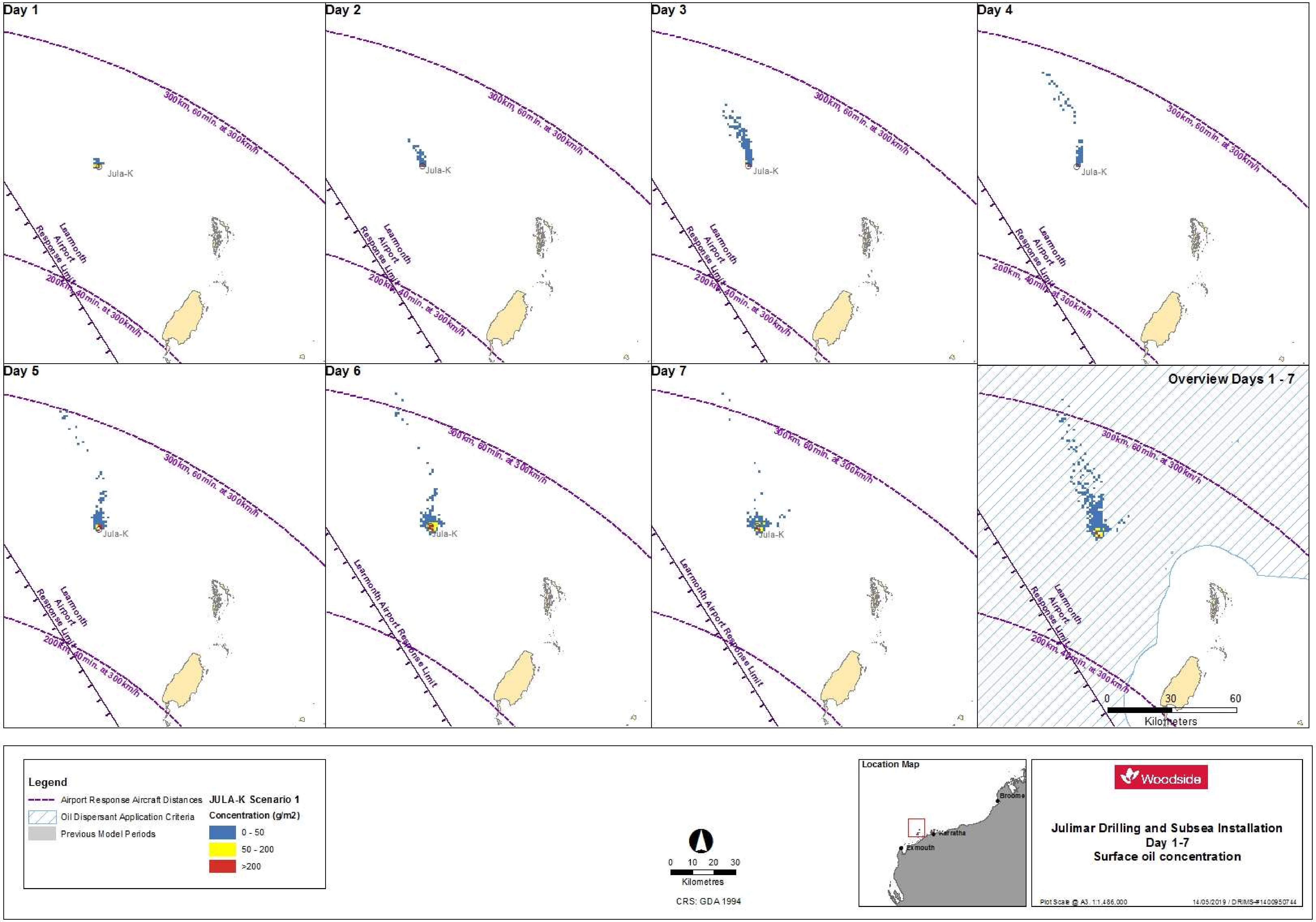

Figure 2-5: Julimar Phase 2 Drilling and Subsea Installation loss of well containment – Day 1-7 – Surface oil concentration

3 IDENTIFY RESPONSE PROTECTION AREAS (RPAs)

In a response, operational monitoring programs – including trajectory modelling and vessel/aerial observations – would be used to predict RPAs that may be impacted. For the purposes of planning and appropriately scaling a response, modelling has been used to identify RPAs as outlined below in Figure 3-1.

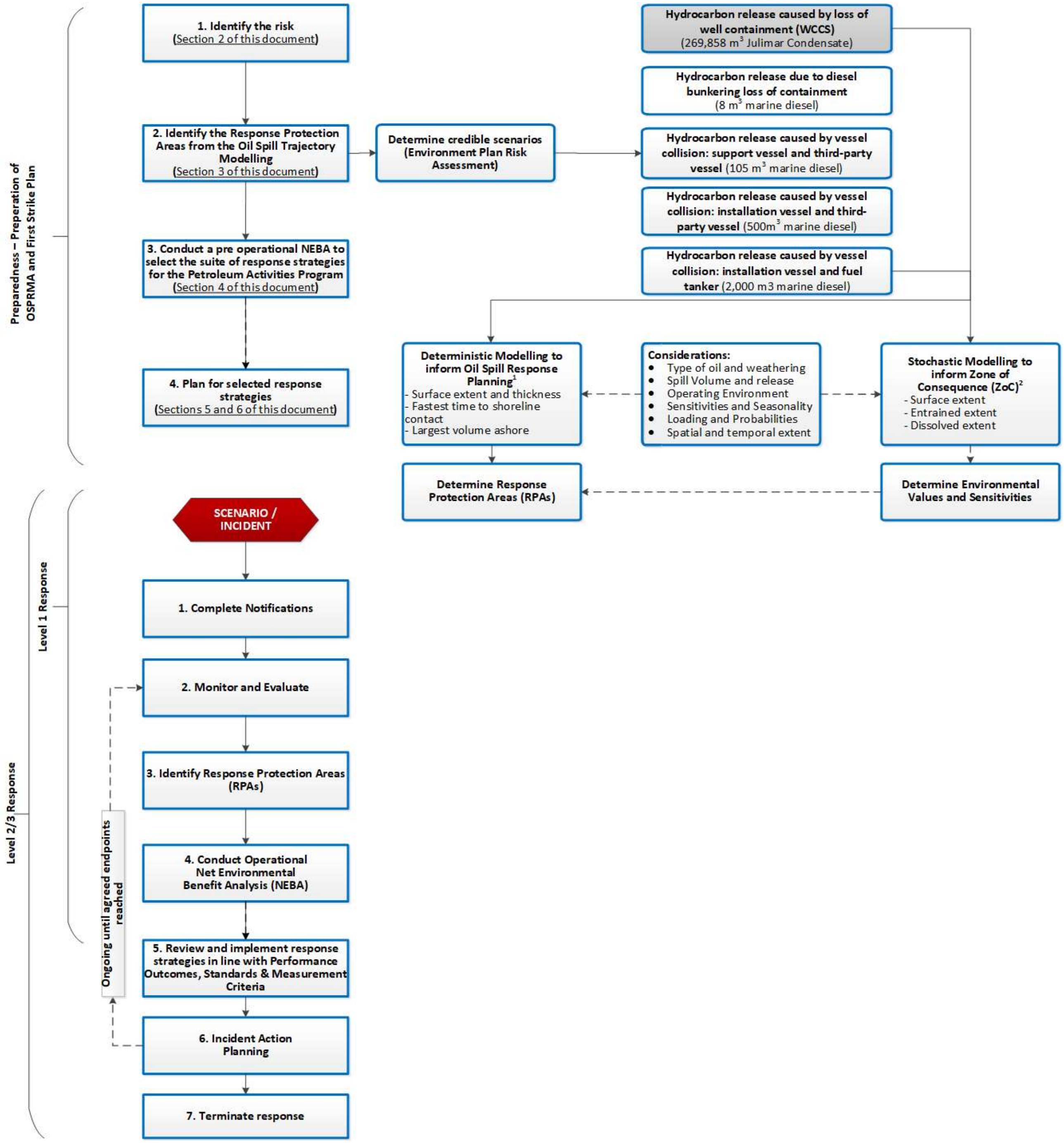

Figure 3-1: Identify Response Protection Areas (RPAs) flowchart

3.1 Identified sensitive receptor locations

Section 6 of the EP includes the list of sensitive receptor locations that have been identified by stochastic modelling as meeting the requirements outlined below:

- Receptors with the potential to incur surface, entrained or shoreline accumulation contact above environmental impact thresholds
- Receptors within the EMBA which meet the following:
  - a number of priority protection criteria/categories
  - International Union of Conservation of Nature (IUCN) marine protected area categories
  - high conservation value habitat and species
  - important socio-economic/heritage value.

3.2 Identify Response Protection Areas (RPAs)

RPAs have been selected on the basis of their environmental ecological, social, economic, cultural and heritage values and sensitivities as described in Section 6 of the EP. Only those at which a shoreline response could feasibly be conducted (accumulation >100 g/m^2 for shoreline assessment and/or contact with surface slicks >10 g/m^2 for operational monitoring as specified in Table 2-4) have been selected for response planning purposes.

3.2.1 Response Protection Areas (RPAs)

While not discounting other sensitivities, the identified RPAs have been used as the basis for demonstrating the capability to respond to the nature and scale of a spill from the WCCS and prioritising response techniques.

Table 3-1 outlines locations which were identified from the deterministic modelling thresholds for the WCCS but does not constitute the full list of Priority Protection Areas (PPAs) potentially contacted from stochastic modelling (as per EMBA definition – see Section 6 of the EP). Other PPA outliers were identified from the stochastic and deterministic modelling and have been included in the assessment of capability in Sections 5 and 6.

Additional sensitive receptors are presented in the existing environment description (Section 4 of the EP) and impact assessment section (Section 6 of the EP) for each respective spill scenario. The pre-operational NEBA (Section 4) considers the results from the stochastic and deterministic modelling to ensure all feasible response techniques are considered in the planning phase, therefore receptors additional to those in Table 3-1 are also included in the pre-operational NEBA.

The RPAs identified in Table 3-1 are used to plan for the nature and scale of a shoreline response. Tactical Response Plans (TRPs) for a shoreline response will be drafted in advance for any RPAs with a contact time of <14 days.

Table 3-1: Response Protection Areas (RPAs) from deterministic modelling

Areas of coastline contacted	Conservation status	IUCN protection category	Minimum time to shoreline contact (above 100 g/m^2) in days (2)	Maximum shoreline accumulation (above 100 g/m^2) in m^3 (3)
Ningaloo Coast Middle World Heritage Area	State Marine Park Australian Marine Park (AMP) World Heritage Area	II – National Park Zone IV – Recreational Use Zone	18.4 days	2 m^3
Kimberley Coast & Northern Coast	State Marine Park Australian Marine Park (AMP)	II –National Park Zone IV – Habitat Protection Zone VI – Multiple Use Zone	63 days	38 m^3
Eighty Mile Beach	Australian Marine Park (AMP)	VI – Multiple Use Zone	63 days	36 m^3
Eighty Mile Beach Marine Park and Ramsar Site	State Marine Park Australian Marine Park (AMP) Ramsar Site, Wetland of International Importance	VI – Multiple Use Zone	71.2 days	5 m^3

The results outlined above are from the selected deterministic scenarios outlined in Section2.3. Based on the stochastic modelling, other sites may potentially be impacted as indicated in Table 6.11 of the EP but the volumes and timings for other impacts are lower than those selected for response assessment.

[2] This volume and time represent the first time to contact on defined shoreline polygon and the maximum volume ashore for that 24 hour period.
[3] This volume and time represent the maximum volume ashore on defined shoreline polygon for any 24 hour time period

4 NET ENVIRONMENTAL BENEFIT ASSESSMENT (NEBA)

A Net Environmental Benefit Assessment (NEBA) is a structured process to consider which response techniques are likely to provide the greatest net environmental benefit.

The NEBA process typically involves four key steps outlined in Figure 4-1: evaluate data, predict outcomes, balance trade-offs, and select response options. These steps are followed in the planning/preparedness process and would also be followed in a response.

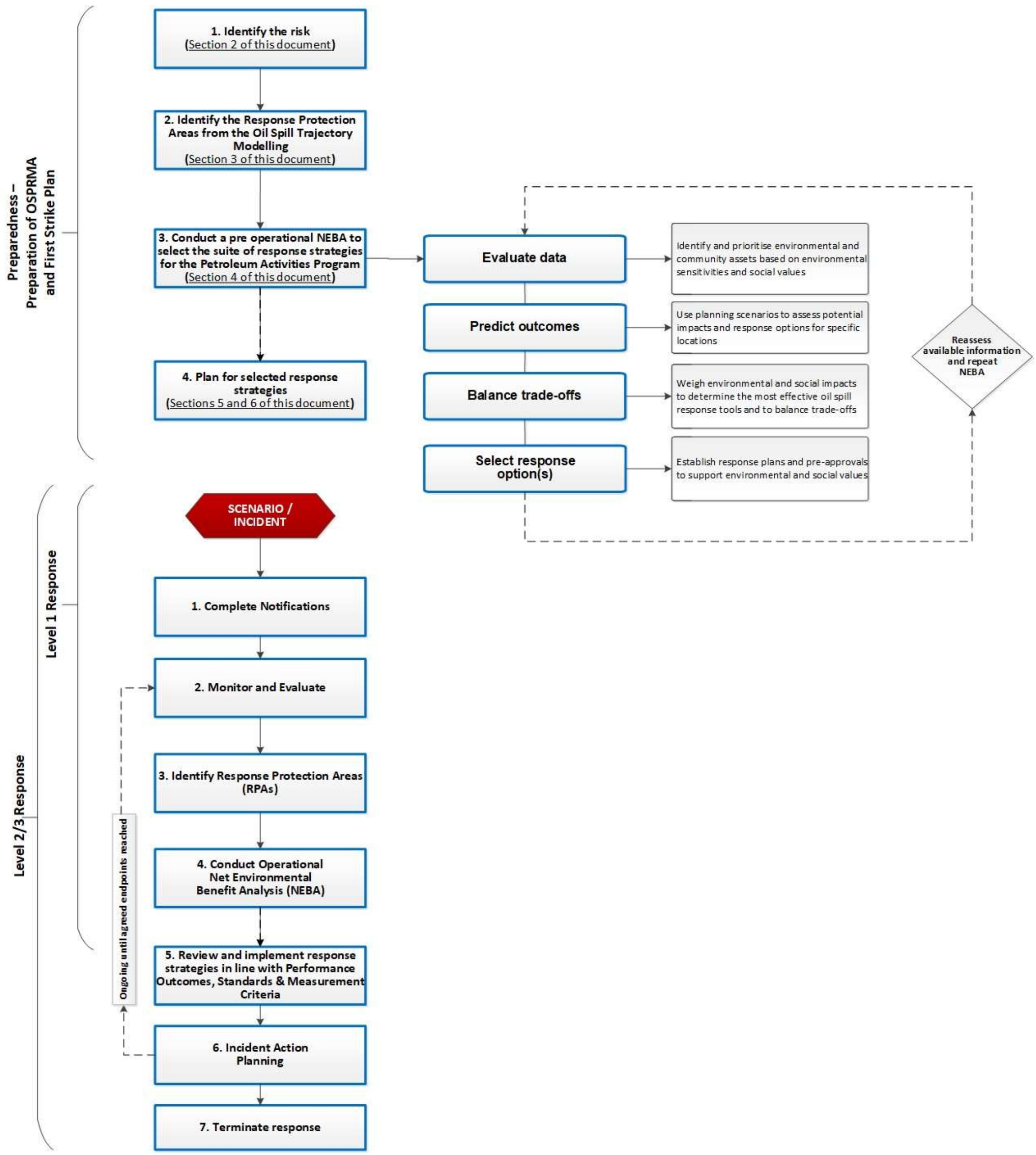

Figure 4-1: Net Environmental Benefit Assessment (NEBA) flowchart

4.1 Pre-operational / Strategic NEBA

The pre-operational NEBA identifies positive and negative impacts to sensitive receptors from implementing the response techniques. Feasibility is considered by assessing the receptors potentially impacted above response thresholds (Section 2.3.2.1) and the surface concentrations (Section 2.3.2.1.1) from the deterministic modelling.

Completing a pre-operational NEBA is a key response planning control that reduces the environmental risks and impacts of implementing the selected response techniques. Comprehensive details of the pre-operational NEBA for this PAP are contained in ANNEX A: Net Environmental Benefit Analysis detailed outcomes.

4.2 Stage 1: Evaluate data

Woodside identifies and prioritises environmental and community assets based on environmental sensitivities and social values, informed through the use of trajectory modelling. Interpretation of stochastic oil spill modelling determines the EMBA for the release, which defines the spatial area that may be potentially impacted by the PAP activities.

4.2.1 Define the scenario(s)

Woodside uses scenarios identified from the risk assessment in the EP to assess potential impacts and response options for specific locations. The overall WCCS is then selected for deterministic modelling and is used for this pre-operational NEBA. Outlier locations with potential environmental impacts, selected from the stochastic modelling may also be included for assessment. The worst-case diesel scenario is also analysed to meet regulatory requirements. Response thresholds and deterministic modelling are then used to assess the feasibility/effectiveness and scale of the response.

Table 4-1: Scenario summary information (WCCS)

Scenario summary information (WCCS – MEE-01)	
Scenario	Hydrocarbon release caused by loss of well containment – JULA-K well (MEE-01)
Location	Lat: 20° 08’ 53.554” S Long: 115° 02’ 28.078” E
Oil Type	Julimar Condensate
Fate and Weathering	48.8% of the mass should evaporate within the first 12 hours (BP < 180 °C); 21.3% of the mass should evaporate within the first 24 hours (180 °C < BP < 265 °C); 29.5% of the mass should evaporate over several days (265 °C < BP < 380 °C).
Volume and duration of release	269,858 m^3 over 77 days
Scenario summary information (diesel – MEE-05)	
Scenario	Hydrocarbon release caused by vessel collision: installation vessel and fuel tanker (MEE-05)
Location	Lat: 20° 08’ 53.554” S Long: 115° 02’ 28.078” E
Oil Type	Marine diesel
Fate and Weathering	6% of the oil mass should evaporate within the first 12 hours (BP < 180 °C); 35% should evaporate within the first 24 hours (180 °C < BP < 265 °C); 54% should evaporate over several days (265 °C < BP < 380 °C).
Volume and duration of release	2,000 m^3 (instantaneous)

4.2.1.1 Hydrocarbon characteristics

Julimar condensate

Julimar Condensate (API 47.9) contains a low proportion (0.4% by mass) of hydrocarbon compounds that will not evaporate at atmospheric temperatures. These compounds will persist in the marine environment.

Selective evaporation of the lower boiling-point components will lead to a shift in the physical properties of the remaining mixture, including an increase in the viscosity and pour point.

Subsea release

The results of the OILMAP simulation predict that the discharge will generate a cone of rising gas that will entrain the oil droplets and ambient sea water up to the water surface. The mixed plume is initially forecast to jet towards the water surface with a vertical velocity of around 14 m/s, gradually slowing and increasing in plume diameter as more ambient water is entrained. The diameter of the central cone of rising water and oil at the point of surfacing is predicted to be approximately 11 m.

The high discharge velocity and turbulence generated by the expanding gas plume is predicted to generate very small oil droplets (<25 µm) that will have very low-rise velocities (<0.01 cm/s). These droplets will be subject to mixing due to turbulence generated by the lateral displacement of the rising plume, as well as vertical mixing induced by wind and breaking waves. Therefore, despite reaching the surface due to the lift produced by the rising plume, the droplets will then tend to remain within the wave-mixed layer of the water column (3-10 m deep, depending on the conditions), where they can resist surfacing due to their weak buoyancy relative to other mixing processes.

The ongoing nature of the release combined with the potential for the plume to breach the water surface may present other hazards, including conditions that may lead to high local concentrations of atmospheric volatiles. These issues should be considered when evaluating the practicality of response operations at or near the blowout site. The results suggest that beyond the immediate vicinity of the blowout the majority of the released hydrocarbons will be present in the upper layers of the ocean, with the potential for oil to form floating slicks under sufficiently calm local wind conditions.

Diesel

Marine Diesel Oil is typically classed as an ITOPF Group I/II oil. It is a mixture of volatile and persistent hydrocarbons with low proportions of highly volatile and residual components.

For these reasons deterministic modelling was not undertaken and the only response techniques that would be considered are monitor and evaluate.

Table 4-2: Oil fate, behaviour and impacts

Deterministic modelling results – WCCS (MEE-01)		
Surface area of hydrocarbons (>50 g/m^2)	Surface hydrocarbons above threshold concentration (>50 g/m^2) are predicted to be 11 km^2 (2,174 m^3), peaking at 12 km^2 (2,055 m^3) on Day 4, then dropping to 0 km^2 on Day 8. There is a second peak of 2 km^2 (102 m^3) on Day 12 and then the surface hydrocarbons return to 0 km^2 thereafter.	
Minimum time to shoreline contact (above 100 g/m^2)	18.4 days (Ningaloo Coast Middle WHA – 2 m^3)	
Largest volume ashore at any single RPA (above 100 g/m^2)	63 days (Kimberly Coast & Northern Coast – 38 m^3)	
Largest total shoreline accumulation (above 100 g/m^2)	63 days (Kimberly Coast & Northern Coast – 38 m^3)	
Response Protection Areas (RPAs)		
	Minimum time to shoreline contact (above 100g/m^2) in days	**Maximum shoreline accumulation (above 100g/m^2) in m^3**
Ningaloo Coast Middle World Heritage Site	18.4 days	2 m^3
Kimberley Coast & Northern Coast*	63 days	38 m^3

** Includes contact at Eighty Mile Beach (63 days, 36 m^3) and Eighty Mile Beach Marine Park and Ramsar Site (71.2 days, 5m^3)*

4.2.2 Determining potential response options

The available response techniques based on current technology can be summarised under the following headings:

- Monitor and evaluate (including operational monitoring)
- Source control
  - Remotely operated vehicle (ROV) intervention
  - debris clearance and/or removal
  - capping stack
  - containment dome
  - relief well drilling
- Subsea dispersant injection
- Containment and recovery
- In-situ burning
- Surface dispersant application:
  - aerial dispersant application
  - vessel dispersant application
- Shoreline protection and deflection:
  - protection
  - deflection
- Shoreline cleanup:
  - Phase 1 – Mechanical cleanup
  - Phase 2 – Manual cleanup
  - Phase 3 – Final polishing

- Oiled wildlife response (including hazing)

Support functions may include:

- Waste management
- Post spill monitoring/scientific monitoring

An assessment of which response options are feasible for the scenarios is included below in Table 4-3 and Table 4-4. These options are evaluated against each scenario's parameters including oil type, volume and characteristics, prevailing weather conditions, logistical support, and resource availability to determine their deployment feasibility.

A shortlist of the feasible response options is then carried forward for the ALARP assessment with a justification for the exclusion of other response techniques included in Section 4.2.3. This assessment will typically result in a range of available options that are deployed at different areas (at-source, offshore, nearshore and onshore) and times through the response. The NEBA process assists in prioritising which options to use where, when and timings throughout the response

.

Table 4-3: Response technique evaluation – Loss of Well Containment MEE-01

Response Technique	Effectiveness	Feasibility	Decision	Rationale for the decision
Hydrocarbon: Julimar Condensate				
Monitor and evaluate	Will be effective in informing other response techniques and predicting potential impacts.	Monitoring of Julimar condensate spill is a feasible response technique and outputs can be used to guide decision making on the use of other response techniques. Techniques include predictive modelling, surveillance and reconnaissance, monitoring of hydrocarbon presence in water, pre-emptive assessment of sensitive receptors at risk, and monitoring of contaminated resources.	Yes	Monitoring the spill will be necessary to: • Validate trajectory and weathering models. • Determine the behaviour of the oil in water. • Determine the location and state of the slick. • Provide forecasts of spill trajectory. • Determine effectiveness of response techniques. • Confirm impact pathways to receptors.
Source control via Blowout Preventer (BOP) intervention	Controlling a loss of well containment at source via BOP intervention would be the most effective way to limit the quantity of hydrocarbon entering the marine environment.	In the event of the worst-case scenario with a loss of well containment during drilling operations, ROV operations to locally operate the BOP would be attempted.	Yes	The use of source control intervention via ROV may be feasible (depending on local concentration of atmospheric volatiles) and would reduce quantity of hydrocarbons entering the marine environment.
Source Control via Debris **Clearance and Capping Stack**	Controlling a loss of well containment at source via debris clearance and capping stack installation would cap the quantity of hydrocarbon entering the marine environment.	In the event of the worst-case scenario with a loss of well containment during drilling operations, debris clearance and capping activities are not considered viable at this water depth.	No	Under Woodside Well Blowout Planning Procedure (Section 3.1) Capping Stack deployment is not feasible in water depths <300 m. The maximum cumulative oil volume accumulated across all shoreline receptors (at concentrations in excess of 100 g/m^2) is 38m^3 at Kimberley Coast & Northern Coast. Successful Capping Stack deployment may contribute minor environmental reduction to total volume ashore however this is not commensurate with the environment impact to air quality, water quality, diesel emissions and responder safety from the mobilisation and deployment of large equipment from overseas to the response area. Woodside has adequate capability to combat surface spill using other techniques described in this assessment, therefore a further feasibility assessment on Capping Stack mobilisation and deployment was not sought.
Source control via relief well drilling	A subsea release of condensate will be over approximately 77 days. Relief well drilling will be the primary option to stop the release.	For a spill from the Julimar Phase 2 Drilling and Subsea Installation, relief well drilling will be the only feasible means of controlling of well containment event. Relief well drilling is a widely accepted and utilised technique.	Yes	Relief well drilling will be the main technique employed to control a loss of well containment event.
Containment and Recovery	Containment and recovery has an effective recovery rate of 5-10% when a hydrocarbon encounter rate of 25-50% is achieved at BAOAC 4 and 5. It has the potential to reduce the magnitude, probability of, extent of, contact with and accumulation of hydrocarbon on shorelines receptors. It also has the potential to reduce the magnitude and extent of contact with submerged receptors by entrained/ dissolved hydrocarbons.	Julimar Condensate is prone to rapid spreading and evaporation, and does not tend to form emulsions thus reducing the feasibility of containment and recovery as a response technique. In addition, this technique can have low effectiveness with on average, <10% of available oil contained and recovered. The largest operation ever mounted was during the Deepwater Horizon/Macondo which achieved an effectiveness of approximately 3-5%. Furthermore, this technique may be prevented from being undertaken due to personnel safety issues arising from predicted high local concentrations of atmospheric volatiles.	No	In addition to low effectiveness and potential safety issues from predicted high local concentrations of atmospheric volatiles, the modelling results show that the non-persistent characteristics and fate/trajectory of Julimar condensate would make containment and recovery an unsuitable response technique.
Subsea Dispersant Injection	Application of subsea dispersant may reduce the scale and extent of surface hydrocarbons, reduce the volumes of surface hydrocarbons contacting sensitive areas and reduce VOCs at/near the source.	In the event of a loss of well containment from the Julimar Phase 2 Drilling and Subsea Installation, the shallow water depth and potential loss of the production tree would prohibit the use of subsea dispersant injection as a response technique. In addition, the high discharge velocity and turbulence from the gas plume is predicted to generate very small oil droplets with very low-rise velocities. These droplets will be subject to mixing from plume turbulence, wind and breaking waves. Therefore at the surface, the droplets will tend to remain within the wave-mixed layer of the water column due to their weak buoyancy. This effectively replicates the action of dispersant thus rendering its use unnecessary.	No	Due to the predicted behaviour of the subsea plume coupled with characteristics of Julimar Condensate, the use of subsea dispersant injection would be unwarranted and could unnecessarily introduce additional chemical substances to the marine environment.

		Furthermore, this technique may be prevented from being undertaken due to personnel safety issues arising from predicted high local concentrations of atmospheric volatiles.		
Surface dispersant application	Application of surface dispersant would likely reduce the volumes of hydrocarbons contacting sensitive receptors. It has the potential to remove large volumes of oil from the surface that could cause secondary contamination of wildlife or shorelines. Dispersant can also enhance biodegradation and may reduce VOCs therefore reducing potential health and safety risk to responders.	Dispersants are not considered a feasible response technique when applied on thin surface films such as condensate as the dispersant droplets tend to pass through the surface films without binding to the hydrocarbon thus providing no net benefit. The modelling undertaken predicts that a spill of Julimar Condensate would be prone to rapid spreading and evaporation and thus the application of dispersant would be deemed inappropriate. Furthermore, this technique may be prevented from being undertaken due to personnel safety issues arising from predicted high local concentrations of atmospheric volatiles.	**No**	Due to the predicted behaviour of a spill of Julimar Condensate, the use of surface dispersant application would be unwarranted and could unnecessarily introduce additional chemical substances to the marine environment.
In-situ Burning	In-situ burning is only effective where minimum slick thickness can be achieved.	Use of in-situ burning as a response technique for Julimar Condensate is unfeasible as the minimum slick thickness cannot be attained due to rapid spreading and evaporation. In addition, there is a limited window of opportunity in which this technique can be applied (prior to evaporation of the volatiles) which is unlikely to be achieved. Furthermore, this technique may be prevented from being undertaken due to personnel safety issues arising from predicted high local concentrations of atmospheric volatiles.	**No**	Julimar Condensate characteristics are not appropriate for the use of in-situ burning and would unnecessarily cause an increase the release of atmospheric pollutants.
Shoreline Protection and Deflection	Shoreline protection and deflection can be effective at preventing contamination of sensitive resources and can be used to corral oil into slicks thick enough to skim effectively.	The modelling undertaken predicts that a spill of Julimar Condensate would be prone to rapid spreading and evaporation, however four (4) shoreline receptors are predicted to be contacted above 100 g/m^2 or in excess of 3m^3 at the Response Protection Area (RPA). The fastest shoreline contact is at Ningaloo Coast Middle WHA within 18.4 days. If Monitor and Evaluate activities indicate surface hydrocarbons in sufficient concentration is moving toward shorelines, existing TRPs will be utilised to guide shoreline protection and deflection operations.	**Potentially**	Response Protection Areas predicted to be contacted are based on modelling outputs and thus may differ under the prevailing conditions of a real event. If RPAs are deemed to be at risk, based on real-time modelling during a spill event, shoreline protection and deflection techniques will be employed to minimise hydrocarbon contact.
Shoreline Clean-up	Shoreline clean-up is an effective means of hydrocarbon removal from contaminated shorelines where coverage is at an optimum level of 250 g/m^2.	The modelling undertaken predicts that a spill of Julimar Condensate would be prone to rapid spreading and evaporation, however four (4) shoreline receptors are predicted to be contacted above 100 g/m^2 or in excess of 3m^3 at the Response Protection Area (RPA). The fastest contact is at Ningaloo Coast Middle WHA at 18.4 days. If Monitor and Evaluate activities indicate hydrocarbons in sufficient concentration will contact shorelines, existing TRPs will be utilised to guide response operations.	**Potentially**	Response Protection Areas predicted to be contacted are based on modelling outputs and thus may differ under the prevailing conditions of a real event. If RPAs are at risk, based on real-time modelling during a spill event, shoreline clean-up techniques will be deployed to expedite clean-up of the impacted sites. This will only be feasible where coverage is around 250 g/m^2.
Oiled wildlife	Oiled wildlife response is an effective response technique for reducing the overall impact of a spill on wildlife. This is mostly achieved through hazing to prevent additional fauna from being contaminated and through rehabilitation of fauna already subject to contamination.	Due to the likely volatile atmospheric conditions surrounding a loss of well containment, response options would be limited to hazing to ensure the safety of response personnel. In addition, any rehabilitation can only be undertaken by trained specialists.	**Potentially**	The modelling undertaken predicts that no sensitive areas will be impacted thus it is unlikely that this technique would be required. However in the event that fauna are at risk of contamination, oiled wildlife response will be undertaken as and where required.

Table 4-4: Response technique evaluation – Vessel Collision: Installation Vessel and Fuel Tanker MEE-05

Response Technique	Effectiveness	Feasibility	Decision	Rationale for the decision
Hydrocarbon: Marine Diesel				
Monitor and Evaluate	Diesel is visible on the water surface and the movement of slicks can be visually monitored.	Monitoring of a diesel spill is a feasible response technique and outputs can be used to guide decision making on the use of other response techniques. Techniques include predictive modelling, surveillance and reconnaissance, monitoring of hydrocarbon presence in water, pre-emptive assessment of sensitive receptors at risk, and monitoring of contaminated resources.	**Yes**	Monitoring of spilled diesel informs and ensure the effectiveness of all other response techniques.
Source Control	Controlling the spill of diesel at source would be the most effective way to limit the quantity of hydrocarbon entering the marine environment.	A spill of diesel from a vessel collision will be instantaneous and source control will be limited to what the vessel or facility can achieve whilst responding to the incident.	**Potentially**	Ability to stop the spill at source will be dependent upon the specific spill circumstances and whether or not it is safe for response personnel to access/isolate the source of the spill.
Containment and Recovery	Containment and recovery has an effective recovery rate of 5-10% when a hydrocarbon encounter rate of 25-50% is achieved at BAOAC 4 and 5.	Marine diesel is non-persistent, prone to rapid spreading and evaporation, and does not tend to form emulsions thus reducing the feasibility of containment and recovery as a response technique.	**No**	Containment and recovery would be an inappropriate response technique as it requires the spilled hydrocarbon to be BAOAC 4 or 5 with a 50-100% coverage of 100 g/m^2 to 200 g/m^2 which a spill of marine diesel would not achieve. In addition, most of the spilled diesel would have been subject to rapid evaporation prior to the commencement of containment and recovery operations.
Surface Dispersant Application	Dispersants are not considered effective when applied on thin surface films such as diesel as the dispersant droplets tend to pass through the surface films without binding to the hydrocarbon.	Marine diesel is non-persistent and is prone to rapid spreading and evaporation thus the use of dispersant would be deemed an unnecessary response technique.	**No**	The application of dispersant to marine diesel is unnecessary as the diesel will rapidly evaporate and would thus expose marine fauna to hydrocarbons unnecessarily.
In-situ Burning	In-situ burning is only effective where minimum slick thickness can be achieved.	Use of in-situ burning as a response technique for marine diesel is unfeasible as the minimum slick thickness cannot be attained due to rapid spreading and evaporation. In addition, there is a limited window of opportunity in which this technique can be applied (prior to evaporation of the volatiles) which is unlikely to be achieved. Furthermore, entering a volatile environment to undertake this technique would be unsafe for response personnel.	**No**	Diesel characteristics are not appropriate for the use of in-situ burning and would unnecessarily cause an increase the release of atmospheric pollutants.
Shoreline Protection and Deflection	Shoreline protection and deflection can be effective at preventing contamination of at-risk areas.	Use of shoreline protection and deflection for a spill of marine diesel is unlikely to provide any significant environmental benefit as the diesel will be subject to rapid spreading and evaporation prior to contact with any sensitive areas.	**No**	In addition to the rapid spreading and evaporation of the diesel, the modelling undertaken predicts that no shoreline receptors would be contacted by floating oil concentrations at any of the assessed thresholds.
Shoreline Clean-up	Shoreline clean-up is an effective means of hydrocarbon removal from contaminated shorelines where coverage is at an optimum level of 250 g/m^2.	Use of shoreline clean-up for a spill of marine diesel is unlikely to provide any significant environmental benefit as the diesel will be subject to rapid spreading and evaporation prior to contact with any sensitive areas. In addition, coverage from marine diesel on a shoreline would not be high enough to allow effective hydrocarbon removal.	**No**	In addition to the rapid spreading and evaporation of the diesel and lack of optimum coverage, the modelling undertaken predicts that no shoreline receptors would be contacted by floating oil concentrations at any of the assessed thresholds.
Oiled Wildlife	Oiled wildlife response is an effective response technique for reducing the overall impact of a spill on wildlife. This is mostly achieved through hazing to prevent additional fauna from being contaminated and through rehabilitation of fauna already subject to contamination.	Due to the likely volatile atmospheric conditions surrounding a diesel spill, response options would be limited to hazing to ensure the safety of response personnel. In addition, any rehabilitation could only be undertaken by trained specialists.	**Potentially**	The modelling undertaken predicts that no sensitive areas will be impacted thus it is unlikely that this technique would be required. However in the event that fauna are at risk of contamination, oiled wildlife response will be undertaken as and where required.

4.2.3 Exclusion of response techniques

4.2.3.1 Debris clearance/removal and capping stack deployment

The worst-case scenario identified for the petroleum activity program is considered to be a loss of well control during drilling operations. The options of debris clearance/removal, in preparation for capping, along with capping stack deployment, are not considered viable options for this scenario due to water depth as defined in the Woodside Drilling and Completions Well Blowout Contingency Planning Procedure and in accordance with the International Association of Oil and Gas Producers Capping and Containment Global Industry Response Group Recommendations.

Woodside does maintain capability for well intervention, debris clearance and capping stack as part of expected industry practice for scenarios.

4.2.3.2 Subsea dispersant injection

Subsea dispersant injection would be unlikely to have any appreciable effect on the simulated behaviour or extent of a rising subsea oil plume, since the initial droplet size distribution of the plume would be very similar to that which would be expected to result post-application of dispersant. Additionally, due to water depth around the well locations and the associated gas plume, subsea dispersant injection is unlikely to be able to be deployed safely.

While the high discharge velocity and turbulence generated by the release is expected to result in the droplets reaching the surface, due to wind and wave activity droplets are predicted to remain entrained within the wave-mixed layer of the water column (approximately 174 m deep) where they are likely to remain due to their relative weak buoyancy.

The initial small droplet size means much of the subsea component is predicted to remain entrained within the water column for the duration of the modelling. Therefore, any application of subsea dispersant would be unlikely to have any appreciable effect on the behaviour or extent of the oil plume.

4.2.3.3 Surface dispersant application

Modelling results for a hydrocarbon release caused by a loss of well containment of Julimar Condensate show surface hydrocarbons above threshold concentration (>50 g/m^2) are predicted to be 11 km^2 on Day 1 (2,174 m^3), peaking at 12 km^2 (2,055 m^3) on Day 4, then dropping to 0 km^2 on Day 8. There is a second peak of 2 km^2 (102 m^3) on Day 12 and then the surface hydrocarbons return to 0 km^2 thereafter.

The weathering data indicate that thicker surface hydrocarbons are likely to rapidly spread, thin and evaporate leading to concentrations of surface hydrocarbons that are not conducive to effective surface dispersant application. Under these circumstances, dispersant droplets tend to pass through the surface films without binding to the hydrocarbon thus providing no net benefit.

The fresh un-weathered hydrocarbons in close proximity to the release location may exceed 50 g/m^2 in ideal calm conditions but the ongoing nature of the release combined with the potential for the plume to breach the surface may cause conditions leading to high local concentrations of atmospheric volatiles producing a health and safety risk, thus limiting the ability of a surface dispersant response to safely target fresh Julimar Condensate.

Surface application of dispersants is therefore considered ineffective, with no incremental benefit over natural weathering.

4.2.3.4 Mechanical Dispersion

Mechanical dispersion involves the use of a vessel's propeller wash and/or fire hose to target surface hydrocarbons to achieve dispersion into the water column. However, this technique is of limited benefit in an open ocean environment where wind and wave action are likely to deliver similar advantages.

4.2.3.5 In-situ Burning

This technique requires calm sea state conditions as is required for containment and recovery operations, which limits its feasibility in the region. Optimum weather conditions are <20 knot wind speed and waves <1 to 1.5 m with oil collected to a minimum 3mm thick layer. Due to the conditions in the region it is expected that the ability to contain oil may be limited as the sea state may exceed the optimum conditions. It is preferable that oil is fresh and does not emulsify to maximise burn efficiency and reduce residue thickness.

There are health and safety risks for response personnel associated with the containment and subsequent burning of hydrocarbons. It is also suggested that the residue from attempts to burn would sink, thereby posing a risk to the environment. The longer-term effects of burn residues on the marine environment are not fully understood and therefore, no assessment of the potential environmental impact can be determined.

Until further operational and environmental information becomes available, Woodside will not consider this option.

4.2.3.6 Containment and Recovery

Modelling results for a hydrocarbon release caused by a loss of well containment of Julimar Condensate show surface hydrocarbons above threshold concentration (>50 g/m^2) are predicted to be 11 km^2 on Day 1 (2,174 m^3), peaking at 12 km^2 (2,055 m^3) on Day 4, then dropping to 0 km^2 on Day 8. There is a second peak of 2 km^2 (102 m^3) on Day 12 and then the surface hydrocarbons return to 0 km^2 thereafter. Although surface thresholds required for containment and recovery (>50 g/m^2) will be reached, the spill area above threshold will have reduced to 0 km^2 at Day 13 (also falls to 0 km^2 on Days 8 and 11). This is due to rapid spreading, thinning and evaporation which will render containment and recovery operations ineffective.

In addition, the ongoing nature of the release combined with the potential for the plume to breach the surface may cause conditions leading to high local concentrations of atmospheric volatiles producing a health and safety risk. This will limit containment and recovery operations in targeting the higher concentrations of Julimar Condensate.

4.3 Stage 2: Predict Outcomes

Woodside uses planning scenarios to assess potential impacts and response options for specific locations. Locations with potential environmental impacts, selected from the stochastic modelling are included for assessment. Response thresholds and deterministic modelling are then used to assess the feasibility/effectiveness of a response.

4.4 Stage 3: Balance trade-offs

Woodside considers environmental impacts and response effectiveness/feasibility to determine the most effective oil spill response tools and balance trade-offs, using an automated NEBA tool. The tool considers potential benefits and impacts associated with a response at sensitive receptors and then considers the effectiveness/feasibility of the response to select the response techniques carried forward to the ALARP assessment (ANNEX A: Net Environmental Benefit Analysis detailed outcomes).

4.5 Stage 4: Select Best Response Options

To select the response technique, all the other stages in the NEBA process are considered and used to establish response plans and any pre-approvals to support protection of identified environmental and social values.

The response techniques implemented may vary according to a particular spill. The hydrocarbon type released and the sensitivities of the receptors (both ecological and socio-economic) may influence the response. The pre-operational NEBA broadly evaluates each response technique and supports decisions on whether they are feasible and of net environmental benefit. Response techniques that are not feasible or beneficial are rejected at this stage and not progressed to planning.

Further risks and impacts from implementing these selected response options are outlined in Section 9.

Table 4-5: Selection and prioritisation of response techniques

Response planning scenario	Key characteristics for response planning (times are minimum times to contact for first receptor and/or shoreline contacted above response threshold)	Feasibility of response techniques: Monitor and evaluate	Source control	Source control – relief well drilling	Subsea dispersant injection	Surface dispersant application	Containment and recovery	Shoreline protection and deflection	Shoreline cleanup	Oiled wildlife response	Outline response technique
Hydrocarbon release caused by vessel collision: installation vessel and fuel tanker 2,000 m^3 marine diesel released instantaneously (residual component of 100 m^3).	No shoreline receptors are predicted to be contacted by floating oil concentrations at any of the assessed thresholds.	Yes Primary Technique	Potentially	No	No	No	No	No	No	Potentially	Monitor and evaluate. Initiate source control if feasible. Plan for oiled wildlife response and implement if oiled wildlife is observed.
Hydrocarbon release caused by loss of well containment. 296,858 m^3 of Julimar Condensate released over 77 days (residual component of 1,079 m^3).	Fastest time to shoreline accumulation >100 g/m^2: Ningaloo Coast Middle WHA 18.4 days (2 m^3) Largest shoreline accumulation: Kimberley Coast & Northern Coast 38 m^3 (63 days)	Yes Primary Technique	No	Yes Primary Technique	No	No	No	Potentially	Potentially	Potentially	Monitor and evaluate. Initiate relief well drilling. Plan for shoreline protection and deflection if there is potential contact predicted above response threshold. Plan for shoreline monitoring and clean-up where contact predicted above response threshold. Plan for oiled wildlife response and implement if oiled wildlife is observed.

From the NEBA undertaken on the WCCS identified (MEE-01 – loss of well containment) and additionally Scenario MEE-05 (vessel collision: installation vessel and fuel tanker), the primary response techniques are;

- Monitor and evaluate
- Source control (relief well drilling)

Secondary response techniques may be considered based on the monitor and evaluate inputs and field reports. These may include;

- Shoreline protection and deflection at identified RPAs
- Shoreline clean-up on priority impacted coastlines
- Wildlife response

Support functions may include:

- Waste management
- Scientific Monitoring programs

5 HYDROCARBON SPILL ALARP PROCESS

Woodside's hydrocarbon spill ALARP process is aligned with guidance provided by NOPSEMA in *Guideline N-04750-GL1687* (2016) and is set out in the 'Woodside Hydrocarbon Spill Oil Spill Preparedness and Response Mitigation Assessment (OSPRMA) Development Guidelines'.

From the identified response planning need and pre-operational NEBA, Woodside conducts a structured, semi-quantitative hydrocarbon spill process which has the following steps:

1. Considers the Response Planning Need identified in terms of surface area (km^2) and available surface hydrocarbon volumes (m^3) against existing Woodside capability;
2. Considers alternative, additional, and improved options for each response technique/control measure by providing an initial and, if required, detailed evaluation of;
   - Predicted cost associated with adopting the control measure,
   - Predicted change/environmental benefit, and
   - Predicted effectiveness/feasibility of the control measure.
3. Evaluates the risks and impacts of implementing the proposed response techniques, and any further control measures with associated environmental performance to manage these additional risks and impacts.

Woodside considers the risks and impacts from a hydrocarbon spill to have been reduced to ALARP when:

1. A structured process for identifying and considering alternative, additional, and improved options has been completed for each selected response technique;
2. The analysis of alternate, additional, and improved control measures meets one of the following criteria:
   - All identified, reasonably practicable control measures have been adopted; or
   - No identified reasonably practicable additional, alternative and/or improved control measures would provide further overall increased proportionate environmental benefit; or
   - No reasonably practical additional, alternative, and/or improved control measures have been identified.
3. Where an alternative, additional and/or improved control measure is adopted, a measurable level of environmental performance has been assigned.
4. Higher order impacts/risks have received more comprehensive alternative, additional, and improved control measure evaluations and do not just compare the cost of the adopted control measures to the costs of an extreme or clearly unreasonable control measure.
5. Cumulative effects have been analysed when considered in combination across the whole activity.

The response technique selection is based on the risk assessment conducted in the EP. The risk assessment identifies the type of oil, volume of release, duration of release, predicted fate, weathering and the EMBA (along with other requirements such as time to impact and predicted volumes ashore). Modelling is then used to inform the NEBA and the prioritisation of suitable response options. The scale of the response techniques selected in the pre-operational NEBA is informed through the assessment of results from deterministic modelling.

For the purpose of the ALARP assessment, the following terms and definitions have been used:

- Response techniques are considered the control measures that reduce consequences from hydrocarbon spill events. The terms 'response technique' and 'control measure' are used interchangeably.
- Cost is defined as the time, effort and/or trouble taken in financial, safety, design/storage/installation, capital/lease, and/or operations/maintenance terms to adopt a control measure.

- Where the predicted change to environmental impact is compared against standard environmental values and sensitivities impacts using positive or negative criteria from the NEBA Impact Ranking Classification Guidance in ANNEX A: Net Environmental Benefit Analysis detailed outcomes.

5.1 Monitor and Evaluate (including operational monitoring)

Monitor and evaluate includes the gathering and evaluation of data to inform the oil spill response planning and operations. It includes fate and trajectory modelling, spill tracking, weather updates and field observations. This response option is deployed in some capacity for every event.

The table below provides the operational monitoring plans that support the successful execution of this response technique.

Table 5-1: Description of supporting operational monitoring plans

ID	Title
OM01	Predictive modelling of hydrocarbons to assess resources at risk
OM02	Surveillance and reconnaissance to detect hydrocarbons and resources at risk
OM03	Monitoring of hydrocarbon presence, properties, behaviour and weathering in water
OM04	Pre-emptive assessment of sensitive receptors at risk
OM05	Shoreline assessment

Woodside maintains an *Operational Monitoring Operational Plan*. If shoreline contact is predicted, Response Protection Areas (RPAs) will be identified and assessed before contact. If shorelines are contacted, a shoreline assessment survey will be completed to guide effective shoreline clean-up operations. This plan includes the process for the IMT to mobilise resources depending on the nature and scale of the spill.

The proximity of Exmouth, Onslow and Dampier to the spill event location means that multiple logistical options are available to monitor the spill in relatively short timeframes. The primary mobilisation base for initial monitoring activities would be Dampier. However, in the event of an extended spill with potential to impact receptors further afield, monitoring activities may also be mobilised from Exmouth, Onslow and Broome.

5.1.1 Response need based on predicted consequence parameters

The following statements identify the key parameters upon which a response need can be based:

- Floating surface oil in sufficient concentrations for effective operational monitoring with surface concentrations of 50 g/m^2 is expected up to 58 km from the well location, and 100 g/m^2 up to 42 km from the well location for the WCCS subsea release.
- The shortest timeframe for shoreline contact from floating oil is predicted to be 18.4 days during a loss of well containment event.
- The time to contact for oil at concentrations of entrained hydrocarbons greater than 500 ppb at shoreline receptors is 1.3 days at Montebello Marine Park.
- Arrangements for support organisations who provide specialist services or resources should be tested regularly.
- Plans, procedures and support documents need to be in place for Operational and Support functions. These should be reviewed and updated regularly.
- The duration of the spill may be up to 77 days with shoreline response operations extending to 63 days. This is due to a modelled impact on Day 63 of 38 m^3 which Woodside has the capacity to clean up within 1 day (Section 6.4).

5.1.2 Environmental performance based on need

Table 5-2: Environmental Performance – Monitor and Evaluate

Environmental Performance Outcome		To gather information from multiple sources to establish an accurate common operating picture as soon as possible and predict the fate and behaviour of the spill to validate planning assumptions and adjust response plans as appropriate to the scenario.		
Control measure		**Performance Standard**		**Measurement Criteria (Section 5.9)**
1	Oil spill trajectory modelling	1.1	Initial modelling available within 6 hours using the Rapid Assessment Tool.	1, 3B, 3C, 4
		1.2	Detailed modelling available within 4 hours of APASA receiving information from Woodside.	
		1.3	Detailed modelling service available for the duration of the incident upon contract activation.	
2	Tracking buoy	2.1	Tracking buoy located on facility/vessel and ready for deployment 24/7.	1, 3A, 3C, 4
		2.2	Deploy tracking buoy from facility within 2 hours as per the First Strike Plan.	1, 3A, 3B, 4
		2.3	Contract in place with service provider to allow data from tracking buoy to be received 24/7 and processed.	1, 3B, 3C, 4
		2.4	Data received to be uploaded into Woodside COP daily to improve the accuracy of other monitor and evaluate strategies.	1, 3B, 4
3	Satellite imagery	3.1	Contract in place with 3rd party provider to enable access and analysis of satellite imagery. Imagery source/type requested on activation of service.	1, 3C, 4
		3.2	3rd party provider will confirm availability of an initial acquisition within 2 hours.	1, 3B, 3C, 4
		3.3	First image received with 24 hours of Woodside confirming to 3rd party provider its acceptance of the proposed acquisition plan.	1
		3.4	3rd party provider to submit report to Woodside per image. Report is to include a polygon of any possible or identified slick(s) with metadata.	1
		3.5	Data received to be uploaded into Woodside COP daily to improve accuracy of other monitor and evaluate strategies.	1, 3B, 4
		3.6	Satellite Imagery services available and employed during response.	1, 3C, 4
4	Aerial surveillance	4.1	2 trained aerial observers available to be deployed by day 1 from resource pool.	1, 2, 3B, 3C, 4
		4.2	One aircraft available for two sorties per day, available for the duration of the response from day 1.	1, 3C, 4
		4.3	Observer to compile report during flight as per First Strike plan. Observers report available to the IMT within 2 hours of landing after each sortie.	1, 2, 3B, 4
		4.4	Unmanned Aerial Vehicles/Systems (UAV/UASs) to support SCAT, containment and recovery and surface dispersal and pre-emptive assessments as contingency if required.	1, 2
5	Hydrocarbon detections in water	5.1	Activate 3rd party service provider as per First Strike plan. Deploy resources within 3 days: • 3 specialists in water quality monitoring • 2 monitoring systems and ancillaries • 1 vessel for deploying the monitoring systems with a dedicated winch, A-frame or Hiab and ancillaries to deploy the equipment.	1, 2, 3C, 3D, 4
		5.2	Water monitoring services available and employed during response.	1, 3C, 4
		5.3	Preliminary results of water sample as per contractor's implementation plan within 7 days of receipt of samples at the accredited lab.	
		5.4	Daily fluorometry reports as per service provider's implementation plan will be provided to IMT to validate modelling and monitor presence/absence of entrained hydrocarbons.	
		5.5	Use of Autonomous Underwater Vehicles (AUVs) for hydrocarbon presence and detection may be used as a contingency if the operational SIMA confirms conventional methods are unsafe or not possible.	1, 2, 3C, 4

6	Pre-emptive assessment of sensitive receptors	6.1	10 days prior to predicted impact, deployment of 2 specialists from resource pool in establishing the status of sensitive receptors.	1, 2, 3B, 3C, 4
		6.2	Daily reports provided to IMT on the status of the receptors to prioritise Response Protection Areas (RPAs) and maximise effective utilisation of resources.	1, 3B, 4
7	Shoreline assessment	7.1	10 days prior to predicted impact, deployment of 1 specialist(s) in SCAT from resource pool for each of the Response Protection Areas (RPAs) with predicted impacts at greater than 100 g/m^2.	1, 2, 3B, 3C, 4
		7.2	SCAT reports provided to IMT daily detailing the assessed areas to maximise effective utilisation of resources.	1, 3B, 4
		7.3	Shoreline access routes with the least environmental impact identified will be selected by a specialist in SCAT operations.	1

The control measures and capability of Woodside and its third-party service providers are shown to support Monitor and Evaluate activities up to and including the identified WCCS. This is demonstrated by the following:

- Woodside has a documented, structured and tested capability for Monitor and Evaluate operations including internal trajectory modelling capabilities, tracking buoys located offshore and contracted aerial observation platforms with access to trained observers.
- Woodside and its third-party service providers ensure there is sufficient capability for the duration of the response.
- Woodside has assessed the existing capability available and considered potential alternative, additional and improved control measures. Where control measures have been selected and implemented, they are included in Section 6.1.
- The health and safety, financial, capital and operations/maintenance costs of implementing the alternative, additional or improved control measures identified and not carried forward are considered clearly disproportionate to the environmental benefit gained and/or not reasonably practicable for this PAP.
- The Monitor and Evaluate capability outlined in this section is part of the response developed to manage potential risks and impacts associated with the scenarios to ALARP, and there are no further additional, alternative and improved control measures other than those implemented that would provide further benefit.

5.2 Source control via relief well drilling

The worst-case credible scenario for a loss of well containment is considered to be loss of well control during drilling operations. This scenario would result in an uncontrolled flow from the well as outlined in the EP. In the event of a loss of well containment, the primary response would be relief well drilling.

Woodside is a signatory to a MoU between Australian offshore operators to provide mutual aid to facilitate and expedite mobilising a MODU and drilling a relief well, if a loss of well containment incident were to occur. The MoU commits the signatories to share rigs, equipment, personnel and services to assist another operator in need.

5.2.1 Response need based on predicted consequence parameters

The following statements identify the key parameters upon which a response need can be based:

- Prior to any source control activities, Woodside will implement protocols to ensure that the site is safe including subsea ROV surveys and surface air monitoring.
- Hydrocarbons will flow from the well until one of the following interventions can be made:
  - Closure of the Tubing Retrievable Safety Valve (TRSV)
  - A relief well is drilled and first attempt at well kill within 77 days
- Arrangements for support organisations who provide specialist services or resources should be tested regularly.
- Plans, procedures and support documents need to be in place for Operational and Support functions. These should be reviewed and updated regularly.
- The duration of the spill may be up to 77 days with shoreline response operations extending to 63 days. This is due to a modelled impact on Day 63 of 38 m^3 which WEL has the capacity to clean up within 1 day (Section 6.4).

In addition, a number of assumptions are required to estimate the response need for source control. These assumptions have been described in the table below.

Table 5-3: Response Planning Assumptions – Source Control

Response planning assumptions	
Safety considerations	Source control operations cannot be implemented if the safety of response personnel cannot be guaranteed. This requires an initial and ongoing risk assessment of health and safety hazards and risks at the site, in accordance with the Woodside Management System (WMS). Personnel safety issues may include: • hydrocarbon gas and/or liquid exposure • high winds, waves and/or sea states • high ambient temperatures.
Feasibility considerations	Woodside's primary source control option would be ROV intervention followed by relief well drilling for the Julimar Drilling and Subsea well. The following approaches outline Woodside's hierarchy for relief well drilling; • Primary – Review internal drilling programs and MODU availability to source an appropriate rig operating within Australia with an approved Safety Case; • Alternate – Source and contract a MODU through APPEA MOU that is operating within Australia with an approved Safety Case; • Contingency – Source and contract a MODU outside Australia with an approved Australian Safety Case

5.2.2 Environmental performance based on need

Table 5-4: Environmental Performance - Source Control

Environmental Performance Outcome		To stop the flow of hydrocarbons into the marine environment		
Control measure		**Performance Standard**		**Measurement Criteria (Section 5.9)**
8	Well intervention	8.1	Frame agreements with ROV providers in place to be mobilised upon notification. ROV equipment deployed within 9 days.	1, 3B, 3C
		8.2	Frame agreements for IMR vessels to maintain/enforce regulatory approvals and provide support in the event of an emergency.	
		8.3	Hot Stab (D&C only) and/or well intervention using ROV attempted within 2 days, subject to risk assessment and approvals.	
		8.4	Source Control vessel will have the following minimum specifications: • Active Heave Compensated crane, rated to at least 150T in shallow water and 250T in deeper water • At least 90m in length • Deck has water/electricity supply Deck capacity to hold at least 110T of capping stack.	
		8.5	Identify source control vessel availability within 24 hours and begin contracting process. Vessel mobilised to site for deployment within 12 days.	
		8.6	Wild Well Control staff available all year round, via contract, to assist with the mobilisation, deployment, and operation of the Well intervention equipment.	
		8.7	Contract in place with Wild Well Control and Oceaneering to provide trained personnel.	1, 3B, 3C, 4
		8.8	MODU mobilised to location for relief well drilling within 21 days.	1, 3C
		8.9	First well kill attempt within 77 days.	1, 3B, 3C
		8.10	Open communication line(s) to be maintained between IMT and infield operations to ensure awareness of progress against plan(s).	1, 3A, 3B
		8.11	Monthly monitoring of the availability of MODUs through existing market intelligence to meet specifications for source control.	3C
		8.12	ROV available on MODU ready for deployment within 48 hours, subject to risk assessment and approvals, to attempt initial BOP well intervention.	1, 3B, 3C
9	Support vessels	9.1	At least two communication methods, one of which will include the capability to communicate with aviation.	1, 3A
		9.2	Monthly monitoring of the availability of larger vessels through existing Frame Agreements and market intelligence to meet specifications for source control.	3C
		9.3	Frame agreements for inspection maintenance repair vessels (IMRs) require vessels to maintain in-force safety case approvals covering ROV operations and provide support in the event of an emergency.	1, 3B, 3C
		9.4	MODU and vessel contracts include clause outlining requirement for support in the event of an emergency.	1, 3C
		9.5	Quarterly monitoring of Registered Operators and Woodside will maintain minimum safe operating standards that can be provided to MODU and vessel operators for Safety Case guidance.	1, 3B, 3C
10	Safety Case	10.1	Woodside will prioritize MODU or vessel(s) for intervention work(s) that have an existing safety case.	1, 3C
		10.2	Woodside Planning, Logistics, and Safety Officers (on roster/Call 24/7) to assist in expediting the safety case assessment process as far as practicable.	1, 3C
		10.3	MODU and vessel contracts include clause outlining requirement for support in the event of an emergency.	1, 3C

		10.4	Woodside will maintain minimum safe operating standards that can be provided to MODU and vessel operators for Safety Case guidance.	

The resulting source control capability has been assessed against the WCCS. The range of techniques provide a feasible and viable approach to relief well drilling operations to stop the well flowing.

- The health and safety, financial, capital and operations/maintenance costs of implementing the alternative, additional or improved control measures identified and not carried forward are considered clearly disproportionate to the insignificant environmental benefit gained and/or not reasonably practicable for this PAP.
- Woodside has assessed the existing capability available and considered potential alternative, additional and improved control measures. Where control measures have been selected and implemented, they are included in Section 6.2.
- No further control measures that may result in an increased environmental benefit that involve moderate to significant cost and/or dedication of resources have been adopted as the limited scale and timeframe for deployment of this technique does not justify the excessive costs of identified additional, alternative and improved control measures.

5.3 Shoreline Protection and Deflection

The placement of containment, protection or deflection booms on and near a shoreline is a response technique to reduce the potential volume of hydrocarbons contacting or spreading along shorelines, which may reduce the scale of shoreline clean-up. Hydrocarbons contained by the booms would be collected where practicable.

Shorelines would be protected where accessible via vessel or shore. Where hydrocarbon contact has already occurred, there may still be value in deploying protection equipment to limit further accumulations and preventing remobilisation of stranded hydrocarbons.

Shoreline protection and deflection equipment would be mobilised to selected locations, where the following conditions were met:

- Sea-states and hydrocarbon characteristics permit safe deployment of protection and deflection measures.
- Oil trajectory has been identified as heading towards identified RPAs.

5.3.1 Response need based on predicted consequence parameters

Julimar Phase 2 Drilling and Subsea Installation loss of well containment

The following statements identify the key parameters upon which the response need can be based:

- The shortest timeframe that shoreline contact from floating oil above threshold is predicted to be 18.4 days (loss of well containment) at Ningaloo Coast Middle WHA ($2m^3$).
- Pre-emptive assessment and shoreline assessments (OM04 and OM05) will be mobilised prior to shoreline contact at 100 g/m^2, which occurs on day 18 at Ningaloo Coast Middle WHA.
- The duration of the spill may be up to 77 days with shoreline response operations extending to 63 days. This is due to a modelled impact on Day 63 of 38 m^3 which WEL has the capacity to clean up within 1 day (Section 6.4).
- Arrangements for support organisations who provide specialist services (trained personnel, protection and deflection equipment) and/or resources and should be tested regularly.
- Tactical Response Plans (TRPs) for Response Protection Areas (RPAs) along with other relevant plans, procedures and support documents need to be in place for Operational and Support functions. These should be reviewed and updated regularly.

In addition, a number of assumptions are required to estimate the response need for Shoreline Protection and Deflection. These assumptions have been described in the table below.

Table 5-5: Response Planning Assumptions – Shoreline Protection and Deflection

Response Planning Assumptions	
Safety considerations	Shoreline protection and deflection operations cannot be implemented if the safety of response personnel cannot be guaranteed. This requires an initial and ongoing risk assessment of health and safety hazards and risks at the site. Personnel safety issues may include: • hydrocarbon gas and/or liquid exposure • high winds, waves and/or sea states • high ambient temperatures.

Shoreline Protection and Deflection	• One (1) Shoreline Protection and Deflection operation may include;
	  • Quantity of shoreline sealing boom (as outlined in TRP)
	  • Quantity of fence or curtain boom (as outlined in TRP)
	  • 1-2 x trained supervisors
	  • 8-10 x personnel / labour hire
	Specific details of each operation would be tailored to the Tactical Response Plan implemented (where available).

5.3.2 Environmental performance based on need

Table 5-6: Environmental Performance – Shoreline Protection and Deflection

Environmental Performance Outcome		To stop hydrocarbons encountering particularly sensitive areas		
Control measure		**Performance Standard**		**Measurement Criteria (Section 5.9)**
11	Response teams	11.1	Relevant Tactical Response Plans (TRPs) will be identified in the First Strike plan for activation 5 days prior to a predicted impact.	1, 3A, 3C, 4
11	Response teams	11.2	Mobilise teams to RPA's 5 days prior to predicted impact. Teams to contaminated RPAs comprised of: • 1-2 trained specialists per operation • 8-10 personnel/labour hire Personnel sourced through resource pool.	1, 2, 3B, 3C, 4
11	Response teams	11.3	1 operation mobilised 5 days prior to predicted impact for each identified RPA. Expected to be 1 RPAs within 18 days. (operation as detailed above).	1, 3A, 3B, 4
11	Response teams	11.4	12 trained personnel available (2 supervisors plus 10 additional personnel) 5 days prior to predicted impact for each identified RPA. Sourced through resource pool.	1, 2, 3A, 3B, 3C, 4
11	Response teams	11.5	Open communication line to be maintained between IMT and infield operations to ensure awareness of progress against plan(s).	1, 3A, 3B
11	Response teams	11.6	The safety of shoreline response operations will be considered and appropriately managed. During shoreline operations: • All personnel in a response will receive an operational/safety briefing before commencing operations • Gas monitoring and site entry protocols will be used to assess safety of an operational area before allowing access to response personnel.	1, 3B, 4
12	Response equipment	12.1	Equipment mobilised from closest stockpile 5 days prior to predicted impact.	1, 3A, 3C, 4
12	Response equipment	12.2	Supplementary equipment mobilised from State, AMOSC, AMSA stockpiles 5 days prior to predicted impact.	1, 3C, 3D, 4
12	Response equipment	12.3	Supplementary equipment mobilised from 5 days prior to predicted impact.	

		12.4	Woodside maintains integrated fleet of vessels. Additional vessels can be sourced through existing contracts/frame agreements	1, 3A, 3C, 4
13	Management of Environmental Impact of the response risks	13.1	If vessels are required for access, anchoring locations will be selected to minimise disturbance to benthic primary producer habitats. Where existing fixed anchoring points are not available, locations will be selected to minimise impact to nearshore benthic environments with a preference for areas of sandy seabed where they can be identified.	1
		13.2	Shallow draft vessels will be used to access remote shorelines to minimise the impacts associated with seabed disturbance on approach to the shorelines.	

The resulting shoreline protection and deflection capability has been assessed against the WCCS. The range of techniques provide an ongoing approach to shoreline protection and deflection at identified RPAs.

Under optimal conditions, during the subsea and surface releases the capability available exceeds the need identified. It indicates that the shoreline protection and deflection capability have the following expected performance:

- Deterministic modelling scenarios indicate that first shoreline impact at Ningaloo Coast Middle WHA within 18.4 days for the loss of well containment scenario.
- Existing capability allows for mobilisation and deployment of shoreline protection operations by Day 2 (if required). Given shoreline contact at RPAs is not predicted until Day 18 at Ningaloo Coast Middle WHA, the existing capability is considered sufficient to mobilise and deploy protection at RPAs prior to hydrocarbon contact, guided by the ongoing operational monitoring.
- TRPs have been developed for all identified RPAs that are predicted to be impacted in less than 14 days excepting international locations.
- Woodside has assessed the existing capability available and considered potential alternative, additional and improved control measures. Where control measures have been selected and implemented, they are included in Section 6.3.

No further control measures that may result in an increased environmental benefit that involve moderate to significant cost and/or dedication of resources have been adopted as the timeframe required for deployment of this technique, does not justify the excessive costs of identified alternate, improved or additional controls.

5.4 Shoreline Clean-up

Shoreline clean-up may be undertaken using a broad range of techniques when floating hydrocarbons contact shorelines. The timing, location and extent of shoreline clean-up activities can vary from one scenario to another, depending on the hydrocarbon type, sensitivities and values contacted, shoreline type and access, degree of oiling, and area oiled.

Shoreline clean-up is typically undertaken as a three-phase process:

- Phase one (gross contamination removal) involving the collection of bulk oil, either floating against the shoreline or stranded on it.
- Phase two (moderate to heavy contamination removal) involving removal or in-situ treatment of shoreline substrates such as sand or pebble beaches.
- Phase three (final treatment or polishing) involving removal of the remaining residues of oil.

As phase one typically involves recovery of floating and pooled oil, and phase three removes minor volumes, they have not been considered in the assessment of response need for the scenarios identified.

The *Shoreline Cleanup Operational Plan* details the mobilisation and resource requirements for a shoreline cleanup operation including the logistics, support and facility arrangements to manage the movement of personnel and resources.

The *Shoreline Cleanup Operational Plan* includes the process for the IMT to mobilise resources depending on the nature and scale of the spill. Woodside would activate and mobilise trained and competent personnel in shoreline assessment before or following shoreline contact at response thresholds.

Shoreline clean-up consists of different manual and mechanical recovery techniques to remove hydrocarbons and contaminated debris from a shoreline; this is to minimise ongoing environmental contamination and impact. The National Plan also provides guidance on shoreline clean-up techniques as outlined in National Plan Guidance *Response, assessment and termination of cleaning for oil contaminated foreshores* (AMSA 2015).

5.4.1 Response need based on predicted consequence parameters

Julimar Phase 2 Drilling and Subsea Installation loss of well containment

The following statements identify the key parameters upon which the response need can be based:

- The shortest timeframe that shoreline contact from floating oil above threshold is predicted to be 18.4 days (loss of well containment) at Ningaloo Coast Middle WHA ($2m^3$).
- Pre-emptive assessment and shoreline assessments (OM04 and OM05) will be mobilised prior to shoreline contact.
- The duration of the spill may be up to 77 days with shoreline response operations extending to 63 days (Week 9). This is due to a modelled impact on Day 63 of 38 m^3 which WEL has the capacity to clean up within 1 day (Section 6.4).
- Following Shoreline Assessment and agreement of prioritisation with WA Department of Transport, clean-up operations would commence until agreed termination criteria are reached.
- Arrangements for support organisations who provide specialist services (trained personnel, labour hire, shoreline clean-up, and site management equipment) and/or resources and should be tested regularly.
- Tactical Response Plans (TRPs) for Response Protection Areas (RPAs) along with other relevant plans, procedures and support documents should be in developed and in place for Operational and Support functions. These should be reviewed and updated regularly.

In addition, a number of assumptions are required to estimate the response need for shoreline clean-up. These assumptions have been described in the table below.

Table 5-7: Response Planning Assumptions – Shoreline Clean-up

Response planning assumptions: Shoreline cleanup	
Safety considerations	Shoreline clean-up operations cannot be implemented if the safety of response personnel cannot be guaranteed. This requires an initial and ongoing risk assessment of health and safety hazards and risks at the site. Personnel safety issues may include: • hydrocarbon gas and/or liquid exposure • high winds, waves and/or sea states • high ambient temperatures.
Manual shoreline clean-up operation (Phase 2)	One, manual shoreline clean-up operation (Phase 2) may include: • 1–2 x trained supervisor • 8–10 x personnel/labour hire • Supporting equipment for manual clean-up including rakes, shovels, buckets, plastic bags etc.

Physical properties	**Surface Threshold**
	• Lower – 100 g/m^2 - 100% coverage of 'stain' – cannot be scratched off easily on coarse sediments or bedrock
	  • Expected trigger to undertake detailed shoreline survey
	• Optimum – 250 g/m^2 – 25% coverage of 'coat' – can be scratched off with a fingernail on coarse sediments
	  • Expected trigger to commence clean-up operations

Efficiency **(m^3 oil recovered per person per day)**	Manual shoreline clean-up (Phase 2) - approx. 0.25–1 m^3 oil recovered per person per 10 hr day is based on moderate to high coverage of oil (100 g/m^2–1000 g/m^2) with manual removal using shovels/rakes, etc. from studies of previous response operations and exercises.
Field operation supervisors required (per team)	Manual shoreline clean-up (Phase 2) – 1-2 trained supervisor(s) per operation (assumes one team per operation).
Personnel/ labour hire (per team)	Manual shoreline clean-up (Phase 2) – 8-10 personnel/labour hire per operation (assumes one team per operation).

Table 5-8: Shoreline Clean-up techniques and recommendations

Technique	Description	Shoreline type		Application
		Recommended	Not recommended	
Natural recovery	Allowing shoreline to self-clean; no intervention undertaken.	Remote and inaccessible shorelines for personnel, vehicles and machinery. Other clean-up techniques may cause more damage than allowing the shoreline to naturally recover. Natural recovery may be recommended for areas with mangroves and coral reefs due to their sensitivity to disturbance from other shoreline clean-up techniques. High-energy shorelines: where natural removal rates are high, and hydrocarbons will be removed over a short timeframe.	Low-energy shorelines: these areas tend to be where hydrocarbon accumulates and penetrates soil and substrates.	May be employed, if the operational NEBA identifies that other clean-up techniques will have a negligible or negative environmental impact on the shoreline. May also be used for buried or reworked hydrocarbons where other techniques may not recover these.
Manual recovery	Use of manpower to collect hydrocarbons from the shoreline. Use of this form of clean-up is based on type of shoreline.	Remote and inaccessible shorelines for vehicles and machinery. Areas where shorelines may not be accessible by vehicles or machinery and personnel can recover hydrocarbons manually. Where hydrocarbons have formed semi-solid to solid masses that can be picked up manually. Areas where nesting and breeding fauna cannot or should not be disturbed.	Coral reef or other sensitive intertidal habitats, as the presence of a response may cause more environmental damage then allowing them to recover naturally. For some high-energy shorelines such as cliffs and sea walls, manual recovery may not be recommended as it may pose a safety threat to responders.	May be used for sandy shorelines. Buried hydrocarbons may be recovered using shovels into small carry waste bags, but where possible the shoreline should be left to naturally recover to prevent any further burying of hydrocarbons (from general clean-up activities).

Technique	Description	Shoreline type		Application
		Recommended	Not recommended	
Sorbents	Sorbent boom or pads used to recover fluid or sticky hydrocarbons. Can also be used after manual clean-up to remove any residues from crevices or from vegetation.	When hydrocarbons are free-floating close to shore or stranded onshore. As a secondary treatment method after hydrocarbon removal and in sensitive areas where access is restricted.	Access for deploying and retrieving sorbents should not be through soft or sensitive habitats or affect wildlife.	Used for rocky shorelines. Sorbent boom will allow for deployment from small shallow draught vessels, which will allow deployment close to shore where water is sheltered and to aid recovery. Sorbents will create more solid waste compared with manual clean-up, so will be limited to clean rocky shorelines.
Vacuum recovery, flushing, washing	The use of high volumes of low-pressure water, pumping and/or vacuuming to remove floating hydrocarbons accumulated at shorelines.	Suited to rocky or pebble shores where flushing can remobilise hydrocarbons (to be broken up) and aid natural recovery. Any accessible shoreline type from land or water. May be mounted on barges for water-based operations, on trucks driven to the recovery area, or hand-carried to remote sites. Flushing and vacuum may be useful for rocky substrate. Medium- to high-energy shorelines where natural removal rates are moderate to high. Where flushed hydrocarbons can be recovered to prevent further oiling of shorelines.	Areas of pooled light, fresh hydrocarbons may not be recoverable via vacuum due to fire and explosion risks. Shorelines with limited access. Flushing and washing not recommended for loose sediments. High-energy shorelines where access is restricted.	High volume low pressure (HVLP) flushing and washing into a sorbent boom could be used for rocky substrate, if protection booming has been unsuccessful in deflecting hydrocarbons from these areas.

Technique	Description	Shoreline type		Application
		Recommended	Not recommended	
Sediment reworking	Movement of sediment to surf to allow hydrocarbons to be removed from the sediment and move sand via heavy machinery.	When hydrocarbons have penetrated below the surface. Recommended for pebble/cobble shoreline types. Medium- to high-energy shorelines where natural removal rates are moderate to high.	Low-energy shorelines as the movement of substrate will not accelerate the natural cleaning process. Areas used by fauna which could potentially be affected by remobilised hydrocarbons.	Use of wave action to clean sediment: appropriate for sandy beaches where light machinery is accessible.
Vegetation cutting	Cutting vegetation to prevent oiling and reduce volume of waste and debris.	Vegetation cutting may be recommended to reduce the potential for wildlife being oiled. Where oiling is restricted to fringing vegetation.	Access in bird-nesting areas should be restricted during nesting seasons. Areas of slow-growing vegetation.	May be used on shorelines where vegetation can be safely cleared to reduce oiling.
Cleaning agents (National Plan registered Oil Spill Cleaning Agent – 'OSCA')	Application of chemicals such as dispersants to remove hydrocarbons.	May be used for manmade structures and where public safety may be a concern.	Natural substrates and in low-energy environments where sufficient mixing energy is not present.	Not recommended for shorelines. Could be used for manmade structures such as boat ramps.

5.4.2 Environmental performance based on need

Table 5-9: Environmental Performance – Shoreline Clean-up

Environmental Performance Outcome		To remove bulk and stranded hydrocarbons from shorelines and facilitate shoreline amenity habitat recovery.		
Control measure		**Performance Standard**		**Measurement Criteria (Section 5.9)**
14	Shoreline responders	14.1	Deployment of 1 shoreline clean-up team to each contaminated RPA comprised of: • 1-2 trained specialists per operation • 8-10 personnel/labour hire Personnel sourced through resource pool 5 days prior to predicted impact upon request from the IMT.	1, 2, 3A, 3B, 3C, 4
		14.2	Relevant Tactical Response Plans (TRPs) will be identified in the First Strike plan for activation 5 days prior to predicted impact.	1, 3A, 3C, 4
		14.3	Relevant Tactical Response Plans (TRPs) available for shoreline contacted by accumulation >100 g/m^2 within 10 days.	1, 3A, 3C, 4
		14.4	Clean-up operations for shorelines in line with results and recommendations from SCAT outputs.	1, 3A, 3B
		14.5	All shorelines zoned and marked before clean-up operations commence to prevent secondary contamination and minimise the mixing of clean and oiled sediment and shoreline substrates.	
		14.6	Mobilise and deploy up to 1 shoreline clean-up operations by Day 18.	1, 2, 3A, 3C, 4
		14.7	Mobilise and deploy up to 1 shoreline clean-up operations by Week 9.	
		14.8	Mobilise and deploy 1 shoreline clean-up operation to each site where operational monitoring predicts accumulations >100 g/m^2 5 days prior to impact.	1, 2, 3A, 3C, 4
		14.9	The safety of shoreline response operations will be considered and appropriately managed. During shoreline clean-up operations: • All personnel in a response will receive an operational/safety briefing before commencing operations • Gas monitoring and site entry protocols will be used to assess safety of an operational area before allowing access to response personnel	1, 3B, 4
		14.10	Open communication line to be maintained between IMT and infield operations to ensure awareness of progress against plan(s).	1, 3A, 3B
15	Waste Management	15.1	Contract with waste management services for transport, removal, treatment and disposal of waste.	1, 3A, 3B, 3C, 4
		15.2	Access to at least 20-100 m^3 of solid waste storage available within 18 days. Then access to an additional 76-380 m^3 of solid waste storage within an additional 45 days.	
		15.3	Waste management services available and employed during response.	
16	Shoreline clean-up equipment	16.1	Contract in place with 3rd party providers to access equipment.	1, 3A, 3C, 4
		16.2	Equipment mobilised from closest stockpile 5 days prior to predicted impact.	
		16.3	Supplementary equipment mobilised from State, AMOSC, AMSA stockpiles 5 days prior to predicted impact.	1, 3C, 3D, 4
		16.4	Supplementary equipment mobilised from OSRL 5 days prior to predicted impact.	
17	Management of Environmental Impact of the response risks	17.1	If vessels are required for access, anchoring locations will be selected to minimise disturbance to benthic primary producer habitats. Where existing fixed anchoring points are not available, locations will be selected to minimise impact to nearshore benthic environments with a preference for areas of sandy seabed where they can be identified.	

		17.2	Shallow draft vessels will be used to access remote shorelines to minimise the impacts associated with seabed disturbance on approach to the shorelines.	1
		17.3	Vehicular access will be restricted on dunes, turtle nesting beaches an in mangroves.	
		17.4	Shoreline access route (foot, car, vessel and helicopter) with the least environmental impact identified will be selected by a specialist in SCAT operations.	
		17.5	Removal of vegetation will be limited to moderately or heavily oiled vegetation.	
		17.6	Oversight by trained personnel who are aware of the risks.	
		17.7	Trained unit leaders brief personnel prior to operations of the environmental risks of presence of personnel on the shoreline.	

The resulting shoreline clean-up capability has been assessed against the WCCS. The range of techniques provide an ongoing approach to shoreline clean-up at identified RPAs. Woodside's capability can cover all required shoreline clean-up operations for the PAP.

Whilst modelling predicts shoreline contact from day 18 (Ningaloo Coast Middle WHA), Woodside is satisfied that the current capability is managing risks and impacts to ALARP.

The capability available meets the need identified for this activity. The shoreline clean-up capability has the following expected performance (if required during a response):

- Woodside has the capacity to mobilise and deploy up to 105-140 shoreline clean-up teams (approx. 1,260-1,680 responders in total) by Week 3 using existing labour hire contracts with Woodside, AMOSC, Core Group, AMSA, WA DoT and OSRL team leads.
- Assessment of response capability indicates that for a worst-case scenario the actual teams required would meet the available capability and the response would be completed by end month 3.
- Woodside has considered deployment of additional personnel to undertake shoreline clean-up operations but is satisfied that the identified level of resource is balanced between cost, time and effectiveness. The most significant constraint on expanding the scale of response operations is accommodation and transport of personnel in the Exmouth to Port Hedland region and management of response generated waste. From previous assessment of accommodation in this region, Woodside estimates that current accommodation can cater for a range of 500-700 personnel per day for an ongoing operation.
- TRPs have been developed for all identified RPAs excepting international locations.
- Woodside has assessed the existing capability available and considered potential alternative, additional and improved control measures. Where control measures have been selected and implemented, they are included in Section 6.4.

No further control measures that may result in an increased environmental benefit that involve moderate to significant cost and/or dedication of resources have been adopted as the limited scale and timeframe for deployment of this technique does not justify the excessive costs of identified alternate, improved or additional controls.

5.5 Waste Management

Waste management is considered a support technique to shoreline clean-up and wildlife response. Waste generated and collected during the response that will require handling, management and disposal may consist of:

- Liquids (hydrocarbons and contaminated liquids) collected during shoreline clean-up and wildlife response, and/or
- Solids/semi-solids (oily solids, garbage, contaminated materials) and debris (e.g. seaweed, sand, woods, and plastics) collected during shoreline clean-up and wildlife response.

Expected waste volumes during an event are likely to vary depending on oil type, volume released, response techniques employed and how weathering of hydrocarbons. Waste management, handling and capacity should be scalable to ensure continuous response operations can be maintained.

All waste management activities will follow the Environment Protection (Controlled Waste) Regulations 2004 and the waste will be managed to minimise final disposal volumes. Waste treatment techniques will consider contaminated solids treatment to allow disposal to landfill and solids with high concentrations of hydrocarbon will be treated and recycled where possible or used in clean fill if suitable.

The waste products would be transported from response locations to the nearest suitable staging area/waste transfer station for treatment, disposal or recycling. Waste will be transferred with appropriately licensed vehicles. Containers will be available for temporary waste storage and will be:

- labelled with the waste type
- provided with appropriate lids to prevent waste being blown overboard
- bunded if storing liquid wastes.
- processes will be in place for transfers of bulk liquid wastes and include:
    - inspection of transfer hose undertaken prior to transfer
    - watchman equipped with radio visually monitors loading hose during transfer
    - tank gauges monitored throughout operation to prevent overflow.

The *Oil Spill Preparedness Waste Management Support Plan* details the procedures, capability and capacity in place between Woodside and its primary waste services contractor (Veolia Waste Management) to manage waste volumes generated from response activities.

5.5.1 Response need based on predicted consequence parameters

Table 5-10: Response Planning Assumptions – Waste Management

Response planning assumptions: Waste management	
Waste loading per m^3 oil recovered (multiplier)	Shoreline clean-up (manual) – approx. 5-10x multiplier for oily solid and liquid wastes generated by manual clean-up.
	Oiled wildlife response – approx. $1m^3$ of oily liquid waste generated for each wildlife unit cleaned.

5.5.2 Environmental performance based on need

Table 5-11: Environmental Performance – Waste Management

Environmental Performance Outcome		To minimise further impacts, waste will be managed, tracked and disposed of in accordance with laws and regulations.		
Control measure		**Performance Standard**		**Measurement Criteria (Section 5.9)**
18	Waste Management	18.1	Contract with waste management services for transport, removal, treatment and disposal of waste.	1, 3A, 3B, 3C, 4
		18.2	Access to at least 20-100 m^3 of solid and liquid waste storage available within 18 days upon activation of 3rd party contract.	
		18.3	Access to up to 380 m^3 by end of Month 3.	
		18.4	Recovered hydrocarbons and wastes will be transferred to licensed treatment facility for reprocessing or disposal.	
		18.5	Teams will segregate liquid and solid wastes at the earliest opportunity.	
		18.6	Waste management provider support staff available year-round to assist in the event of an incident with waste management as detailed in contract.	
		18.7	Open communication line to be maintained between IMT and waste management services to ensure the reliable flow of accurate information between parties.	1, 3A, 3B
		18.8	Waste management to be conducted in accordance with Australian laws and regulations.	1, 3A, 3B, 3C, 4
		18.9	Waste management services available and employed during response.	

The resulting waste management capability has been assessed against the WCCS. The range of techniques provide an ongoing approach to waste management at identified RPAs.

Given the largest shoreline volumes ashore are predicted during Week 9 at a maximum volume of 38 m^3, 380 m^3 of waste is expected across all shoreline clean-up operations, and the capability available exceeds the need identified.

It indicates that the waste management capability has the following expected performance:

- Shoreline and nearshore operations may generate up to 380 m^3 over 3 months of operations.
- Woodside has assessed the existing capability available and considered potential alternative, additional and improved control measures. Where control measures have been selected and implemented, they are included in Section 6.5.

Veolia Waste Management has a waste treatment capacity of approximately 120,000 m^3, at both Exmouth Port and King Bay supply base, thus the waste management requirements are within Woodside's and Veolia's existing capacity.

5.6 Oiled wildlife response (including hazing)

Woodside would implement a response in accordance with the *Oiled Wildlife Operational Plan* (W0000AH9756292). This plan includes the process for the IMT to mobilise resources depending on the nature and scale of the spill. Oiled wildlife operations would be implemented with advice and assistance from the Oiled Wildlife Advisor from the Department of Biodivseristy Conservation and Attractions (DBCA).

Oiled wildlife response is undertaken in accordance with the Western Australian Oiled Wildlife Response Plan to ensure it is conducted in accordance with legislative requirements under the *Animal Welfare Act 2002*.

If there is a net environmental benefit, oiled wildlife operations will be conducted 24 hours per day to reduce the time for rehabilitation and release of oiled wildlife. Hazing and pre-emptive capture techniques to keep non-**oiled animals** away from contaminated habitat in instances where it is deemed appropriate will be conducted in accordance with the Western Australian Oiled Wildlife Response Plan, specifically vessels used in hazing/pre-emptive capture will approach fauna at slow speeds to ensure animals are not directed towards the oil and deterrence/hazing and pre-emptive capture will only be conducted if Woodside has licensed authority from DBCA and approval from the Incident Controller.

Shoreline access will be considered as part of the operational NEBA. Vehicular access would be restricted on dunes, turtle nesting beaches and in mangroves. Woodside retains specialist personnel to support and manage oiled wildlife operations, including trained and competent responders in Exmouth and Dampier. Additional personnel would be sourced through Woodside's arrangements to support an oiled wildlife response as required.

5.6.1 Response need based on predicted consequence parameters

The following statements identify the key parameters upon which a response need can be based:

- Modelling predicts the shortest time to shoreline contact at day 18 (Ningaloo Coast Middle WHA).
- The offshore location of the release site is expected to initially result in low numbers of at-risk or impacted wildlife.
- As the surface oil approaches shorelines, potential for oiled wildlife impacts are likely to increase.
- It is estimated that an oiled wildlife response would be between Level 1 and 2, as defined in the WA OWRP (Table 5-14).

Table 5-12: Key at-risk species potentially in Priority Protection Areas and open ocean

Species	Ningaloo Coast	Rankin Bank	Montebello MP	Kimberley Coast	Eighty Mile Beach
Marine turtles (including foraging and inter-nesting areas and significant nesting beaches)	✓		✓		✓
Whale sharks	✓				
Seabirds and/or migratory shorebirds	✓		✓	✓	✓
Cetaceans – migratory whales	✓			✓	✓
Cetaceans – dolphins and porpoises	✓		✓		
Dugongs	✓		✓	✓	✓

Sharks and rays	✓				✓

The oiled wildlife response technique targets key wildlife populations at risk within Commonwealth open waters and the nearshore waters as described in Section 4 of the EP. Responding to oiled wildlife consists of eight key stages, as described in Table 5-13 below.

Table 5-13: Oiled wildlife response stages

Stage	Description
Stage 1: Wildlife first strike response	Gather situational awareness including potential wildlife assets at risk.
Stage 2: Mobilisation of wildlife resources	Resources include personnel, equipment and facilities.
Stage 3: Wildlife reconnaissance	Reconnaissance to identify potentially affected animals.
Stage 4: IAP wildlife sub-plan development	The IAP includes the appropriate response options for oiled wildlife, including wildlife priorities for protection from oiling; deterrence measures (see below); and recovery and treatment of oiled wildlife; resourcing of equipment and personnel. It includes consideration of deterrence practices such as ‘hazing’ to prevent fauna from entering areas potentially contaminated by spilled hydrocarbons, as well as dispersing, displacing or relocating fauna to minimise/prevent contact and provide time for clean-up.
Stage 5: Wildlife rescue and staging	This includes the different roles of finding oiled wildlife, capturing wildlife, and holding and/or transportation of wildlife to oiled wildlife facilities.
Stage 6: Establishment of an oiled wildlife facility	Treatment facilities would be required for the first-aid, cleaning and rehabilitation of affected animals. A vessel-based ‘on-water’ facility would likely need to be established to enable stabilisation of oiled wildlife before transport to a suitable treatment facility. Suitable staging sites in the Dampier and Exmouth have been identified in the draft Regional OWROP, should a land-based site be required.
Stage 7: Wildlife rehabilitation	Considerations include a suitable rehabilitation centre and personnel, wildlife housing, record keeping and success tracking.
Stage 8: Oiled wildlife response termination	Once a decision has been made to terminate operations, the Incident Controller will stand down individual participating and supporting agencies.

Reconnaissance and primary response would be done during operational monitoring and surveillance activities. Where marine fauna are observed on water or transiting near or within the spill area, observations would be recorded through surveillance records. The shoreline assessments would be done in accordance with OM05, which would be used as a further tool to identify fauna and habitats contacted by hydrocarbons.

Staging sites would be established as forward bases for shoreline- or vessel-based field teams. Once recovered to a staging site, wildlife would be transported to the designated oiled wildlife facility or a temporary holding centre (before being transported to the oiled wildlife facility). Temporary holding centres are required when there is significant distance between a staging site and the oiled wildlife facility, to enable stabilisation of oiled animals. The oiled wildlife facility is the primary location where animals would be housed and treated. Sites proposed for staging a regional oiled wildlife response in Dampier and Exmouth have been identified.

To deploy a response that is appropriate to the nature and scale of the event, as well as scalable over time, Woodside would implement an oiled wildlife response in consultation with DBAC and use the capability outlined in the WA OWRP, with additional capability if required (e.g. volunteers) accessible through Woodside's *People & Global Capability Surge Labour Requirement Plan*.

The WA OWRP provides indicative oiled wildlife response levels (Table 5-14) and the resources likely to be needed at each increasing level of response.

Table 5-14: Indicative oiled wildlife response level (adapted from the WA OWRP, 2014)

OWR Level	Indicative personnel numbers	Indicative duration	Indicative number of birds (non-threatened species)	Indicative number of birds (threatened species)	Turtles (hatchlings, juveniles, adults)	Cetaceans	Pinnipeds	Dugongs
Level 1	6	<3 days	1–2/day <5 total	No complex birds	None	None	None	None
Level 2	26	4–14 days	1–5/day <20 total	No complex birds	<20 hatchlings No juv/adults	None	None	None
Level 3	59	4–14 days	5–10/day <50 total	1–5/day <10 total	<5 juv/adults <50 hatchlings	None	<5	None
Level 4	77	>14 days	5–10/day <200 total	5–10/day	<20 juv/adults <500 hatchlings	<5, or known habitats affected	5–50	Habitat affected only
Level 5	116	>14 days	10–100/ day >200 total	10–50/day	>20 juv/adults >500 hatchlings	>5 dolphins	>50	Dugongs oiled
Level 6	122	>14 days	>100/day	10–50/day	>20 juv/adults >500 hatchlings	>5 dolphins	>50	Dugongs oiled

5.6.2 Environmental performance based on need

Table 5-15: Environmental Performance – Oiled Wildlife Response

Environmental Performance Outcome		Oiled Wildlife Response is conducted in accordance with the Western Australian Oiled Wildlife Response Plan (WAOWRP) to ensure it is conducted in accordance with legislative requirements to house, release or euthanise fauna under the Animal Welfare Act 2002.		
Control measure		**Performance Standard**		**Measurement Criteria (Section 5.9)**
19	Wildlife response equipment	19.1	Contracted capability to treat 100 individual fauna for immediate mobilisation to Response Priority Areas (RPAs).	1, 3A, 3B, 3C, 4
		19.2	Contracted capability to treat up to an additional 250 individual fauna within a five-day period.	
		19.3	National plan access to additional resources under the guidance of the DoT (up to a Level 5 oiled wildlife response as specified in the OWRP), with the ability to treat about 600 individual fauna by the time hydrocarbons contact the shoreline.	1, 3C, 4
		19.4	Vessels used in hazing/pre-emptive capture will approach fauna at slow speeds to ensure animals are not directed towards the hydrocarbons.	1, 3A, 3B, 4
		19.5	Facilities for the rehabilitation of oiled wildlife are operational 24/7 as per WAOWRP.	1, 3A, 4
20	Wildlife responders	20.1	2 wildlife divisional commanders to lead the oiled wildlife operations who have completed an Oiled Wildlife Response Management course.	1, 2, 3B
		20.2	Wildlife responders to be accessed through resource pool and additional agreements with specialist providers.	1, 2, 3A, 3B, 3C, 4
		20.3	Oiled wildlife operations (including hazing) would be implemented with advice and assistance from the Oiled Wildlife Advisor from the DBCA, and in accordance with the processes and methodologies described in the WA OWRP and the relevant regional plan.	1
		20.4	Open communication line to be maintained between IMT and infield operations to ensure awareness of progress against plan(s).	1, 3A, 3B

The resulting wildlife response capability has been assessed against the WCCS. The range of techniques provide an ongoing approach to response at identified RPAs.

Under optimal conditions, during the subsea or surface release the capability available meets the need identified. It indicates that, the wildlife response capability has the following expected performance:

- Mobilisation and deployment of approximately 1 wildlife collection team by Week 3 at Ningaloo Coast Middle WHA RPA.
- Mobilisation and deployment of approx. 1 wildlife collection team by Week 9 at Kimberley Coast RPA (Eighty Mile Beach).
- Mobilisation and deployment of up to 2 central wildlife treatment and rehabilitation locations at Exmouth and Dampier in accordance with WA OWRP, if required.

Wildlife collection operations would be expected to be completed by the third month based on the potential shoreline impacts predicted. Additional capability could be deployed but given modelling predicts that impacts will desist after the third month, additional personnel are unlikely to increase the net environmental benefit and this capability meets the need.

Woodside would establish a wildlife collection point at the RPA for identified oiled wildlife collection and sorting. From these locations, recovered wildlife would be transported to a central treatment location at Dampier or Exmouth.

5.7 Scientific monitoring

A scientific monitoring program (SMP) would be activated following a Level 2 or 3 unplanned hydrocarbon release, or any release event with the potential to contact sensitive environmental receptors. This would consider receptors at risk (ecological and socio-economic) for the entire predicted Environment that May Be Affected (EMBA) and in particular, any identified Pre-emptive Baseline Areas (PBAs) for the worst-case credible spill scenario(s) or other identified unplanned hydrocarbon releases associated with the operational activities (refer to Table 2-1: Petroleum Activities Program credible spill scenarios).

The outputs of the stochastic hydrocarbon spill modelling are used to assess the environmental risk, in terms of delineating which areas of the marine environment are predicted to be exposed to hydrocarbons exceeding environmental threshold concentrations and MEE-01 and MEE-05 (refer to Table 2-2, Section 2.3.1.1, see Section 6 of the EP for further information on applicable thresholds and Table 2-1). The summary of all the locations where hydrocarbon thresholds could be exceeded by any of the simulations modelled is defined as EMBA. It should be noted that the resulting SMP receptor locations differ from the Response Protection Areas (RPAs) presented and discussed in Section 3 of this document due to the applicability of different hydrocarbon threshold levels.

The SMP would be informed by the data collected via the operational monitoring program (OMP) studies, however, it differs from the OMP in being a long-term program independent of, and not directing, the operational oil spill response or monitoring of impacts from response activities (refer to ANNEX B: Operational Monitoring Activation and Termination Criteria for operational monitoring overview).

Key objectives of the Woodside oil spill SMP are:

- Assess the extent, severity and persistence of the environmental impacts from the spill event; and
- Monitor subsequent recovery of impacted key species, habitats and ecosystems.

The SMP comprises ten targeted environmental monitoring programs to assess the condition of a range of physical-chemical (water and sediment) and biological (species and habitats) receptors including EPBC Act listed species, environmental values associated with protected areas and socio-economic values, such as fisheries. The ten SMPs are as follows:

- SM01 – Assessment of the presence, quantity and character of hydrocarbons in marine waters (linked to OM01 to OM03)
- SM02 – Assessment of the presence, quantity and character of hydrocarbons in marine sediments (linked to OM01 and OM05)
- SM03 – Assessment of impacts and recovery of subtidal and intertidal benthos
- SM04 – Assessment of impacts and recovery of mangroves/saltmarsh habitat
- SM05 – Assessment of impacts and recovery of seabird and shorebird populations
- SM06 – Assessment of impacts and recovery of nesting marine turtle populations
- SM07 – Assessment of impacts to pinniped colonies including haul-out site populations
- SM08 – Desktop assessment of impacts to other non-avian marine megafauna
- SM09 – Assessment of impacts and recovery of marine fish (linked to SM03)
- SM10 – Assessment of physiological impacts to important fish and shellfish species (fish health and seafood quality/safety) and recovery.

5.7.1 Scientific Monitoring Deployment Considerations

Scientific Monitoring Deployment Considerations	
Existing baseline studies for sensitive receptor locations predicted to be affected by a spill	Pre-emptive Baseline Areas (PBAs) of the following two categories: • PBAs within the predicted <10-day hydrocarbon contact time prediction: The approach is to conduct a desktop review of available and appropriate baseline data for key receptors for locations (if any) that are potentially impacted within 10 days of a spill and look to conduct baseline data collection to address data gaps and demonstrate spill response preparedness. Planning for baseline data acquisition is typically commenced pre-PAP and execution of studies undertaken with consideration of weather, receptor type, seasonality and temporal assessment requirements. • PBAs >10 days' time to predicted hydrocarbon contact in the event of an unplanned hydrocarbon release (from the facility operational activities). SMP activation (as per the Julimar Phase 2 Drilling and Subsea Installation First Strike Response Plan) directs the SMP team to follow the steps outlined in the SMP Operational Plan. The steps include: checking the availability and type of existing baseline data, with particular reference to any Pre-emptive Baseline Areas (PBAs) identified as >10 days to hydrocarbon contact. Such information is used to identify response phase PBAs and plan for the activation of SMPs for pre-emptive (i.e. pre-hydrocarbon contact) baseline assessment.
Pre-emptive Baseline in the event of a spill	Activation of SMPs in order to collect baseline data at sensitive receptor locations with predicted hydrocarbon contact time >10 days (as documented in ANNEX C: Oil Spill Scientific monitoring Program).
Survey platform suitability and availability	In the event of the SMP activation, suitable survey platforms are available and can support the range of equipment and data collection methodologies to be implemented in nearshore and offshore marine environments.
Trained personnel to implement SMPs suitable and available.	Access to trained personnel and the sampling equipment contracted for scientific monitoring via a dedicated scientific monitoring program standby contract.
Met-ocean conditions	The following met-ocean conditions have been identified to implement SMPs: • Waves <1 m for nearshore systems • Waves <1.5 m for offshore systems • Winds <20 knots • Daylight operations only SMP implementation will be planned and managed according to HSE risk reviews and the met-ocean conditions on a day to day basis by SMP operations.

5.7.2 Response planning assumptions

Response Planning Assumptions	
Pre-emptive Baseline Areas (PBAs)	Pre-emptive Baseline Areas (PBAs) identified through the application of defined hydrocarbon impact thresholds during the Quantitative Spill Risk Assessment process and a consideration of the minimum time to contact at receptor locations fall into two categories: • PBAs for which baseline data are planned for and data collection may commence pre-PAP (≤ 10 days minimum time to contact), where identified as a gap. • PBAs (> 10 days minimum time to contact) for which baseline data may be collected in the event of an unplanned hydrocarbon release. Response phase PBAs are prioritised for SMP activities due to vulnerability (i.e. time to contact and environmental sensitivity) to potential impacts from hydrocarbon contact and an identified need to acquire baseline data. Time to hydrocarbon contact of >10 days has been identified as a minimum timeframe within which it is feasible to plan and mobilise applicable SMPs and commence collection of baseline

	(pre-hydrocarbon contact) data, in the event of an unplanned hydrocarbon release from the Julimar Phase 2 Drilling and Subsea Installation. Pre-emptive Baseline Areas for the Julimar Phase 2 Drilling and Subsea Installation are identified and listed in ANNEX D: Monitoring Program and Baseline Studies for the Petroleum Activities Program, Table D-1. The PBAs together with the situational awareness (from the operational monitoring) are the basis for the response phase SMP planning and implementation.
Pre-Spill	A review of existing baseline data for receptor locations with potential to be contacted by floating or entrained hydrocarbons at environmental thresholds within ≤10 days has identified the following: • Ningaloo Coast (including WHA and State Marine Park) • Montebello State Marine Park • Rankin Bank* • Pilbara Islands – Southern Island Group (Serrurier, Thevenard and Bessieres Islands – State Nature reserves) *Floating oil will not accumulate on submerged features and at open ocean locations, therefore, no surface contact is possible with only entrained contacted predicted at these location within ≤10 days. Australian Marine Parks potentially affected includes: • Montebello AMP* • Ningaloo AMP* • Gascoyne AMP* These AMPs are located in offshore waters where hydrocarbon exposure is possible on surface waters and upper surface layers of the water column. Seabed habitats and benthic communities will not be affected and SMP activities in the response phase will focus on coastal receptor sensitive locations.
In the Event of a Spill	Locations with >10 days to hydrocarbon contact, as well as the wider area, will be investigated and identified by the SMP team (in the Environment Unit of the ICC) as the spill event unfolds and as the situational awareness provided by the OMPs permits delineation of the spill affected area (for example, updates to the spill trajectory tracking). The full list is presented in ANNEX D: Monitoring Program and Baseline Studies for the Petroleum Activities Program, based on the PAP credible spill scenario(s) (Table 2-1). To address the initial focus in a response phase SMP planning situation, receptor locations predicted to be contacted between >10 days and 20 days have been identified as follows: • Muiron Islands (WHA, State Marine Park) (13 days to hydrocarbon contact) • Barrow Island (including State Nature Reserves, State Marine Park and Marine Management Area) (approximately 13 days to hydrocarbon contact) • Montebello Islands (approximately 17 days to hydrocarbon contact) • Lowendal Islands (including State Nature Reserves) (approximately 28 days to hydrocarbon contact) * The unfolding spill affected area predictions and confirmation of appropriate baseline data will determine the selection of receptor locations and SMPs to be activated in order to gather pre-emptive (pre-hydrocarbon contact) data. The timing of SMP activation and mobilisation of the individual SMPs to undertake data collection will be decided and documented by the Woodside SMP team following the process outlined in the SMP Operational Plan. In the event key receptors within geographic locations that are potentially impacted after 10 days following a spill event or commencement of the spill and where adequate and appropriate baseline data are not available, there will be a response phase effort to collect baseline data for the following purposes: i. Priority will be given to the collection of baseline data for receptors predicted to be within the spill affected area prior to hydrocarbon contact. The process is initiated with the investigation of available baseline and time to hydrocarbon contact (>10 days which is sufficient time to mobilise SMP teams and acquire data before hydrocarbon contact). With reference to the Julimar Phase 2 Drilling and Subsea Installation facility, priority would be focused on the Muiron Islands (WHA, State Marine Park).

	ii. Collect baseline data for receptors predicted to be outside the spill affected area so reference datasets for comparative analysis with impacted receptor types can be assessed post-spill. * Note - ≥10 day threshold is specifically applicable to Barrow Island and Montebello Islands; however, the Lowendal Islands are being included as a precautionary approach, given the spill modelling does not encompass the complex hydrographic processes for these islands groups.
Baseline Data	A summary of the spill affected area and receptor locations as defined by the EMBA for the PAP worst case credible spill scenario(s), is presented in the Julimar Drilling and Subsea Installation EP (Section 6). The key receptors at risk by location and corresponding SMPs based on the EMBA for the PAP are presented in ANNEX D: Monitoring Program and Baseline Studies for the Petroleum Activities Program, as per the PAP worst credible spill scenario(s). This matrix maps the receptors at risk with their location and the applicable SMPs that may be triggered in the event of a Level 2 or 3 hydrocarbon release, or any release event with the potential to contact sensitive environmental receptors. Receptor locations and applicable SMPs are colour coded to highlight possible time to contact based on receptor locations identified as PBAs. The status of baseline studies relevant to the PAP are tracked by Woodside through the maintenance of a Corporate Environment Environmental Baseline Database (managed by the Woodside Environmental Science team), as well as accessing external databases such as I-GEM (Industry-Government Environmental Metadata database) (refer to ANNEX C: Oil Spill Scientific monitoring Program).

5.7.3 Summary – scientific monitoring

The resulting scientific monitoring capability has been assessed against the PAP worst case credible spill scenario. The range of techniques provide an ongoing approach to monitoring operations to assess and evaluate the scale and extent of impacts. All known reasonably practicable control measures have been adopted with the cost and organisational complexity of these options determined to be moderate and the overall delivery effectiveness determined to be medium. The SMP's main objectives can be met, with no additional, alternative or improved control measures providing further benefit.

5.7.4 Response planning: need, capability and gap – scientific monitoring

The receptor locations identified in ANNEX D: Monitoring Program and Baseline Studies for the Petroleum Activities Program provide the basis of the SMPs likely to be selected and activated. Once the Woodside SMP Delivery team and Standby SMP contractor have been stood up and the exact nature and scale of the spill becomes known, the SMPs to be activated will be confirmed as per the process set out in the SMP Operational Plan.

<u>Scope of SMP Operations in the event of a hydrocarbon spill:</u>

Receptor locations of interest for the SMP during the response phase are:

- Ningaloo Coast
- Muiron Islands (WHA, State Marine Park) (13 days to hydrocarbon contact)
- Montebello Islands (including State Marine Park)
- Barrow Island (including State Nature Reserves, State Marine Park and Marine Management Area) (approximately 13 to hydrocarbon contact)
- Lowendal Islands (including State Nature Reserves) (approximately 28 to hydrocarbon contact)

Documented baseline studies are available for certain sensitive receptor locations including the Ningaloo coast, Muiron Islands, Montebello Islands, Barrow Island, Lowendal Island, Rankin Bank and the southern Pilbara Islands (ANNEX D: Monitoring Program and Baseline Studies for the Petroleum Activities Program, Table D-2). The SMP technique, however, would be to deploy SMP teams to maximise the opportunity to collect pre-emptive data at sensitive receptor locations as Ningaloo Coastline (North and Middle), Muiron Islands and nearshore habitats of Montebello, Barrow and Lowendal Island groups. As the exact locations where hydrocarbon contact occurs may be unpredictable, SM01 would be mobilised as a priority to be able to detect hydrocarbons and track the leading edge of the spill to verify where hydrocarbon contact occurs which will assist with where SMP resources are a priority need to obtain pre-emptive baseline data.

The option analysis in Section 6.7 considers ways to reduce the gap by considering alternate, additional, and/or improved control measures on each selected response technique.

5.7.5 Environmental performance based on need

Table 5-16: Scientific monitoring

Environmental Performance Outcome		Woodside can demonstrate preparedness to stand up the SMP to quantitatively assess and report on the extent, severity, persistence and recovery of sensitive receptors impacted from the spill event.		
Control measure		**Performance Standard**		**Measurement Criteria**
21	• Woodside has an established and dedicated SMP team comprising the Environmental Science Team and additional Environment Advisers within the HSEQ Function.	21.1	SMP team comprises a pool of competent Environment Advisers (stand up personnel) who receive training regarding the SMP, SMP activation and implementation of the SMP on an annual basis.	• Training materials • Training attendance registers • Process that maps minimum qualification and experience with key SMP role competency and a tracker to manage availability of competent people for the SMP team including redundancy and rostering
22	• Woodside have contracted SMP standby contractor to provide scientific personnel to resource a base capability of one team per SMP (SM01-SM10, see ANNEX C: Oil Spill Scientific monitoring Program Table C-2) as detailed in Woodside's SMP standby contractor Implementation Plan, to implement the oil spill scientific monitoring programs. The availability of relevant personnel is reported to Woodside on a monthly basis via a simple report on the base-loading availability of people for each of the SMPs comprising field work for data collection (SMP resourcing report register). • In the event of a spill and the SMP is activated, the base-loading availability of scientific personnel will be provided by SMP standby contractor for the individual SMPs and where gaps in resources are identified, SMP standby contractor /Woodside will seek additional personnel (if needed) from other sources including Woodside's Environmental Services Panel.	22.1	Woodside maintains the capability to mobilise personnel required to conduct scientific monitoring programs SM01 – SM10 (except desktop based SM08): • Personnel are sourced through the existing standby contract with SMP standby contractor, as detailed within the SMP Implementation Plan. • Scientific Monitoring Program Implementation Plan describes the process for standing up and implementing the scientific monitoring programs. • SMP team stand up personnel receive training regarding the stand up, activation and implementation of the SMP on an annual basis.	• OSPU Internal Control Environment tracks the quarterly review of the Oil Spill Contracts Master • SMP resource report of personnel availability provided by SMP contractor on monthly basis (SMP resourcing report register) • Training materials • Training attendance registers • Competency criteria for SMP roles • SMP annual arrangement testing and reporting
23	• Roles and responsibilities for SMP implementation are captured in Table C-1 (ANNEX C: Oil Spill Scientific monitoring Program) and the SMP team (as per the organisational structure of the ICC) is outlined in SMP Operational Plan. Woodside has a defined Crisis and Incident Management structure including Source Control, Operations, Planning and Logistics functions to manage a loss of well containment response. • SMP Team structure, interface with SMP standby contractor and linkage to the ICC is presented in Figure C-1, ANNEX C: Oil Spill Scientific monitoring Program. • Woodside has a defined Command, Control and Coordination structure for Incident and Emergency Management that is based on the AIIMS framework utilised in Australia. • Woodside utilises an online Incident Management Information System (IMIS) to coordinate and track key incident management functions. This includes specialist modelling programs, geographic information systems (GIS), as well as communication flows within the Command, Control and Coordination structure. • SMP activated via the First Strike Plan. • Step by step process to activation of individual SMPs provided in the SMP Operational Plan. • All decisions made regarding SMP logged in the online IMIS (SMP team members trained in using Woodside's online Incident Management System). • SMP component input to the ICC Incident Action Plan (IAP) as per the identified ICC timed sessions and the SMP IAP logged on the online IMIS. • Woodside Environmental Science Team provide awareness training on the activation and standup of the Scientific Monitoring Programme (SMP) for the Environment Advisers in Woodside who are listed on the SMP team on an annual basis. • Woodside Environmental Science Team provide awareness training on the activation and standup of the Scientific Monitoring Programme (SMP) for the SMP Standby provider. • Woodside Environmental Science Team co-ordinates an annual SMP arrangement testing exercise which the Standby SMP standby contractor SMP team participates in since 2016 (report on 2016 SMP simulation) and Standby SMP contractor SMP arrangements (people and equipment availability) tested annually since 2016.	23.1	• Woodside have established an SMP organisational structure and processes to stand up and deliver the SMP.	• SMP Oil Spill Scientific Monitoring Operational Plan • SMP Implementation Plan • SMP annual arrangement testing and reporting

24	• Chartered and mutual aid vessels. • Suitable vessels would be secured from the Woodside support vessels, regional fleet of vessels operated by Woodside and other operators and the regional charter market. • Vessel suitability will be guided by the need to be equipped to operate grab samplers, drop camera systems and water sampling equipment (the individual vessel requirements are outlined in the relevant SMP methodologies (refer to Table C-2, ANNEX C: Oil Spill Scientific monitoring Program)). • Nearshore mainland waters could use the same approach as for open water. Smaller vessels may be used where available and appropriate. Suitable vehicles and machinery for onshore access to nearshore SMP locations would be provided by Woodside's transport services contract and sourced from the wider market. • Dedicated survey equipment requirements for scientific monitoring range from remote towed video and drop camera systems to capture seabed images of benthic communities to intertidal/onshore surveying tools such as quadrats, theodolites and spades/trowels, cameras and binoculars (specific survey equipment requirements are outlined in the relevant SMP methodologies (refer to Table C-2, ANNEX C: Oil Spill Scientific monitoring Program)). Equipment would be sourced through the existing SMP standby contract with Standby SMP contractor for SMP resources and if additional surge capacity is required this would be available through the other Woodside Environmental Services Panel Contractors and specialist contractors. Standby SMP contractor can also address equipment redundancy through either individual or multiple suppliers. MoUs are in place with one marine sampling equipment companies and one analytical laboratory (SMP resourcing report register). • Availability of SMP equipment for offshore/onshore scientific monitoring team mobilisation is within one week to ten days of the commencement of a hydrocarbon release. This meets the SMP mobilisation lead time that will support meeting the response objective of 'acquire, where practicable, the environmental baseline data prior to hydrocarbon contact required to support the post-response SMP.	24.1	Woodside maintains standby SMP capability to mobilise equipment required to conduct scientific monitoring programs SM01 – SM10 (except desktop based SM08): • Equipment are sourced through the existing standby contract with Standby SMP standby contractor, as detailed within the SMP Implementation Plan.	• OSPU Internal Control Environment tracks the quarterly review of the Oil Spill Contracts Master. • SMP standby monthly resource reports of equipment availability provided by SMP contractor (SMP resourcing report register). • SMP annual arrangement testing and reporting.
25	Woodside's SMP approach addresses the pre-PAP acquisition of baseline data for Pre-emptive Baseline Areas (PBAs) with ≤10 days if required following a baseline gap analysis process. Woodside maintains knowledge of Environmental Baseline data through: • Documentation annual reviews of the Woodside Baseline Environmental Studies Database, and specific activity baseline gap analyses. • Industry IGEM Baseline Studies Database: http://www.igem.com.au/landing/ (Note – the IGEM password is documented in the SMP Operational Plan).	25.1	• Annual reviews of environmental baseline data. • PAP specific Pre-emptive Baseline Area baseline gap analysis.	• Annual review/update of Woodside Baseline Environmental Studies Database • Desktop review to assess the environmental baseline study gaps completed prior to EP submission • Accessing baseline knowledge via the SMP annual arrangement testing

Environmental Performance Outcome		SMP plan to acquire response phase monitoring targeting pre-emptive data achieved.		
Control measure		**Performance Standard**		**Measurement Criteria**
26	Woodside's SMP approach addresses: • Scientific data acquisition for PBAs >10 days to hydrocarbon contact and activated in the response phase; and • Transition into post-response SMP monitoring.	26.1	**Pre-emptive Baseline Area (PBA) baseline data acquisition in the response phase** If baseline data gaps are identified for PBAs that has predicted hydrocarbon contact (contact time >10 days), there will be a response phase effort to collect baseline data with priority in implementing SMPs given to receptors where pre-emptive baseline data can be acquired or improved. SMP team (within the Environment Unit of the ICC) contribute the SMP component of the ICC Planning Function in development of the IAP.	• Response SMP plan • Woodside's online Incident Management System Records • SMP component of the Incident Action Plan
		26.2	**Post Spill contact** For the receptors contacted by the spill in where baseline data are available, SMPs programs to assess and monitor receptor condition will be implemented post spill (i.e. after the response phase).	• SMP planning document • SMP Decision Log • Incident Action Plans (IAPs)

Environmental Performance Outcome		Implementation of the SMP (response and post-response phases).		
Control measure		**Performance Standard**		**Measurement Criteria**
27	• Scientific monitoring will address quantitative assessment of environmental impacts of a level 2 or 3 spill or any release event with the potential to contact sensitive environmental receptors. The SMP comprises ten targeted environmental monitoring programs. • SMP supporting documentation: 1. Oil Spill Scientific Monitoring Operational Plan; (2) SMP Implementation Plan and (3) SMP Process and Methodologies Guideline. • The Oil Spill Scientific Monitoring Operational Plan details the process of SMP selection, input to the IAP to trigger operational logistic support services. Methodology documents for each of the ten SMPs are accessible detailing equipment, data collection techniques and the specifications required for the survey platform support. • The SMP standby contractor holds a Woodside SMP implementation plan detailing activation processes, linkage with the Woodside SMP team and the general principles for the planning and mobilisation of SMPs to deliver the individual SMPs activated. Monthly resourcing report are issued by the SMP standby contractor (SMP resourcing report register). All SMP documents and their status are tracked via SMP document register.	27.1	**Implementation of SM01** SM01 will be implemented to assess the presence, quantity and character of hydrocarbons in marine waters during the spill event in nearshore areas.	Evidence SM01 has been triggered: • Documentation as per requirements of the SMP Operational Plan • Woodside's online Incident Management System Records • SMP component of the IAP • SMP data records from field
		27.2	**Implementation of SM02-SM10** SM02-SM10 will be implemented in accordance with the objectives and activation triggers (As per Table C-2 of ANNEX C: Oil Spill Scientific monitoring Program).	Evidence SMPs have been triggered: • Documentation as per requirements of the SMP Operational Plan • Woodside's online Incident Management System Records • SMP component of the IAP • SMP Data records from field
		27.3	**Termination of SMP plans** The Scientific Monitoring Program will be terminated in accordance with termination triggers for the SMP's detailed in Table C-2 of ANNEX C: Oil Spill Scientific monitoring Program and the Termination Criteria Decision-tree for Oil Spill Environmental Monitoring (Figure C-3 of ANNEX C: Oil Spill Scientific monitoring Program).	Evidence of Termination Criteria triggered: • Documentation and approval by relevant stakeholders to end SMPs for specific receptor types.

5.8 Incident Management System

The Incident Management System is both a control measure and a measurement criteria. As a control measure the IMS function is to prompt, facilitate and record the completion of three key response planning processes detailed below. As a measurement criteria, the IMS records the evidence of the timeliness of all response actions included in the environmental performance standards and the plans used of the PAP.

As the IMS does not directly remove hydrocarbons spilt into the marine environment there is no direct relationship to the response planning need.

5.8.1 Incident action planning

The ICC will be required to collect and interpret information from the scene of the incident to determine support requirements to the site-based IMT, develop an incident action plan (IAP) and assist the IMT with the execution of that plan. The site-based IC may request the ICC to complete notifications internally within Woodside, to stakeholders and government agencies as required. Depending on the type and scale of the incident either the ICC DM or IC will be responsible for ensuring the development of the IAP. Incident Action Planning is an ongoing process that involves continual review to ensure techniques to control the incident are appropriate to the situation at the time.

5.8.2 Operational NEBA process

In the event of a response Woodside will confirm that the response techniques adopted at the time of Environment Plan/Oil Pollution Emergency Plan (EP/OPEP) acceptance remain appropriate to reduce the consequences of the spill. This process verifies that there is a continuing net environmental benefit associated with continuing the response technique through the operational NEBA process. This process manages the environmental risks and impacts of response techniques during the spill response, an operational NEBA will be undertaken throughout the response, for each operational period.

The operational NEBA will consider the risks and benefits of conducting and response activity. For example, if vessels are required for access to nearshore or onshore areas, anchoring locations will be selected to minimise disturbance to benthic habitats. Vessel cleanliness would be commensurate with the receiving environment. The operational NEBA will consider the risks and benefits of conducting other response techniques.

The operational NEBA process is also used to terminate a response. Using data from operational and scientific monitoring activities the response to a hydrocarbon spill will be terminated in accordance with the termination process outlined in the Oil Pollution Emergency Arrangements (Australia). In effect the operational NEBA will determine whether there is net environmental benefit to continue response operations.

5.8.3 Stakeholder engagement process

Woodside will ensure stakeholders are engaged during the spill response in accordance with internal standards. This process requires that Woodside will:

- Undertake all required notifications (including government notifications) for stakeholders in the region (identified in the First-Strike Response Plan). This includes notification to mariners to communicate navigational hazards introduced through response equipment and personnel.
- In the event of a response, identify and engage with relevant stakeholders and continually assess and review.

5.8.4 Environmental performance based on need

Table 5-17: Environmental Performance – Incident Management System

Environmental Performance Outcome		To support the effectiveness of all other control measures and monitor/record the performance levels achieved.		
Control measure		**Performance Standard**		**Measurement Criteria (Section 5.9)**
28	Operational SIMA	28.1	Confirm that the response strategies adopted at the time of acceptance remain appropriate to reduce the consequences of the spill within 24 hours.	1, 3A
		28.2	Record the evidence and justification for any deviation from the planned response activities.	
		28.3	Record the information and data from operational and scientific monitoring activities used to inform the SIMA.	
29	Stakeholder engagement	29.1	Prompt and record all notifications (including government notifications) for stakeholders in the region are made.	
		29.2	In the event of a response, identification of relevant stakeholders will be re-assessed throughout the response period.	
		29.3	Undertake communications in accordance with: 1) Woodside Crisis Management Functional Support Team Guideline – Reputation 2) External Communication Operating Standard External Stakeholder Engagement Operating Standard	
30	Personnel required to support any response	30.1	Action planning is an ongoing process that involves continual review to ensure strategies to control the incident are appropriate to the situation at the time.	1, 3B
		30.2	A duty roster of trained and competent people will be maintained to ensure that minimum manning requirements are met all year round.	3C
		30.3	Immediately activate the IMT with personnel filling one or more of the following roles: • Operations Duty Manager; • D&C Duty Manager; • Operations Coordinator; • Deputy Operations Coordinator; • Planning Coordinator; • Logistics (materials, aviation, marine and support positions); • Management Support; • Health and Safety Advisor; • Environment duty Manager; • People Coordinator; • Public Information Coordinator; • Intelligence Coordinator; and • Finance Coordinator.	1, 2, 3B, 3C, 4
		30.4	Collect and interpret information from the scene of the incident to determine support requirements to the site-based IMT, develop an Incident Action Plan (IAP) and assist with the execution of that plan.	
		30.5	S&EM advisors will be integrated into ICC to monitor performance of all functional roles.	
		30.6	Continually communicate the status of the spill and support Woodside to determine the most appropriate response by delivering on the responsibilities of their role.	
		30.7	Follow the OPEA, Operational Plans, FSRPs, support plans and the IAPs developed.	1, 2, 3A, 4

		30.8	Contribute to Woodside's response in accordance with the aims and objectives set by the Duty Manager.	1, 2, 3B, 3C, 4

5.9 Measurement criteria for all response techniques

Woodside ensures compliance with environmental performance outcomes and standards through four primary mechanisms. The performance tables aforementioned identify which of these four mechanisms monitors the readiness, and records the effectiveness and performance of the control measures adopted.

1. The Incident Management System

The Incident Management System (IMS) supports the implementation of the Emergency & Crisis Management Procedure. The IMS provides a near real-time, single source of information for monitoring and recording an incident and measuring the performance of those control measures.

The Emergency & Crisis Management Procedure defines the management framework, including roles and responsibilities, to be applied to any size incident (including hydrocarbon spills). The organisational structure required to manage an incident is developed in a modular fashion and is based on the specific requirements of each incident. The structure can be scaled up or down.

The Incident Action Plan (IAP) process formally documents and communicates the:

- Incident objectives;
- Status of assets;
- Operational period objectives;
- Response techniques (defined during response planning); and
- The effectiveness of response techniques.

The information captured in the IMS (including information from personal logs and assigned tasks/close outs) confirms the response techniques implemented remain appropriate to reduce the consequences of the spill. The system also records all information and data that can be used to support the site-based IMT, development and the execution of the IAP.

2. The S&EM Competency Dashboard

The S&EM Competency Dashboard (Dashboard) records the number of trained and competent responders that are available across Woodside, and some external providers, to participate in a response.

This number varies dependent on expiry of competency certificates, staff attrition, internal rotations, leave and other absences. As such the Dashboard is designed to identify the minimum manning requirements and to identify sufficient redundancy to cater for the variances listed above.

Figure 5-1 shows the minimum manning numbers for the different hydrocarbon spill response roles and the number of qualified persons against those roles.

Woodside's pool of trained responders is composed of, but not limited to, personnel from the following organisations:

- Woodside internal
- Australian Marine Oil Spill Centre (AMOSC) core group
- AMOSC
- Oil Spill Response Limited (OSRL)
- Marine Spill Response Corporation (MSRC)
- AMSA
- Woodside contracted workforce

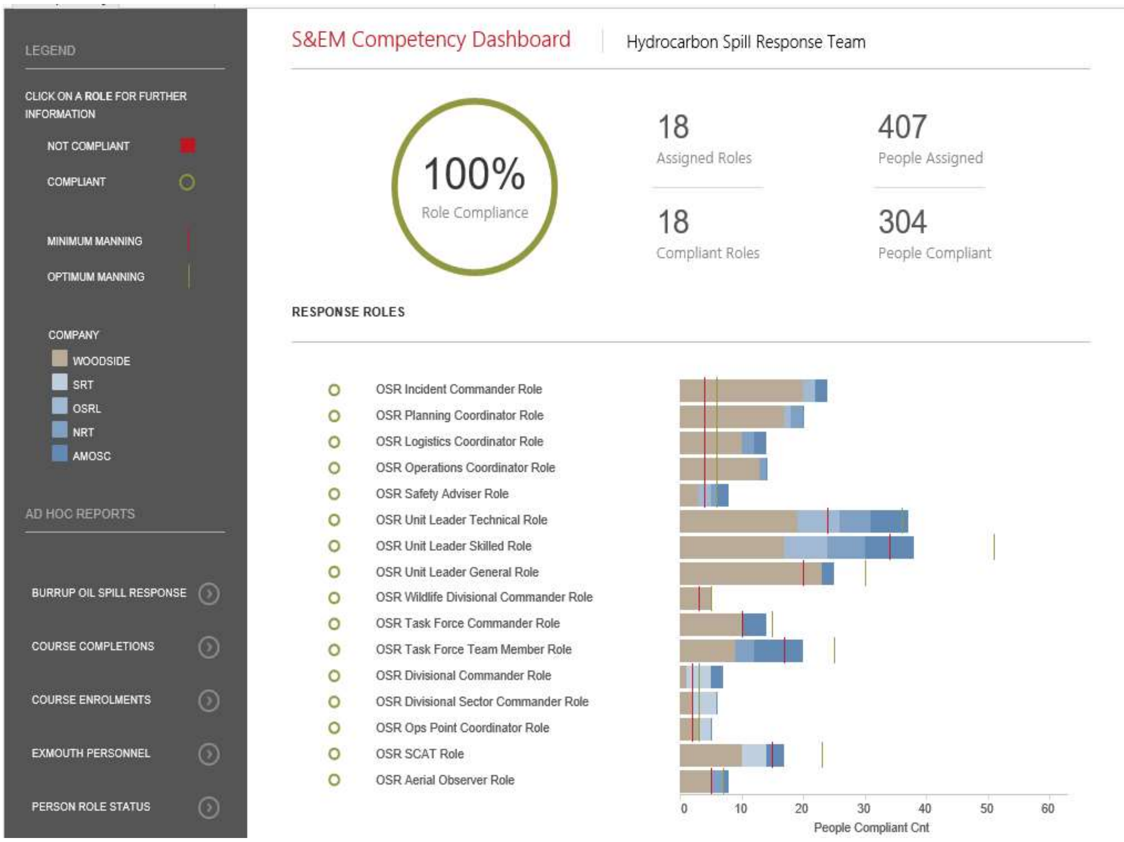

Figure 5-1: Example screenshot of the Hydrocarbon Spill Preparedness (HSP) competency dashboard

The Dashboard is one of Woodside's key means of monitoring its readiness to respond. It also shows that Woodside can meet the requirements of the environmental performance standard that relate to filling certain response roles.

Figure 5-2 shows deeper dive into the Operations Point Coordinator role and the training modules required to show competence.

Figure 5-2: Example screenshot for the Operations Point Coordinator role

3. The Hydrocarbon Spill Preparedness ICE Assurance Process

The Hydrocarbon Spill Response Team has developed a Hydrocarbon Spill Preparedness and Response Internal Control Environment (ICE) process to align and feed into the Woodside Management System Assurance process for hydrocarbon spill. The process tracks compliance over four key control areas:

a) **Plans** – Ensures all plans (including: Oil Pollution Emergency Arrangements, first strike response
plans, operational plans, support plans and tactical response plans) are current and in line with regulatory and internal requirements.

b) **Competency** – Ensures the competency dashboard is up to date and there are the minimum competency numbers across ICC, CMT and hydrocarbon spill response roles. The hydrocarbon spill training plan and exercise schedule, including testing of arrangements is also tracked. The Testing of Arrangements (TOA) register tracks the testing of all hydrocarbon spill response arrangements, key contracts and agreements in place with internal and external parties to ensure compliance.

c) **Capability** – Tracks and monitors capability that could be required in a hydrocarbon incident, including but not limited to: integrated fleet4 vessel schedule, dispersant availability, rig/vessels monitoring, equipment stockpiles, tracking buoy locations and the CICC duty roster.

d) **Compliance & Assurance** – Ensures all regulator inspection outcomes are actioned and closed out, the global legislation register is up to date and that the key assurance components are tracked and managed. Assurance activities (including Audits) conducted on memberships with key Oil Spill Response Organisations (OSROs) including AMOSC and OSRL are also tracked and recorded in the ICE.

The ICE assurance process records how each commitment listed in the performance tables above is managed to ensure ongoing compliance monitoring. The level of compliance can be reviewed in real time and is reported on a monthly basis through the S&EM Function.
The completion of the assurance checks (over and above the ICE process) is also applied via the Woodside Integrated Risk & Compliance System (WiRCs) and subject to the requirements of Woodside's Provide Assurance Procedure.

4. The Hydrocarbon Spill Preparedness and Response Procedure

This procedure sets out how to plan and prepare for a liquid hydrocarbon spill to the marine environment (Note, this procedure does not apply to scenarios relating to gas releases in the marine environment).

This procedure details the:

- Requirement for an Oil Pollution Emergency Plan (OPEP) to be developed, maintained, reviewed, and approved by appropriate regulators (where applicable) including:
  - Defining how spill scenarios are developed on an activity specific basis;
  - Developing and maintaining all hydrocarbon spill related plans;
  - Ensuring the ongoing maintenance of training and competency for personnel;
  - Developing the testing of spill response arrangements; and
  - Maintaining access to identified equipment and personnel.
- Planning for hydrocarbon spill response preparedness
- Accountabilities for hydrocarbon spill response preparedness
- Spill training requirements
- Requirements for spill exercising / testing of spill response arrangements
- Spill equipment and services requirements.

The procedure also details the roles and responsibilities of the dedicated Woodside Hydrocarbon Spill Preparedness team. This team is responsible for:

- Assuring that Woodside hydrocarbon spill responders meet competency requirements
- Establishing the competency requirements, annual training schedule and a training register of trained personnel

- Establishing and maintaining the total numbers of trained personnel required to provide an effective response to any hydrocarbon spill incident
- Ensuring equipment and services contracts are maintained
- Establishing OPEPs
- Establishing OPEAs
- Priority response receptor determination
- ALARP determination
- Ensuring compliance and assurance is undertaken in accordance with external and internal requirements

6 ALARP EVALUATION

This Section should be read in conjunction with Section 5 which is the capability planned for this activity.

6.1 Monitor and Evaluate – ALARP Assessment

Alternative, Additional and Improved options have been identified and assessed against the base capability described in Section 5 with those that have been selected for implementation highlighted in green. Items highlighted in red have been considered and rejected on the basis that they are not feasible, the costs are clearly disproportionate to the environmental benefit, and/or the option is not reasonably practical. Control measures where there is not a clear justification for their inclusion or exclusion may be subject to a detailed ALARP assessment.

6.1.1 Monitor and Evaluate – Control Measure Options Analysis

6.1.1.1 Alternative Control Measures

Table 6-1: Monitor and Evaluate – Control Measure Options considered

Alternative Control Measures considered *Alternative, including potentially more effective and/or novel control measures are evaluated as replacements for an adopted control*				
Option considered	**Environmental consideration**	**Feasibility**	**Cost**	**Implemented**
Aerostat (or similar inflatable observation platform) for localised aerial surveillance.	Lead time to Aerostat surveillance is disproportionate to the environmental benefit. The system also provides a very limited field of visibility around the vessel it is deployed from.	Long lead time to access (>10 days). Each system would require an operator to interpret data and direct vessels accordingly. Requires multiple systems for shoreline use.	Purchase cost per system approx. $300,000.	No
Use of Autonomous Underwater Vehicles (AUVs) for hydrocarbon presence and detection.	Use of AUVs may be feasible and may provide an environmental benefit in assessing inaccessible areas for presence of hydrocarbons in the water however cost of purchase is disproportionate to the environmental benefit when compared to the monitoring types in place.	AUVs may be considered as an additional method of monitoring, should remote systems be required for health and safety reasons.	Cost $10,000 for mobilisation and $15,000 a day when deployed.	No

6.1.1.2 Additional Control Measures

Additional Control Measures considered *Additional control measures are evaluated in terms of them reducing an environmental impact or an environmental risk when added to the existing suite of control measures*				
Option considered	**Environmental consideration**	**Feasibility**	**Cost**	**Implemented**
Additional personnel trained to use systems.	Current arrangement provides an environmental benefit in the availability of trained personnel facilitating access to monitoring data used to inform all other response techniques. No improvement required.	No improvement can be made, all personnel in technical roles e.g. intelligence unit are trained and competent on the software systems. Personnel are trained and exercised regularly. Use of the software and systems forms part of regular work assignments and projects.	Cost for training in-house staff would be approx. $25,000.	No
Additional satellite tracking buoys to enable greater area coverage.	Increased capability does not provide an environmental benefit compared to the disproportionate cost in having an additional contract in place.	Tracking buoy on location at manned facility, additional needs are met from WEL owned stocks in King Bay Support Facility (KBSF) and Exmouth or can be provided by service provider.	Cost for an additional satellite tracking buoy would be $200 per day or $6,000 to purchase.	No
Additional trained aerial observers.	Current capability meets need. WEL has access to a pool of trained, competent observers at strategic locations to ensure timely and sustainable response. Additional observers are available through current contracts with AMOSC and OSRL.	Current capability meets need. WEL has a pool of trained, competent observers at strategic locations to ensure timely and sustainable response. Additional observers are available through current contracts with AMOSC and OSRL Aviation standards & guidelines ensure all aircraft crews are competent for their roles. WEL maintains a pool of trained and competent aerial observers with various home base locations to be called upon at the time of an incident. Regular audits of oil spill response organisations ensure training and competency is maintained.	Cost for additional trained aerial observers would be $2,000 per person per day.	No

6.1.1.3 Improved Control Measures

Additional Control Measures considered *Additional control measures are evaluated in terms of them reducing an environmental impact or an environmental risk when added to the existing suite of control measures*				
Option considered	**Environmental consideration**	**Feasibility**	**Cost**	**Implemented**
Faster turnaround time from modelling contractor.	Improved control measure does not provide an environmental benefit compared to the disproportionate cost in having an additional contract in place.	External contractor on ICC roster to be called as soon as required. However initial information needs to be gathered by ICC team to request an accurate model. External contractor has person on call to respond from their own location.	Modelling service with a faster activation time would be achieved via membership of an alternative modelling service at an annual cost of $50,000 for 24hr access plus an initial $5,000 per modelling run.	No
Night time aerial surveillance.	The risk of undertaking the aerial observations at night is disproportionate to the limited environmental benefit. The images would be of low quality and as such the variable is not adopted.	Flights will only occur when deemed safe by the pilot. The risk of night operations, is disproportionate to the benefit gained, as images from sensors (IR, UV, etc). will be low quality. Flight time limitations will be adhered to.	No improvement can be made without risk to personnel health and safety and breaching Woodside's golden rules.	No
Faster mobilisation time (for water quality monitoring).	Due to the restriction on accessing the spill location on Day one there is no environmental benefit in having vessels available from day one. The cost of having dedicated equipment and personnel is disproportionate to the environmental benefit. The availability of vessels and personnel meets the response need. Shortening the timeframes for vessel availability would require dedicated response vessels on standby in KBSF. The cost and organisational complexity of employing two dedicated response vessels (approximately $15M/year per vessel) is considered disproportionate to the potential environmental benefit to be realised by adopting this delivery options.	Operations are not feasible on day 1 as the hydrocarbon will take time to surface, and Volatility has potential to cause health concerns within the first 24 hours of the response.	Cost for purchase of equipment approx. $200,000. Ongoing costs per annum for cost of hire and pre-positioning for life of asset/activity would be larger than the purchase cost. Dedicated equipment and personnel, living locally and on short notice to mobilise. The cost would be approx. $1M per annum, which is disproportionate to the incremental benefit this would provide, assets are already available on day 1. 2 integrated fleet vessels are available from day 1, however these could be tasked with other operations.	No

6.1.2 Selected Control Measures

Following review of alternative, additional and improved control measures as outlined above, the following controls were selected for implementation for the PAP.

- Alternative
  - None selected
- Additional
  - None selected
- Improved
  - None selected

6.2 Source Control - ALARP Assessment

Woodside has based its response planning on the worst-case credible scenario (as described in Section 2.2). This includes the following selection of source control and well intervention techniques which would be conducted concurrently;

- ROV intervention
- Relief well drilling

6.2.1 ROV Intervention

Following confirmation of an emergency event, Woodside would mobilise inspection class ROVs through existing frame agreements. It is not expected that any additional regulatory approvals would be required as inspection, maintenance and repair is within the scope of activities for the Julimar Phase 2 Drilling and Subsea Installation Operations Safety Case as well as the scope of activities for contracted Frame Agreement vessels.

As Woodside holds Frame Agreements for vessels along with contracts for ROV providers and pilots, inspection activities using ROVs are expected to commence within nine days.

Table 6-2: ROV timings

	Estimate ROV inspection duration for Julimar Phase 2 Drilling and Subsea Installation Well (days)
Source and mobilise vessel and re-supply	2 days
Source and mobilise ROV and pilot to port	2 days
Liaise with Regulator regarding risks and impacts*	4 days
Undertake ROV Inspection	1 day
TOTAL	**9 days***

** Based on timings from the Report into the Montara Commission of Enquiry, submission and discussion of revised documentation for limited activities inside the Petroleum Safety Zone (water deluge operations) to manage personnel risks and impacts was up to 20 days.*

6.2.2 Relief Well drilling

The following approaches outline Woodside's hierarchy for sourcing a rig for relief well drilling;

- Primary – Review internal drilling programs and MODU availability to source an appropriate rig operating within Australia with an approved Safety Case;
- Alternate – Source and contract a MODU through APPEA MOU that is operating within Australia with an approved Safety Case;
- Contingency – Source and contract a MODU outside Australia with an approved Australian Safety Case.

Based on the detail provided below, the Primary, Alternate and Contingency approaches are expected to be achieved within the 77 day period. The detail of these arrangements demonstrates that the risks have been reduced to ALARP and Acceptable levels through the control measures and performance standards outlined in Section 5.2.

The options analysis detailed in this section considers options to source, contract and mobilise a MODU and ensure necessary regulatory approvals are in place to meet timelines for relief well drilling.

A Safety Case revision may be required for the relief well drilling MODU based on the existing scope of activities and agreement with the Operator. Whilst due consideration has been given to relief well drilling rig availability, the Report of the Montara Commission of Enquiry (2010) noted that blowouts are typically rare and infrequent, and the associated costs of maintaining a standby rig would be neither practical nor cost-effective. Additionally, the Report also noted that whilst efforts should be made to identify the needs and requirements for relief well drilling, it is also necessary to retain a degree of flexibility in relation to the choice of rig for these activities.

6.2.2.1 Relief Well drilling timings

The duration of a blowout (from initiation to a successful kill) is assessed as 77 days for Julimar Phase 2 Drilling and Subsea Installation well. Relief wells for other wells within the field are expected to be similar duration.

Details on the time required to source and contract a MODU is shown in Table 6-3 below. A dynamically positioned (DP) MODU will be used in the event that one is available and within a shorter range/ response time than a moored MODU, however, DP MODUs are typically not readily available in Australia and thus the predictions for moored MODUs in the table are expected to be the most likely scenario during a real event.

The internal and external availability of both DP and moored MODUs, plus rig activities of registered operators and rigs with approved safety cases, are tracked by Woodside on a monthly basis to ensure that the best available option can be sourced and utilised in the event of the worst-case credible scenario. Under any circumstances, Woodside will execute relief well drilling in the fastest possible timeframe, regardless of cost or resources.

Woodside has considered a broad range of alternate, additional, and improved options as outlined later in this section. Contingency is included in the timing breakdown due to the many unpredictable variables which could be present during the relief well drilling.

Table 6-3: Relief well drilling timings

	Estimate Relief Well duration for Julimar Phase 2 Drilling and Subsea Installation Well (days) – Moored
Source and contract MODU comprising the following stages:	**21 days total:**
Activate MOU. Secure and suspend well. Complete relief well design. Secure relief well materials.	*8 days*
Transit to location based on mobilisation from Northwest shelf region.	*2 days*
Backload and loadout bulks and equipment, complete internal assurance of relief well design.	*2 days*
Contingency for unforeseen event (e.g.: Longer transit from another area of Australia, problems in securing well, cyclone event).	*9 days*
Pre-spud survey	**Already included**
Mooring Spread Installation *NB Occurs in parallel with the 21 days to mobilise the rig, so the timing included here is the difference.*	**15.6 days**
Drilling, casing and look ahead estimate	**26.1 days**
Intersection & well kill comprising the following stages:	**14 days total:**
Drill out shoe, conduct formation integrity test and drill towards intersection point.	*1.5 days*
Execute well-specific ranging plan to intersect blowout wellbore in minimum timeframe, with highest possible accuracy.	*9.5 days*

Pump kill weight drilling fluid per the relief well plan. Confirm the well is static with no further flow.	*0.5 days*
Contingency for unforeseen technical issues (e.g.: more ranging runs required to make intersect, additional mud circulations required to execute kill).	*2.5 days*
	76.7 days (77 days)

The following conditions and assumptions are applicable:

- A dynamically positioned MODU is not available.
- A pre-lay mooring spread is required to moor the rig over subsea infrastructure. Estimated duration to procure and install the pre-lay moorings is five (5) weeks, which would occur in parallel to MODU mobilisation. The breakdown of this timeframe is as follows:

Table 6-4: Mooring Spread installation timings

Activity	Duration (days)
Design mooring spread and commence sourcing equipment	7
Source equipment and mobilise to supply base	21
Install pre-lay spread	7
Run anchors and prepare to spud	1.6
Total	**36.6**

- Whilst Woodside will make every endeavour to accelerate these activities to reduce the pre-lay mooring timeframe, Woodside believes that the 5-week timeframe is sufficiently conservative to ensure these activities can be completed. Based on the key tasks outlined above to be achieved within the five-week timeframe, Woodside has considered a broad range of alternate, additional, and improved options as outlined in Section 6.2.4.
- Intersect and kill duration is estimated at 14 days. This is a moderately conservative estimate. During the intersect process, the relief well will be incrementally drilled and logged to accurately approach and locate the existing well bore. This will result in the highest probability of intersecting the well on the first attempt and thus will reduce the overall time to kill the well. During the Montara incident, it took five attempts to achieve a successful intersect.

6.2.2.2 Safety Case Revision

Woodside recognises that it will not be the Operator or holder of the Safety Case for the MODU and/or vessels involved in relief well activities. In the event that a revision to the Operator's Safety Case is required for relief well drilling, Woodside has identified measures to ensure timely response and optimise preparedness as far as practicable that can be undertaken to expedite a straightforward Safety Case revision for a MODU/ vessel to commence drilling a relief well. Performance standards associated with these measures have been included in Section 5.2.

These include;

- Access to Safety and Risk discipline personnel with specialist knowledge.
- Monitoring internal and external rigs and vessel availability in region and extended area through contracted arrangements on a monthly basis.
- Prioritisation of rigs/vessels with current or historical contracting arrangements. Woodside maintains records of previous contracting arrangements and companies. All current contracts for vessels and rigs are required to support Woodside in the event of an emergency.
- Leverage mutual aid arrangements such as the APPEA MOU for vessel and rig support.
- Woodside Planning and Logistics, and Safety Officers (on-Roster /Call 24/7) which can articulate need for, and deliver Woodside support, in key delivery tasks including sitting with potential outside operators.
- Ongoing strategic industry engagement and collaboration with NOPSEMA to work toward time reductions in regulatory approvals for emergency events.

Woodside has assessed the timing for three possible safety case revisions for a SSDI vessel/ MODU and plotted these alongside the other relief well preparation activities in Figure 6-1. The assumptions for each of the cases are detailed in subsequent Table 6-5.

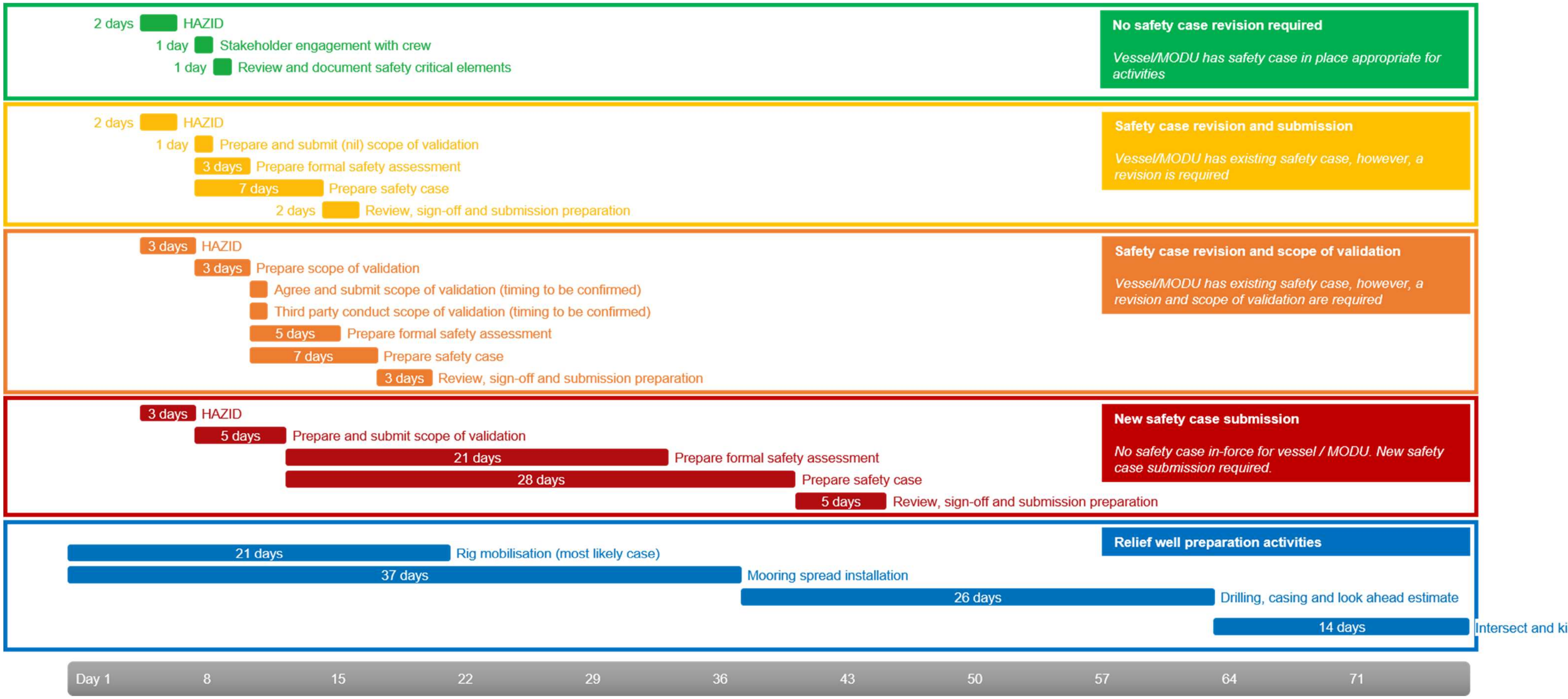

Figure 6-1: Timeline showing safety case revision timings alongside other relief well preparation activity timings

Table 6-5 Safety case revision conditions and assumptions

Case	No safety case revision required	Safety case revision and submission	Safety case revision and scope of validation	New safety case submission
Description	Vessel/MODU has a safety case in place appropriate for activities.	Vessel/MODU has an existing safety case, however, a revision is required.	Vessel/MODU has an existing safety case, however, a revision is required plus scope of validation.	No safety case in-force of vessel / MODU. New safety case submission required.
Conditions/ assumptions	• Assumes that existing vessel/MODU safety case covers working under the same conditions or the loss of containment is not severe enough to result in any risk on the sea surface.	• Safety case timing assumes vessel/MODU selected and crew and available for workshops and safety case studies.	• Safety case timing assumes vessel/ MODU selected and crew and available for workshops and safety case studies.	• Safety case timing assumes vessel/ MODU selected and crew and available for workshops and safety case studies.
		• Assumes nil scope of validation. This assumes that the vessel for SSDI allows for working in a hydrocarbon environment and control measures are already in place in the existing safety case. For MODU, it assumes that the relief well equipment is already part of the MODU facility and MODU safety case.	• Validation will be required for new facilities only. The time needed for the validator to complete the review (from the last document received) and prepare validation statement is undetermined. This is not accounted for here as the safety case submission is not dependent on the validation statement, however the safety case acceptance is.	• Validation will be required for new facilities. The time needed for the validator to complete the review (from the last document received) and prepare validation statement is undetermined. This is not accounted for here as the safety case submission is not dependent on the validation statement, however the safety case acceptance is.
		• Assumes safety case preparation is undertaken 24/7.	• Assumes safety case preparation is undertaken 24/7.	• Assumes safety case preparation is undertaken 24/7.

6.2.3 Primary Response – Relief Well Drilling

The Primary response would be sourcing and mobilising a MODU that is operating within Australia with an existing Safety Case and currently contracted to Woodside.

This option is considered the worst-case scenario and is therefore the planning case for environmental impacts. It is expected to achieve the predicted 77 day well kill.

Woodside would complete a safety case revision for an available MODU already operating within Australia to commence relief well drilling. This option has been included as the worst-case scenario (base case) for planning. Given the low associated costs and potential environmental benefits, this would be the primary option selected for implementation in the event of a loss of well containment. Woodside has planned for the worst-case scenario of major damage or complete loss of well control during drilling operations would prioritise sourcing a MODU operating within Australia with existing regulatory approvals and contracted to Woodside. A revision of the safety case would be undertaken if required. This option is considered feasible and reliable with the associated dependencies outlined above.

A moored MODU will likely be used in this water depth, and an opportunity will be taken to contract Dynamical Positioned MODU, if it's within a shorter range/ response time than a moored MODU, however, DP MODUs are not readily available in Australia and thus the use of a moored MODUs is the most likely scenario during a real event. The internal and external availability of both DP and moored MODUs, plus rig activities of registered operators and rigs with approved safety cases, are tracked by Woodside on a monthly basis to ensure that the best available option can be sourced and utilised in the event of the worst-case credible scenario. Under any circumstances, Woodside will execute relief well drilling in the fastest possible timeframe, regardless of cost or resources.

6.2.4 Alternate Response - Relief Well Drilling

The Alternate response would be to source a rig operating within Australia through the APPEA MOU and approving a revision to that Operators Safety Case.

Woodside would utilise an existing MODU with in force regulatory approvals sourced through the APPEA MOU to commence relief well drilling as soon as possible. Dependent upon the scope of activities in the SC and Operator, relief well drilling may be able to commence without the need for a SC revision.

Given the low associated costs and potential environmental benefits, may allow the well to be killed up to seven days sooner, in a reduction of up to 22,610 m3 of Julimar Condensate for the worst-case credible scenario, this option has been selected as the Alternate approach in the event of a loss of well containment. Woodside has planned for the worst-case scenario of a loss of well control during drilling operations but would prioritise sourcing a MODU with existing regulatory approvals through the APPEA MOU/Mutual Aid arrangements if available. This option is considered feasible and reliable with the associated dependencies outlined above.

A moored MODU will likely be used in this water depth, and an opportunity will be taken to contract Dynamical Positioned MODU, if it's within a shorter range/ response time than a moored MODU, however, DP MODUs are not readily available in Australia and thus the use of a moored MODUs is the most likely scenario during a real event. The internal and external availability of both DP and moored MODUs, plus rig activities of registered operators and rigs with approved safety cases, are tracked by Woodside on a monthly basis to ensure that the best available option can be sourced and utilised in the event of the worst-case credible scenario. Under any circumstances, Woodside will execute relief well drilling in the fastest possible timeframe, regardless of cost or resources.

6.2.5 Source Control – Control Measure Options Analysis

The assessment described in Section 6.2.3 and 6.2.4 outlines the primary and alternate approach respectively that Woodside would implement for relief well drilling**.** Whilst a contingency option has been identified in Section 6.2.2, it has not been carried forward for further evaluation as sufficient detail has been provided regarding the primary and alternate options as the two key techniques that would be implemented.

Woodside has outlined the options considered against the activation, mobilisation (improved options), deployment (alternate and additional options) process described in Section 2.1.1 that provides an evaluation of:

- Predicted cost associated with adopting the option.
- Predicted change/environmental benefit.
- Predicted effectiveness/feasibility of the option.

Alternative, Additional and Improved options have been identified and assessed against the base capability described in Section 5 with those that have been selected for implementation highlighted in green. Items highlighted in red have been considered and rejected on the basis that they are not feasible, the costs are clearly clearly disproportionate to the environmental benefit, and/or the option is not reasonably practical.

- Alternative options, including potentially more effective and/or novel control measures are evaluated as replacements for an adopted control.
- Additional control measures are evaluated in terms of their ability to reduce an impact or risk when added to the existing suite of control measures.
- Improved control measures are evaluated for improvements they could bring to the effectiveness of adopted control measures in terms of functionality, availability, reliability, survivability, independence and compatibility.

Options where there is not a clear justification for their inclusion or exclusion may be subject to a detailed assessment.

6.2.5.1 Activation/Mobilisation Options considered

Alternative

- SRC01 - Standby MODU shared for all Woodside activities
- SRC02 - Standby MODU shared across APPEA MOU Titleholders

Additional

- SRC03 - Maintain minimum standard required for Safety Case development

Improved

- SRC04 - Monitor internal drilling programs for rig availability
- SRC05 - Monitor external drilling programs for rig availability
- SRC06 - Monitor status of Registered Operators / Approved Safety cases for rigs

6.2.5.2 Deployment Options considered

Additional

- SRC08 - Pre-drilling top-hole
- SRC09 - Pre-installed moorings
- SRC11 - Purchase and maintain mooring system
- SRC12 - Pre-design mooring spread
- SRC13 - Contract in place with Wild Well Control Inc and Oceaneering to provide trained personnel

Improved

- SRC10 - Maintaining relief well drilling supplies (mud, casing, etc)

6.2.6 Activation/Mobilisation – Control Measure Options Analysis

Of the four steps outlined in Table 6-3, reducing the time to source, contract and mobilise the rig to site is the key step where timing may be reduced for well kill operations. The other three steps may be reduced once operations commence but limited options are available to reduce their duration until relief well drilling commences.

6.2.6.1 Alternative Control Measures

Table 6-6: Source Control – Activation/Mobilisation – Control Measure Options Analysis

	Alternative Control Measures considered *Alternative, including potentially more effective and/or novel control measures are evaluated as replacements for an adopted control*				
Option considered	**Environmental consideration**	**Feasibility**	**Cost**	**Assessment Conclusions**	**Implemented**
Standby MODU shared for all Woodside activities	A standby MODU shared across all Woodside activities is likely to provide a moderate environmental benefit as it may reduce the 21-day sourcing, contracting and mobilisation time by up to 10 days (to 11 days). This would reduce the volume and duration of release and may reduce impacts on receptors and sensitivities. This may allow the well to be killed up to 10 days sooner (total of 67 days for well kill) and may result in a reduction of up to 32,450 m^3 of Julimar Condensate for the worst-case credible scenario.	This option is not considered feasible for all Woodside activities as there are a large range of well depths, complexities, geologies and geophysical properties across all Woodside's operations. The large geographic area of Woodside activities also means that the MODU is unlikely to be in the correct location at the right time when required.	Even with costs shared across Woodside operations, the costs (approx $219M per annum, $1,095B over the five years) of maintaining a shared MODU are considered disproportionate to the environmental benefit potentially achieved by reducing mobilisation times by up to 10 days.	The costs and complexity of having a MODU and maintaining this arrangement for the duration of the Petroleum Activities Program are disproportionate to the environmental benefit gained above finding a MODU through the MOU agreement for all spill scenarios.	No
Standby MODU shared across APPEA MOU Titleholders	A standby MODU shared across all titleholders who are signatories to the APPEA MOU is likely to provide a minor environmental benefit as it may reduce the 21-day sourcing, contracting and mobilisation time by up to seven days (to 14 days). This would reduce the volume and duration of release and may reduce impacts on receptors and sensitivities. This may result in a reduction of up to 22,610 m^3 of Julimar Condensate for the worst-case credible scenario.	This option is not considered feasible for a number of Titleholders due to the remote distances in Australia as well as a substantial range of well depths, types, complexities, geologies and geophysical properties across a range of Titleholders	As the environmental benefit is only considered minor and the reduction in timing would only be for the mobilisation period (reduction from 21 days to 14 days) the costs are considered disproportionate to the minor benefit gained.	The costs and complexity of having a MODU and maintaining a shared arrangement for the duration of the Petroleum Activities Program are disproportionate to the environmental benefit gained above finding a MODU through the MOU agreement for all spill scenarios.	No

6.2.6.2 Additional Control Measures

Additional Control Measures considered *Additional control measures are evaluated in terms of them reducing an environmental impact or an environmental risk when added to the existing suite of control measures*					
Option considered	**Environmental consideration**	**Feasibility**	**Cost**	**Assessment conclusions**	**Implemented**
Implement and maintain minimum standards for Safety Case development	Woodside's contingency planning consideration would be to source a rig from outside Australia with an existing Safety Case. This would require development and approval of a safety case revision for the rig and activities prior to commencing well kill operations.	This option is considered feasible and would require Woodside to develop minimum standards for safe operations for relevant Safety Case input along with maintaining key resources to support review of Safety Cases. Woodside would not be the operator for relief well drilling and would therefore not develop or submit the Safety Case revision. Woodside's role as Titleholder would be to provide minimum standard for safe operations that MODU operators would be required to meet and/or exceed.	Woodside has outlined control measures and performance standards regarding template Safety Case documentation and maintenance of resources and capability for expedited Safety Case review.	This option has been selected based on its feasibility, low cost and the potential environmental benefits it would provide.	Yes

6.2.6.3 Improved Control Measures

Improved Control Measures considered *Improved control measures are evaluated for improvements they could bring to the effectiveness of adopted control measures in terms of functionality, availability, reliability, survivability, independence and compatibility*					
Option considered	**Environmental consideration**	**Feasibility**	**Cost**	**Assessment conclusions**	**Implemented**
Monitor internal drilling programs for rig availability	Woodside may be conducting other campaigns that overlap with the Petroleum Activities Program, potentially providing availability of a relief well drilling rig within Woodside. The environmental benefit of monitoring other drilling programs internally is for Woodside to understand what other rigs may be rapidly available for relief well operations if required, potentially reducing the time to drill the relief well, resulting in less hydrocarbon to the environment.	Woodside monitors vessel and MODU availability through market intelligence services for location. Woodside will continually monitor other drilling and exploration activities within Australia and as available throughout the region to track rigs and explore rig availability during well intervention operations.	Associated cost of implementation is minimal to the environmental benefit gained. Woodside has outlined control measures and performance standards.	This option is a low-cost control measure with potential to reduce the volume of hydrocarbon released to the environment.	Yes
Monitor external activity for rig availability	The environmental benefit achieved by monitoring drilling programs and rig movements across industry provides the potential for increased availability of suitable rigs for relief well drilling. Additional discussions with other Petroleum Titleholders may be undertaken to potentially gain faster access to a rig and reduce the time taken to kill the well and therefore volume of hydrocarbons released.	Woodside will source a relief well drilling rig in accordance with the APPEA MOU on rig sharing in the unlikely event this is required. Commercial and operational provisions do not allow WEL to discuss current and potential drilling programs in detail with other Petroleum Titleholders.	Associated cost of implementation is moderate to the environmental benefit gained. Woodside will continually engage with other Titleholders and Operators regarding activities within Australia and as available throughout the region to track rigs and explore rig availability during well intervention operations.	This option is a low-cost control measure with potential to reduce the volume of hydrocarbon released to the environment.	Yes
Monitor status of Registered Operators / Approved Safety cases for rigs	The environmental benefit of monitoring rigs is for Woodside to understand what other rigs may be rapidly available for relief well operations if required, potentially reducing the time to drill the relief well, resulting in less hydrocarbon to the environment.	Woodside will monitor the status of rigs operating within Australia (and therefore safety case status) on a quarterly basis. This allows for a prioritised selection of rigs in the event of a response with priority given to those with an existing safety case.	Associated cost of implementation is minimal to the environmental benefit gained, Woodside will monitor the status of safety cases on a quarterly basis. Woodside has outlined control measures and performance standards to meet these controls.	This option is a low-cost control measure with potential to reduce the volume of hydrocarbon released to the environment.	Yes

6.2.7 Deployment Options Analysis

6.2.7.1 Additional Control Measures

Table 6-7: Source Control – Deployment – Control Measure Options Analysis

Additional Control Measures considered *Additional control measures are evaluated in terms of them reducing an environmental impact or an environmental risk when added to the existing suite of control measures*					
Option considered	**Environmental consideration**	**Feasibility**	**Cost**	**Assessment conclusions**	**Implemented**
Pre-drilling top-holes	This option represents additional environmental impacts associated with discharge of additional drill cuttings and fluids along with benthic habitat disturbance. It is also not expected to result in a significant decrease in relief well timings.	This option is not considered feasible due to the uncertainties related to the location and trajectory of the intervention well, which may vary according to the actual conditions at the time the loss of containment event occurs. Additionally, there is only expected to be a minor reduction in timing for this option of one to two days based on the drilling schedule. Duration to drill and kill may be reduced by one to two days, but top-hole may have to be relocated, due to location being unsafe or unsuitable and further works will be required each year to maintain the top holes.	Utilising an existing MODU and pre-drilling top-hole for relief well commencement would significantly increase costs associated the Petroleum Activities Program. Estimated cost over the program's life is approx. $555,000 per day over the PAP based on two to four days of top-hole drilling (plus standby time) for the five wells as the worst-case scenarios.	This strategy is not considered feasible.	No
Purchase and maintain mooring system	Purchasing and maintaining a mooring system could provide a moderate environmental benefit as it may reduce equipment sourcing time. However, due to the continued need for specialists to install the equipment plus sourcing a suitable vessel, the timeframe reduction would be minimal.	Woodside is not a specialist in installing and maintaining moorings so would require specialists to come in to install the moorings and would also require specialist vessels to be sourced to undertake the work.	The cost of purchasing, storing and maintaining pre-lay mooring systems with anchors, chains, buoys and ancillary equipment is considered disproportionate to the environmental benefit gained.	This strategy is not considered feasible.	No
Contract in place with Wild Well Control and Oceaneering	Woodside has an agreement in place with Wild Well Control Inc and Oceaneering to provide trained personnel in the event of an incident. This will ensure that competent personnel are available in the shortest possible timeframe.	Having contracts in place to access trained, competent personnel in the event of an incident would reduce mobilization times. This option is considered reasonably practicable.	This control measure is adopted as the costs and complexity are not considered disproportionate to any environmental benefit that might be realised.	This control is selected to provide further certainty that competent personnel are available.	Yes

6.2.7.2 Improved Control Measures

Improved Control Measures considered *Improved control measures are evaluated for improvements they could bring to the effectiveness of adopted control measures in terms of functionality, availability, reliability, survivability, independence and compatibility*					
Option considered	**Environmental consideration**	**Feasibility**	**Cost**	**Assessment conclusions**	**Implemented**
Maintaining relief well drilling supplies	There is not predicted to be any reduction in relief well timing or spill duration from Woodside maintaining stocks of drilling supplies (mud, casing, cement, etc.)	It would be feasible to source some relief well drilling supplies such as casing but the actual composition of the cement and mud required will need to be specific to the well. This option is also not deemed necessary as the lead time for sourcing and mobilising these supplies is included in the 21 days for sourcing and mobilising a rig.	The capital cost of Woodside purchasing relevant drilling supplies is expected to be approximately $600K with additional costs for storage and ongoing costs for replenishment. These costs are considered disproportionate to the environmental benefit gained.	This option would not provide an environmental benefit.	No

6.2.8 Selected Control Measures

Following review of alternative, additional and improved control measures as outlined above, the following controls were selected for implementation for the PAP.

- Alternative
  - None selected
- Additional
  - Implement and maintain minimum standards for Safety Case development (PS 10.1, 10.2, 10.3, 10.4)

    - Contract in place with Wild Well Control and Oceaneering to supply trained, competent personnel (PS 8.6, 8.7)
- Improved
    - Monitor internal drilling programs for rig availability (PS 8.11)
    - Monitor external activity for rig availability (PS 8.11)
    - Monitor status of Registered Operators / Approved Safety cases (PS 9.5)

6.3 Shoreline Protection & Deflection – ALARP Assessment

Alternative, Additional and Improved options have been identified and assessed against the base capability described in Section 5 with those that have been selected for implementation highlighted in green. Items highlighted in red have been considered and rejected on the basis that they are not feasible, the costs are clearly disproportionate to the environmental benefit, and/or the option is not reasonably practical. Control measures where there is not a clear justification for their inclusion or exclusion may be subject to a detailed ALARP assessment.

6.3.1 Existing Capability – Shoreline Protection and Deflection

Woodside's exiting level of capability is based on internal and third-party resources that are available 24 hours, 7 days per week. The capability presented below is displayed as ranges to incorporate operational factors such as weather, crew/vessel/aircraft/vehicle location and duties, survey or classification society inspection requirements, overflight/port/quarantine permits and inspections, crew/pilot duty and fatigue hours, re-fuelling/re-stocking provisions, and other similar logistic and operational limitation that are beyond Woodside's direct control.

6.3.2 Response Planning: Julimar Phase 2 Drilling and Subsea Installation – Shoreline Protection and Deflection

Planning for shoreline protection is based upon identification of Response Protection Areas (RPAs) from deterministic modelling and the logistics associated with deploying protection at these locations. The response planning scenarios indicate that this would require effective mobilisation to priority shorelines and maintenance of protection until operational monitoring confirms that the locations were no longer at risk. Woodside has identified the RPAs from deterministic modelling results provided from specific scenarios.

The control measures selected provide capability to mobilise shoreline protection equipment by Day 13 (if required). Deterministic modelling scenarios indicate that first shoreline impact at Ningaloo Coast Middle WHA within 18.4 days for the loss of well containment scenario. Given shoreline contact at RPAs is not predicted until Day 18 at Ningaloo Coast Middle WHA, the existing capability is considered sufficient to mobilise and deploy protection at RPAs prior to hydrocarbon contact, guided by the ongoing operational monitoring.

Tactical response plans exist for many of the RPAs identified. The plans identify values and sensitivities that would be protected at location. Modelling does not predict that all priority protection shorelines will be at risk of contact at the same time. Therefore, to allow for the best use of available shoreline protection and deflection resources, operational monitoring (OM01 and OM02) will inform the response, targeting RPAs where contact is predicted above response threshold levels (Table 6-10).

Table 6-8 below outlines the capability required (number of RPAs predicted to be impacted) against the capability available (number of shoreline protection and deflection operations that can be mobilised and deployed). As can be seen from the table below. Woodside's capability exceeds the response planning need identified for shoreline protection and deflection operations at identified RPAs.

Table 6-8: Response Planning – Shoreline Protection and Deflection

	Shoreline Protection & Deflection	Day	Day	Day	Day	Day	Day	Day	Week	Week	Week	Month	Month	Month
		1	2	3	4	5	6	7	2	3	4	2	3	4
	Oil on shoreline (from deterministic modelling) m^3	0	0	0	0	0	0	0	0	2	0	0	38	0
A	Capability Required													
A1	Number of RPAs contacted (>100 g/m^2) - Julimar Phase 2 Drilling and Subsea Installation LOWC	0	0	0	0	0	0	0	0	1	0	0	1	0
B	Capability Available (operations per day)	0	0	0	0	0	0	0	0	1	0	0	1	
B1	SPD operations available – per day (lower)	0	1	1	2	2	4	6	70	70	70	330	330	0
B2	SPD operations available – per day (upper)	1	2	3	4	6	8	10	84	84	84	336	336	0
C	Capability Gap (operations per day)													
C1	SPD operations gap – per day (lower)	0	0	0	0	0	0	0	0	0	0	0	0	0
C2	SPD operations gap – per day (upper)	0	0	0	0	0	0	0	0	0	0	0	0	0

A1 – the number of Response Protection Areas contacted by surface hydrocarbons above 100 g/m^2.

B1 and B2 – the upper and lower number of shoreline protection and deflection operations available (based on response planning assumptions in Section 5.3).

C1 and C2 – the gap between the upper and lower number of shoreline protection and deflection operations required in A1 compared to the operations available in B1 and B2.

Table 6-9: RPAs for Julimar Phase 2 Drilling and Subsea Installation Operations

Areas of coastline contacted	Conservation status	IUCN management category	Minimum time to shoreline contact (above 100 g/m^2) in days [4]	Maximum shoreline accumulation (above 100 g/m^2) in m^3 [5]
Ningaloo Coast Middle World Heritage Area	State Marine Park Australian Marine Park (AMP) World Heritage Area	II – National Park Zone IV – Recreational Use Zone	18.4 days	2 m^3
Kimberley Coast & Northern Coast	State Marine Park Australian Marine Park (AMP)	II –National Park Zone IV – Habitat Protection Zone VI – Multiple Use Zone	63 days	38 m^3
Eighty Mile Beach	Australian Marine Park (AMP)	VI – Multiple Use Zone	63 days	36 m^3
Eighty Mile Beach Marine Park and Ramsar Site	State Marine Park Australian Marine Park (AMP) Ramsar Site, Wetland of International Importance	VI – Multiple Use Zone	71.2 days	5 m^3

[4] This volume and time represent the first time to contact on defined shoreline polygon and the maximum volume ashore for that 24 hour period.
[5] This volume and time represent the maximum volume ashore on defined shoreline polygon for any 24 hour time period.

Table 6-10: Indicative Tactical response plan, aims and methods for RPAs

Tactical Response Plan	Response aims and methods
Ningaloo coast – Mangrove Bay	**First Response Aim: Protection of Mangrove Bay Lagoon.** Methods: Prevent oil ingress to lagoons through use of shore sealing booms. Complete northern lagoon first, then southern if required – depending on beach topography and tidal cycle. **Second Response Aim: Pre-clean of the beach area.** Methods: Using rakes and shovels move any debris on the beach to above the high tide area, above the reach of any floating oil. **Third Response Aim: Recovery of oil at lagoon entrance.** Methods: Use skimmer to recover floating oil. **Fourth Response Aim: Clean-up of oiled shoreline.** Methods: Manual clean-up techniques, predominantly rakes and shovels, with flushing and vacuum skimming if appropriate and required
Ningaloo coast – Turquoise Bay	**First Response Aim: Pre-clean of the beach area.** Method: Using rakes and shovels move any debris on the beach to above the high tide area, above the reach of any floating oil. **Second Response Aim: Clean-up of oiled shoreline.** Method: Manual clean-up techniques, predominantly rakes and shovels, with flushing and vacuum skimming if appropriate and required.
Ningaloo coast – Yardie Creek	**First Response Aim: Protection of Yardie Creek entrance.** Methods: Prevent oil ingress to lagoon through use of shore sealing boom. **Second Response Aim: Pre-clean of the beach area.** Methods: Using rakes and shovels move any debris on the beach to above the high tide area, above the reach of any floating oil.

	Third Response Aim: Recovery of oil at Yardie Creek entrance. Methods: Use skimmer to recover floating oil into temporary storage. **Fourth Response Aim: Cleanup of oiled shoreline.** Methods: Manual clean-up techniques, predominantly rakes and shovels, with flushing and vacuum skimming if appropriate and required.
Ningaloo coast – Jurabi-Lighthouse Beaches	**First Response Aim: Pre-clean of the beach area.** Method: Using rakes and shovels move any debris on the beach to above the high tide area, above the reach of any floating oil. **Second Response Aim: Clean-up of oiled shoreline.** Method: Manual clean-up techniques, predominantly rakes and shovels, with flushing and vacuum skimming if appropriate and required.

Pre-emptive mobilisation of equipment and personnel would commence as soon as practicable prior to oil contact. Additional resources would be mobilised depending on the scale of the event to increase the length or number of shorelines being protected.

A shoreline protection and deflection response would be launched and additional tactical response plans drafted only when monitoring and modelling indicated that contact could occur within 14 days and monitor and evaluate operations identify spill heading towards RPA(s).

6.3.3 Shoreline Protection and Deflection – Control Measure Options Analysis

6.3.3.1 Alternative Control Measures

Table 6-11: Shoreline Protection and Deflection – Control Measure Options considered

Alternative Control Measures considered *Alternative, including potentially more effective and/or novel control measures are evaluated as replacements for an adopted control*				
Option considered	**Environmental consideration**	**Feasibility**	**Cost**	**Implemented**
Pre-position equipment at Response Protection Areas (RPAs)	Additional environmental benefit of having equipment prepositioned is considered minor and unlikely to reduce the environmental consequence of a significant hydrocarbon release beyond the adopted delivery options. Equipment is currently available to protect priority receptor areas and additional shorelines, within estimated minimum times until shoreline contact at Priority Protection Areas, enabling mobilisation of the selected delivery options.	Considering the highly unlikely nature of a significant hydrocarbon release and the costs and organisational complexity associated with prepositioning and maintenance of equipment, the sacrifice is considered disproportionate to the limited environmental benefit that might be realised. Furthermore, these options would conflict with the mutual aid philosophy being adopted under the selected delivery options The selected delivery options for shoreline protection and deflection meet the relevant objectives of this control measure and do not require prepositioned or additional equipment in Exmouth.	Total cost to preposition protection/ deflection packages at each site of potential impact would be approx. $6,100 per package per day.	No

6.3.3.2 Additional Control Measures

Additional Control Measures considered *Additional control measures are evaluated in terms of them reducing an environmental impact or an environmental risk when added to the existing suite of control measures*				
Option considered	**Environmental consideration**	**Feasibility**	**Cost**	**Implemented**
Supplemented stockpiles of equipment in Exmouth to protect additional shorelines	The incremental environmental benefit associated with these delivery options is considered minor and unlikely to reduce the environmental consequence of a significant hydrocarbon release beyond the adopted delivery options. Considering the highly unlikely nature of a significant hydrocarbon release and the costs and organisational complexity associated with prepositioning and maintenance of equipment, the sacrifice is considered disproportionate to the limited environmental benefit that might be realised.	Additional equipment would increase the number of receptor areas that could be protected from hydrocarbon contact. However, current availability of personnel and equipment is capable of protecting up to 30km of shoreline, commensurate with the scale and progressive nature of shoreline impact. Additional stocks would be made available from international sources if long term up scaling were necessary. A reduction in environmental consequence from a ‘B’ rating (serious long-term impacts) is unlikely to be realised as a result of having more equipment available locally. Furthermore, these options would conflict with the mutual aid philosophy being adopted under the selected delivery options. The selected delivery options for shoreline protection and deflection meet the relevant objectives of this control measure and do not require prepositioned or additional equipment in Exmouth.	Total cost for purchase supplemental protection and deflection equipment would be approx. $455,000 per package.	No
Additional trained personnel	The level of training and competency of the response personnel ensures the shoreline protection and deflection operation is delivered with minimum secondary impact to the environment. Training additional personnel does not provide an increased environmental benefit.	Additional personnel required to sustain an extended response can be sourced through the WEL *People & Global Capability Surge Labour Requirement Plan*. Additional personnel sourced from contracted OSRO’s (OSRL/AMOSC) to manage other responders. Response personnel are trained and exercised regularly in shoreline response techniques and methods. All personnel involved in a response will receive a full operational/safety brief prior to commencing operations.	Additional Specialist Personnel would cost $2,000 per person per day.	No

6.3.3.3 Improved Control Measures

Improved Control Measures considered *Improved control measures are evaluated for improvements they could bring to the effectiveness of adopted control measures in terms of functionality, availability, reliability, survivability, independence and compatibility*				
Option considered	**Environmental consideration**	**Feasibility**	**Cost**	**Implemented**
Faster response/ mobilisation time	Given modelling does not predict shoreline contact until approx. 18.4 days, WEL considers that there is sufficient time for deployment of protection and deflection operations on coastal location of the Ningaloo World Heritage Area (WHA) prior to impact.	Response teams, trained personnel, contracted oil spill response service providers, government agencies and the associated mitigation equipment required to enact an initial protection and deflection response will be available for mobilisation within 24-48hrs of activation. Additional equipment from existing stockpiles and oil spill response service providers can be on scene within days. Hydrocarbons are predicted to strand after a period of approximately 18.4 days therefore allowing enough time to re-locate existing equipment, personnel and other resources to the most appropriate areas.	The cost of establishing a local stockpile of new mitigation equipment (including protection and deflection boom) closer to the expected hydrocarbon stranding areas is not commensurate with the need.	No

6.3.4 Selected Control Measures

Following review of alternative, additional and improved control measures as outlined above, the following controls were selected for implementation for the PAP.

- Alternative
  - None selected
- Additional
  - None selected
- Improved
  - None selected

6.4 Shoreline Clean-up – ALARP Assessment

Alternative, Additional and Improved options have been identified and assessed against the base capability described in Section 5 with those that have been selected for implementation highlighted in green. Items highlighted in red have been considered and rejected on the basis that they are not feasible, the costs are clearly disproportionate to the environmental benefit, and/or the option is not reasonably practical. Control measures where there is not a clear justification for their inclusion or exclusion may be subject to a detailed ALARP assessment.

6.4.1 Existing Capability – Shoreline Clean-up

Woodside's existing level of capability is based on internal and third-party resources that are available 24 hours, 7 days per week. The capability presented below is displayed as ranges to incorporate operational factors such as weather, crew/vessel/aircraft/vehicle location and duties, survey or classification society inspection requirements, overflight/port/quarantine permits and inspections, crew/pilot duty and fatigue hours, re-fuelling/re-stocking provisions, and other similar logistic and operational limitation that are beyond Woodside's direct control.

6.4.2 Response planning: Julimar Phase 2 Drilling and Subsea Installation – Shoreline Clean-up

Woodside has assessed existing capability against the WCCS and has identified that the range of techniques provide an ongoing approach to shoreline clean-up at identified RPAs. Woodside's capability can cover all required shoreline clean-up operations for the PAP.

Given modelling predicts shoreline contact from day 18.4 days (Ningaloo Coast Middle WHA) for the loss of well containment scenario at a volume of two m^3, Woodside is satisfied that the current capability is managing risks and impacts to ALARP. The largest volumes ashore are on the Kimberley Coast with approx. 38 m^3 predicted on day 63 (Table 6-9).

These figures have been combined into a single response planning need scenario that provides a worst-case scenario for planning purposes as outlined below. Given all other shoreline contact scenarios identified from deterministic modelling are longer time frames and lesser volumes, demonstration of capability against this need will ensure Woodside can meet requirements for any other outcome.

Woodside has identified several options which could be mobilised to achieve defined response objectives. Evaluation considers the benefit in terms of the time to respond and the scale of response made possible by each option. The evaluation of possible control measures is summarised in Section 6.4.3.

Table 6-12: Response Planning – Shoreline Clean-up

	Shoreline Clean-up (Phase 2)	Day	Day	Day	Day	Day	Day	Day	Week	Week	Week	Month	Month	Month
		1	2	3	4	5	6	7	2	3	4	2	3	4
	Oil on shoreline (from deterministic modelling) m^3													
	Shoreline accumulation (above 100 g/m^2) - m^3	0	0	0	0	0	0	0	0	2	0	0	38	0
	Oil remaining following response operations - m^3	0	0	0	0	0	0	0	0	2	0	0	38	0
A	Capability Required (number of operations)	0	0	0	0	0	0	0	0	0	0	0	0	0
A1	Shoreline clean-up operations required (lower)													
A2	Shoreline clean-up operations required (upper)	0	0	0	0	0	0	0	0	1	0	0	4	0
B	Capability Available (number of operations)	0	0	0	0	0	0	0	0	1	0	0	5	0
B1	Shoreline clean-up operations available - Stage 2 - Manual (lower)	0	0	0	0	0	0	0	0	1	0	0	4	0
B2	Shoreline clean-up operations available - Stage 2 - Manual (upper)	0	1	3	5	8	12	15	105	105	105	560	560	560
C	Capability Gap	0	2	5	8	10	15	20	140	140	140	560	560	560
C1	Shoreline clean-up operations gap (lower)													
C2	Shoreline clean-up operations gap (upper)	0	0	0	0	0	0	0	0	0	0	0	0	0

A1 and A2 – the number of Shoreline Clean-up operations required based on the hydrocarbon volumes ashore above 100 g/m^2.

B1 and B2 – the upper and lower number of shoreline clean-up operations available (based on response planning assumptions in Section 5.4).

C1 and C2 – the gap between the upper and lower number of shoreline clean-up operations required in A1 and A2 compared to the operations available in B1 and B2.

6.4.3 Shoreline Clean-up – Control measure options analysis

6.4.3.1 Additional Control Measures

Table 6-13: Shoreline Clean-up – Control Measure Options considered

Additional Control Measures considered *Additional control measures are evaluated in terms of them reducing an environmental impact or an environmental risk when added to the existing suite of control measures*				
Option considered	**Environmental consideration**	**Feasibility**	**Cost**	**Implemented**
Additional trained personnel available	The level of training and competency of the response personnel ensures the shoreline clean-up operation is delivered with minimum secondary impact to the environment. Training additional personnel does not provide an increased environmental benefit.	Additional personnel required to sustain an extended response can be sourced through the WEL *People & Global Capability Surge Labour Requirement Plan*. Additional personnel sourced from contracted OSRO's (OSRL/AMOSC) to manage other responders Response personnel are trained and exercised regularly in shoreline response techniques and methods. All personnel involved in a response will receive a full operational/safety brief prior to commencing operations.	Additional Specialist Personnel would cost $2,000 per person per day.	No

6.4.3.2 Improved Control Measures

Improved Control Measures considered *Improved control measures are evaluated for improvements they could bring to the effectiveness of adopted control measures in terms of functionality, availability, reliability, survivability, independence and compatibility*				
Option considered	**Environmental consideration**	**Feasibility**	**Cost**	**Implemented**
Faster response/ mobilisation time	Given modelling does not predict shoreline contact until approx. 18.4 days, WEL considers that there is sufficient time for deployment of protection and deflection operations on coastal location of the Ningaloo World Heritage Area (WHA) prior to impact.	Response teams, trained personnel, contracted oil spill response service providers, government agencies and the associated mitigation equipment required to enact an initial protection and deflection response will be available for mobilisation within 24-48hrs of activation. Additional equipment from existing stockpiles and oil spill response service providers can be on scene within days. Hydrocarbons are predicted to strand after a period of approximately 18.4 days therefore allowing enough time to re-locate existing equipment, personnel and other resources to the most appropriate areas.	The cost of establishing a local stockpile of new mitigation equipment (including protection and deflection boom) closer to the expected hydrocarbon stranding areas is not commensurate with the need.	No

6.4.4 Selected Control Measures

Following review of alternative, additional and improved control measures as outlined above, the following controls were selected for implementation for the PAP.

- Alternative
  - None selected
- Additional
  - None selected
- Improved
  - None selected

6.5 Waste Management – ALARP Assessment

Alternative, Additional and Improved options have been identified and assessed against the base capability described in Section 5 with those that have been selected for implementation highlighted in green. Items highlighted in red have been considered and rejected on the basis that they are not feasible, the costs are clearly disproportionate to the environmental benefit, and/or the option is not reasonably practical. Control measures where there is not a clear justification for their inclusion or exclusion may be subject to a detailed ALARP assessment.

6.5.1 Existing Capability – Waste Management

Woodside's exiting level of capability is based on internal and third-party resources that are available 24 hours, 7 days per week. The capability presented below is displayed as ranges to incorporate operational factors such as weather, crew/vessel/aircraft/vehicle location and duties, survey or classification society inspection requirements, overflight/port/quarantine permits and inspections, crew/pilot duty and fatigue hours, refuelling/restocking provisions, and other similar logistic and operational limitation that are beyond Woodside's direct control.

6.5.2 Waste Management - Control Measure Options Analysis

6.5.2.1 Additional Control Measures

Table 6-14: Waste Management – Control Measure Options considered

Additional Control Measures considered *Additional control measures are evaluated in terms of them reducing an environmental impact or an environmental risk when added to the existing suite of control measures*				
Option considered	**Environmental consideration**	**Feasibility**	**Cost**	**Implemented**
Increased waste storage capability	The procurement of waste storage equipment options on the day of the event will allow immediate response and storage of collected waste. The environmental benefit of immediate waste storage is to reduce ecological consequence by safely securing waste, allowing continuous response operations to occur.	Access to Veolia's storage options provides the resources required to store and transport sufficient waste to meet the need. Access to waste contractors existing facilities enables waste to be stockpiled and gradually processed within the regional waste handling facilities. Additional temporary storage equipment is available through existing contract and arrangements with OSRL. Existing arrangements meet identified need for the PAP.	Cost for increased waste disposal capability would be approx. $1,300 per m3. Cost for increased onshore temporary waste storage capability would be approx. $40 per unit per day.	No

6.5.2.2 Improved Control Measures

Improved Control Measures considered *Improved control measures are evaluated for improvements they could bring to the effectiveness of adopted control measures in terms of functionality, availability, reliability, survivability, independence and compatibility*				
Option considered	**Environmental consideration**	**Feasibility**	**Cost**	**Implemented**
Faster response time	The access to Veolia waste storage options provides the resources to store and transport waste, permitting the wastes to be stockpiled and gradually processed within the regional waste handling facilities. Bulk transport to Veolia's licensed waste management facilities would be undertaken via controlled-waste-licensed vehicles and in accordance with Environmental Protection (Controlled Waste) Regulations 2004. The environmental benefit from successful waste storage will reduce pressure on the treatment and disposal facilities reducing ecological consequences by safely securing waste. In addition, waste storage and transport will allow continuous response operations to occur. This delivery option would increase known available storage, eliminating the risk of additional resources not being available at the time of the event. However, the environmental benefit of Woodside procuring additional waste storage is considered minor as the risk of additional storage not being available at the time of the event is considered low and existing arrangements provide adequate storage to support the response.	WEL already maintains an equipment stockpile in Dampier to enable shorter response times to incidents. This stockpile includes temporary waste storage equipment. WEL has access to stockpiles of waste storage and equipment in Dampier and Exmouth through existing contracts and arrangements.	The incremental benefit of having a dedicated local WEL owned stockpile of waste equipment and transport is considered minor and cost is considered grossly disproportionate to the benefit gained given predicted shoreline contact times.	No

6.5.3 Selected control measures

Following review of alternative, additional and improved control measures as outlined above, the following controls were selected for implementation for the PAP.

- Alternative
  - None selected
- Additional
  - None selected
- Improved
  - None selected

6.6 Wildlife Response – ALARP Assessment

Alternative, Additional and Improved options have been identified and assessed against the base capability described in Section 5 with those that have been selected for implementation highlighted in green. Items highlighted in red have been considered and rejected on the basis that they are not feasible, the costs are clearly disproportionate to the environmental benefit, and/or the option is not reasonably practical. Control measures where there is not a clear justification for their inclusion or exclusion may be subject to a detailed ALARP assessment.

6.6.1 Existing Capability – Wildlife Response

Woodside's exiting level of capability is based on internal and third-party resources that are available 24 hours, 7 days per week. The capability presented below is displayed as ranges to incorporate operational factors such as weather, crew/vessel/aircraft/vehicle location and duties, survey or classification society inspection requirements, overflight/port/quarantine permits and inspections, crew/pilot duty and fatigue hours, re-fuelling/re-stocking provisions, and other similar logistic and operational limitation that are beyond Woodside's direct control.

6.6.2 Wildlife Response – Control Measure Options Analysis

6.6.2.1 Alternative Control Measures

Table 6-15: Wildlife Response – Control Measure Options considered

Alternative Control Measures considered *Alternative, including potentially more effective and/or novel control measures are evaluated as replacements for an adopted control*				
Option considered	**Environmental consideration**	**Feasibility**	**Cost**	**Implemented**
Direct contracts with service providers	This option duplicates the capability accessed through AMOSC and OSRL and would compete for the same resources. Does not provide a significant increase in environmental benefit.	These delivery options provide increased effectiveness through more direct communication and control of specialists. However, no significant net benefit is anticipated.		No

6.6.2.2 Additional Control Measures

Additional Control Measures considered *Additional control measures are evaluated in terms of them reducing an environmental impact or an environmental risk when added to the existing suite of control measures*				
Option considered	**Environmental consideration**	**Feasibility**	**Cost**	**Implemented**
Additional wildlife treatment systems	The selected delivery options provide access to call-off contracts with selected specialist providers. The agreements ensure that these resources can be mobilised to meet the required response objectives, commensurate with the progressive nature of environmental impact and the time available to monitor hydrocarbon plume trajectories. Provides response equipment and personnel by Day 3. The additional cost in having a dedicated oiled wildlife response (equipment and personnel) in place is disproportionate to environmental benefit. These selected delivery options provide capacity to carry out an oiled wildlife response if contact is predicted; and to scale up the response if required to treat widespread contamination. Current capability meets the needs required and there is no additional environmental benefit in adopting the improvements.	Although hydrocarbon contact above threshold concentrations with offshore waters is expected from Day one, given the low likelihood of such an event occurring and the low environmental benefit of an offshore response, the cost of implementing measures to reduce the mobilisation time is considered disproportionate to the benefit. Additionally, the remote offshore location of the release site with no predicted contact of shoreline receptors provides sufficient opportunity for the ongoing monitoring and surveillance operations to inform the scale of the response. Numbers of oiled wildlife are expected to be low in the remote offshore setting of the oiled wildlife response, given the distance from known aggregation areas. Oiled wildlife response capacity would be addressed for open Commonwealth waters through the AMOSC arrangements, as informed by operational monitoring. The cost and organisational complexity of this approach is moderate, and the overall delivery effectiveness is high.	Additional wildlife response resources could total $1,700 per operational site per day.	No
Additional trained wildlife responders	Current numbers meet the needs required and additional personnel are available through existing contracts with oil spill response organisations and environmental panel contractors. Numbers of oiled wildlife are expected to be low in the remote offshore setting of the oiled wildlife response, given the distance from known aggregation areas. The potential environmental benefit of training additional personnel is expected to be low.	The capability provides the capacity to treat approximately 600 wildlife units (primarily avian fauna) by day six, with additional capacity available from OSRL. Additional equipment and facilities would be required to support ongoing response, depending on the scale of the event and the impact to fauna. Materials for holding facilities, portable pools, enclosures and rehabilitation areas would be sourced as required.	Additional wildlife response personnel cost $2,000 per person per day	No

6.6.2.3 Improved Control Measures

Improved Control Measures considered *Improved control measures are evaluated for improvements they could bring to the effectiveness of adopted control measures in terms of functionality, availability, reliability, survivability, independence and compatibility*				
Option considered	**Environmental consideration**	**Feasibility**	**Cost**	**Implemented**
Faster mobilisation time for wildlife response	Response time is limited by specialist personnel mobilisation time. Current timing is sufficient for expected first shoreline contact. This control measure provides increased effectiveness through faster mobilisation of specialists. However, no significant net environmental benefit is expected due to shoreline stranding times. The cost of having dedicated equipment and personnel available to respond faster is considered grossly disproportionate to the environmental benefit.	Pre-positioning vessels or equipment would reduce mobilisation time for oiled wildlife response activities. However, given the effectiveness of an oiled wildlife response is expected to be low, an earlier response would provide a marginal increase in environmental benefit. The selected delivery options provide the capacity to mobilise an oiled wildlife response capable of treating up to 600 wildlife from at least Day 6 and exceeds the estimated Level four OWR response thought to be applicable. This delivery option provides the maximum expertise pooled across the participating operators, backed up by the international resources provided by OSRL. The availability of vessels and personnel meets the response need.	Wildlife response packages to preposition at vulnerable sites identified through the deterministic modelling cost $700 per package per day.	No

6.6.3 Selected control measures

Following review of alternative, additional and improved control measures as outlined above, the following controls were selected for implementation for the PAP.

- Alternative
  - None selected
- Additional
  - None selected
- Improved
  - None selected

6.7 Scientific Monitoring – ALARP Assessment

been considered and rejected on the basis that they are not feasible, the costs are clearly disproportionate to the environmental benefit, and/or the option is not reasonably practical. Control measures where there is not a clear justification for their inclusion or exclusion may be subject to a detailed ALARP assessment.

6.7.1 Existing Capability – Scientific Monitoring

Woodside's existing level of capability is based on internal and third-party resources that are available 24 hours/7 days. The capability presented below is displayed as ranges to incorporate operational factors such as weather, crew/vessel/aircraft/vehicle location and duties, survey or classification society inspection requirements, overflight/port/quarantine permits and inspections, crew/pilot duty and fatigue hours, re-fuelling/re-stocking provisions, and other similar logistic and operational limitation that are beyond Woodside's direct control.

6.7.2 Scientific Monitoring – Control Measure Options Analysis

Evaluate Alternative, Additional and Improved Control Measures

Alternative Control Measures considered
Alternative, including potentially more effective and/or novel control measures are evaluated as replacements for an adopted control

Ref	Control Measure Category	Option considered	Implemented	Environmental Consideration	Feasibility / Cost
SM01	System	Analytical laboratory facilities closer to the likely spill affected area	No	SM01 water quality monitoring requires water samples to be transported to NATA rated laboratories in Perth or over to the East coast. Consider the benefit of laboratory access and transportation times to deliver water samples and complete lab analysis. There is a time lag from collection of water samples to being in receipt of results and confirming hydrocarbon contact to sensitive receptors). The environmental consideration of having access to suitable laboratory facilities in Karratha to carry out the hydrocarbon analysis would provide faster turnaround in reporting of results only by a matter of days (as per the time to transport samples to laboratories).	Laboratory facilities and staff available at locations closer to the spill affected area can reduce reporting times only to a moderate degree (days) with associated high costs of maintaining capability do not improve the environmental benefit.
SM01	System	Dedicated contracted SMP vessel (exclusive to Woodside)	No	Would provide faster mobilisation time of scientific monitoring resources, environmental benefit associated with faster mobilisation time would be minor compared to selected options.	Chartering and equipping additional vessels on standby for scientific monitoring has been considered. The option is reasonably practicable but the sacrifice (charter costs and organisational complexity) is significant, particularly when compared with the anticipated availability of vessels and resources within in the required timeframes. The selected delivery provides capability to meet the scientific monitoring objectives, including collection of pre-emptive data where baseline knowledge gaps are identified for receptor locations where spill predictions of time to contact are >10 days. The effectiveness of this alternative control (weather dependency, availability and survivability) is rated as very low The cost and organisational complexity of employing a dedicated response vessel is considered disproportionate to the potential environmental benefit by adopting these delivery options.

Additional Control Measures considered
Additional control measures are evaluated in terms of them reducing an environmental impact or an environmental risk when added to the existing suite of control measures

Ref	Control Measure Category	Option considered	Implemented	Environmental Consideration	Feasibility / Cost
SM01	System	Determine baseline data needs and provide implementation plan in the event of an unplanned hydrocarbon release	Yes	Address resourcing needs to collect post spill (pre-contact) baseline data as spill expands in the event of a loss of well containment from the PAP activities.	Woodside rely on existing environmental baseline for receptors which have predicted hydrocarbon contact (above environment threshold) <10 days and acquiring pre-emptive data in the event of a loss of well containment from the PAP activities based on receptors predicted to have hydrocarbon contact >10 days. Ensure there is appropriate baseline for key receptors for all geographic locations that are potentially impacted <10 days of spill event, where practicable. Address resourcing needs to collect pre-emptive baseline as spill expands in the event of a loss of well containment from the PAP activities.

6.7.3 Improved Control Measures

Improved Control Measures considered – No reasonably practicable improved Control Measures identified

6.7.4 Selected Control Measures

Following review of alternative, additional and improved control measures as outlined above, the following controls were selected for implementation for the PAP.

- Alternative
  - None selected
- Additional
  - Determine baseline data needs and activate SMPs for any identified PBAs in the event of an unplanned hydrocarbon release
- Improved
  - None Selected

6.7.5 Operational Plan

Key actions from the Scientific Monitoring Program Operational Plan for implementing the response are outlined in Table 6-16.

Table 6-16: Scientific monitoring program operational plan actions

Responsibility	Action
Activation	
Perth ICC Planning (ICC Planning – Environment Unit)	Mobilises Chief Environmental Scientist/SMP Lead/Manager and SMP Coordinator to the ICC Planning function.
Perth ICC Planning (ICC Planning – Environment Unit) (SMP Lead/Manager and SMP Coordinator)	Constantly assesses all outputs from OM01, OM02 and OM03 (Section 5 and ANNEX B: Operational Monitoring Activation and Termination Criteria **Table B-1: Operational monitoring objectives, triggers and termination criteria**

Responsibility	Action			
	Operational Monitoring Operational Plan	**Objectives**	**Activation triggers**	**Termination criteria**
	Operational Monitoring Operational Plan 1 (OM01) Predictive Modelling of Hydrocarbons to Assess Resources at Risk	OM01 focuses on the conditions that have prevailed since a spill commenced, as well as those that are forecasted in the short term (1–3 days ahead) and longer term. OM01 utilises computer-based forecasting methods to predict hydrocarbon spill movement and guide the management and execution of spill response operations to maximise the protection of environmental resources at risk. The objectives of OM01 are to: • Provide forecasting of the movement and weathering of spilled hydrocarbons • Identify resources that are potentially at risk of contamination • Provide simulations showing the outcome of alternative response options (booming patterns etc.) to inform on-going Net Environmental Benefit Analysis (NEBA) and continually assess the efficacy of available response options in order to reduce risks to ALARP	OM01 will be triggered immediately following a level 2/3 hydrocarbon spill.	The criteria for the termination of OM01 are: • The hydrocarbon discharge has ceased • Response activities have ceased • Hydrocarbon spill modelling (as verified by OM02 surveillance observations) predicts no additional natural resources will be impacted

Responsibility	Action			
	Operational Monitoring Operational Plan 2 (OM02) Surveillance and reconnaissance to detect hydrocarbons and resources at risk	OM02 aims to provide regular, on-going hydrocarbon spill surveillance throughout a broad region, in the event of a spill. The objectives of OM02 are: • Verify spill modelling results and recalibrate spill trajectory models (OM01). • Understand the behaviour, weathering and fate of surface hydrocarbons. • Identify environmental receptors and locations at risk or contaminated by hydrocarbons. • Inform ongoing Net Environmental Benefit Analysis (NEBA) and continually assess the efficacy of available response options in order to reduce risks to ALARP. • To aid in the subsequent assessment of the short- to long-term impacts and/or recovery of natural resources (assessed in SMPs) by ensuring that the visible cause and effect relationships between the hydrocarbon spill and its impacts to natural resources have been observed and recorded during the operational phase.	OM02 will be triggered immediately following a level 2/3 hydrocarbon spill.	The termination triggers for the OM02 are: • 72 hours has elapsed since the last confirmed observation of surface hydrocarbons. • Latest hydrocarbon spill modelling results (OM01) do not predict surface exposures at visible levels.

Responsibility	Action				
	Operational Monitoring Operational Plan 3 (OM03) Monitoring of hydrocarbon presence, properties, behaviour and weathering in water	OM03 will measure surface, entrained and dissolved hydrocarbons in the water column to inform decision-making for spill response activities. The specific objectives of OM03 are as follows: • Detect and monitor for the presence, quantity, properties, behaviour and weathering of surface, entrained and dissolved hydrocarbons. • Verify predictions made by OM01 and observations made by OM02 about the presence and extent of hydrocarbon contamination. Data collected in OM03 will also be used for the purpose of longer-term water quality monitoring during SM01.	OM03 will be triggered immediately following a level 2/3 hydrocarbon spill.	The criteria for the termination of OM03 are as follows: • The hydrocarbon release has ceased. • Response activities have ceased. • Concentrations of hydrocarbons in the water are below available ANZECC/ ARMCANZ (2000) trigger values for 99% species protection.

Responsibility	Action			
	<u>Operational Monitoring Operational Plan 4 (OM04)</u> Pre-emptive assessment of sensitive receptors at risk	OM04 aims to undertake a rapid assessment of the presence, extent and current status of shoreline sensitive receptors prior to contact from the hydrocarbon spill, by providing categorical or semi-quantitative information on the characteristics of resources at risk. The primary objective of OM04 is to confirm understanding of the status and characteristics of environmental resources predicted by OM01 and OM02 to be at risk, to further assist in making decisions on the selection of appropriate response actions and prioritisation of resources. Indirectly, qualitative/semi-quantitative pre-contact information collected by OM04 on the status of environmental resources may also aid in the verification of environmental baseline data and provide context for the assessment of environmental impacts, as determined through subsequent SMPs.	Triggers for commencing OM04 include: • Contact of a sensitive habitat or shoreline is predicted by OM01, OM02 and/or OM03. • The pre-emptive assessment methods can be implemented before contact from hydrocarbons (once a receptor has been contacted by hydrocarbons it will be assessed under OM05).	The criteria for the termination of OM04 at any given location are: • Locations predicted to be contacted by hydrocarbons have been contacted. • The location has not been contacted by hydrocarbons and is no longer predicted to be contacted by hydrocarbons (resources should be reallocated as appropriate).

<table>
<tr><th>Responsibility</th><th>Action</th></tr>
<tr><td></td><td>
<table>
<tr><td><u>Operational monitoring operational plan 5 (OM05)</u>
Monitoring of contaminated resources</td><td>OM05 aims to implement surveys to assess the condition of fauna and habitats contacted by hydrocarbons at sensitive habitat and shoreline locations.
The primary objectives of OM05 are:
• Record evidence of oiled fauna (mortalities, sub-lethal impacts, number, extent, location) and habitats (mortalities, sub-lethal impacts, type, extent of cover, area, hydrocarbon character, thickness, mass and content) throughout the response and clean-up at locations contacted by hydrocarbons to inform and prioritise clean-up efforts and resources, while minimising the potential impacts of these activities.
Indirectly, the information collected by OM05 may also support the assessment of environmental impacts, as determined through subsequent SMPs.</td><td>OM05 will be triggered when a sensitive habitat or shoreline is predicted to be contacted by hydrocarbons by OM01, OM02 and/or OM03.</td><td>The criteria for the termination of OM05 at any given location are:
• No additional response or clean-up of fauna or habitats is predicted.
• Spill response and clean-up activities have ceased.
OM05 survey sites established at sensitive habitat and shoreline locations will continue to be monitored during SM02.
The formal transition from OM05 to SM02 will begin on cessation of spill response and clean-up activities.</td></tr>
</table>
) to determine receptor locations and receptors at risk. Confirm sensitive receptors likely to be exposed to hydrocarbons, timeframes to specific receptor locations and which SMPs are triggered.
Review baseline data for receptors at risk.</td></tr>
<tr><td>Perth ICC Planning
(ICC Planning – Environment Unit)
(SMP Lead/Manager and SMP Coordinator)</td><td>SMP co-ordinator stands up SMP standby contractor as the SMP contractor.
Stands up subject matter experts, if required.</td></tr>
<tr><td>Perth ICC Planning (ICC Planning – Environment Unit)</td><td>Establish if, and where, pre-contact baseline data acquisition is required.
Determines practicable baseline acquisition program based on predicted timescales to contact and anticipated SMP mobilisation times.</td></tr>
</table>

Responsibility	Action
(SMP Lead/Manager SMP Coordinator, SMP standby contractor SMP manager)	Determines scope for preliminary post-contact surveys during the Response Phase. Determines which SMP activities are required at each location based on the identified receptor sensitivities.
Perth ICC Planning (ICC Planning – Environment Unit) (SMP Lead/Manager, SMP Coordinator, SMP standby contractor SMP manager)	If response phase data acquisition is required, stand up the contractor SMP teams for data acquisition and instruct them to standby awaiting further details for mobilisation from the IMT.
Perth ICC Planning (ICC Planning – Environment Unit) (SMP Lead/Manager, SMP Coordinator, SMP standby contactor SMP manager)	SMP contractor, SMP standby contractor to prepare the Field Implementation Plan. Prepare and obtain sign-off of the Response Phase SMP work plan and Field Implementation Plan. Update the IAP.
Perth ICC Planning (ICC Planning – Environment Unit) (SMP Lead/Manager, SMP Coordinator SMP standby contactor SMP manager)	Liaise with ICC Logistics, and determine the status and availability of aircraft, vessels and road transportation available to transport survey personnel and equipment to point of departure. Engage with SMP standby contactor SMP Manager and ICC Logistics to establish mobilisation plan, secure logistics resources and establish ongoing logistical support operations, including: • Vessels, vehicles and other logistics resources • Vessel fit-out specifications (as • Detailed in the Scientific Monitoring Program Operational Plan • Equipment storage and pick-up locations • Personnel pick-up/airport departure locations • Ports of departure • Land based operational centres and forward operations bases Accommodation and food requirements.
Perth ICC Planning (ICC Planning – Environment Unit) (SMP Lead/Manager, SMP Coordinator, SMP standby contactor (SMP manager)	Confirm communications procedures between Woodside SMP team, SMP standby contactor SMP Manager, SMP Team Leads and Operations Point Coordinator.
Mobilisation	
Perth ICC Logistics	Engage vessels and vehicles and arrange fitting out as specified by the mobilisation Plan Confirm vessel departure windows and communicate with the Jacob's SMP Manager. Agree SMP mobilisation timeline and induction procedures with the Division and Sector Command Point(s).
Perth ICC Logistics	Coordinate with SMP standby contactor SMP Manager to mobilise teams and equipment according to the logistics plan and Sector induction procedures.
SMP Survey Team Leads	SMP Survey Team Leader(s) coordinate on-ground/on-vessel mobilisations and support services with the Sector Command point(s).

6.7.6 ALARP and Acceptability Summary

ALARP and Acceptability Summary		
Scientific Monitoring		
ALARP Summary	X	All known reasonably practicable control measures have been adopted
		No additional, alternative and improved control measures would provide further benefit
		No reasonably practical additional, alternative, and/or improved control measure exists
	The resulting scientific monitoring capability has been assessed against the credible spill scenarios. The range of techniques provide an ongoing approach to monitoring operations to assess and evaluate the scale and extent of impacts. All known reasonably practicable control measures have been adopted with the cost and organisational complexity of these options determined to be Moderate and the overall delivery effectiveness considered Medium. The SMP's main objectives can be met, with the addition of alternative control measures to provide further benefit.	
Acceptability Summary	• The control measures selected for implementation manage the potential impacts and risks to ALARP. • In the event of a hydrocarbon spill for the PAP, the control measures selected, meet or exceed the requirements of Woodside Management System and industry best-practice. • Throughout the PAP, relevant Australian standards and codes of practice will be followed to evaluate the impacts from a loss of well containment. • The level of impact and risk to the environment has been considered with regard to the principles of ESD; and risks and impacts from a range of identified scenarios were assessed in detail. The control measures described consider the conservation of biological and ecological diversity, through both the selection of control measures and the management of their performance. The control measures have been developed to account for the worst credible case scenarios, and uncertainty has not been used as a reason for postponing control measures.	
On the basis from the impact assessment above and in Section 6 of the EP Woodside considers the adopted controls discussed manage the impacts and risks associated with implementing scientific monitoring activities to a level that is ALARP and acceptable.		

7 ENVIRONMENTAL RISK ASSESSMENT OF SELECTED RESPONSE TECHNIQUES

The implementation of response techniques may modify the impacts and risks identified in the EP and response activities can introduce additional impacts and risks from response operations themselves. Therefore, it is necessary to complete an assessment to ensure these impacts and risks have been considered and specific measures are put in place to continually review and manage these further impacts and risks to ALARP and Acceptable levels. A simplified assessment process has been used to complete this task which covers the identification, analysis, evaluation and treatment of impacts and risks introduced by responding to the event.

7.1.1 Identification of impacts and risks from implementing response techniques

Each of the control measures can modify the impacts and risks identified in the EP. These impacts and risks have been previously assessed within the scope of the EP. Refer to the EP for details regarding how these risks are being managed. They are not discussed further in this document.

- Atmospheric emissions
- Routine and non-routine discharges
- Physical presence, proximity to other vessels (shipping and fisheries)
- Routine acoustic emissions vessels
- Lighting for night work/navigational safety
- Invasive marine species
- Collision with marine fauna
- Disturbance to Seabed

Additional impacts and risks associated with the control measures not included within the scope of the EP include:

- Vessel operations and anchoring
- Presence of personnel on the shoreline
- Increase in entrained hydrocarbons
- Toxicity of dispersant
- Human presence (manual cleaning)
- Vegetation cutting
- Additional stress or injury caused to wildlife
- Secondary contamination from the management of waste

7.1.2 Analysis of impacts and risks from implementing response techniques

The table below compares the adopted control measures for this activity against the environmental values that can be affected when they are implemented.

Table 7-1: Analysis of risks and impacts

	Environmental Value						
	Soil & Groundwater	**Marine Sediment Quality**	**Water Quality**	**Air Quality**	**Ecosystems/ Habitat**	**Species**	**Socio-Economic**
Monitor and evaluate		✓	✓		✓	✓	
Source control		✓	✓	✓	✓	✓	✓
Shoreline Protection & Deflection	✓	✓	✓		✓	✓	✓
Shoreline Clean-up	✓	✓	✓		✓	✓	✓
Oiled Wildlife					✓	✓	
Scientific Monitoring	✓	✓	✓	✓	✓	✓	✓
Waste Management	✓	✓		✓	✓	✓	✓

7.1.3 Evaluation of impacts and risks from implementing response techniques

Vessel operations and anchoring

Typical booms used in containment and recovery operations are designed to float, meaning that fauna capable of diving, such as cetaceans, marine turtles and seasnakes can readily avoid contact with the boom. Impacts to species that inhabit the water column such as sharks, rays and fish are not expected. Additionally, some fauna, such as cetaceans, are likely to detect and avoid the spill area, and are not expected to be present in the proximity of containment and recovery operations.

During the implementation of response techniques, where water depths allow, it is possible that response vessels will be required to anchor (e.g. during shoreline surveys). The use of vessel anchoring will be minimal and likely to occur when the impacted shoreline is inaccessible via road. Anchoring in the nearshore environment of sensitive receptor locations will have the potential to impact coral reef, seagrass beds and other benthic communities in these areas. Recovery of benthic communities from anchor damage depends on the size of anchor and frequency of anchoring. Impacts would be highly localised (restricted to the footprint of the vessel anchor and chain) and temporary, with full recovery expected.

Distribution of entrained hydrocarbons

Surface dispersant application in intended to treat floating hydrocarbons, thereby reducing the risk of air breathing marine fauna (e.g. cetaceans, dugongs, marine turtles, seabirds and shorebirds) from becoming oiled. It also has the potential to reduce/eliminate contamination of sensitive intertidal habitats such as mangroves, coral reefs, salt marshes and sandy shores (recreational and tourist areas) through the reduction in shoreline loadings.

Chemical dispersants act to break up hydrocarbons by reducing surface tension between the oil and the surrounding water. Dispersants, whether applied on the surface or subsea, result in the breakup of hydrocarbons into micron-sized droplets, which are easier to disperse throughout the water column. These small, dispersed hydrocarbons droplets are degraded by bacteria due to the increased surface area presented by the small droplets. The application of dispersants can enhance biodegradation and dissolution, reducing the volume of hydrocarbons that have the potential to impact shorelines.

Surface application of dispersants results in the micron-sized droplets being mixed into the upper layer of the water column, usually the first 10 to 20m, through wave and wind energy. These elevated concentrations of dispersed hydrocarbons within the upper layer of the water column are rapidly diluted through vertical and horizontal mixing. The application of surface dispersants may result in a greater risk that water column and subtidal habitats could be exposed to elevated concentrations of dispersed hydrocarbons.

Toxicity of dispersants

The evaluation of the potential impacts to the receiving environment needs to consider not only the redistribution of hydrocarbons into the water column, but also the potential toxic nature of the dispersant applied and the toxicity effects of dispersed hydrocarbons.

The potential toxicity to the marine environment can be from the chemical/dispersant itself but also chemical dispersion of hydrocarbon can increase the concentration of toxic hydrocarbon compounds in the water column (Anderson et al 2014). Subtidal habitats and communities such as coral reefs, seagrass meadows, plankton, fish, known spawning grounds and periods of increased reproductive outputs (early life stages of fish and invertebrates i.e. meroplankton) are susceptible to toxic effects of chemically dispersed hydrocarbons.

Presence of personnel on the shoreline

Presence of personnel on the shoreline during shoreline operations could potentially result in disturbance to wildlife and habitats. During the implementation of response techniques, it is possible that personnel may have minimal, localised impacts on habitats, wildlife and coastlines. The impacts associated with human presence on shorelines during shoreline surveys may include:

- Damage to vegetation/habitat to gain access to areas of shoreline oiling;
- Damage or disturbance to wildlife during shoreline surveys;
- Removal of surface layers of intertidal sediments (potential habitat depletion); and
- Excessive removal of substrate causing erosion and instability of localised areas of the shoreline.

Human presence

Human presence for manual clean-up operations may lead to the compaction of sediments and damage to the existing environment especially in sensitive locations such as mangroves and turtle nesting beaches. However, any impacts are expected to be localised with full recovery expected.

Drill cuttings and Drilling Fluids Environmental Impact Assessment for Relief Well Drilling

The identified potential impacts associated with the discharge of drill cuttings and fluids during a relief well drilling activity include a localised reduction in water and seabed sediment quality, and potential localised changes to benthic biota (habitats and communities).

A number of direct and indirect ecological impact pathways are identified for drill cuttings and drilling fluids as follows:

- Temporary increase in total suspended solids (TSS) in the water column;
- Attenuation of light penetration as an indirect consequence of the elevation of TSS and the rate of sedimentation;
- Sediment deposition to the seabed leading to the alteration of the physio-chemical composition of sediments, and burial and potential smothering effects to sessile benthic biota; and
- Potential contamination and toxicity effects to benthic and in-water biota from drilling fluids.

Potential impacts from the discharge of cuttings range from the complete burial of benthic biota in the immediate vicinity of the well site due to sediment deposition, smothering effects from raised sedimentation concentrations as a result of elevated Total Suspended Solids (TSS), changes to the physico-chemical properties of the seabed sediments (particle size distribution and potential for reduction in oxygen levels within the surface sediments due to organic matter degradation by aerobic bacteria) and subsequent changes to the composition of infauna communities to minor sediment loading above background and no associated ecological effects. Predicted impacts are generally confined to within a few hundred metres of the discharge point (International Association of Oil and Gas Producers 2016) (ie within the EMBA for a hydrocarbon spill event).

The discharge of drill cuttings and unrecoverable fluids from relief well drilling is expected to increase turbidity and TSS levels in the water column, leading to an increased sedimentation rate above ambient levels associated with the settlement of suspended sediment particles in close proximity to the seabed or below sea surface, depending on location of discharge. Cuttings with retained (unrecoverable) drilling fluids are discharged below the water line at the MODU location, resulting in drill cuttings and drilling fluids rapidly diluting, as they disperse and settle through the water column. The dispersion and fate of the cuttings is determined by particle size and density of the retained (unrecoverable) drilling fluids, therefore, the sediment particles will primarily settle in proximity to the well locations with potential for localised spread downstream (depending on the speed of currents throughout the water column and seabed) (IOGP 2016). The finer particles will remain in suspension and will be transported further before settling on the seabed.

These conclusions were supported by discharge modelling which was undertaken by Woodside in support of the Greater Enfield Development Environment Plan. Modelling results indicating that the TSS plume of suspended cuttings will typically disperse to the south-west while oscillating with the tide and diminish rapidly with increasing distance from the well locations. Maximum TSS concentrations predicted for 100 m; 250 m and 1 km distances from the wellsite were 7, 5 and 1 mg/L, respectively. Furthermore, water column concentrations below 10 mg/L remain within 235 m of the discharge location for each modelled well. For all well discharge locations (outside of direct discharge sites), TSS concentration did not exceed 10 mg/l. Nelson et al. (2016) identified <10 mg/L as a no effect or sub-lethal minimal effect concentration.

The low sensitivity of the deep-water benthic communities/habitats within and in the vicinity of relief well locations, combined with the relatively low toxicity of WBM and NWBMs, no bulk discharges of NWBM and the highly localised nature and scale of predicted physical impacts to seabed biota indicate that any localised impact would likely be of a slight magnitude (especially when considering the broader consequence of the LOC event a relief well drilling activity would be responding too).

Waste generation

Implementing the selected response techniques will result in the generation of the following waste streams that will require management and disposal:

- Liquids (recovered oil/water mixture), recovered from containment and recovery and shoreline clean-up operations
- Semi-solids/solids (oily solids), collected during containment and recovery and shoreline clean-up operations
- Debris (e.g. seaweed, sand, woods, plastics), collected during containment and recovery and shoreline clean-up operations and oiled wildlife response.

If not managed and disposed of correctly, wastes generated during the response have the potential for secondary contamination similar to that described above, impacts to wildlife through contact with or ingestion of waste materials and contamination risks if not disposed of correctly onshore.

Cutting back vegetation could allow additional oil to penetrate the substrate and may also lead to localised habitat loss. However, any loss is expected to be localised in nature and lead to an overall net environmental benefit associated with the response by reducing exposure of wildlife to oiling.

Additional stress or injury caused to wildlife

Additional stress or injury to wildlife could be caused through the following phases of a response:

- Capturing wildlife
- Transporting wildlife
- Stabilisation of wildlife
- Cleaning and rinsing of oiled wildlife
- Rehabilitation (e.g. diet, cage size, housing density)

- Release of treated wildlife

Inefficient capture techniques have the potential to cause undue stress, exhaustion or injury to wildlife, additionally pre-emptive capture could cause undue stress and impacts to wildlife when there are uncertainties in the forecast trajectory of the spill. During the transportation and stabilisation phases there is the potential for additional thermoregulation stress on captured wildlife. Additionally, during the cleaning process, it is important personnel undertaking the tasks are familiar with the relevant techniques to ensure that further injury and the removal of water proofing feathers are managed and mitigated. Finally, during the release phase it’s important that wildlife is not released back into a contaminated environment.

7.1.4 Treatment of impacts and risks from implementing response techniques

In respect of the impacts and risks assessed the following treatment measures have been adopted. It must be recognised that this environmental assessment is seeking to identify how to maintain the level of impact and risks at levels that are ALARP and of an acceptable level rather than exploring further impact and risk reduction. It is for this reason that the treatment measures identified in this assessment will be captured in Operational Plans, Tactical Response Plans, and/or First Strike Response Plans.

In respect of the impacts and risks assessed the following treatment measures have been adopted. It must be recognised that this environmental assessment is seeking to identify how to maintain the level of impact and risks at levels that are ALARP and of an acceptable level rather than exploring further impact and risk reduction. It is for this reason that the treatment measures identified in this assessment will be captured in Operational Plans, Tactical Response Plans, and/or First Strike Response Plans.

Vessel operations and access in the nearshore environment

- Where existing fixed anchoring points are not available, locations will be selected to minimise impact to nearshore benthic environments with a preference for areas of sandy seabed where they can be identified (PS 13.1, 17.1).
- Shallow draft vessels will be used to access remote shorelines to minimise the impacts associated with seabed disturbance on approach to the shorelines (PS 13.2, 17.2).

Presence of personnel on the shoreline

- Oversight by trained personnel who are aware of the risks (PS 17.6).
- Trained unit leader’s brief personnel of the risks prior to operations (PS 17.7).

Human presence

- Shoreline access route (foot, car, vessel and helicopter) with the least environmental impact identified will be selected by a specialist in SCAT operations (PS 17.4).
- Vehicular access will be restricted on dunes, turtle nesting beaches and in mangroves. (PS 17.3).

Waste generation

- All shorelines zoned and marked before clean-up operations commence to prevent secondary contamination and minimise the mixing of clean and oiled sediment and shoreline substrates (PS 14.5).
- Limiting vegetation removal to only that vegetation that has been moderately or heavily oiled (PS 17.5).

Additional stress or injury caused to wildlife

- Oiled wildlife operations (including hazing) would be implemented with advice and assistance from the Oiled Wildlife Advisor from the DBCA and in accordance with the processes and methodologies described in the WA OWRP and the relevant regional plan (PS 20.3).

8 ALARP CONCLUSION

An analysis of alternative, additional and improved control measures has been undertaken to determine their reasonableness and practicability. The tables in Section 6 document the considerations made in this evaluation. Where the costs of an alternative, additional, or improved control measure has been determined to be clearly disproportionate to the environmental benefit gained from its adoption it has been rejected. Where this is not considered to be the case the control measure has been adopted.

The risks from a hydrocarbon spill have been reduced to ALARP because:

- Woodside has a significant hydrocarbon spill response capability which to respond to the WCCS through the control measures identified.
- New and modified impacts and risks associated with implementing response techniques have been considered and will not increase the risks associated with the activity.
- A consideration of alternative, additional, and improved control measures identified any other control measures that delivered proportionate environmental benefit compared to the cost of adoption for this activity ensuring that:
    - All known, reasonably practicable control measures have been adopted.
    - No additional, reasonably practicable alternative and/or improved control measures would provide further environmental benefit.
    - No reasonably practical additional, alternative, and/or improved control measure exists.
- A structured process for considering alternative, additional, and improved control measures was completed for each control measure.
- The evaluation was undertaken based on the outputs of the WCCS so that the capability in place is sufficient for all other scenario from this activity.
- The likelihood of the WCCS spill has been ignored in evaluating what was reasonably practicable.

9 ENVIRONMENTAL RISK ASSESSMENT OF SELECTED RESPONSE TECHNIQUES

The implementation of response techniques may modify the impacts and risks identified in the EP and response activities can introduce additional impacts and risks from response operations themselves. Therefore, it is necessary to complete an assessment to ensure these impacts and risks have been considered and specific measures are put in place to continually review and manage these further impacts and risks to ALARP and Acceptable levels. A simplified assessment process has been used to complete this task which covers the identification, analysis, evaluation and treatment of impacts and risks introduced by responding to the event.

9.1.1 Identification of impacts and risks from implementing response techniques

Each of the control measures can modify the impacts and risks identified in the EP. These impacts and risks have been previously assessed within the scope of the EP. Refer to the EP for details regarding how these risks are being managed. There are not discussed further in this document.

- Atmospheric emissions
- Routine and non-routine discharges
- Physical presence, proximity to other vessels (shipping and fisheries)
- Routine acoustic emissions vessels
- Lighting for night work/navigational safety
- Invasive marine species
- Collision with marine fauna
- Disturbance to Seabed

Additional impacts and risks associated with the control measures not included within the scope of the EP include:

- Vessel operations and anchoring
- Presence of personnel on the shoreline
- Increase in entrained hydrocarbons
- Toxicity of dispersant
- Human Presence (manual cleaning)
- Vegetation cutting
- Additional stress or injury caused to wildlife
- Secondary contamination from the management of waste

9.1.2 Analysis of impacts and risks from implementing response techniques

The table below compares the adopted control measures for this activity against the environmental values that can be affected when they are implemented.

Table 9-1: Analysis of risks and impacts

	Environmental Value						
	Soil & Groundwater	Marine Sediment Quality	Water Quality	Air Quality	Ecosystems/ Habitat	Species	Socio-Economic
Monitor and evaluate		✓	✓		✓	✓	
Source control		✓	✓	✓	✓	✓	✓
Shoreline Protection & Deflection	✓	✓	✓		✓	✓	✓
Shoreline Clean-up	✓	✓	✓		✓	✓	✓
Oiled Wildlife					✓	✓	
Scientific Monitoring	✓	✓	✓	✓	✓	✓	✓
Waste Management	✓	✓		✓	✓	✓	✓

9.1.3 Evaluation of impacts and risks from implementing response techniques

Vessel operations and anchoring

Typical booms used in containment and recovery operations are designed to float, meaning that fauna capable of diving, such as cetaceans, marine turtles and sea snakes can readily avoid contact with the boom. Impacts to species that inhabit the water column such as sharks, rays and fish are not expected. Additionally, some fauna, such as cetaceans, are likely to detect and avoid the spill area, and are not expected to be present in the proximity of containment and recovery operations.

During the implementation of response techniques, where water depths allow, it is possible that response vessels will be required to anchor (e.g. during shoreline surveys). The use of vessel anchoring will be minimal and likely to occur when the impacted shoreline is inaccessible via road. Anchoring in the nearshore environment of sensitive receptor locations will have the potential to impact coral reef, seagrass beds and other benthic communities in these areas. Recovery of benthic communities from anchor damage depends on the size of anchor and frequency of anchoring. Impacts would be highly localised (restricted to the footprint of the vessel anchor and chain) and temporary, with full recovery expected.

Distribution of entrained hydrocarbons

Surface dispersant application in intended to treat floating hydrocarbons, thereby reducing the risk of air breathing marine fauna (e.g. cetaceans, dugongs, marine turtles, seabirds and shorebirds) from becoming oiled. It also has the potential to reduce/eliminate contamination of sensitive intertidal habitats such as mangroves, coral reefs, salt marshes and sandy shores (recreational and tourist areas) through the reduction in shoreline loadings.

Chemical dispersants act to break up hydrocarbons by reducing surface tension between the oil and the surrounding water. Dispersants, whether applied on the surface or subsea, result in the breakup of hydrocarbons into micron-sized droplets, which are easier to disperse throughout the water column. These small, dispersed hydrocarbons droplets are degraded by bacteria due to the increased surface area presented by the small droplets. The application of dispersants can enhance biodegradation and dissolution, reducing the volume of hydrocarbons that have the potential to impact shorelines.

Surface application of dispersants results in the micron-sized droplets being mixed into the upper layer of the water column, usually the first 10 to 20m, through wave and wind energy. These elevated concentrations of dispersed hydrocarbons within the upper layer of the water column are rapidly diluted through vertical and horizontal mixing. The application of surface dispersants may result in a greater risk that water column and subtidal habitats could be exposed to elevated concentrations of dispersed hydrocarbons.

Toxicity of dispersants

The evaluation of the potential impacts to the receiving environment needs to consider not only the redistribution of hydrocarbons into the water column, but also the potential toxic nature of the dispersant applied and the toxicity effects of dispersed hydrocarbons.

The potential toxicity to the marine environment can be from the chemical/dispersant itself but also chemical dispersion of hydrocarbon can increase the concentration of toxic hydrocarbon compounds in the water column (Anderson et al 2014). Subtidal habitats and communities such as coral reefs, seagrass meadows, plankton, fish, known spawning grounds and periods of increased reproductive outputs (early life stages of fish and invertebrates i.e. meroplankton) are susceptible to toxic effects of chemically dispersed hydrocarbons.

Presence of personnel on the shoreline

Presence of personnel on the shoreline during shoreline operations could potentially result in disturbance to wildlife and habitats. During the implementation of response techniques, it is possible that personnel may have minimal, localised impacts on habitats, wildlife and coastlines. The impacts associated with human presence on shorelines during shoreline surveys may include:

- Damage to vegetation/habitat to gain access to areas of shoreline oiling;
- Damage or disturbance to wildlife during shoreline surveys;
- Removal of surface layers of intertidal sediments (potential habitat depletion); and
- Excessive removal of substrate causing erosion and instability of localised areas of the shoreline.

Human presence

Human presence for manual clean-up operations may lead to the compaction of sediments and damage to the existing environment especially in sensitive locations such as mangroves and turtle nesting beaches. However, any impacts are expected to be localised with full recovery expected.

Drill cuttings and Drilling Fluids Environmental Impact Assessment for Relief Well Drilling

The identified potential impacts associated with the discharge of drill cuttings and fluids during a relief well drilling activity include a localised reduction in water and seabed sediment quality, and potential localised changes to benthic biota (habitats and communities).

A number of direct and indirect ecological impact pathways are identified for drill cuttings and drilling fluids as follows:

- Temporary increase in total suspended solids (TSS) in the water column;
- Attenuation of light penetration as an indirect consequence of the elevation of TSS and the rate of sedimentation;
- Sediment deposition to the seabed leading to the alteration of the physio-chemical composition of sediments, and burial and potential smothering effects to sessile benthic biota; and
- Potential contamination and toxicity effects to benthic and in-water biota from drilling fluids.

Potential impacts from the discharge of cuttings range from the complete burial of benthic biota in the immediate vicinity of the well site due to sediment deposition, smothering effects from raised sedimentation concentrations as a result of elevated Total Suspended Solids (TSS), changes to the physico-chemical properties of the seabed sediments (particle size distribution and potential for reduction in oxygen levels within the surface sediments due to organic matter degradation by aerobic bacteria) and subsequent changes to the composition of infauna communities to minor sediment loading above background and no associated ecological effects. Predicted impacts are generally confined to within a few hundred metres of the discharge point (International Association of Oil and Gas Producers 2016) (ie within the EMBA for a hydrocarbon spill event).

The discharge of drill cuttings and unrecoverable fluids from relief well drilling is expected to increase turbidity and TSS levels in the water column, leading to an increased sedimentation rate above ambient levels associated with the settlement of suspended sediment particles in close proximity to the seabed or below sea surface, depending on location of discharge. Cuttings with retained (unrecoverable) drilling fluids are discharged below the water line at the MODU location, resulting in drill cuttings and drilling fluids rapidly diluting, as they disperse and settle through the water column. The dispersion and fate of the cuttings is determined by particle size and density of the retained (unrecoverable) drilling fluids, therefore, the sediment particles will primarily settle in proximity to the well locations with potential for localised spread downstream (depending on the speed of currents throughout the water column and seabed) (IOGP 2016). The finer particles will remain in suspension and will be transported further before settling on the seabed.

These conclusions were supported by discharge modelling which was undertaken by Woodside in support of the Greater Enfield Development Environment Plan. Modelling results indicating that the TSS plume of suspended cuttings will typically disperse to the south-west while oscillating with the tide and diminish rapidly with increasing distance from the well locations. Maximum TSS concentrations predicted for 100 m; 250 m and 1 km distances from the wellsite were 7, 5 and 1 mg/L, respectively. Furthermore, water column concentrations below 10 mg/L remain within 235 m of the discharge location for each modelled well. For all well discharge locations (outside of direct discharge sites), TSS concentration did not exceed 10 mg/l. Nelson et al. (2016) identified <10 mg/L as a no effect or sub-lethal minimal effect concentration.

The low sensitivity of the deep-water benthic communities/habitats within and in the vicinity of relief well locations, combined with the relatively low toxicity of WBM and NWBMs, no bulk discharges of NWBM and the highly localised nature and scale of predicted physical impacts to seabed biota indicate that any localised impact would likely be of a slight magnitude (especially when considering the broader consequence of the LOC event a relief well drilling activity would be responding too).

Waste generation

Implementing the selected response techniques will result in the generation of the following waste streams that will require management and disposal:

- Liquids (recovered oil/water mixture), recovered from containment and recovery and shoreline clean-up operations
- Semi-solids/solids (oily solids), collected during containment and recovery and shoreline clean-up operations
- Debris (e.g. seaweed, sand, woods, plastics), collected during containment and recovery and shoreline clean-up operations and oiled wildlife response.

If not managed and disposed of correctly, wastes generated during the response have the potential for secondary contamination similar to that described above, impacts to wildlife through contact with or ingestion of waste materials and contamination risks if not disposed of correctly onshore. Woodside's waste management technique to manage the potential volumes of waste generated by the selected response techniques

Cutting back vegetation could allow additional oil to penetrate the substrate and may also lead to localised habitat loss. However, any loss is expected to be localised in nature and lead to an overall net environmental benefit associated with the response by reducing exposure of wildlife to oiling.

Additional stress or injury caused to wildlife

Additional stress or injury to wildlife could be caused through the following phases of a response:

- Capturing wildlife
- Transporting wildlife
- Stabilisation of wildlife
- Cleaning and rinsing of oiled wildlife

- Rehabilitation (e.g. diet, cage size, housing density)
- Release of treated wildlife

Inefficient capture techniques have the potential to cause undue stress, exhaustion or injury to wildlife, additionally pre-emptive capture could cause undue stress and impacts to wildlife when there are uncertainties in the forecast trajectory of the spill. During the transportation and stabilisation phases there is the potential for additional thermoregulation stress on captured wildlife. Additionally, during the cleaning process, it is important personnel undertaking the tasks are familiar with the relevant techniques to ensure that further injury and the removal of water proofing feathers are managed and mitigated. Finally, during the release phase it’s important that wildlife is not released back into a contaminated environment.

9.1.4 Treatment of impacts and risks from implementing response techniques

In respect of the impacts and risks assessed the following treatment measures have been adopted. It must be recognised that this environmental assessment is seeking to identify how to maintain the level of impact and risks at levels that are ALARP and of an acceptable level rather than exploring further impact and risk reduction. It is for this reason that the treatment measures identified in this assessment will be captured in Operational Plans, Tactical Response Plans, and/or First Strike Response Plans.

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Vessel operations and access in the nearshore environment

- Where existing fixed anchoring points are not available, locations will be selected to minimise impact to nearshore benthic environments with a preference for areas of sandy seabed where they can be identified (PS 13.1, 17.1).
- Shallow draft vessels will be used to access remote shorelines to minimise the impacts associated with seabed disturbance on approach to the shorelines (PS 13.2, 17.2).

Presence of personnel on the shoreline

- Oversight by trained personnel who are aware of the risks (PS 17.6).
- Trained unit leader’s brief personnel of the risks prior to operations (PS 17.7).

Human presence

- Shoreline access route (foot, car, vessel and helicopter) with the least environmental impact identified will be selected by a specialist in SCAT operations (PS 17.4).
- Vehicular access will be restricted on dunes, turtle nesting beaches and in mangroves. (PS 17.3).

Waste generation

- All shorelines zoned and marked before clean-up operations commence to prevent secondary contamination and minimise the mixing of clean and oiled sediment and shoreline substrates (PS 14.5).
- Limiting vegetation removal to only that vegetation that has been moderately or heavily oiled (PS 17.5).

Additional stress or injury caused to wildlife

- Oiled wildlife operations (including hazing) would be implemented with advice and assistance from the Oiled Wildlife Advisor from the DBCA and in accordance with the processes and methodologies described in the WA OWRP and the relevant regional plan (PS 20.3).

10 ALARP CONCLUSION

An analysis of alternative, additional and improved control measures has been undertaken to determine their reasonableness and practicability. The tables in Section 6 document the considerations made in this evaluation. Where the costs of an alternative, additional, or improved control measure has been determined to be grossly disproportionate to the environmental benefit gained from its adoption it has been rejected. Where this is not considered to be the case the control measure has been adopted.

The risks from a hydrocarbon spill have been reduced to ALARP because:

- Woodside has a significant hydrocarbon spill response capability with which to respond to the WCCS through the control measures identified.
- New and modified impacts and risks associated with implementing response techniques have been considered and will not increase the risks associated with the activity.
- A consideration of alternative, additional, and improved control measures identified any other control measures that delivered proportionate environmental benefit compared to the cost of adoption for this activity ensuring that:
    - All known, reasonably practicable control measures have been adopted.
    - No additional, reasonably practicable alternative and/or improved control measures would provide further environmental benefit.
    - No reasonably practical additional, alternative, and/or improved control measure exists.
- A structured process for considering alternative, additional, and improved control measures was completed for each control measure.
- The evaluation was undertaken based on the outputs of the WCCS so that the capability in place is sufficient for all other scenario from this activity.
- The likelihood of the WCCS spill has been ignored in evaluating what was reasonably practicable.

11 ACCEPTABILITY CONCLUSION

Following the ALARP evaluation process, Woodside deems the hydrocarbon spill risks and impacts to have been reduced to an acceptable level by meeting all of the following criteria:

- Techniques are consistent with Woodside's processes and relevant internal requirements including policies, culture, processes, standards, structures and systems.
- Levels of risk/ impact are deemed acceptable by relevant persons (external stakeholders) and are aligned with the uniqueness of, and/or the level of protection assigned to the environment, its sensitivity to pressures introduced by the activity, and the proximity of activities to sensitive receptors, and have been aligned with Part 3 of the Environment Protection and Biodiversity Conservation Act 1999 (EPBC).
- Selected control measures meet requirements of legislation and conventions to which Australia is a signatory e.g. MARPOL, the World Heritage Convention, the Ramsar Convention, and the Biodiversity Convention etc. In addition to these, other non-legislative requirements to which Woodside adheres include:
  - Australian International Union for Conservation of Nature (IUCN) reserve management principles for Commonwealth marine protected areas and bioregional marine plans.
  - National Water Quality Management Strategy and supporting guidelines.
  - Conditions of approval set under other legislation.
  - National and international requirements for managing pollution from ships.
  - National biosecurity requirements.
- Industry standards, best practices and widely adopted standards and other published materials have been used and referenced when defining acceptable levels. Where these are inconsistent with mandatory/ legislative regulations, explanation has been provided for the proposed deviation; any deviation produces the same or a better level of environmental performance (or outcome).

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13 GLOSSARY & ABBREVIATIONS

13.1 Glossary

Term	Description / Definition
ALARP	Demonstration through reasoned and supported arguments that there are no other practicable options that could reasonably be adopted to reduce risks further.
Availability	The availability of a control measure is the percentage of time that it is capable of performing its function (operating time plus standby time) divided by the total period (whether in service or not). In other words, it is the probability that the control has not failed or is undergoing a maintenance or repair function when it needs to be used.
Control	The means by which risk from events is eliminated or minimised.
Control effectiveness	A measure of how well the control measures perform their required function.
Control measure (risk control measure)	The features that eliminate, prevent, reduce or mitigate the risk to environment associated with PAP.
Credible spill scenario	A spill considered by Woodside as representative of maximum volume and characteristics of a spill that could occur as part of the PAP.
Dependency	The degree of reliance on other systems in order for the control measure to be able to perform its intended function.
Incident	An event where a release of energy resulted in or had (with) the potential to cause injury, ill health, damage to the environment, damage to equipment or assets or company reputation.
Major Environment Event	The events with potential environment, reputation, social or cultural consequences of category C or higher (as per Woodside's operational risk matrix) which are evaluated against credible worst-case scenarios which may occur when all controls are absent or have failed.
Performance outcome	A statement of the overall goal or outcome to be achieved by a control measure
Performance standard	The parameters against which [risk] controls are assessed to ensure they reduce risk to ALARP. A statement of the key requirements (indicators) that the control measure has to achieve in order to perform as intended in relation to its functionality, availability, reliability, survivability and dependencies.
Preparedness	Measures taken before an incident in order to improve the effectiveness of a response
Reasonably practicable	... a computation ... made by the owner, in which the quantum of risk is placed on one scale and the sacrifice involved in the measures necessary for averting the risk (whether in money, time or trouble) [showing whether or not] that there is a gross disproportion between them ... made by the owner at a point of time anterior to the accident. (Judgement: Edwards v National Coal Board [1949])
Receptors at risk	Physical, biological and social resources identified as at risk from hydrocarbon contact using oil spill modelling predictions.
Receptor areas	Geographically referenced areas such as bays, islands, coastlines and/or protected area (WHA, Commonwealth or State marine reserve or park) containing one or more receptor type, e.g., [location].

Term	Description / Definition
Receptor Sensitivities	This is a classification scheme to categorise receptor sensitivity to an oil spill. The Environmental Sensitivity Index (ESI) is a numerical classification of the relative sensitivity of a particular environment (particularly different shoreline types) to an oil spill. Refer to the Woodside Oil Pollution Emergency Arrangements (Australia) for more details.
Regulator	NOPSEMA are the Environment Regulator under the Environment Regulations.
Reliability	The probability that at any point in time a control measure will operate correctly for a further specified length of time.
Response technique	The key priorities and objectives to be achieved by the response plan Measures taken in response to an event to reduce or prevent adverse consequences.
Survivability	Whether or not a control measure is able to survive a potentially damaging event is relevant for all control measures that are required to function after an incident has occurred.
Threshold	Hydrocarbon threshold concentrations applied to the risk assessment to evaluate hydrocarbon spills. These are defined as: surface hydrocarbon concentration – ≥10 g/m^2, dissolved – ≥100 ppb and entrained hydrocarbon concentrations – ≥500 ppb.
Zone of Consequence	The summary of quantitative modelling where the marine environment could be exposed to hydrocarbons levels exceeding hydrocarbon threshold concentrations.
Zone of Application	The zone in which Woodside may elect to apply dispersant. The zone is determined based on a range of considerations, such as hydrocarbon characteristics, weathering and metocean conditions. The zone is a key consideration in the Net Environmental Benefit Analysis for dispersant use.

13.2 Abbreviations

Abbreviation	Meaning
ADIOS	Automated Data Inquiry for Oil Spills
AIIMS	Australasian Inter-Service Incident Management System
ALARP	As low as reasonably practicable
AMOSC	Australian Marine Oil Spill Centre
AMP	Australian Marine Park
AMSA	Australian Maritime Safety Authority
APASA	Asia Pacific ASA
BAOAC	Bonn Agreement Oil Appearance Code
BOP	Blowout Preventer
CAR	Containment and Recovery
CICC	Corporate Incident Coordination Centre
CMR	Commonwealth Marine Reserve
DM	Duty Manager
DoT	Western Australia Department of Transport
DBCA	Western Australia Department of Biodiversity, Conservation and Attractions (former Western Australian Department of Parks and Wildlife)
EMBA	Environment that May Be Affected
EMSA	European Maritime Safety Agency
EP	Environment Plan
Environment Regulations	Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009
ESI	Environmental Sensitivity Index
ESD	Emergency Shut Down
ESP	Environmental Services Panel
FPSO	Floating Production Storage Offloading
FSRP	First Strike Response Plan
GIS	Geographic Information System
GPS	Global Positioning System
HSP	Hydrocarbon Spill Preparedness
IAP	Incident Action Plan
ICC	Incident Coordination Centre
IMT	Incident Management Team
IPIECA	International Petroleum Industry Environment Conservation Association
ITOPF	International Tanker Owners Pollution Federation
IUCN	International Union for Conservation of Nature
KBSF	King Bay Support Facility
KICC	Karratha Incident Coordination Centre
KSAT	Kongsberg Satellite
ME	Monitor and Evaluate

Abbreviation	Meaning
MODU	Mobile Offshore Drilling Unit
MoU	Memorandum of Understanding
NEBA	Net Environmental Benefit Analysis
NOAA	National Oceanic and Atmospheric Administration
NRT	National Response Team
OILMAP	Oil Spill Model and Response System
OPEA	Oil Pollution Emergency Arrangements
OPEP	Oil Pollution Emergency Plan
OPGGSA	Offshore Petroleum and Greenhouse Gas Storage Act
OSCA	Oil Spill Cleaning Agent registered for use within the National Plan
OSMP	Operational and Scientific Monitoring Program
OSRL	Oil Spill Response Limited
OSTM	Oil Spill Trajectory Modelling
OWR	Oiled Wildlife Response
OWRP	Oiled Wildlife Response Plan
OWROP	Regional Oiled Wildlife Response Operational Plan
PAP	Petroleum Activities Program
PEARLS	People, Environment, Asset, Reputation, Livelihood and Services
PBA	Pre-emptive Baseline Areas
PPA	Priority Protection Area
PPB	Parts per billion
PPM	Parts per million
PS	Performance Standard
ROV	Remotely Operated Vehicle(s)
RPA	Response Protection Area
SCAT	Shoreline Contamination Assessment Techniques
SDA	Surface Dispersant Application
SHC	Shoreline Clean-up
SIMAP	Integrated Oil Spill Impact Model System
SSDI	Subsea Dispersant Injection
SFRT	Subsea First Response Toolkit
SMP	Scientific monitoring program
SOP	Standard Operating Procedure
TRP	Tactical Response Plan
WHA	World Heritage Area
WEL	Woodside Energy Limited
Woodside	Woodside Energy Limited
WCC	Woodside Communication Centre
WWCI	Wild Well Control Inc

Abbreviation	Meaning
WCCS	Worst Case Credible Scenario

ANNEX A: NET ENVIRONMENTAL BENEFIT ANALYSIS DETAILED OUTCOMES

A pre-operational NEBA has been conducted to assess the net environmental benefit of different response techniques to selected receptors in the event of an oil spill from the PAP for a loss of well containment of Julimar Condensate from the Julimar Phase 2 Drilling and Subsea Installation. The complete list of potential receptor locations within the EMBA within the PAP is included in Section 6 of the EP.
The locations utilised for the NEBA were limited to the identified RPAs of the PAP identified from modelling (see Section 3 for outline of selection).
These include receptors which have potential for the following:

- Surface contact (>50 g/m^2)
- Shoreline accumulation (100 g/m^2) at any time

The detailed NEBA assessment outcomes are shown below.

The Julimar Phase 2 Drilling and Subsea Installation Preoperational NEBA contains the full assessments.

Table A-1: NEBA assessment technique recommendations for Julimar Condensate

Receptor	Monitor and Evaluate	Containment and Recovery	Dispersant application: sub-sea	Dispersant application: >20 m water depth and >10 km from shore/reefs	Shoreline protection	Shoreline clean-up (manual)	Shoreline clean-up (mechanical)	Shoreline clean-up (chemical)	Oiled Wildlife Response	In situ burning	Mechanical dispersion	Well control and intervention
Ningaloo Coast	Yes	No	No	No	Potentially	Potentially	Potentially	No	Potentially	No	No	No
Rankin Bank	Yes	No	No	No	No	No	No	No	Potentially	No	No	No
Montebello MP	Yes	No	No	No	Potentially	Potentially	Potentially	No	Potentially	No	No	No
Kimberley Coast	Yes	No	No	No	Potentially	Potentially	Potentially	No	Potentially	No	No	No
Eighty Mile Beach	Yes	No	No	No	Potentially	Potentially	Potentially	No	Potentially	No	No	No
Open Ocean	Yes	No	No	No	No	No	No	No	Potentially	No	No	Yes

Overall assessment

Sensitive receptor (Sites identified in EP)	Monitor and Evaluate	Containment and Recovery	Dispersant application: sub-sea	Dispersant application: >20 m water depth and >10 km from shore/reefs	Shoreline protection	Shoreline clean-up (manual)	Shoreline clean-up (mechanical)	Shoreline clean-up (chemical)	Oiled Wildlife Response	In situ burning	Mechanical dispersion	Well control and intervention
Is this response Practicable?	Yes	No	No	No	Potentially	Potentially	Potentially	No	Potentially	No	No	Yes
NEBA identifies Response potentially of Net Environmental Benefit?	Yes	No	No	No	Potentially	Potentially	Potentially	No	Potentially	No	No	Yes

Table A-2: Summary of NEBA assessment technique recommendations for marine diesel

Receptor	Monitor and Evaluate	Dispersant application: sub-sea at spill source	Dispersant application: within defined dispersant application zone	Containment and Recovery	Shoreline protection and deflection	Shoreline clean-up	Shoreline clean-up (mechanical)	Shoreline clean-up (chemical)	Oiled Wildlife Response	In situ burning	Mechanical dispersion
Open Ocean - Commonwealth Waters	Yes	No	No	No	No	No	No	No	Yes	No	No

Overall assessment

Sensitive receptor (Sites identified in EP)	Monitor and Evaluate	Dispersant application: sub-sea at spill source	Dispersant application: within defined dispersant application zone	Containment and Recovery	Shoreline protection and deflection	Shoreline clean-up	Shoreline clean-up (mechanical)	Shoreline clean-up (chemical)	Oiled Wildlife Response	In situ burning	Mechanical dispersion
Is this response Practicable?	Yes	No	No	No	No	No	No	No	Yes	No	No
NEBA identifies Response potentially of Net Environmental Benefit?	Yes	No	No	No	No	No	No	No	Yes	No	No

NEBA Impact Ranking Classification Guidance

To reduce variability between assessments, the following ranking descriptions have been devised to guide the workshop process:

			Degree of impact	Potential duration of impact	Equivalent Woodside Corporate Risk Matrix Consequence Level
Positive	3P	Major	Likely to prevent: • behavioural impact to biological receptors • behavioural impact to socio-economic receptors e.g. changes to day-today business operations, public opinion/behaviours (e.g. avoidance of amenities such as beaches) or regulatory designations.	Decrease in duration of impact by >5 years	N/A
	2P	Moderate	Likely to prevent: • significant impact to a single phase of reproductive cycle of biological receptors • detectable financial impact, either directly (e.g. loss of income) or indirectly (e.g. via public perception), for socio-economic receptors.	Decrease in duration of impact by 1–5 years	N/A
	1P	Minor	Likely to prevent impacts on: • significant proportion of population or breeding stages of biological receptors • socio-economic receptors such as: o significant impact to the sensitivity of protective designation; or o significant and long-term impact to business/industry.	Decrease in duration of impact by several seasons (< 1 year)	N/A
	0	Non-mitigated spill impact	**No detectable difference to unmitigated spill scenario.**		
Negative	1N	Minor	Likely to result in: • behavioural impact to biological receptors • behavioural impact to socio-economic receptors e.g. changes to day-to-day business operations, public opinion/behaviours (e.g. avoidance of amenities such as beaches), or regulatory designations. **[Note 1]**	Increase in duration of impact by several seasons (< 1 year)	Increase in risk by one sub-category, without changing category (e.g. Minor (E) to Minor (D))
	2N	Moderate	Likely to result in: • significant impact to a single phase of reproductive cycle for biological receptors; or • detectable financial impact, either directly (e.g. loss of income) or indirectly (e.g. via public perception), for socio-economic receptors. This level of negative impact is recoverable and unlikely to result in closure of business/industry in the region.	Increase in duration of impact by 1–5 years	Increase in risk by one category (e.g. Minor (D) to Moderate (C or B))
	3N	Major	Likely to result in impacts on: • significant proportion of population or breeding stages of biological receptors • socio-economic receptors resulting in either: o significant impact to the sensitivity of protective designation; or o significant and long-term impact to business/industry.	Increase in duration of impact by >5 years or unrecoverable	Increase in risk by two categories (e.g. Minor (E) to Major (A))

NOTE: the maximum likely impact should be considered; for example, if a spill were to directly impact the behaviour that results in an impact to reproduction and/or the breeding population (such as fish failing to aggregate to spawn), then the score should be a 2 or 3 rather than a 1. Similarly, if a change in behaviour resulted in an increased risk of mortality of a population, then it should be scored as a 2 or 3.

ANNEX B: OPERATIONAL MONITORING ACTIVATION AND TERMINATION CRITERIA

Table B-1: Operational monitoring objectives, triggers and termination criteria

Operational Monitoring Operational Plan	Objectives	Activation triggers	Termination criteria
Operational Monitoring Operational Plan 1 (OM01) Predictive Modelling of Hydrocarbons to Assess Resources at Risk	OM01 focuses on the conditions that have prevailed since a spill commenced, as well as those that are forecasted in the short term (1–3 days ahead) and longer term. OM01 utilises computer-based forecasting methods to predict hydrocarbon spill movement and guide the management and execution of spill response operations to maximise the protection of environmental resources at risk. The objectives of OM01 are to: • Provide forecasting of the movement and weathering of spilled hydrocarbons • Identify resources that are potentially at risk of contamination • Provide simulations showing the outcome of alternative response options (booming patterns etc.) to inform on-going Net Environmental Benefit Analysis (NEBA) and continually assess the efficacy of available response options in order to reduce risks to ALARP	OM01 will be triggered immediately following a level 2/3 hydrocarbon spill.	The criteria for the termination of OM01 are: • The hydrocarbon discharge has ceased • Response activities have ceased • Hydrocarbon spill modelling (as verified by OM02 surveillance observations) predicts no additional natural resources will be impacted

Operational Monitoring Operational Plan	Objectives	Activation triggers	Termination criteria
Operational Monitoring Operational Plan 2 (OM02) Surveillance and reconnaissance to detect hydrocarbons and resources at risk	OM02 aims to provide regular, on-going hydrocarbon spill surveillance throughout a broad region, in the event of a spill. The objectives of OM02 are: • Verify spill modelling results and recalibrate spill trajectory models (OM01). • Understand the behaviour, weathering and fate of surface hydrocarbons. • Identify environmental receptors and locations at risk or contaminated by hydrocarbons. • Inform ongoing Net Environmental Benefit Analysis (NEBA) and continually assess the efficacy of available response options in order to reduce risks to ALARP. • To aid in the subsequent assessment of the short- to long-term impacts and/or recovery of natural resources (assessed in SMPs) by ensuring that the visible cause and effect relationships between the hydrocarbon spill and its impacts to natural resources have been observed and recorded during the operational phase.	OM02 will be triggered immediately following a level 2/3 hydrocarbon spill.	The termination triggers for the OM02 are: • 72 hours has elapsed since the last confirmed observation of surface hydrocarbons. • Latest hydrocarbon spill modelling results (OM01) do not predict surface exposures at visible levels.
Operational Monitoring Operational Plan 3 (OM03) Monitoring of hydrocarbon presence, properties, behaviour and weathering in water	OM03 will measure surface, entrained and dissolved hydrocarbons in the water column to inform decision-making for spill response activities. The specific objectives of OM03 are as follows: • Detect and monitor for the presence, quantity, properties, behaviour and weathering of surface, entrained and dissolved hydrocarbons. • Verify predictions made by OM01 and observations made by OM02 about the presence and extent of hydrocarbon contamination. Data collected in OM03 will also be used for the purpose of longer-term water quality monitoring during SM01.	OM03 will be triggered immediately following a level 2/3 hydrocarbon spill.	The criteria for the termination of OM03 are as follows: • The hydrocarbon release has ceased. • Response activities have ceased. • Concentrations of hydrocarbons in the water are below available ANZECC/ ARMCANZ (2000) trigger values for 99% species protection.

Operational Monitoring <u>Operational Plan</u>	Objectives	Activation triggers	Termination criteria
<u>Operational Monitoring Operational Plan 4 (OM04)</u> Pre-emptive assessment of sensitive receptors at risk	OM04 aims to undertake a rapid assessment of the presence, extent and current status of shoreline sensitive receptors prior to contact from the hydrocarbon spill, by providing categorical or semi-quantitative information on the characteristics of resources at risk. The primary objective of OM04 is to confirm understanding of the status and characteristics of environmental resources predicted by OM01 and OM02 to be at risk, to further assist in making decisions on the selection of appropriate response actions and prioritisation of resources. Indirectly, qualitative/semi-quantitative pre-contact information collected by OM04 on the status of environmental resources may also aid in the verification of environmental baseline data and provide context for the assessment of environmental impacts, as determined through subsequent SMPs.	Triggers for commencing OM04 include: • Contact of a sensitive habitat or shoreline is predicted by OM01, OM02 and/or OM03. • The pre-emptive assessment methods can be implemented before contact from hydrocarbons (once a receptor has been contacted by hydrocarbons it will be assessed under OM05).	The criteria for the termination of OM04 at any given location are: • Locations predicted to be contacted by hydrocarbons have been contacted. • The location has not been contacted by hydrocarbons and is no longer predicted to be contacted by hydrocarbons (resources should be reallocated as appropriate).

Operational Monitoring <u>Operational Plan</u>	**Objectives**	**Activation triggers**	**Termination criteria**
<u>Operational monitoring operational plan 5 (OM05)</u> Monitoring of contaminated resources	OM05 aims to implement surveys to assess the condition of fauna and habitats contacted by hydrocarbons at sensitive habitat and shoreline locations. The primary objectives of OM05 are: • Record evidence of oiled fauna (mortalities, sub-lethal impacts, number, extent, location) and habitats (mortalities, sub-lethal impacts, type, extent of cover, area, hydrocarbon character, thickness, mass and content) throughout the response and clean-up at locations contacted by hydrocarbons to inform and prioritise clean-up efforts and resources, while minimising the potential impacts of these activities. Indirectly, the information collected by OM05 may also support the assessment of environmental impacts, as determined through subsequent SMPs.	OM05 will be triggered when a sensitive habitat or shoreline is predicted to be contacted by hydrocarbons by OM01, OM02 and/or OM03.	The criteria for the termination of OM05 at any given location are: • No additional response or clean-up of fauna or habitats is predicted. • Spill response and clean-up activities have ceased. OM05 survey sites established at sensitive habitat and shoreline locations will continue to be monitored during SM02. The formal transition from OM05 to SM02 will begin on cessation of spill response and clean-up activities.

ANNEX C: OIL SPILL SCIENTIFIC MONITORING PROGRAM

Oil Spill Environmental Monitoring

The following provides some further detail on Woodside's oil spill Scientific Monitoring Program and includes the following:

- The organisation, roles and responsibilities of the Woodside oil spill scientific monitoring team and external resourcing.
- A summary table of the ten scientific monitoring programs as per the specific focus receptor, objectives, activation triggers and termination criteria.
- Details on the oil spill environmental monitoring activation and termination decision-making processes.
- Baseline knowledge and environmental studies knowledge access via geo-spatial metadata databases.
- An outline of the reporting requirements for oil spill scientific monitoring programs.

Oil Spill Scientific Monitoring – Delivery Team Roles and Responsibilities

Woodside Oil Spill Scientific Monitoring Delivery Team

The Woodside science team are responsible for the delivery of the oil spill scientific monitoring. The roles and responsibilities of the Woodside scientific monitoring delivery team are presented in Table C-1 and the organisational structure and Incident Control Centre (ICC) linkage provided in Figure C-1.

Woodside Oil Spill Scientific monitoring program - External Resourcing

In the event of a Level 2 or 3 hydrocarbon release, or any release event with the potential to contact sensitive environmental receptors, scientific monitoring personnel and scientific equipment to implement the appropriate SMPs will be provided by standby SMP contractor who hold a standby contract for SMP via the Woodside Environmental Services Panel (ESP). In the event, that additional resources are required other consultancy capacity within the Woodside ESP will be utilised (as needed and may extend to specialist contractors such as research agencies engaged in long-term marine monitoring programs). In consultation with the standby SMP contractor and/or specialist contractors, the selection, field sampling and approach of the SMPs will be determined by the nature and scale of the spill.

Table C-1: Woodside and Environmental Service Provider – Oil Spill Scientific Monitoring Program Delivery Team Key Roles and Responsibilities

Role	Location	Responsibility
Woodside Roles		
SMP Lead/Manager	Onshore (Perth)	• Approves activated the SMPs based on operational monitoring data provided by the Planning Function • Provides advice to the ICC in relation to scientific monitoring • Provides technical advice regarding the implementation of scientific monitoring • Approves detailed sampling plans prepared for SMPs • Directs liaison between statutory authorities, advisors and government agencies in relation to SMPs.
SMP Co-ordinator	Onshore (Perth)	• Activates the SMPs based on operational monitoring data provided by the Planning Function • Sits in the Planning function of the ICC. • Liaises with other ICC functions to deliver required logistics, resources and operational support from Woodside to support the Environmental Service Provider in delivering on the SMPs. Acts as the conduit for advice from the Chief Environmental Scientist to the Environmental Service Provider • Manages the Environmental Service Provider’s implementation of the SMPs • Liaises with the Environmental Service Provider on delivery of the SMPs • Arranges all contractual matters, on behalf of Woodside, associated with the Environmental Service Provider’s delivery of the SMPs.

Role	Location	Responsibility
Environmental Service Provider Roles		
SMP Standby Contractor – SMP Duty Manager/Project Manager	Onshore (Perth)	• Coordinates the delivery of the SMPs • Provides costings, schedule and progress updates for delivery of SMPs • Determines the structure of the Environmental Service Provider's team to necessitate delivery of the SMPs • Verifies that HSE Plans, detailed sampling plans and other relevant deliverables are developed and implemented for delivery of the SMPs • Directs field teams to deliver SMPs • Arranges all contractual matters, on behalf of Environmental Service Provider, associated with the delivery of the SMPs to Woodside • Manages sub-consultant delivery to Woodside • Provides required personnel and equipment to deliver the SMPs.
SMP Field Teams	Offshore – Monitoring Locations	• Delivers the SMPs in the field consistent with the detailed sampling plans and HSE requirements, within time and budget. • Early communication of time, budget, HSE risks associated with delivery of the SMPs to the Environmental Service Provider – Project Manager • Provides start up, progress and termination updates to the Environmental Service Provider – Project Manager (will be led in-field by a party chief).

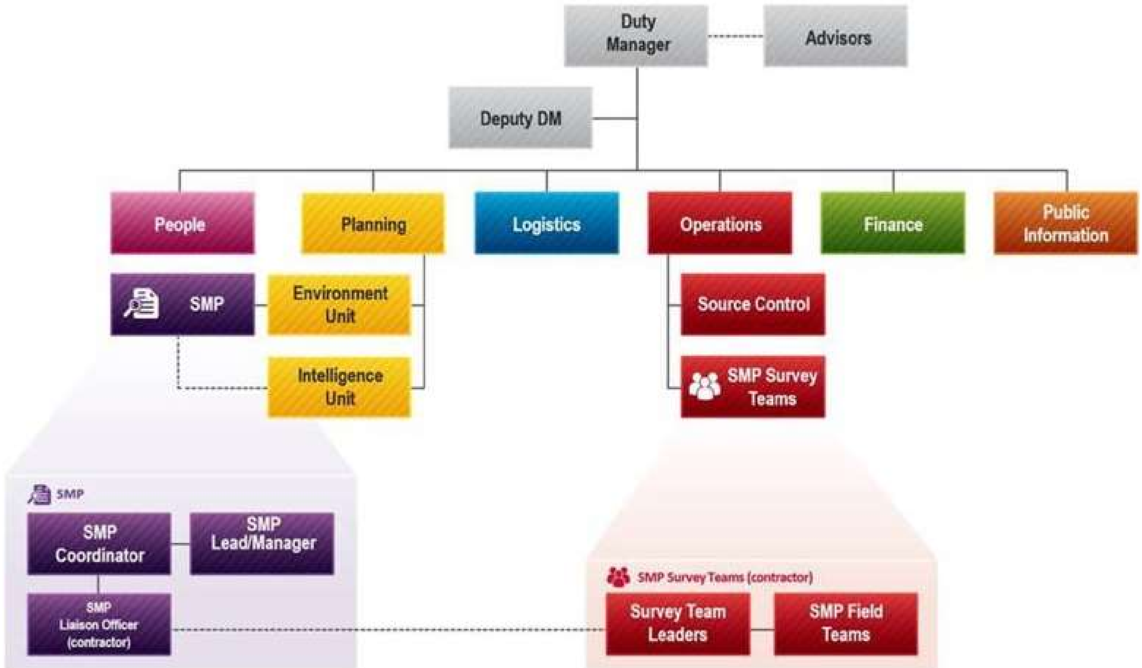

Figure C-1: Woodside Oil Spill Scientific Monitoring Program Delivery Team and Linkage to Incident Control Centre (ICC) organisational structure.

Table C-2: Oil Spill Environmental Monitoring: Scientific Monitoring Program - Objectives, Activation Triggers and Termination Criteria

Scientific monitoring Program (SMP)	Objectives	Activation Triggers	Termination Criteria
Scientific monitoring program 1 (SM01) **Assessment of Hydrocarbons in Marine Waters**	SM01 will detect and monitor the presence, extent, persistence and properties of hydrocarbons in marine waters following the spill and the response. The specific objectives of SM01 are as follows: • Assess and document the extent, severity and persistence of hydrocarbon contamination with reference to observations made during surveillance activities and / or in-water measurements made during operational monitoring; and • Provide information that may be used to interpret potential cause and effect drivers for environmental impacts recorded for sensitive receptors monitored under other SMPs.	SM01 will be initiated in the event of a Level 2 or 3 hydrocarbon release, or any release event with the potential to contact sensitive environmental receptors	SM01 will be terminated when: • Operational monitoring data relating to observations and / or measurements of hydrocarbons on and in water have been compiled, analysed and reported; and • The report provides details of the extent, severity and persistence of hydrocarbons which can be used for analysis of impacts recorded for sensitive receptors monitored under other SMPs. SMP monitoring of sensitive receptor sites: • Concentrations of hydrocarbons in water samples are below ANZECC/ ARMCANZ (2018[6]) default guideline values (DGVs) for biological disturbance; and • Details of the extent, severity and persistence of hydrocarbons from concentrations recorded in water have been documented at sensitive receptor sites monitored under other SMPs.
Scientific monitoring program 2 (SM02) **Assessment of the Presence, Quantity and Character of Hydrocarbons in Marine Sediments**	SM02 will detect and monitor the presence, extent, persistence and properties of hydrocarbons in marine sediments following the spill and the response. The specific objectives of SM02 are as follows: • Determine the extent, severity and persistence of hydrocarbons in marine sediments across selected sites where hydrocarbons were observed or recorded during operational monitoring; and • Provide information that may be used to interpret potential cause and effect drivers for environmental impacts recorded for sensitive receptors monitored under other SMPs.	SM02 will be initiated in the event of a Level 2 or 3 hydrocarbon release, or any release event with the potential to contact sensitive environmental receptors and implemented as follows: • Response activities have ceased; and • Operational monitoring results made during the response phase indicate that shoreline, intertidal or sub-tidal sediments have been exposed to surface, entrained or dissolved hydrocarbons (at or above 0.5 g/m^2 surface, 5 ppb for entrained/dissolved hydrocarbons and ≥1 g/m^2 for shoreline accumulation).	SM02 will be terminated once pre-spill condition is reached and agreed upon as per the SMP termination criteria process and include consideration of: • Concentrations of hydrocarbons in sediment samples are below ANZECC/ ARMCANZ (2013[7]) sediment quality guideline values (SQGVs) for biological disturbance; and • Details of the extent, severity and persistence of hydrocarbons from concentrations recorded in sediments have been documented.
Scientific monitoring program 3 (SM03) **Assessment of Impacts and Recovery of Subtidal and Intertidal Benthos**	The objectives of SM03 are: • Characterize the status of intertidal and subtidal benthic habitats and quantify any impacts to functional groups, abundance and density that may be a result of the spill; and • Determine the impact of the hydrocarbon spill and subsequent recovery (including impacts associated with the implementation of response options). Categories of intertidal and subtidal habitats that may be monitored include: • Coral reefs • Seagrass • Macro-algae • Filter-feeders SM03 will be supported by sediment contamination records (SM02) and characteristics of the spill derived from OMPs.	SM03 will be activated in the event of a Level 2 or 3 hydrocarbon release, or any release event with the potential to contact sensitive environmental receptors and implemented as follows: • As part of a pre-emptive assessment of PBAs of receptor locations identified by time to hydrocarbon contact >10 days, to target receptors and sites where it is possible to acquire pre-hydrocarbon contact baseline; and • Operational monitoring identified shoreline potential contact of hydrocarbons (at or above 0.5 g/m^2 surface, 5 ppb for entrained/dissolved hydrocarbons and ≥1 g/m^2 for shoreline accumulation) for subtidal and intertidal benthic habitat.	SM03 will be terminated once pre-spill condition is reached and agreed upon as per the SMP termination criteria process and include consideration of: • Overall impacts to benthic habitats from hydrocarbon exposure have been quantified. • Recovery of impacted benthic habitats has been evaluated. • Agreement with relevant stakeholders and regulators based on the nature and scale of the hydrocarbon spill impacts and/or that observed impacts can no longer be attributed to the spill.
Scientific monitoring program 4 (SM04) **Assessment of Impacts and Recovery of Mangroves / Saltmarsh**	The objectives of SM04 are: • Characterize the status of mangroves (and associated salt marsh habitat) at shorelines exposed/contacted by spilled hydrocarbons; • Quantify any impacts to species (abundance and density) and mangrove/saltmarsh community structure; and	SM04 will be activated in the event of a Level 2 or 3 hydrocarbon release, or any release event with the potential to contact sensitive environmental receptors and implemented as follows: • As part of a pre-emptive assessment of receptor locations identified by time to hydrocarbon contact >10 days; and	SM04 will be terminated once pre-spill condition is reached and agreed upon as per the SMP termination criteria process and include consideration of: • Impacts to mangrove and saltmarsh habitat from hydrocarbon exposure have been quantified. • Recovery of impacted mangrove/saltmarsh habitat has been evaluated.

[6] http://www.waterquality.gov.au/anz-guidelines, accessed 29th April 2019
[7] Simpson SL, Batley GB and Chariton AA (2013). Revision of the ANZECC/ARMCANZ Sediment Quality Guidelines. CSIRO and Water Science Report 08/07. Land and Water, pp. 132.

Scientific monitoring Program (SMP)	Objectives	Activation Triggers	Termination Criteria
	• Determine and monitor the impact of the hydrocarbon spill and potential subsequent recovery (including impacts associated with the implementation of response options). SM03 will be supported by sediment sampling undertaken in SM02 and characteristics of the spill derived from OMPs.	• Operational monitoring identified shoreline potential contact of hydrocarbons (at or above 0.5 g/m^2 surface, 5 ppb for entrained/dissolved hydrocarbons and ≥1 g/m^2 for shoreline accumulation) for mangrove/saltmarsh habitat.	• Agreement with relevant stakeholders and regulators based on the nature and scale of the hydrocarbon spill impacts and/or that observed impacts can no longer be attributed to the spill.
Scientific monitoring program 5 (SM05) **Assessment of Impacts and Recovery of Seabird and Shorebird Populations**	The Objectives of SM05 are to: • Collate and quantify impacts to avian wildlife from results recorded during OM02 and OM05 (such as mortalities, oiling, rescue and release counts) and undertake a desk-based assessment to infer potential impacts at species population level; and • Undertake monitoring to quantify and assess impacts of hydrocarbon exposure to seabirds and shorebird populations at targeted breeding colonies / staging sites / important coastal wetlands where hydrocarbon contact was recorded.	SM05 will be initiated in the event of a Level 2 or 3 hydrocarbon release, or any release event with the potential to contact sensitive environmental receptors and implemented as follows: • As part of a pre-emptive assessment of receptor locations identified by time to hydrocarbon contact >10 days; • Operational monitoring predicts shoreline contact of hydrocarbons (at or above 0.5 g/m^2 surface, 5 ppb for entrained/dissolved hydrocarbons and ≥1 g/m^2 for shoreline accumulation) at important bird colonies / staging sites / important coastal wetland locations; or • Records of dead, oiled or injured bird species made during the hydrocarbon spill or response.	SM05 will be terminated once it is agreed that the receptor has returned to pre-spill condition. The SMP termination criteria process will be followed and include consideration of: • Impacts to seabird and shorebird populations from hydrocarbon exposure have been quantified. • Recovery of impacted seabird and shorebird populations has been evaluated. • Agreement with relevant stakeholders and regulators based on the nature and scale of the hydrocarbon spill impacts and/or that observed impacts can no longer be attributed to the spill.
Scientific monitoring program 6 (SM06) **Assessment of Impacts and Recovery of Nesting Marine Turtle Populations**	The objectives of SM06 are to: • To quantify impacts of hydrocarbon exposure or contact on marine turtle nesting populations (including impacts associated with the implementation of response options); • Collate and quantify impacts to adult and hatchling marine turtles from results recorded during OM02 and OM05 (such as mortalities, oiling, rescue and release counts) and undertake a desk-based assessment to infer potential impacts at species population levels (including impacts associated with the implementation of response options); .and • Undertake monitoring to quantify and assess impacts of hydrocarbon exposure to nesting marine turtle populations at known rookeries (including impacts associated with the implementation of response options).	SM06 will be initiated in the event of a Level 2 or 3 hydrocarbon release, or any release event with the potential to contact sensitive environmental receptors and implemented if operational monitoring has: • As part of a pre-emptive assessment of receptor locations identified by time to hydrocarbon contact >10 days; • Predicted shoreline contact of hydrocarbons (at or above 0.5 g/m^2 surface, 5 ppb for entrained/dissolved hydrocarbons and ≥1 g/m^2 for shoreline accumulation) at known marine turtle rookery locations; or • Records of dead, oiled or injured marine turtle species made during the hydrocarbon spill or response.	SM06 will be terminated once it is agreed that the receptor has returned to pre-spill condition. The SMP termination criteria process will be followed and include consideration of: • Impacts to nesting marine turtle populations from hydrocarbon exposure have been quantified. • Recovery of impacted nesting marine turtle populations has been evaluated. • Agreement with relevant stakeholders and regulators based on the nature and scale of the hydrocarbon spill impacts and/or that observed impacts can no longer be attributed to the spill.
Scientific monitoring program 7 (SM07) **Assessment of Impacts to Pinniped Colonies including Haul-out Site Populations**	The objectives of SM07 are to: • Quantify impacts on pinniped colonies and haul-out sites as a result of hydrocarbon exposure/contact. • Collate and quantify impacts to pinniped populations from results recorded during OM02 and OM05 (such as mortalities, oiling, rescue and release counts) and undertake a desk-based assessment to infer potential impacts at species population levels.	SM07 will be initiated in the event of a Level 2 or 3 hydrocarbon release, or any release event with the potential to contact sensitive environmental receptors and implemented if operational monitoring has: • As part of a pre-emptive assessment of receptor locations identified by time to hydrocarbon contact >10 days; • Identified shoreline contact of hydrocarbons ((at or above 0.5 g/m^2 surface, ≥5 ppb for entrained/dissolved hydrocarbons and ≥1 g/m^2 for shoreline accumulation) at known pinniped colony or haul-out site(s) (i.e. most northern site is the Houtman Abrolhos Islands); or • Records of dead, oiled or injured pinniped species made during the hydrocarbon spill or response.	SM07 will be terminated once it is agreed that the receptor has returned to pre-spill condition. The SMP termination criteria process will be followed and include consideration of: • Impacts to pinniped populations from hydrocarbon exposure have been quantified. • Recovery of pinniped populations has been evaluated. • Agreement with relevant stakeholders and regulators based on the nature and scale of the hydrocarbon spill impacts and/or that observed impacts can no longer be attributed to the spill.
Scientific monitoring program 8 (SM08) **Desk-Based Assessment of Impacts to Other Non-Avian Marine Megafauna**	The objective of SM08 is to provide a desk-based assessment which collates the results of OM02 and OM05 where observations relate to the mortality, stranding or oiling of mobile marine megafauna species not addressed in SM06 or SM07, including: • Cetaceans; • Dugongs; • Whale sharks and other shark and ray populations; • Sea snakes; and • Crocodiles.	SM08 will be initiated in the event of a Level 2 or 3 hydrocarbon release, or any release event with the potential to contact sensitive environmental receptors and implemented if operational monitoring reports records of dead, oiled or injured non-avian marine megafauna during the spill/ response phase.	SM08 will be terminated when the results of the post-spill monitoring have quantified impacts to non-avian megafauna. • Agreement with relevant stakeholders and regulators based on the nature and scale of the hydrocarbon spill impacts and/or that observed impacts can no longer be attributed to the spill.

Scientific monitoring Program (SMP)	Objectives	Activation Triggers	Termination Criteria
	The desk-based assessment will include population analysis to infer potential impacts to marine megafauna species populations.		
Scientific monitoring program 9 (SM09) **Assessment of Impacts and Recovery of Marine Fish associated with SM03 habitats**	The objectives of SM09 are: • Characterise the status of resident fish populations associated with habitats monitored in SM03 exposed/contacted by spilled hydrocarbons; • Quantify any impacts to species (abundance, richness and density) and resident fish population structure (representative functional trophic groups); and • Determine and monitor the impact of the hydrocarbon spill and potential subsequent recovery (including impacts associated with the implementation of response options).	SM09 will be initiated in the event of a Level 2 or 3 hydrocarbon release, or any release event with the potential to contact sensitive environmental receptors and implemented with SMO3.	SM09 will be undertaken and terminated concurrent with monitoring undertaken for SM03, as per the SMP termination criteria process • Agreement with relevant stakeholders and regulators based on the nature and scale of the hydrocarbon spill impacts and/or that observed impacts can no longer be attributed to the spill.
Scientific monitoring program 10 (SM10) **SM10 - Assessment of physiological impacts important fish and shellfish species (fish health and seafood quality/safety) and recovery**	SM10 aims to assess any physiological impacts to important commercial fish and shellfish species (assessment of fish health) and if applicable, seafood quality/safety. Monitoring will be designed to sample key commercial fish and shellfish species and analyse tissues to identify fish health indicators and biomarkers, for example: • Liver Detoxification Enzymes (ethoxyresorufin-O-deethylase (EROD) activity) • PAH Biliary Metabolites • Oxidative DNA Damage • Serum SDH • Other physiological parameters, such as condition factor (CF), liver somatic index (LSI), gonado-somatic index (GSI) and gonad histology, total weight, length, condition, parasites, egg development, testes development, abnormalities. Seafood tainting may be included (where appropriate) using applicable sensory tests to objectively assess targeted finfish and shellfish species for hydrocarbon contamination. Results will be used to make inferences on the health of commercial fisheries and the potential magnitude of impacts to fishing industries.	SM10 will be initiated in the event of a Level 2 or 3 hydrocarbon release, or any release event with the potential to contact sensitive environmental receptors and implemented if operational monitoring (OM01, OM02 and OM05) indicates the following: • The hydrocarbon spill will or has intersected with active commercial fisheries or aquaculture activities. • Commercially targeted finfish and/or shellfish mortality has been observed/recorded. • Commercial fishing or aquaculture areas have been exposed to hydrocarbons (≥0.5 g/m^2 surface and ≥5 ppb for entrained/dissolved hydrocarbons); and • Taste, odour or appearance of seafood presenting a potential human health risk is observed.	SM10 will be terminated once it is agreed that the receptor has returned to pre-spill condition. The SMP termination criteria process will be followed and include consideration of: • Physiological impacts to important commercial fish and shellfish species from hydrocarbon exposure have been quantified. • Recovery of important commercial fish and shellfish species from hydrocarbon exposure has been evaluated. • Impacts to seafood quality/safety (if applicable) have been assessed and information provided to the relevant stakeholders and regulators for the management of any impacted fisheries. • Agreement with relevant stakeholders and regulators based on the nature and scale of the hydrocarbon spill impacts and/or that observed impacts can no longer be attributed to the spill.

Activation Triggers and Termination Criteria

Scientific monitoring program activation

The Woodside oil spill scientific monitoring team will be stood up immediately with the occurrence of a hydrocarbon spill (actual or suspected) Level 2 or 3 hydrocarbon release, or any release event with the potential to contact sensitive environmental receptors via the First Strike plan for the petroleum activity programme. The presence of any level of hydrocarbons in the marine environment triggers the activation of the oil spill scientific monitoring program (SMP). This is to ensure the full range of eventualities relating to the environmental, socio-economic and health consequences of the spill are considered in the planning and execution of the SMP. The activation process also takes into consideration the management objectives, species recovery plans, conservation advices and conservations plans for any World Heritage Area (WHA), AMPs, State Marine Parks, other protected area designations (e.g., State nature reserves) and Matters of National Environmental Significance (including listed species under part 3 of the EPBC Act) potentially exposed to hydrocarbons. With the first 24-48 hours of a spill event, such information will be sourced and evaluated as part of the SMP planning process guided by Appendix D (identified receptors vulnerable to hydrocarbon contact), the information presented in the Existing Environment section of the EP as well as other information sources such as the Woodside Baseline Environmental Studies Database.

The starting point for decision-making on which SMPs are activated, and the spatial extent of monitoring activities, will be based on the predictive modelling results (OM01) in the first 24-48 hours until more information is made available from other operational monitoring activities such as aerial surveillance and shoreline surveys. Pre-emptive Baseline Areas (WHA, AMPs and State Marine Parks encompassing key ecological and socio-economic values) are a key focus of the SMP activation decision-making process, particularly, in the early spill event/response phase. As the operational monitoring progresses and further situational awareness information becomes available, it will be possible to understand the nature and scale of the spill. The SMP activation and implementation decision-making will be revisited on a daily basis to account for the updates on spill information. One of the priority focus areas in the early phase of the incident will be to identify and execute pre-emptive SMP assessments at key receptor locations, as required. The SMP activation and implementation decision tree is presented in Figure C-2.

Scientific monitoring program termination

The basis of the termination process for the active SMPs (SMPs 1-10) will include quantification of impacts, evaluation of recovery for the receptor at risk and consultation with relevant authorities, persons and organisations. Termination of each SMP will not be considered until the results (as presented in annual SMP reports for the duration of each program) indicate that the target receptor has returned to pre-spill condition.

Once the SMP results indicate impacted receptor(s) have returned to pre-spill condition (as identified by Woodside) a termination decision-making process will be triggered and a number of steps will be undertaken as follows:

- Woodside will engage expert opinion on whether the receptor has returned to pre-spill condition (based on monitoring data). Subject Matter Expert (SMEs) will be engaged (via the Woodside SME scientific monitoring terms of reference to review program outcomes, provide expert advice and recommendations for the duration of each SMP.
- Where expert opinion agrees that the receptor has returned to pre-spill condition, findings will then be presented to the relevant authorities, persons and organisations (as defined by the Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulation 11A). Stakeholder identification, planning and engagement will be managed by Woodside's Reputation Functional Support Team (FST) and follow the stakeholder management FST guidelines. These guidelines outline the FST roles and responsibilities, competencies, stakeholder communications and planning processes. An assessment of the merits of any objection to termination will be documented in the SMP final report.
- Woodside will decide on termination of SMP based on expert opinion and merits of any stakeholder objections. The final report following termination will include: monitoring results, expert opinion and stakeholder consultation including merits of any objections.
- Termination of SMPs will also consider applicable management objectives, species recovery plans, conservation advices and conservations plans for any World Heritage Area (WHA), AMPs,

State Marine Parks, other protected area designations (e.g., State nature reserves) and Matters of National Environmental Significance (including listed species under part 3 of the EPBC Act).

The SMP termination decision-making process will be applied to each active SMP and an iterative process of decision steps continued until each SMP has been terminated (refer to decision-tree diagram for SMP termination criteria, Figure C-3).

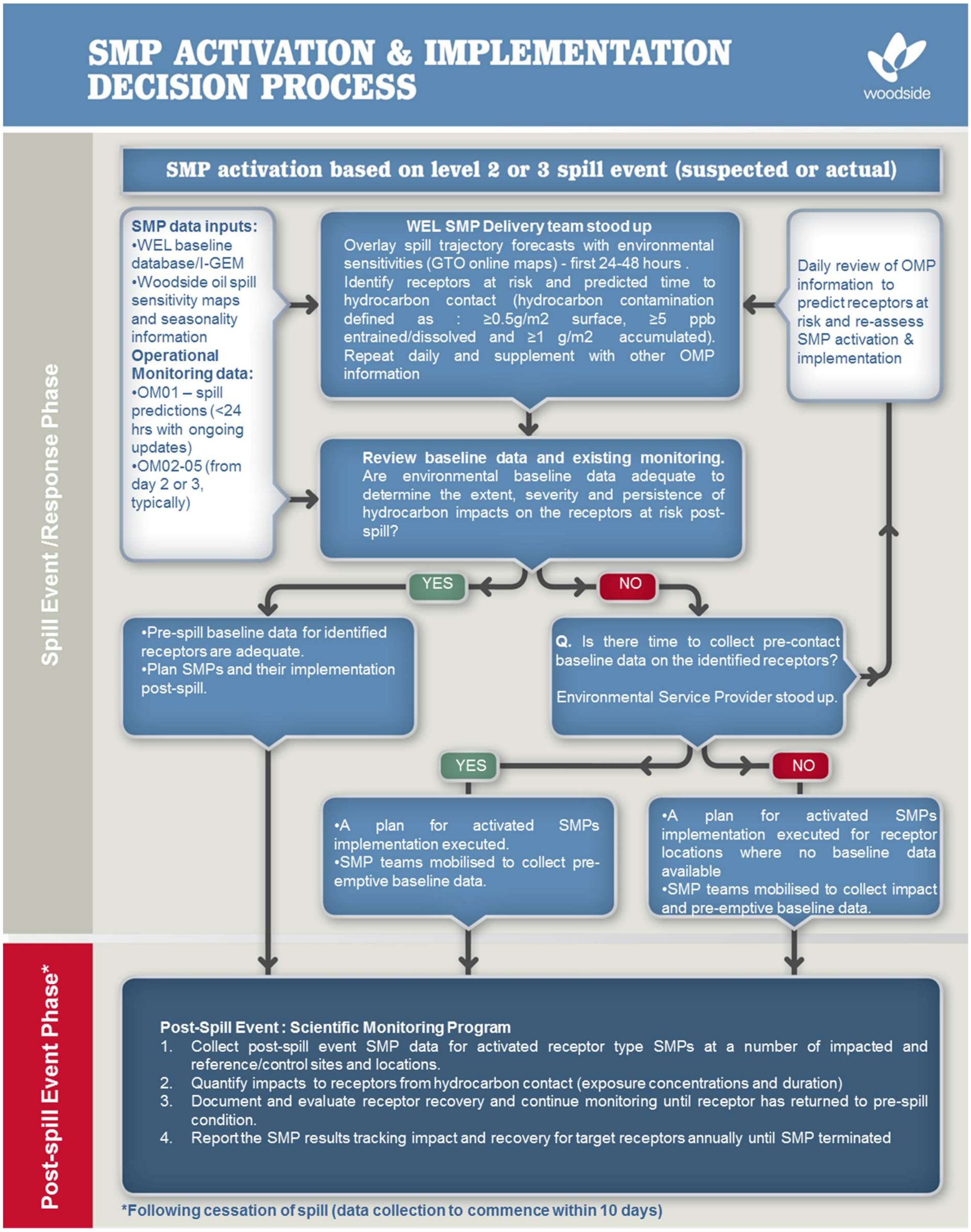

Figure C-2: Activation and Implementation Decision-tree for Oil Spill Environmental Monitoring

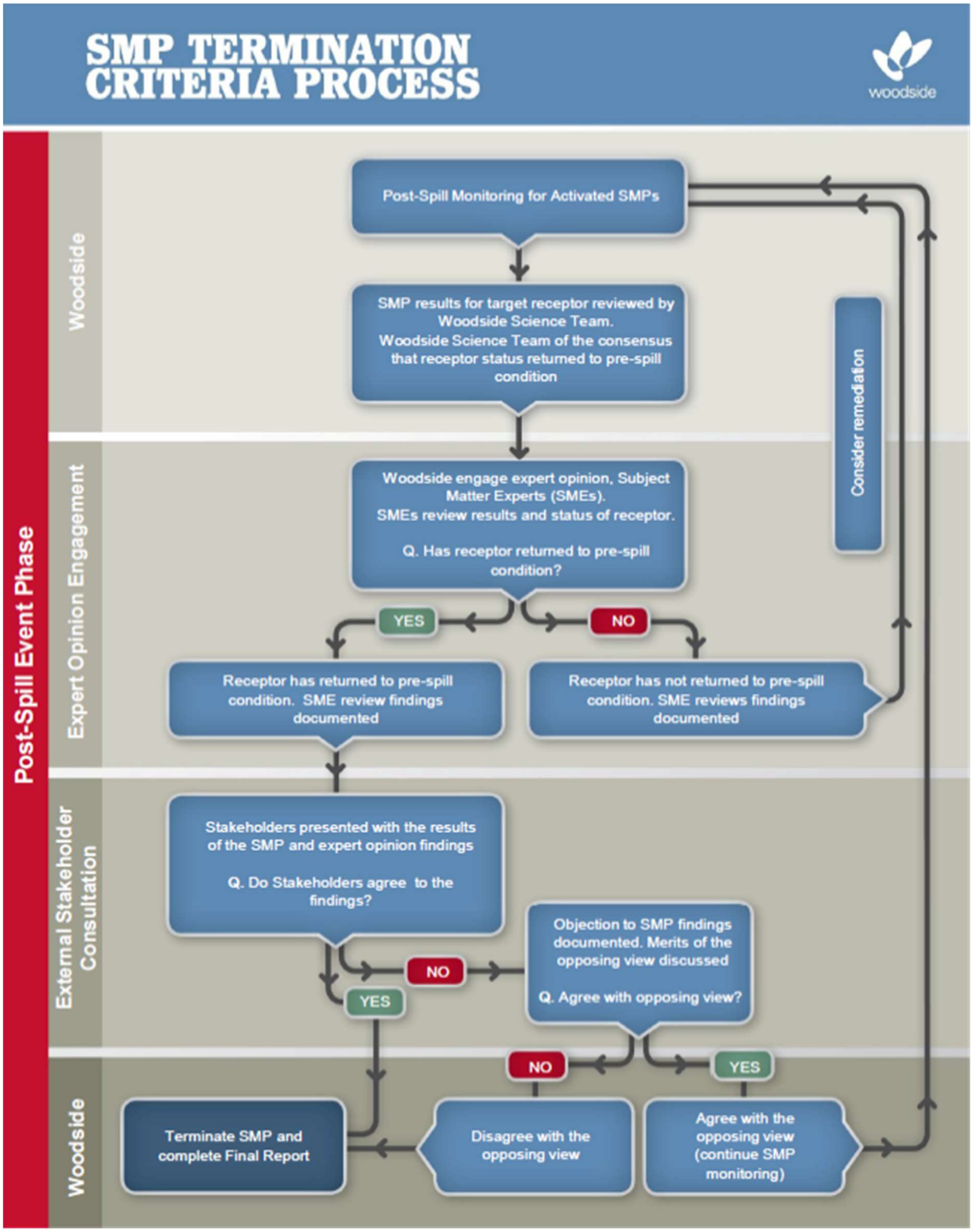

Figure C-3: Termination Criteria Decision-tree for Oil Spill Environmental Monitoring

Receptors at Risk and Baseline Knowledge

In order to assess the baseline studies available and suitability for oil spill scientific monitoring, Woodside maintains knowledge of environmental baseline studies through the upkeep and use of its Environmental Knowledge Management System.

Woodside's Environmental Knowledge Management System is a centralised platform for scientific information on the existing environment, marine biodiversity, Woodside environmental studies, key environmental impact topics, key literature and web-based resources. The system comprises a number of data directories and an environmental baseline database, as well as folders within the 'Corporate Environment' server space. The environmental baseline database was set up to support Woodside's SMP preparedness and as a SMP resource in the event of an unplanned hydrocarbon spill. The environmental baseline database is subject to updates including annual reviews completed as part of the contracted SMP standby, SMP standby contract. This database is accessed pre-PAP to identify Pre-emptive Baseline Areas (PBAs) where hydrocarbon contact is predicted to occur <10 days.

In addition to Woodside's Environmental Knowledge Management System, it is acknowledged that many relevant baseline datasets are held by other organisations (e.g. other oil and gas operators, government agencies, state and federal research institutions and non-governmental organisations). In order to understand the present status of environmental baseline studies a spatial environmental metadata database for Western Australia (Industry-Government Environmental Metadata, I-GEM) was established. IGEM is a collaboration comprising oil and gas operators (including Woodside), government and research agencies and other organisations. The key objective of IGEM is for participating organisations to have the ability to identify quantitative marine baseline datasets available for species and habitats via a geo-spatially referenced metadata database. It provides members the ability to enter, view and filter metadata records on baseline studies as well as customise and generate report outputs. IGEM aims to provide a foundational baseline framework so industry and government can access the same knowledge base to understand baseline data in the event of an unplanned hydrocarbon release.

In the event of an unplanned hydrocarbon release, Woodside intends to interrogate the information on baseline studies status as held by the various databases (e.g. Woodside Environmental Knowledge Management System, IGEM and other sources of existing baseline data) to identify Pre-emptive Baseline Areas (PBAs), i.e., receptors at risk where hydrocarbon contact is predicted to be >10 days, and baseline data can be collected before hydrocarbon contact.

Reporting

For the scientific monitoring program relevant regulators will be provided with:

- Annual reports summarising the SMPs deployed and active, data collection activities and available findings; and
- Final reports for each SMP summarising the quantitative assessment of environmental impacts and recovery of the receptor once returned to pre-spill condition and termination of the monitoring program.

The reporting requirements of the scientific monitoring program will be specific to the individual SMPs deployed and terms of responsibilities, report templates, schedule, QA/QC and peer-review will be agreed with the contractors engaged to conduct the SMPs. Compliance and auditing mechanisms will be incorporated into the reporting terms.

ANNEX D: MONITORING PROGRAM AND BASELINE STUDIES FOR THE PETROLEUM ACTIVITIES PROGRAM

Table D-1: Oil Spill Environmental Monitoring – scientific monitoring program scope for the Petroleum Activities Program based on Spill EMBA for MEE-01 and MEE-05 (Table 2-1)

Receptors to be Monitored	Applicable SMP	Receptor Areas - Potential Impact and Reference Scientific Monitoring Sites (marked X): Kimberley AMP	Agro-Rowley Terrace AMP	Montebello AMP	Dampier AMP	Carnarvon Canyon AMP	Ningaloo AMP	Gascoyne AMP	Shark Bay Open Ocean (including AMP)	Abrolhos AMP	Jurien AMP	Two Rocks AMP	Perth Canyon AMP	Geographe AMP	South-west Corner AMP	Ashmore Reef and AMP	Seringapatam Reef	Scott Reef (North and South)	Mermaid Reef and AMP	Clerke Reef and State Marine Park	Imperieuse Reef and State Marine Park	Rankin Bank	Glomar Shoals	Rowley Shoals (including Sate Maine Park)	Fantome Shoals	Adele Island	Lacepede Islands	Montebello Islands (including State Marine Park)	Lowendal Islands (including State Nature Reserve)	Barrow Island (including State Nature Reserves, State Marine Park and Marine Management Area)	Muiron Islands (WHA, State Marine Park)	Pilbara Islands - Southern Island Group (Serrurier, Thevenard and Bessieres Islands - State Nature Reserves)	Pilbara Islands - Northern Island Group (Sandy Island Passage Islands - State nature reserves)	Abrolhos Islands	Kimberley Coast	Dampier Peninsula	Northern Pilbara Shoreline	Ningaloo Coast (North/North West Cape, Middle and South) (WHA, and State Marine Park)	Shark Bay - Open Ocean Coast	Shark Bay WHA	Ngari Capes State Marine Park
Habitat																																									
Water Quality	SM01	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Marine Sediment Quality	SM02	X		X		X		X	X	X	X	X				X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Coral Reef	SM03	X		X												X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X			X	X	X	X	X	X	X	
Seagrass / Macro-Algae	SM03	X									X					X	X	X									X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Deeper Water Filter Feeders	SM03	X			X	X	X							X	X		X	X	X	X	X	X	X	X	X						X							X			
Mangroves and Saltmarsh	SM04																											X						X	X	X	X	X		X	
Species																																									
Sea Birds and Migratory Shorebirds (significant colonies / staging sites / coastal wetlands)	SM05	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X					X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Marine Turtles (significant nesting beaches)	SM06	X	X	X	X		X	X	X							X	X	X	X	X	X						X	X	X	X	X	X	X	X	X	X	X	X	X	X	
Pinnipeds (significant colonies / haul-out sites)	SM07									X	X	X			X																										X
Cetaceans - Migratory Whales	SM08	X	X	X	X		X	X	X	X	X	X	X	X	X			X									X	X	X	X	X			X	X	X		X		X	X
Oceanic and Coastal Cetaceans	SM08	X	X	X	X		X	X	X	X			X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Dugongs	SM08	X							X							X												X	X	X	X	X	X		X	X	X	X	X	X	
Sea Snakes	SM08	X		X	X			X	X	X						X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	
Whale Sharks	SM08			X			X	X										X										X	X	X	X							X			
Other Shark and Ray Populations	SM08, SM09	X	X	X	X		X	X	X	X	X			X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Fish Assemblages	SM09	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Socio-economic																																									
Fisheries - Commercial	SM10		X	X	X	X	X	X	X	X	X	X										X	X	X	X			X	X	X		X	X	X	X	X	X	X	X	X	X
Fisheries - Traditional	SM10															X	X	X									X													X	
Tourism (incl. recreational fishing)	SM10	X		X			X	X	X		X			X	X	X	X	X	X	X	X	X	X	X				X	X	X	X	X	X	X	X	X	X	X	X	X	X

(dark red)	Receptor areas identified as Pre-emptive Baseline Areas (based on criteria of surface contact and/or entrained hydrocarbon contact ≤10 days (Offshore Australian Marine Parks contacted by hydrocarbons in this timeframe also noted)
(light red)	Receptor areas identified as Pre-Emptive Basline Areas in the response phase >10 days (based on criteria of surface contact and/or entrained hydrocarbon contact >10 days)
(white)	Receptor areas that may be identified as impact or reference sites in the event of major hydrocarbon release and would be identified as part of the SMP planning process

Table D-2: Baseline Studies for the SMPs applicable to identified Pre-emptive Baseline Areas for the Petroleum Activities Program

Major Baseline	Proposed Scientific monitoring operational plan and Methodology	Ningaloo and Muiron Islands	Montebello Islands	Barrow Island	Lowendal Islands	Rankin Bank	Pilbara Islands – Southern Island Group (Serrurier, Thevenard and Bessieres Islands – State Nature Reserve)
Benthic Habitat (Coral Reef)	SM03 Quantitative assessment using image capture using either diver held camera or towed video. Post analysis into broad groups based on taxonomy and morphology.	Studies:					
		AIMS/BCA 2014 Baseline Ningaloo and Muiron Islands Survey – repeat and expansion on the LTM (Co-funded survey: Woodside and AIMS). AIMS Long Term Monitoring (LTM) Ningaloo Reef programme: 1995 and 2002. DBCA LTM Ningaloo Reef programme: 1991, 1994, 1998, 1999, 2001, 2005, 2006, 2010, 2011, 2012 and 2015. (WAMSI LTM Study:) Ningaloo Research node: 2009 -10 over the length of Ningaloo reef system (with a focus on coral and fish recruitment). Ningaloo Outlook (CSIRO) - Shallow and Deep Reefs Program (2015). Ningaloo Collaboration Cluster: Habitats of the Ningaloo Reef and adjacent coastal areas determined through hyperspectral imagery. Australian Institute of Marine Science – CReefs: Ningaloo Reef Biodiversity Expeditions (2008-2010). Le Nohaic et al. 2017.Marine heatwave causes unprecedented Regional Mass Bleaching in NW Australia Coral Bay Location).	1. Broad benthic habitat classifications and habitat maps for the Montebello islands by DBCA. 2. Coral monitoring at sites across Barrow Island, Lowendal and the Montebello islands. Most recent survey 2012. 3. Benthic community monitoring as part of DBCA Western Australian Marine Monitoring Program (2015-ongoing. 4. Pilbara Marine Conservation Partnership Seabed biodiversity survey (2013).	Chevron LTM of corals for the Gorgon Gas Development. Marine Baseline Program (2008), Marine Monitoring Program (2010) Post Development Surveys (2011 – 2013). Coral monitoring at sites around Barrow Island, Lowendal and the Montebello islands. Most recent survey 2012. Benthic community (coral, seagrass and macroalgae) monitoring as part of DBCA's Western Australian Marine Monitoring Program (2015-ongoing). Pilbara Marine Conservation Partnership Seabed biodiversity survey (2013).	Benthic habitats surrounding the Lowendal Islands for the Gorgon Gas Development. Coral assemblages on the eastern side of Double Island, and coral bommies on the south-western edge of the Lowendal Shelf. Coral monitoring at sites across Barrow Island, Lowendal and the Montebello islands. Most recent survey 2012. Pilbara Marine Conservation Partnership Seabed biodiversity survey (2013).	Glomar Shoals and Rankin Bank baseline survey, 2013, quantitatively surveyed benthic habitats and communities. Habitat assessment of an area southeast of Rankin Bank. North West Atlas: what do we know about Glomar Shoal and Rankin Bank. Glomar Shoals and Rankin Bank Monitoring survey (2017).	1. Benthic habitat mapping of the subtidal and intertidal habitats of the islands and shoals. Coral communities in shallow subtidal habitat, intertidal pavement. 2. Coral monitoring at Varanus and Airlie Islands (2000 to present) to identify corals, growth from and percentage cover. 3. Pilbara Marine Conservation Partnership Seabed biodiversity survey (2013; 2016).
		Methods:					
		1. LTM sites, transects, diver-based video quadrat. 2. LTM transects, diver based (video) photo quadrat. 3. Video point intercept transects recorded by towed video or diver hand-held video camera. 4. Video transects. 5. LTM transects, diver based (video) photo quadrat. 6. LTM transects, diver based (video) photo quadrat. 7. LTM transects, diver based (video) photo quadrats, specimen collection 8. Intertidal walks and snorkelling transects with photo quadrats. In situ water temperature loggers deployed for survey period.	1. Habitat mapping. 2. Quantitative assessment details not available. 3. Drop camera. (not in the hardcopy) 4. Fixed long-term monitoring sites. Diver video transect. 5. Towed video, benthic trawl and sled.	1. Belt transect, size class frequency, video transects, photo quadrat, tagged colonies and terracotta tiles for coral recruitment. 2. Quantitative assessment details not available. 3. Fixed long-term monitoring sites. Diver video transects. 4. Towed camera, benthic trawl and sled.	Benthic habitat mapping, diver swum transects, tagged colonies. Quantitative assessment details not available. Towed video, benthic trawl and sled.	Towed video transects, Photo quadrats using towed video system. Towed video transects. Towed video. Towed Video.	1. ROV transects. 2. ROV transects and driver surveys. 3. Towed video, benthic trawl and sled.
		References and Data:					

Major Baseline	Proposed Scientific monitoring operational plan and Methodology	Ningaloo and Muiron Islands	Montebello Islands	Barrow Island	Lowendal Islands	Rankin Bank	Pilbara Islands – Southern Island Group (Serrurier, Thevenard and Bessieres Islands – State Nature Reserve)
		1. AIMS 2014. DATAHOLDER: AIMS. 2. AIMS unpublished data. DATAHOLDER: AIMS. 3. DBCA unpublished data. DATAHOLDER: DBCA 4. Depczynski et al. 2011. DATAHOLDER: AIMS, DBCA and WAMSI. 5. CSIRO 2015. Damian Thompson (shallow reefs) and Russell Babcock (Deep reefs) 6. Murdoch University - Kobryn et al 2011 and Keulen and Langdon 2011. 7. AIMS (2010) - http://www.aims.gov.au/creefs 8. Verna Shoepf at University of Western Australia (UWA) and Western Australian Marine Science Institution, Perth, email: verena.schoepf@uwa.edu.au)	1. DBCA 2007. DATAHOLDER: DBCA. 2. RPS, 2012. DATAHOLDER: Santos. 3. DATAHOLDER: DBCA. 4. Pitcher et al. (2016). DATAHOLDER: CSIRO.	1. Baseline: Chevron Australia 2010. Marine Monitoring Program: Chevron Australia 2011 Post Dredge: Chevron Australia 2013 DATAHOLDER: Chevron Australia. 2. RPS, 2012. DATAHOLDER: Santos. 3. Bancroft 2009. DATAHOLDER: DoEE. 4. Pitcher et al. (2016). DATAHOLDER: CSIRO.	1. RPS-Bowman Bishaw Gorham 2005. DATAHOLDER: Chevron. 2. RPS, 2012. DATAHOLDER: Santos. 3. Pitcher et al. (2016). DATAHOLDER: CSIRO.	1. AIMS 2017. DATAHOLDER: AIMS. 2. AIMS 2014. DATAHOLDER: Woodside. 3. North West Atlas http://northwestatlas.org/node/1633 AIMS 2017. DATAHOLDER. AIMS	1. Chevron 2010. DATAHOLDER: Chevron. 2. Quadrant Energy/Santos 2016 DATAHOLDER: Santos. 3. CSIRO (2013; 2016). Roland Pitcher. DATAHOLDER. Chevron Australia.
Benthic Habitat (Seagrass and Macro-algae)	SM03 Quantitative assessment using image capture using either diver held camera or towed video. Post analysis into broad groups based on taxonomy and morphology.	Studies:					
		1. Quantitative descriptions of Ningaloo sanctuary zones habitats types including lagoon and offshore areas – Cassata and Collins (2008). 2. CSIRO/BHP Ningaloo Outlook Program. 3. Ningaloo Collaboration Cluster: Habitats of the Ningaloo Reef and adjacent coastal areas determined through hyperspectral imagery. 4. Australian Institute of Marine Science – CReefs: Ningaloo Reef Biodiversity Expeditions (2008-2010).	1. Santos, macroalgae monitoring at sites across Lowendal and the Montebello islands in 2012. 2. Pilbara Marine Conservation Partnership Seabed biodiversity survey (2013).	1. Chevron LTM of Seagrass and Macro algae habitats for the Gorgon Gas Development project. Marine baseline Program (2008, 2009), Marine Monitoring Program (2010), Post Dredge Survey one (2011) 2. Chevron study by RPS in 2004 on Barrow Island intertidal zone. 3. Pilbara Marine Conservation Partnership Seabed biodiversity survey (2013).	1. Benthic habitats including seagrass and macroalgae for the (Lowendal Islands, Chevron Janz Feed Gas Pipeline Project.) Gorgon Gas Development Project. 2. Santos macroalgae monitoring at sites across Lowendal and the Montebello islands in 2012. 3. Pilbara Marine Conservation Partnership Seabed biodiversity survey (2013).	Glomar Shoals and Rankin Bank baseline survey, 2013, quantitatively surveyed benthic habitats and communities. Glomar Shoals and Rankin Bank surveys, 2017 and 2018, quantitatively surveyed benthic habitats and communities. GWF-2- Rankin Bank: Environmental Research and monitoring Programme.	1. Benthic habitat mapping of the subtidal and intertidal habitats of the islands and shoals. Algae communities in shallow subtidal habitat, intertidal pavement. 2. Pilbara Marine Conservation Partnership Seabed biodiversity survey (2013; 2016).
		Methods:					
		1. Video transects to ground truth aerial photographs and satellite imagery. 2. Diver video transects. 3. LTM transects, diver based (video) photo quadrat. 4. LTM transects, diver based (video) photo quadrats, specimen collection.	1. Quantitative assessment details not available. 2. Towed video, benthic trawl and sled.	1. Diver transects, photo quadrats, biomass. 2. Physical observational survey of intertidal habitats on Barrow Island. 3. Towed video, benthic trawl and sled.	1. Diver Transects, Photo Quadrats. 2. Quantitative assessment details not available. 3. Towed video, benthic trawl and sled.	Towed video transects, photo quadrats using towed video system.	1. ROV transects. 2. Towed video, benthic trawl and sled.
		References and Data:					

Major Baseline	Proposed Scientific monitoring operational plan and Methodology	Ningaloo and Muiron Islands	Montebello Islands	Barrow Island	Lowendal Islands	Rankin Bank	Pilbara Islands – Southern Island Group (Serrurier, Thevenard and Bessieres Islands – State Nature Reserve)
		1. Cassata and Collins 2008. DATAHOLDER: Curtin University – Applied Geology. 2. CSIRO Damian Thompson - Damian.Thomson@csiro.au 3. Murdoch University - Kobryn et al 2011 and Keulen and Langdon 2011. 4. AIMS (2010) - http://www.aims.gov.au/creefs	1. RPS 2012. DATAHOLDER: Santos. 2. Pitcher et al. (2016). DATAHOLDER: CSIRO.	1. Baseline: Chevron Australia 2010. Marine Monitoring Program: Chevron Australia 2011 Post Dredge: Chevron Australia 2013 DATAHOLDER: Chevron Australia. 2. RPS-Bowman Bishaw Gorham 2005. DATAHOLDER: Chevron Australia. 3. Pitcher et al. (2016). DATAHOLDER: CSIRO.	1. RPS-Bowman Bishaw Gorham 2005. DATAHOLDER: Chevron. 2. RPS 2012. DATAHOLDER: Santos. 3. Pitcher et al. (2016). DATAHOLDER: CSIRO.	AIMS 2014. DATAHOLDER: AIMS. AIMS 2017 and 2018. DATAHOLDER: AIMS.	1. Chevron 2010. DATAHOLDER: Chevron 2. CSIRO (2013, 2016). Roland Pitcher. DATAHOLDER. Chevron Australia.
Benthic Habitat (Deeper Water Filter Feeders)	SM03 Quantitative assessment using image capture using towed video. Post analysis into broad groups based on taxonomy and morphology.	Studies:					
		WAMSI 2007 deep-water Ningaloo benthic communities' study, Colquhoun and Heyward (2008). CSIRO/BHP Ningaloo Outlook Program - Deep reef themes.	N/A – See Table D-1	N/A – See Table D-1	Chevron Wheatstone Project – Field investigation of benthic habitat (70-250 m depth).	1.Glomar Shoals and Rankin Bank baseline survey, 2013, quantitatively surveyed benthic habitats and communities. 2.Glomar Shoals and Rankin Bank baseline survey, 2017 and 2018, quantitatively surveyed benthic habitats and communities.GWF-2- Rankin Bank: Environmental Research and monitoring Programme.	N/A – See Table D-1
		Methods:					
		Towed video and benthic sled (specimen sampling). Side-scan sonar and AUV transects.	N/A – See Table D-1	N/A – See Table D-1	Towed video seabed surveys.	Towed video transects, photo quadrats using towed video system. Towed video, baited cameras	N/A – See Table D-1
		References and Data:					
		Colquhoun and Heyward (eds) 2008. DATAHOLDER: WAMSI, AIMS. Russell Babcock (Deep reefs) - Russ.Babcock@csiro.au	N/A – See Table D-1	N/A – See Table D-1	RPS-Bowman Bishaw Gorham 2005. DATAHOLDER: Chevron Australia.	AIMS 2014. DATAHOLDER: AIMS. AIMS 2017 and 2018 Report DATAHOLDER: AIMS.	N/A – See Table D-1
Mangroves and	SM04	Studies:					

Major Baseline	Proposed Scientific monitoring operational plan and Methodology	Ningaloo and Muiron Islands	Montebello Islands	Barrow Island	Lowendal Islands	Rankin Bank	Pilbara Islands – Southern Island Group (Serrurier, Thevenard and Bessieres Islands – State Nature Reserve)
Saltmarsh	Aerial photography and satellite imagery will be used in conjunction with field surveys to map the range and distribution of mangrove communities.	Woodside hold Rapid Eye imagery of the Ningaloo Reef and coastal area. Hyperspectral survey (2006) of Ningaloo Reef and coastal area (not yet analysed for Mangroves). North West Cape sensitivity mapping 2012 included Mangrove Bay. Global mangrove distribution as mapped by the USGS and located on UNEP's Ocean Data viewer.	1. Advanced Land Observing Satellite (ALOS) images taken in 2006, 2008, and 2010 by DBCA. Digital Aerial Photos were taken in 2009, and the area ground-truthed in 2006. 2. Ground truthing aerial photography to map the spatial extent of mangroves on the Montebello Islands. 3. Mangrove monitoring as part of DBCA Western Australian Marine Monitoring Program (ongoing).	Chevron LTM of Mangroves for the Gorgon Gas Development project. Marine Baseline Program (2009), Post Dredge Survey 1 (2011), Post Dredge Survey 2 (2013). Baseline state of the mangroves 2008.	1. Santos Mangrove baseline (2010). 2. Santos - Long-term mangrove monitoring (1999-2011).	N/A – See Table D-1	1. Study conducted by URS (November 2008 to May 2009) to ground truth aerial photography taken between 2001 and 2009 and to identify mangrove species present in the area.
		Methods:					
		Rapid Eye imagery – High resolution satellite imagery from October/November/December 2011. Remote sensing – acquisition of HyMap airborne hyperspectral imagery and ground truthing data collection. Reconnaissance surveys of the shorelines of the North West Cape and Muiron Islands. Remote sensing study of global mangrove coverage.	1. ALOS and Digital aerial photos, ground truthing, for Mangrove extent and mangrove relative canopy density. 2. Species Composition, LUX, canopy density. 3. Methods unknown.	Health scoring system, percentage cover, mean canopy density, qualitative health assessment. Annual Mangrove composition, canopy density, pneumatophore density, leaf pathology, qualitative health.	1. Aerial imagery (resolution of 0.2 m2 captured in 2010). 2. Qualitative data includes the presence of new growth, reproductive state, extent of defoliation and pneumatophore condition. Quantitative data, collected at the tree level, includes seedling density, stem diameter, number of defoliated branches and a number of canopy condition parameters.	N/A – See Table D-1	1.Aerial Photography and Satellite imagery Species identification and community composition.
		References and Data:					
		AAM 2012. DATAHOLDER: Woodside. Kobryn et al. 2013. DATAHOLDER: Murdoch University, AIMS; Woodside. Joint Carnarvon Basin Operators, 2012. DATAHOLDER: Woodside Apache Energy Ltd. http://data.unep-wcmc.org/	1. DBCA unpublished data. DATAHOLDER: DBCA. 2. Voga unpublish data DATAHOLDER: Voga Contact: voga.envrironment@vermilionenergy.com 3. DBCA. DATAHOLDER DBCA.	Baseline: Chevron Australia 2010. Marine Monitoring Program: Chevron Australia 2011 Post Dredge: Chevron Australia 2013 DATAHOLDER: Chevron Australia. Chevron 2014. DATAHOLDER: Chevron.	1. Santos 2014. DATAHOLDER: Santos. 2. Santos 2011. DATAHOLDER: Santos.	N/A – See Table D-1	URS (2010c) DATAHOLDER: Chevron Australia.
Seabirds	SM05	Studies:					

Major Baseline	Proposed Scientific monitoring operational plan and Methodology	Ningaloo and Muiron Islands	Montebello Islands	Barrow Island	Lowendal Islands	Rankin Bank	Pilbara Islands – Southern Island Group (Serrurier, Thevenard and Bessieres Islands – State Nature Reserve)
	Visual counts of breeding seabirds, nest counts, intertidal bird counts at high tide.	1. LTM Study of marine and shoreline birds: 1970-2011. 2. LTM of shorebirds within the Ningaloo coastline (Shorebirds 2020). Available through Birdlife. 3. Exmouth Sub-basin Marine Avifauna Monitoring Program (Quadrant Energy/Santos). 4. Integrated Shearwater Monitoring Program (1994-2016). 5. Seabird and Shorebird baseline studies, Ningaloo Region – Report on January 2018 bird surveys. 6.FieldReport – Wedge-tailed shearwater foraging behaviour in the Exmouth Region.	No recent studies. A DBCA/WAM study of terrestrial fauna of the islands was published in 2000 (Burbidge et al 2000). The most recent bird survey referenced in this review was 1998 by DBCA (DPaW, CALM).	1. Barrow Island migratory behaviour, nesting and foraging behaviour. 2. Migratory waders at Barrow Island. 3. LTM on Barrow island (island wide) Study September 2003 – 2006. 4. Chevron - Gorgon Gas Development. Terrestrial and subterranean environment monitoring program (2008-2015). Monitoring of Wedge-tailed Shearwaters, Bridled Terns, Silver Gulls.	1. Ongoing study of Bridled Terns from 2009. 2. Quadrant Energy seabird nesting on Lowendal Island, study 2013. 3. Lowendal Islands, common breeding bird species, structure, feeding and disturbances to the population. 4. Quadrant Energy/Santos – Integrated Shearwater Monitoring Program (1994-2016).	N/A – See Table D-1	1. Migratory waterbirds relevant to the Wheatstone Project on behalf of URS in 2008 - 2009. 2. Quadrant Energy/Santos – Integrated Shearwater Monitoring Program (1994-2016). 3. Exmouth Sub-basin Avifauna Monitoring Program (2013-2014).
		Methods:					
		1. Counts of nesting areas, counts of intertidal zone during high tide. 2. The Shorebirds 2020 database comprises the most complete shorebird count data available in Australia. The data have been collected by volunteer counters and BirdLife Australia staff for approximately 150 roosting and feeding sites, mainly in coastal Australia. The data go back as far as 1981 for key areas. 3. The Exmouth Sub-basin Marine Avifauna Monitoring Program undertook a detailed assessment of seabird and shorebird use in the Exmouth Sub-basin. Four aerial surveys and four island surveys were conducted between February 2013 and January 2015 for this Program, inclusive of the mainland coasts, offshore islands and a 2,500 km2 area of ocean adjacent to the Exmouth Sub-basin. 4. Airlie and Serrurier islands, with Abutilon and Parakeelya islands (Lowendal Island group) added in 2014. 5.Shorebird counts, Shearwater Burrow Density. 6. Tagging (GPS & Satellite).	Bird observations and counts.	Species, total numbers, Distribution, Roosting locations and foraging numbers. Migratory behaviour. High tide roost counts, abundance counts. Nest burrow density (number of burrows per m2); presence/absence of eggs or chicks in burrows; collapsed burrows and predation and mortality records. Barrow Island: Variation in abundance and spatial/temporal distribution on beaches. Middle Island: Abundance; nest density; Presence and absence of eggs/chicks in nest.	1. Nest Density, presence and absence of chicks, predation and mortality counts. 2. Nest burrow density (number of burrows per m2); presence/absence of eggs or chicks in burrows. 3. Burrowscopes, Ultrasonic monitors to monitor burrows. 4. The distribution and abundance of other nesting seabirds within the Lowendal Island group, including up to 45 islands and islets, also occurred from 2004 onwards.	N/A – See Table D-1	1. Ground counts, aerial surveys of wetlands by helicopter. 2. Burrow count and observation data, burrow density, colony stability, breeding participation, incubation effort and reproductive success has been determined. Tagging data. 3. Aerial surveys and onshore island surveys.
		References and Data:					

Major Baseline	Proposed Scientific monitoring operational plan and Methodology	Ningaloo and Muiron Islands	Montebello Islands	Barrow Island	Lowendal Islands	Rankin Bank	Pilbara Islands – Southern Island Group (Serrurier, Thevenard and Bessieres Islands – State Nature Reserve)
		1. Johnstone et al. 2013. DATAHOLDER: WA MUSEUM. AMOSC/DBCA (DPaW) 2014. 2. BirdLife Australia Shorebirds 2020 programme (http://www.birdlife.org.au/projects/shorebirds-2020). http://dmslink/link/link.aspx?dmsn=1400456992 3. Santos (Libby Howitt) – Report. 4. Santos (I-GEM, UUID: bdd428fe-cf24-4596-a822-cd578695ee16). 5. BirdLife Australia: Dataholder. Woodside 6. UWA Dataholder. UWA	DBCA/WAM – Burbidge et al 2000.	Bamford M.J. & A.R 2004. DATAHOLDER: Chevron. Bamford M.J & A.R 2011. DATAHOLDER: Chevron. Chevron, 2013. DATAHOLDER: Chevron. Chevron 2013. DATAHOLDER: Chevron.	1. Bamford M.J. & A.R 2004. DATAHOLDER: Chevron. 2. Surman 2012. DATAHOLDER: Santos. 3. Bamford M.J & A.R 2011. DATAHOLDER: Chevron. 4. DATAHOLDER: Santos.	N/A – See Table D-1	1. Bamford, MJ & AR. 2011. DATAHOLDER: Chevron. 2. Quadrant Energy/Santos. Dataholder. Santos. 3. Quadrant Energy/Santos. Dataholder. Santos.
Turtles	SM06 Beach surveys (recording species, nests, and false crawls).	Studies:					
		1. Ningaloo LTM turtle program was established in 2002, with the most recent survey during the 2016-2017 season. The primary aim is to predict long-term trends in marine turtle populations along Ningaloo coast. 2. Exmouth Islands Turtle Monitoring Program. 3. Ningaloo Turtle Program Annual Report 2016-2017. 4. Turtle activity and nesting on the Muiron Islands and Ningaloo Coast (2018). 5. Field Report: Spatial and temporal use of inter-nesting habitat by sea turtles along the Murion Islands and Ningaloo Coast (2018).	1. LTM Study of Green, Flatback, Hawksbill turtles on beaches within the Barrow, Lowendal and Montebello Island Complex for Chevron. 2. Marine turtle monitoring as part of DBCA long-term turtle monitoring program (ongoing).	Chevron - Gorgon Gas Development. Long-term Turtle Monitoring Program - Flatback tagging program and marine turtle track census program (2005 – ongoing).	1. LTM Study of Green, Flatback, Hawksbill turtles on beaches within the Barrow, Lowendal and Montebello Island Complex. 2. Santos 2013 turtle nesting survey on the Lowendal islands. 3. Varanus Island Turtle monitoring program (2005 – present).	N/A – See Table D-1	1. Baseline marine turtle surveys 2009 (included the islands of Serrurier, Bessieres and Thevenard), Pendoley (2009). 2. Exmouth Islands Turtle Monitoring Program (2013 and 2014). 3. North West Shelf Flatback Turtle Conservation Program's. 4. Inter-nesting distribution of flatback turtles and industrial development in Western Australia (Thevenard Island).
		Methods:					

Major Baseline	Proposed Scientific monitoring operational plan and Methodology	Ningaloo and Muiron Islands	Montebello Islands	Barrow Island	Lowendal Islands	Rankin Bank	Pilbara Islands – Southern Island Group (Serrurier, Thevenard and Bessieres Islands – State Nature Reserve)
		1. Beach surveys, track counts, best location, mortality counts. 2. was undertaken by Astron (on behalf of Santos) to address a gap in the knowledge of turtle numbers at key locations (offshore islands within the region) that are not currently part of an existing monitoring programs (e.g. the NTP). Field surveys were conducted in October 2013 and January 2014. Surveys were conducted on 12 islands, with each island surveyed once (with the exception of Beach 8 at North Muiron Island) and all tracks counted. 3. Long term trends in marine turtle populations, nesting levels, nesting success rates. 4. On-beach monitoring and aerial surveys. 5.Tagging (satellite).	Nesting demographics (composition, spatial variability, seasonal distribution, post-nesting dispersion).	Island wide (though primary nesting occurs on east coast). Mundabullangana on mainland is the reference location for the Flatback tagging program.	1. Nesting demographics (composition, spatial variability, seasonal distribution, post-nesting dispersion). 2. Tagging and nest counts. 3. Tagging and nest counts. Varanus, Beacon, Bridled, Abutilon and Parakeelya islands.	N/A – See Table D-1	1. Beach/Nesting surveys (counts by species). 2. Beach/Nesting surveys (counts by species). 3. Nesting and tagging studies. 4. Satellite tracking methods.
		References/Data:					
		1. Markovina, K, 2017. DATAHOLDERS: DBCA. Reports available at http://www.ningalooturtles.org.au/media_reports.html 2. Santos (Libby Howitt) – Report. 3. Woodside (Author Keely Markovina). 4.DBCA Dataholder. 5.DBCA Dataholder.	1. AMOSC/DPaW 2014. DATAHOLDER: Chevron. 2.DBCA.	Pendoley Environmental (2005-ongoing). DATAHOLDER: Chevron.	1. Pendoley 2005. AMOSC/DBCA (DPaW) 2014. DATAHOLDER: Chevron/ Santos. 2. Santos, 2014. DATAHOLDER: Santos. 3. Santos (2005 – present)	N/A – See Table D-1	1. Pendoley 2009. DATAHOLDER: Chevron. 2. Quadrant Energy/Santos. Dataholders. Santos. 3. DBCA. Dataholder. 4. Pendoley Environment -Whittock, Pendoley and Hamann (2010-2011).
Fish	SM09	Studies:					

Major Baseline	Proposed Scientific monitoring operational plan and Methodology	Ningaloo and Muiron Islands	Montebello Islands	Barrow Island	Lowendal Islands	Rankin Bank	Pilbara Islands – Southern Island Group (Serrurier, Thevenard and Bessieres Islands – State Nature Reserve)
	Baited Remote Underwater Video Stations (BRUVS), Visual Underwater Counts (VUC), Diver Operated Video (DOV).	1. AIMS/DBCA 2014 Baseline Ningaloo Survey – repeat and expansion on the LTM (Co-funded survey: Woodside and AIMS). 2. Demersal fish populations – baseline assessment (AIMS/WAMSI). 3. DBCA study measured Species Richness, Community Composition, and Target Biomass, through UVC. BRUVS studies determining max N, Species Richness, and Biomass. 4. Pilbara Marine Conservation Partnership Stereo BRUVS in shallow water (~10m) in 2014 in northern region of the Ningaloo Marine Park, in shallow water (~10m) inside the lagoonal reef of the Ningaloo Marine Park in 2016, in deep water (~40m) across the length of the Ningaloo Marine Park in 2015, in shallow water outside of Ningaloo Reef from Waroora to Jurabi in 2015 and offshore of the Muiron Islands in 2015. 5. Elasmobranch faunal composition of Ningaloo Marine Park. 6. Juvenile fish recruitment surveys at Ningaloo reef. 7. Demersal fish assemblage sampling method comparison 8. Ningaloo Outlook (CSIRO) - Shallow and Deep Reefs Program	1. DBCA diver surveys 2009-2012. 2. Pilbara Marine Conservation Partnership Stereo BRUVS drops in shallow water (~8-20m) in 2014 and deeper (20-60m) in 2015 inside and outside sanctuary zones at the Montebello Islands and in the area from Cape Preston to the Montebello Islands in 2015. 3. Finfish monitoring as part of DBCA Western Australian Marine Monitoring Program (2015-ongoing).	1. Chevron LTM of demersal fish for the Gorgon Gas Development project. Marine Baseline Program (2008, 2009), Post Dredge Survey 1 (2011), Post Dredge Survey 2 (2012). 2. Pilbara Marine Conservation Partnership Stereo BRUVS drops in shallow water (~10m) from Exmouth to Barrow Islands in 2015. 3. Finfish monitoring as part of DBCAs Western Australian Marine Monitoring Program (2015-ongoing).	1. Pilbara Marine Conservation Partnership Stereo BRUVS drops in shallow water (~10m) Montebello Sanctuaries 2015. 2. WA Museum fish surveys of Dampier Archipelago 1998-2000 (Hutchins 2004).	1. Glomar Shoals and Rankin Bank BRUVS, Australian Institute of Marine Science (AIMS) in August and September 2013. 2. Glomar Shoals and Rankin Bank BRUVS, Australian 2017 and 2018.	1.Pilbara Marine Conservation Partnership Stereo BRUVS drops in deep water (20-55m) offshore of Bessieres Island in 2016.
		Methods:					
		1. UVC surveys. 2. BRUVS Study with 304 video samples at three specific depth ranges (1-10 m, 10-30 m and 30-110m). 3. UVC surveys. 4. Stereo BRUVS 5. Snorkel and Scuba surveys. 5. Underwater visual census. 6. Diver operated video. 7. Diver UVS.	1. Diver Operated Video - species richness, community composition, and biomass were recorded from 2009-2012. 2. Stereo BRUVS. 3. Diver UVS.	1. Intertidal and subtidal surveys using BRUVS and Netting. 2. Stereo BRUVS. 3. Diver UVS.	1. Stereo BRUVS 2. Diver surveys _ Underwater Visual Census (UVC).	1. BRUVs.	Stereo BRUVs.
		References/Data:					

Major Baseline	Proposed Scientific monitoring operational plan and Methodology	Ningaloo and Muiron Islands	Montebello Islands	Barrow Island	Lowendal Islands	Rankin Bank	Pilbara Islands – Southern Island Group (Serrurier, Thevenard and Bessieres Islands – State Nature Reserve)
		1. AIMS 2014. DATAHOLDER: AIMS/Woodside. 2. Fitzpatrick et al. 2012. DATAHOLDERS: WAMSI, AIMS. Contacts: Mat Vanderklift, Rick Stuart Smith, and Tom Holmes. 3. DBCA unpublished data. DATAHOLDER: DBCA/AIMS. 4. CSIRO Data DATAHOLDER: CSIRO Data Centre (data-requestes-hf@csiro.au). 5. Stevens, J.D: ast, P.R., White, W.T., McAuley, R.B., Meekan, M.G. 2009. 6. WAMSI unpublished data DATAHOLDER: AIMS (m.case@aims.gov.au). 7. WAMSI DATAHOLDER: Ben Fitzpatrick (whaleshark@oceanwise.com.au). 8. CSIRO 2015. Damian Thompson (shallow reefs) and Russell Babcock (Deep reefs). Damian.Thomson@csiro.au and Russ.Babcock@csiro.au	1. DBCA data. DATAHOLDER: DBCA 2. CSIRO Data DATAHOLDER: CSIRO Data centre (data-requests-hf@csiro.au) 3. DBCA.	1. Baseline: Chevron Australia 2010. Marine Monitoring Program: Chevron Australia 2011. Post Dredge: Chevron Australia 2013 DATAHOLDER: Chevron Australia. 2. CSIRO Data DATAHOLDER: CSIRO Data centre (data-requests-hf@csiro.au) 3. DBCA.	1. UWA. Diane McLean and Tim Langlois. The UWA Oceans Institute & School of Biological Sciences. timothy.langlois@uwa.edu.au 2. DATAHOLDER: Woodside and WAM.	1. AIMS 2014. DATAHOLDER: AIMS. 2. AIMS 2017 and 2018 DATAHOLDER: AIMS.	CSIRO. DATAHOLDER: CSIRO (data-requests-hf@csiro.au)

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ANNEX E: TACTICAL RESPONSE PLANS

TACTICAL RESPONSE PLANS
Exmouth
Mangrove Bay
Turquoise Bay
Yardie Creek
Muiron Islands
Jurabi to Lighthouse Beaches Exmouth
Ningaloo Reef - Refer to Mangrove/Turquoise bay and Yardie Creek
Exmouth Gulf
Shark Bay Area 1 : Carnarvon to Wooramel
Shark Bay Area 2 : Wooramel to Petite Point
Shark Bay Area 3: Petite Point to Dubaut Point
Shark Bay Area 4: Dubaut Point to Herald Bight
Shark Bay Area 5: Herald Bight to Eagle Bluff
Shark Bay Area 6: Eagle Bluff to Useless Loop
Shark Bay Area 7: Useless Loop to Cape Bellefin
Shark Bay Area 8: Cape Bellefin to Steep Point
Shark Bay Area 9: Western Shores of Edel Land
Shark Bay Area 10: Dirk Hartog Island
Shark Bay Area 11: Bernier and Dorre Islands
Abrohlos Islands: Pelseart Group
Abrohlos Islands: Wallabi Group
Abrohlos Islands: Easter Group
Dampier
Rankin Bank & Glomar Shoals
Barrow and Lowendal Islands
Pilbara Islands - Southern Island Group
Montebello Is - Stephenson Channel Nth
Montebello Is Champagne Bay & Chippendale channel
Montebello Is - Claret Bay
Montebello Is - Hermite/Delta Is Channel
Montebello Is - Hock Bay
Montebello Is - North & Kelvin Channel
Montebello Is - Sherry Lagoon Entrance
Withnell Bay
Holden Bay
King Bay
No Name Bay / No Name Beach
Enderby Is -Dampier
Rosemary Island - Dampier
Legendre Is - Dampier
Karratha Gas Plant

KGP to Whitnell Creek
KGP to Northern Shore
KGP Fire Pond & Estuary
KGP to No Name Creek
Broome
Sahul Shelf Submerged Banks and Shoals
Clerke Reef (Rowley Shoals)
Imperieuse Island (Rowley Shoals)
Mermaid Reef (Rowley Shoals)
Scott Reef
Oiled Wildlife Response
Exmouth
Dampier region
Shark Bay

APPENDIX E: NOPSEMA REPORTING FORMS

NOPSEMA Recordable Environmental Incident monthly Reporting Form
https://www.nopsema.gov.au/assets/Forms/A198750.doc
Report of an accident, dangerous occurrence or environmental incident
https://www.nopsema.gov.au/assets/Forms/N-03000-FM0831-Report-of-an-Accident-Dangerous-Occurrence-or-Environmental-Incident-Rev-8-Jan-2015-MS-Word-2010.docx

APPENDIX F: STAKEHOLDER CONSULTATION

Consultation with all relevant stakeholders – 8 February 2018

Woodside sent the email below and consultation Information Sheet to all relevant stakeholders.

Dear Stakeholder

Subject to a final investment decision, Woodside is proposing to undertake drilling, construction and installation activities for the Julimar Project in Production Licence WA-49-L in Commonwealth waters, starting Q1 2020.

A Consultation Information Sheet is attached, which provides background on the proposed activity, including a summary of potential key risk and associated management measures. The Information Sheet is also available on our web site.

Activity overview
Details of the proposed activity are:

Activity purpose:	• Up to five production wells are planned to support future production at the Julimar Project in WA-49-L • An exploration well and an appraisal well may be drilled to help improve understanding of the reservoir		
Activity:	• Drilling of up to five production wells and installation of a 22 km flowline, subsea manifold and associated subsea infrastructure • Drilling of an exploration well and an appraisal well		
Activity location:	185 km North West of Dampier, Western Australia		
Well locations:	JULA-A	20^0 08’ 52.996” S	115^0 02’ 28.377” E
	JULA-C	20^0 08’ 52.222” S	115^0 02’ 26.436” E
	JULA-K	20^0 08’ 53.554” S	115^0 02’ 28.078” E
	JULA-M	20^0 08’ 51.855” S	115^0 02’ 27.005” E
	Exploration well	20^0 02’ 6.754 S	115^0 06’ 32.749 E
	Advice will be provided to stakeholders of locations for the appraisal well and fifth production well once planning is finalised for all wells		
Water depth:	174 m to 201 m		
Start date:	From Q1 2020		
Duration:	• Production wells – up to 70 days per well • Exploration/appraisal well – up to 40 days per well • Pipelay – cumulative duration of 30 days		
Vessel/rig:	• Semi-submersible mobile offshore drilling unit (MODU), with one support vessel in the field • Installation vessel and pipelay vessel		
Exclusion Zone:	• A 500 m radius petroleum safety zone will be in place around the MODU and pipelay vessel for the duration of the drilling activities • For safety reasons, Woodside asks marine users to observe Operational Areas for the duration of the activities, these		

	being a 4 km radius area around the MODU and a 1.5 km radius area (eg 3 km corridor) from subsea infrastructure, such as the proposed flowline.

Your feedback

Your feedback on the proposed activity and our response will be included in an Environment Plan for consideration by the National Offshore Petroleum Safety and Environmental Management Authority, as is required under the *Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009* (Cth).

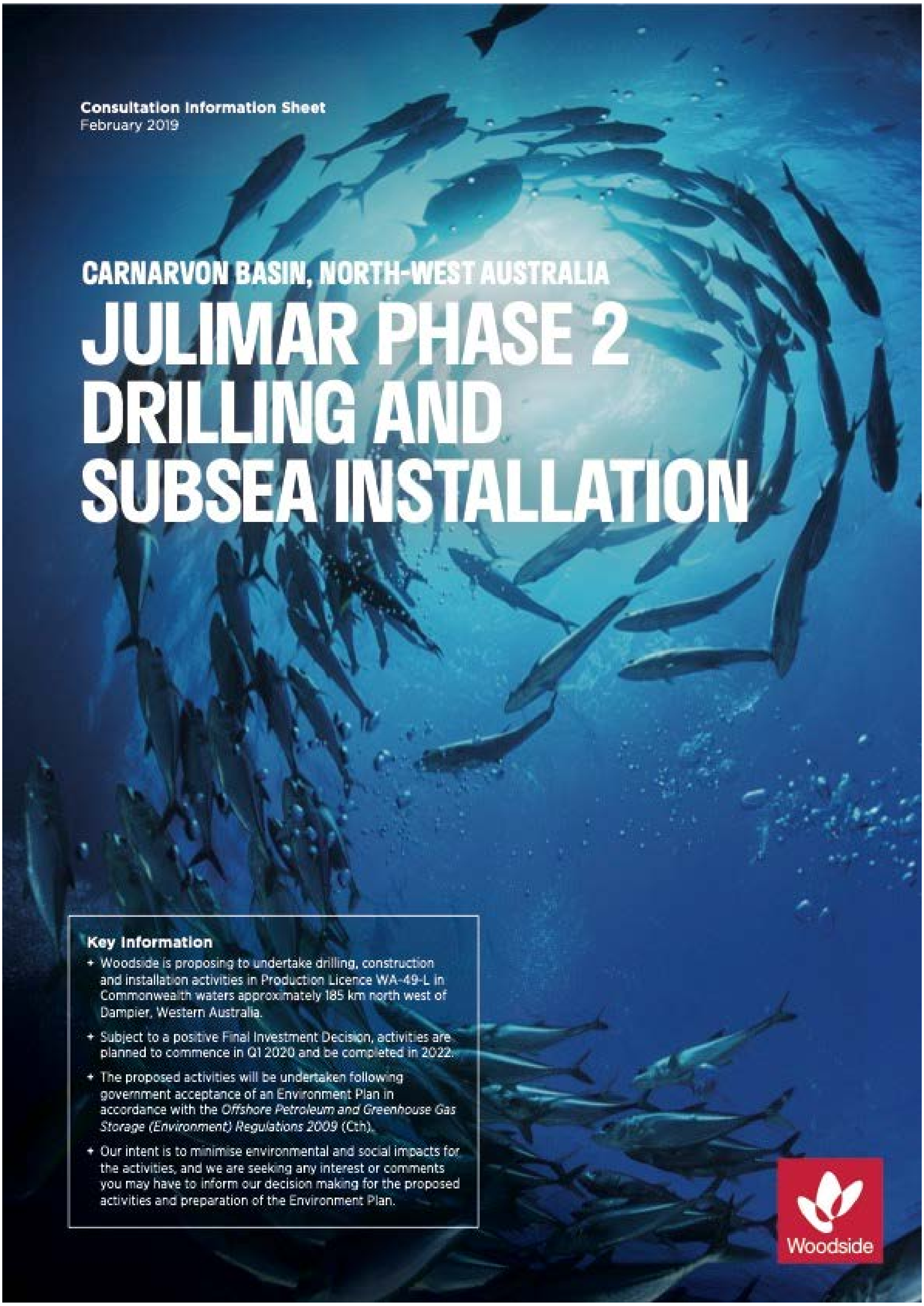
Please provide your views by **COB Monday, 11 March 2019** to allow us sufficient time to inform our planning for the proposed activity. Comments can be made by email, letter or by phone.

Notification will be provided to relevant marine users closer to the time of the proposed activity.

Regards

Corporate Affairs Adviser | Corporate Affairs
Woodside Energy Ltd

Woodside consultation Information Sheet



Consultation Information Sheet
February 2019

CARNARVON BASIN, NORTH-WEST AUSTRALIA

JULIMAR PHASE 2 DRILLING AND SUBSEA INSTALLATION

Key Information

- Woodside is proposing to undertake drilling, construction and installation activities in Production Licence WA-49-L in Commonwealth waters approximately 185 km north west of Dampier, Western Australia.
- Subject to a positive Final Investment Decision, activities are planned to commence in Q1 2020 and be completed in 2022.
- The proposed activities will be undertaken following government acceptance of an Environment Plan in accordance with the *Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009* (Cth).
- Our intent is to minimise environmental and social impacts for the activities, and we are seeking any interest or comments you may have to inform our decision making for the proposed activities and preparation of the Environment Plan.

Woodside

About the consultation

Activity Overview

Woodside is planning to undertake drilling, construction and installation activities in Production Licence WA-49-L in Commonwealth waters to support the proposed Julimar Project, commencing in Q1 2020 and ending in 2022.

Up to seven wells are proposed to be drilled and are located about 185 km north west of Dampier, Western Australia. Five wells will support future production, while an exploration well and potential appraisal well will help Woodside improve subsurface and chemistry understanding of the reservoirs. Woodside also plans to install a production manifold, a 22 km flowline, structures and a control umbilical as part of the production installation activities.

The Julimar Project is a subsea development that will supply raw gas and condensate from the fields to the offshore Chevron-operated Wheatstone platform and from there to the Wheatstone Project's onshore LNG trains and domestic gas plant at the Ashburton North Strategic Industrial Area.

Woodside is operator of the Julimar Project with a 65% interest, with KUFPEC Australia (Julimar) Pty Ltd holding a 35% interest.

Activity Location

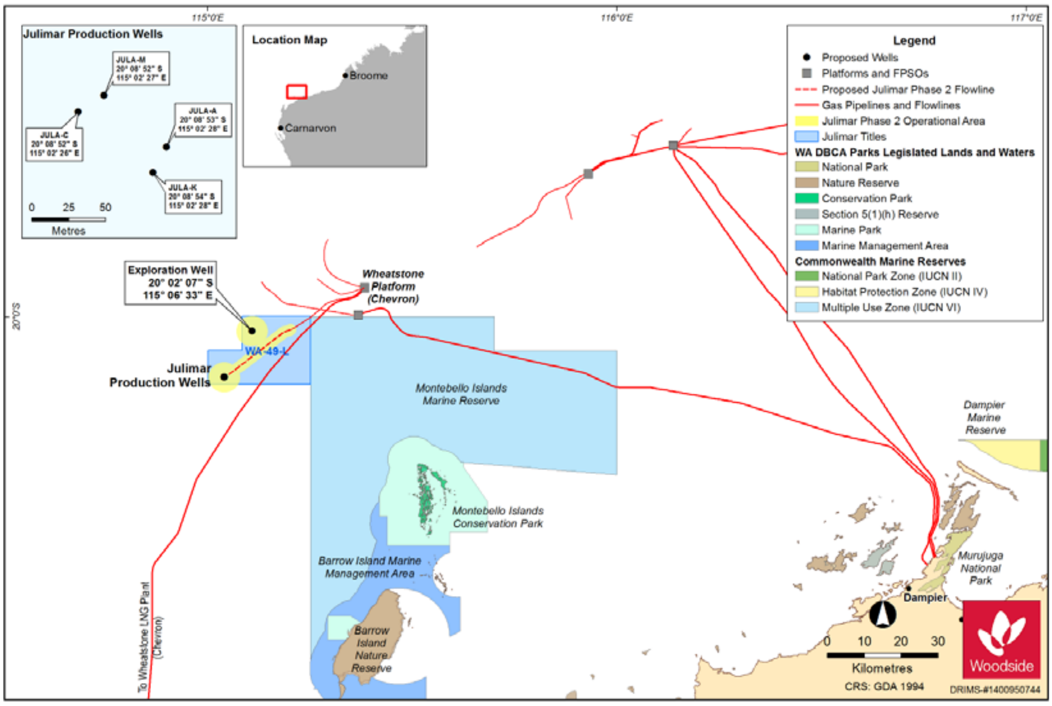
The proposed activities are located in Production Licence WA-49-L, with the closest landfall being the Montebello Islands, approximately 48 km to the south.

At the time of initial consultation, the location of the fifth production well and the potential appraisal well had not been confirmed. Relevant stakeholders will be advised of these locations once planning is finalised for all wells.

Approximate well locations for all other activities are in Table 1.

Table 1. Approximate well location details

Activity	Water Depth	Latitude	Longitude	Production Licence
JULA-A	174 m	20º 08' 52.996" S	115º 02' 28.377" E	WA-49-L
JULA-C	174 m	20º 08' 52.222" S	115º 02' 26.436" E	WA-49-L
JULA-K	174 m	20º 08' 53.554" S	115º 02' 28.078" E	WA-49-L
JULA-M	174 m	20º 08' 51.855" S	115º 02' 27.005" E	WA-49-L
Exploration well	201 m	20º 02' 6.754" S	115º 06' 32.749" E	WA-49-L



Environmental Management

Table 3. Summary of key risks and/or impacts and management measures.

Potential Risk and/or Impact	Mitigation and/or Management Measure
Planned	
Chemical use	+ Chemical use will be managed in accordance with the Contractors Chemical Selection and Approval Procedure.
Interests of relevant stakeholders with respect to: + Defence activities + Petroleum activities + Commercial fishing activities + Shipping activities	+ Consultation with petroleum titleholders, commercial fishers and their representative organisations, and government departments and agencies to inform decision making for the proposed activity and development of the Environment Plan. + Advice to relevant stakeholders prior to the commencement of activities.
Marine fauna interactions	+ Measures will be taken to protect marine fauna and ecosystems from vessel activities and to prevent vessel collisions and groundings.
Marine discharges	+ All routine marine discharges will be managed according to legislative and regulatory requirements and Woodside's Environmental Performance Standards where applicable.
Seabed disturbance	+ Well location and site appraisal to identify and address well-specific hazards and drilling constraints. + MODU mooring analysis and anchor deployment in accordance with internal standards. + No anchoring of support and installation vessels during drilling, construction and installation activities, as well as logging/ retrieval of wet-stored items.
Underwater noise	+ Vertical well profiling undertaken in accordance with internal procedure, including pre-start visual observations and shutdown for whales.
Vessel interaction	+ Woodside will notify relevant fishery stakeholders and Government maritime safety agencies of specific start and end dates, specific vessel-on-location dates and any exclusion zones prior to commencement of the activity. + A 500 m radius petroleum safety zone will be in place around the MODU and pipelay vessel for the duration of the drilling activities + Commercial fishers are permitted to use but should take care, when entering the Operational Area around the MODU (4 km radius) and pipelay vessel (1.5 km radius).
Waste generation	+ Waste generated on the vessels will be managed in accordance with legislative requirements and a Waste Management Plan. + Wastes will be managed and disposed of in a safe and environmentally responsible manner that prevents accidental loss to the environment. + Wastes transported onshore will be sent to appropriate recycling or disposal facilities by a licensed waste contractor.
Unplanned	
Hydrocarbon release	+ Appropriate spill response plans, equipment and materials will be in place and maintained. + Appropriate refuelling procedures and equipment will be used to prevent spills to the marine environment.
Introduction of invasive marine species	+ All vessels will be assessed and managed as appropriate to prevent the introduction of invasive marine species. + Compliance with Australian biosecurity requirements and guidance.

Providing Feedback

Our intent is to minimise environmental and social impacts associated with the proposed activities, and we are seeking any interest or comments you may have to inform our decision making.

An Environment Plan for the proposed activity 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).

If you would like to comment on the proposed activities outlined in this information sheet, or would like additional information, please contact Woodside before Monday, 11 March 2019.

Andrew Winter *Corporate Affairs Adviser*
Woodside Energy Ltd

E: feedback@woodside.com.au
Toll free: 1800 442 977

Please note that stakeholder feedback will be communicated to NOPSEMA as required under legislation. Woodside will communicate any material changes to the proposed activity to affected stakeholders as they arise.

Woodside

woodside.com.au

Please note that stakeholder feedback will be communicated to NOPSEMA

Consultation with specific stakeholders

Woodside sent the following emails, consultation Information Sheet, activity maps and other information relevant to specific stakeholder interests.

Email to WAFIC – 8 February 2019

Subject to a final investment decision, Woodside is proposing to undertake drilling, construction and installation activities for the Julimar Project in Production Licence WA-49-L in Commonwealth waters, starting Q1 2020.

We have identified and assessed potential risks and impacts to active commercial fishers, fishing activity, the commercial fishing resource and the marine environment in the development of the proposed Environment Plan for this activity. These risks are summarised below.

Woodside has endeavoured to reduce these risks to ALARP level. Please contact the undersigned if you believe we have overlooked any potential impacts to the commercial fishing industry or missed any points of importance.

Activity overview
Details of the proposed activity are:

Activity purpose:	• Up to five production wells are planned to support future production at the Julimar Project in WA-49-L • An exploration well and an appraisal well may be drilled to help improve understanding of the reservoir		
Activity:	• Drilling of up to five production wells and installation of a 22 km flowline, subsea manifold and associated subsea infrastructure • Drilling of an exploration well and an appraisal well		
Activity location:	185 km North West of Dampier, Western Australia		
State fisheries licensed to fish in activity area:	• Pilbara Fish Trawl • Pilbara Trap • Pilbara Line • Mackerel fishery • Onslow Prawn • Specimen shell		
Well locations:	JULA-A	20^0 08’ 52.996” S	115^0 02’ 28.377” E
	JULA-C	20^0 08’ 52.222” S	115^0 02’ 26.436” E
	JULA-K	20^0 08’ 53.554” S	115^0 02’ 28.078” E
	JULA-M	20^0 08’ 51.855” S	115^0 02’ 27.005” E
	Exploration well	20^0 02’ 6.754” S	115^0 06’ 32.749" E
	Advice will be provided to stakeholders of locations for the appraisal well and fifth production well once planning is finalised for all wells		

Water depth:	174 m to 201 m
Start date:	From Q1 2020
Duration:	• Production wells – up to 70 days per well • Exploration/appraisal well – up to 40 days per well • Pipelay – cumulative duration of 30 days
Vessel/rig:	• Semi-submersible mobile offshore drilling unit (MODU), with one support vessel in the field • Installation vessel and pipelay vessel
Exclusion Zone:	• A 500 m radius petroleum safety zone will be in place around the MODU and pipelay vessel for the duration of the drilling activities • Commercial fishers are permitted to use but should take care, when entering the wider Operational Area around the MODU (4 km radius), and pipelay vessel (1.5 km radius).

Potential risks to commercial fishing

Potential risk	Risk description	Mitigation and/or management measures
Planned Activities		
Vessel interaction	The presence of the MODU, pipelay vessel and other support vessels may preclude other marine users from access to the area.	• Woodside will notify relevant fishery stakeholders and Government maritime safety agencies of specific start and end dates, specific vessel-on-location dates and any exclusion zones prior to commencement of the activity.
Seabed disturbance	Disturbance to the seabed from mooring of the MODU, drilling and subsea installation of infrastructure.	• Woodside will seek to minimise seabed disturbance for the drilling and installation activities, including: • Well location and site appraisal to identify and address well-specific hazards and drilling constraints. • MODU mooring analysis and anchor deployment in accordance with internal standards. • No anchoring of support and installation vessels during drilling, construction and installation activities, as well as logging/retrieval of wet-stored items.
Underwater noise	Noise will be generated by the MODU, vertical well profiling undertaken during drilling, pipelay vessel and other support vessels. Due to the	• Vertical well profiling undertaken in accordance with internal procedure, including pre-start visual observations and shutdown for whales.

	low acoustic source levels associated with MODU and vessel operations there is not likely to be any interaction or potential impact to fish hearing, feeding or spawning.	
Marine discharges	Discharges from drilling include water based drill mud and cuttings, brines and cement. Discharges from the operation of the MODU include sewage, grey water, cooling water, desalination brine, deck drainage, ballast and bilge water These discharges may result in a localised short term reduction in water quality however they will be rapidly diluted and dispersed in the water column.	• Implementation of chemical assessment and approval process
Unplanned Risks		
Hydrocarbon release	Loss of hydrocarbons to the marine environment via loss of well control or from a vessel collision resulting a tank rupture.	• In the unlikely event of an oil spill or unplanned discharge into the environment, relevant agencies and organisations will be notified as appropriate to the nature and scale of the event, as soon as practicable following the occurrence. • Oil spill response strategies will be assessed based on potential impact to identified key receptor locations and sensitivities, which includes fish spawning and nursery areas.
Invasive Marine Species	Introduction or translocation and establishment of invasive marine species to the area via vessels ballast water or biofouling.	• All vessels will be assessed and managed as appropriate to prevent the introduction of invasive marine species. • Compliance with Australian biosecurity requirements and guidance.

Your feedback
Your feedback on the proposed activity and our response will be included in an Environment Plan for consideration by the National Offshore Petroleum Safety and Environmental Management Authority, as is required under the *Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009* (Cth).

Please provide your views by COB 11 March 2019 to allow us sufficient time to inform our planning for the proposed activity. Comments can be made by email, letter or by phone.

Regards

Corporate Affairs Adviser | Corporate Affairs
Woodside Energy Ltd

Letter to relevant State fishery licence holders – 8 February 2019

Woodside
Woodside Energy Ltd.
ACN 005 482 986
Mia Yellagonga
11 Mount Street
Perth WA 6000
Australia
T +61 8 9348 4000
F +61 8 9214 2777
www.woodside.com.au

Please direct all responses/queries to:
Andrew Winter
T: +61 8 9348 6115
E: andrew.winter@woodside.com.au
Our reference: 1401022933

8 February 2019

Dear Licence Holder

CONSULTATION INFORMATION – JULIMAR PHASE 2 DRILLING AND SUBSEA INSTALLATION

Subject to a final investment decision, Woodside is proposing to undertake drilling, construction and installation activities for the Julimar Project in Production Licence WA-49-L in Commonwealth waters, starting Q1 2020.

We have identified and assessed potential risks and impacts to active commercial fishers, fishing activity, the commercial fishing resource and the marine environment in the development of the proposed Environment Plan for this activity. These risks are summarised in Appendix A.

Woodside has endeavoured to reduce these risks to ALARP level. Please contact the undersigned if you believe we have overlooked any potential impacts to the commercial fishing industry or missed any points of importance.

Details of the proposed activity

Purpose:	Up to five production wells are planned to support future production at the Julimar Project in WA-49-L. An exploration well and an appraisal well may be drilled to help improve understanding of the reservoir.		
Activity:	Drilling of up to five production wells and installation of a 22 km flowline, subsea manifold and associated subsea infrastructure. Drilling of an exploration well and an appraisal well.		
Location:	185 km North West of Dampier, Western Australia		
Well locations:	JULA-A	20⁰ 08' 52.996" S	115⁰ 02' 28.377" E
	JULA-C	20⁰ 08' 52.222" S	115⁰ 02' 26.436" E
	JULA-K	20⁰ 08' 53.554" S	115⁰ 02' 28.078" E
	JULA-M	20⁰ 08' 51.855" S	115⁰ 02' 27.005" E
	Exploration well	20⁰ 02' 6.754" S	115⁰ 06' 32.749" E
	Advice will be provided to stakeholders of locations for the appraisal well and fifth production well once planning is finalised for all wells		
Water depth:	174 m to 201 m		
Start date:	From Q1 2020		
Duration:	Production wells – up to 70 days per well		
	Exploration/appraisal well – up to 40 days per well		
	Pipelay – cumulative duration of 30 days		
Exclusion zone:	A 500 m radius petroleum safety zone will be in place around the MODU and pipelay vessel for the duration of the drilling activities		
	Commercial fishers are permitted to use but should take care, when entering the Operational Area around the MODU (4 km radius) and pipelay vessel (1.5 km radius)		

A consultation Information Sheet is enclosed with this letter, which provides background on the proposed activity, as well as a State fisheries map. The information sheet is also available on our website at: https://www.woodside.com.au/sustainability/transparency/consultation-activities.

Your feedback on the proposed activity and our response will be included in an Environment Plan for consideration by the National Offshore Petroleum Safety and Environmental Management Authority, as is required under the *Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009* (Cth).

Please provide your views by COB Monday, 11 March 2019 to allow us sufficient time to inform our planning for the proposed activity. Comments can be made by email, letter or by phone.

Notification will be provided to relevant marine users closer to the time of the proposed activity.

Kind Regards

Andrew Winter
Corporate Affairs Adviser

APPENDIX A

Potential risks to commercial fishing – planned activities

Potential risk	Risk description	Mitigation and/or management measures
Vessel interaction	The presence of the MODU, pipelay vessel and other support vessels may preclude other marine users from access to the area.	• Woodside will notify relevant fishery stakeholders and Government maritime safety agencies of specific start and end dates, specific vessel-on-location dates and any exclusion zones prior to commencement of the activity. • A 500 m radius petroleum safety zone will be in place around the MODU and pipelay vessel for the duration of the drilling activities. • Commercial fishers are permitted to use but should take care, when entering the Operational Area around the MODU (4 km radius) and pipelay vessel (1.5 km radius).
Seabed disturbance	Disturbance to the seabed from mooring of the MODU, drilling and subsea installation of infrastructure.	• Woodside will seek to minimise seabed disturbance for the drilling and installation activities, including: • Well location and site appraisal to identify and address well-specific hazards and drilling constraints. • MODU mooring analysis and anchor deployment in accordance with internal standards. • No anchoring of support and installation vessels during drilling, construction and installation activities, as well as logging/retrieval of wet-stored items.
Underwater noise	Noise will be generated by the MODU, vertical well profiling undertaken during drilling, pipelay vessel and other support vessels. Due to the low acoustic source levels associated with MODU and vessel operations there is not likely to be any interaction or potential impact to fish hearing, feeding or spawning.	• Vertical well profiling undertaken in accordance with internal procedure, including pre-start visual observations and shutdown for whales.
Marine discharges	Discharges from drilling include water-based drill mud and cuttings, brines and cement. Discharges from the operation of the MODU include sewage, grey water, cooling water, desalination brine, deck drainage, ballast and bilge water. These discharges may result in a localised short-term reduction in water quality however they will be rapidly diluted and dispersed in the water column.	• Implementation of chemical assessment and approval process.

Page 3 of 4

Potential risks to commercial fishing – unplanned activities

Potential risk	Risk description	Mitigation and/or management measures
Hydrocarbon release	Loss of hydrocarbons to the marine environment via loss of well control or from a vessel collision resulting a tank rupture.	• In the unlikely event of an oil spill or unplanned discharge into the environment, relevant agencies and organisations will be notified as appropriate to the nature and scale of the event, as soon as practicable following the occurrence. • Oil spill response strategies will be assessed based on potential impact to identified key receptor locations and sensitivities, which includes fish spawning and nursery areas.
Invasive Marine Species	Introduction or translocation and establishment of invasive marine species to the area via vessels ballast water or biofouling.	• All vessels will be assessed and managed as appropriate to prevent the introduction of invasive marine species. • Compliance with Australian biosecurity requirements and guidance.

Page 4 of 4

Email to DNP – 8 April 2019

Dear Director of National Parks

Woodside is planning to undertake drilling, construction and installation activities in Production Licence WA-49-L in Commonwealth waters to support the proposed Julimar Phase 2 Project, commencing in Q1 2020 and ending in 2022.

We note Australian Government Guidance on consultation activities with respect to the proposed activities and confirm that:

- The proposed activities are outside the boundaries of a proclaimed Commonwealth marine reserve, with the nearest being the Montebello Islands Marine Reserve, about 40 km to the east.

- We have assessed potential risks to Commonwealth marine reserves in the development of the proposed Environment Plan for this activity and believe that there are no credible risks as part of planned activities that have potential to impact Marine Reserve values.

- In the unlikely event of a loss of hydrocarbons, the worst-case credible spill scenario assessed for the activities is the remote likelihood event of a subsea loss of well control. For this consequence to occur, there must be a failure of multiple physical and procedural barriers within the well and related to its operation. Given the controls in place to prevent and control loss of well control events and mitigate their consequences, it is considered that the risk associated with a subsea well blow out is managed to as low as reasonably practical. If such an event were to occur and based on deterministic modelling, there is the potential for surface hydrocarbons to enter the following Marine Parks or strand on shorelines:
  - Montebello Islands Marine Park
  - Ningaloo World Heritage Area
  - Kimberley Coast Marine Park and Commonwealth Marine Reserve
  - Eighty Mile Beach Marine Park, RAMSAR site and Commonwealth Marine Reserve

A Commonwealth Government-approved oil spill response plan will be in place for the duration of the activities, which includes notification to relevant agencies and organisations as to the nature and scale of the event, as soon as practicable following an occurrence.
The Director of National Parks will be advised if an environmental incident occurs that may impact on the values of these Marine Parks.

Regards

Corporate Affairs Adviser | Corporate Affairs
Woodside Energy Ltd

Email to relevant stakeholders who provided feedback – 16 April 2019

Woodside sent the email below to relevant stakeholders who provided feedback during initial consultation, offering stakeholders the opportunity for their feedback to be confidential to NOPSEMA and not published in the accepted Environment Plan as part of new transparency arrangements for Environment Plans.

Dear Stakeholder

Thanks for providing feedback on our proposed Julimar Phase 2 drilling and subsea installation activities.

As you may be aware, new transparency arrangements for Environment Plans are coming into effect on 25 April 2019.

As a result, the Environment Plan for this activity will be published in full following acceptance by NOPSEMA, including a full transcript of your feedback to us.

Please let us know if there is any information you feel to be sensitive and do not want published, and we will provide separately to NOPSEMA. NOPSEMA has committed to ensuring all sensitive information remains confidential.

We look forward to hearing from you on this matter.

Regards

Corporate Affairs Adviser | Corporate Affairs
Woodside Energy Ltd

Email to all relevant stakeholders – 18 April 2018

Woodside sent the email below to all relevant stakeholders advising of a change in timing and additional project definition for the proposed activity.

Dear Stakeholder

For the Julimar Phase 2 Development, Woodside now proposes that the activity timing commence in Q4 2019, rather than Q1 2020.

For subsea installation activity there is additional Project definition, which has resulted in the requirement to potentially install anchoring systems (including wire) by either an anchor handling vessel or pipelay vessel to support the pipelay activity. The pipelay vessel is expected to be in the field for a cumulative duration of approximately four to eight weeks.

This anchoring activity has resulted in a change to the mitigation and/or management measure related to seabed disturbance in Table 3 of the factsheet. There remains no anchoring of support vessels during drilling and installation activities, however anchors may be set to support the pipelay activity.

Please let me know if you have any further comments by 10 May 2019.

As you may be aware, new transparency arrangements for Environment Plans are coming into effect on 25 April 2019. As a result, the Environment Plan for this activity will be published in full following acceptance by NOPSEMA, including a full transcript of your feedback to us. Please let us know if there is any information you feel to be sensitive and do not want published, and we will provide separately to NOPSEMA. NOPSEMA has committed to ensuring all sensitive information remains confidential.

Regards

Corporate Affairs Adviser | Corporate Affairs
Woodside Energy Ltd

Oil Pollution Consultation

Woodside sent the emails below to stakeholders with responsibilities for oil pollution response in Commonwealth and State waters.

Email to DoT – 18 April 2018

Good Afternoon,

As part of Woodside's ongoing consultation for its current and planned activities, we advise that we're preparing an Environment Plan (EP) for the Julimar Phase 2 Drilling and Subsea Installation.

The proposed petroleum activities program is located about 185 km offshore from Dampier on the north west coast of Western Australia.

A Consultation Information Sheet is attached, providing information on the proposed activity. The Information Sheet is available on our website also.

Information as requested in the Offshore Petroleum Industry Guidance Note (September 2018) is presented in the table below.

In accordance with the *Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009* (Cth), Woodside plan to submit the EP end of May to support these activities.

As part of this approval submission Woodside has drafted an Oil Pollution First Strike Plan. Therefore I would like to offer you the opportunity to review or provide comment on the prepared DRAFT (attached).

Should you require additional information or have a comment to make about the proposed activity, please contact myself latest by 24 May 2019 to allow us sufficient time to inform our activity planning and EP development. Comments can be made by email, letter or by phone.

Please be aware that your feedback will be communicated to the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA), as is required under legislation.

We look forward to hearing from you.

Information Requested in the Offshore Petroleum Industry Guidance Note (December 2017)	Information Provided
Description of activity, including the intended schedule, location (including coordinates), distance to nearest landfall and map.	Included in the consultation information sheet
Worst case spill volumes.	Included in Appendix A of the First Strike Plan
Known or indicative oil type/properties.	Included in Appendix A of the First Strike Plan
Amenability of oil to dispersants and window of opportunity for dispersant efficacy.	Dispersants (subsea and surface) have been assessed as not feasible for this activity.
Description of existing environment and protection priorities.	Included in Section 4 of the First Strike Plan
Details of the environmental risk assessment related to marine oil pollution – describe the process and key outcomes around risk identification, risk analysis, risk evaluation and risk treatment. For further information see the Oil Pollution Risk Management Information Paper (NOPSEMA 2017).	Unplanned loss of containment events from the Petroleum Activities Program have been identified during the risk assessment process (presented in **Section 6** of the EP). Further descriptions of risk, impacts and mitigation measures (which are not related to hydrocarbon preparedness and response) are provided in Section 5 of the EP. Five unplanned events or credible spill scenarios for the Petroleum Activities Program have been selected as representative across types, sources and incident/response levels, up to and including the WCCS. **Table 2-1** of the EP presents the credible scenarios for the Petroleum Activities Program. The WCCS for the activity is then used for response planning purposes, all other scenarios are of a lesser scale and extent. By demonstrating capability to meet and manage an event of this size, Woodside assumes relevant scenarios that are smaller in nature and scale can also be managed by the same capability. Response performance outcomes have been defined based on a response to the WCCS.
Outcomes of oil spill trajectory modelling, including predicted times to enter State waters and contact shorelines.	No receptors will be contacted above threshold concentrations within 48 hours. Preliminary hydrocarbon spill modelling results indicate the sensitive receptors listed below have the potential to be contacted by hydrocarbons above threshold concentrations beyond 48 hours of a spill: • Ningaloo Coast Middle World Heritage Area (2 m³, 18.4 days) • Kimberley Coast & Northern Coast (38 m³, 63 days) • Eighty Mile Beach (36 m³, 36 days) • Eighty Mile Beach Marine Park and Ramsar Site (5 m³, 71.2 days)
Details on initial response actions and key activation timeframes.	Included in Section 2 and 3 of the First Strike Plan
Potential Incident Control Centre arrangements.	Included in Appendix E and F of the First Strike Plan
Potential staging areas/Forward Operating Base.	A Forward Operating Base can be established at Exmouth
Details on response strategies.	Included in Section 2 and 3 of the First Strike Plan
Details and diagrams on proposed IMT structure including integration of DoT arrangements as per this IGN.	Included in Appendix E and F of the First Strike Plan
Details on testing of arrangements of OPEP/OSCP.	One oil spill response themed level 1 drill to be conducted within two weeks of arriving on location, per well. This drill should test elements of the recommended response identified in the Julimar

	Phase 2 Drilling and Subsea Installation – Oil Pollution First Strike Plan in relation to the level of the incident. 1x Crisis oil spill response focused exercise annually. ***Testing of Oil Spill Response Arrangements*** There are a number of arrangements which in the event of a spill will underpin Woodside's ability to implement a response across its petroleum activities. In order to ensure each of these arrangements is adequately tested, the Hydrocarbon Spill Preparedness Capability and Competency Coordinator ensures tests are conducted in alignment with the Hydrocarbon Spill Arrangements Testing Schedule (Woodside Doc No. 10058092). Woodside's Hydrocarbon Spill Preparedness & Response Testing Schedule aligns with international good practice for spill preparedness & response management; the testing is compatible with the IPIECA Good Practice Guide and the Australian Emergency Management Institute Handbook. The Hydrocarbon Spill Arrangements Testing Schedule (Woodside Doc No. 10058092) identifies the type of test which will be conducted annually for each arrangement, and how this type will vary over a five year rolling schedule. Testing methods may include (but are not limited to): audits, drills, field exercises, functional workshops, assurance reporting, assurance monitoring and reviews of key external dependencies. Activity specific Oil Spill Pollution First Strike Plans are developed to meet the response needs of that particular activity's WCCS. The ability to implement these plans may rely on specific arrangements or those common to other Woodside activities. Regardless of their commonality each arrangement will be tested in at least one of the methods annually. This ensures that personnel are familiar with spill response procedures, reporting requirements, and roles/responsibilities. At the completion of testing a report is produced to demonstrate the outcomes achieved against the tested objectives. The report will include the lessons learned, any improvement actions and a list of the participants. Alternatively, an assurance report, assurance records, or audit report may be produced. These reports record findings and include any recommendations for improvement. Improvement actions and their close-out are actively recorded and managed. This is over and above the emergency management exercises conducted.

Hydrocarbon Spill Adviser | Security & Emergency Management
Woodside Energy Ltd

Email to AMSA – 18 April 2019

Good Afternoon,

As part of Woodside's ongoing consultation for its current and planned activities, we advise that we're preparing an Environment Plan (EP) for the Julimar Phase 2 Drilling and Subsea Installation.

The proposed petroleum activities program is located about 185 km offshore from Dampier on the north west coast of Western Australia.

A Consultation Information Sheet is attached, providing information on the proposed activity. The Information Sheet is available on our website also.

In accordance with the *Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009* (Cth), Woodside plan to submit the EP end of May to support these activities.

As part of this approval submission Woodside has drafted an Oil Pollution First Strike Plan. Therefore I would like to offer you the opportunity to review or provide comment on the prepared DRAFT (attached).

Should you require additional information or have a comment to make about the proposed activity, please contact myself latest by 24 May 2019 to allow us sufficient time to inform our activity planning and EP development. Comments can be made by email, letter or by phone.

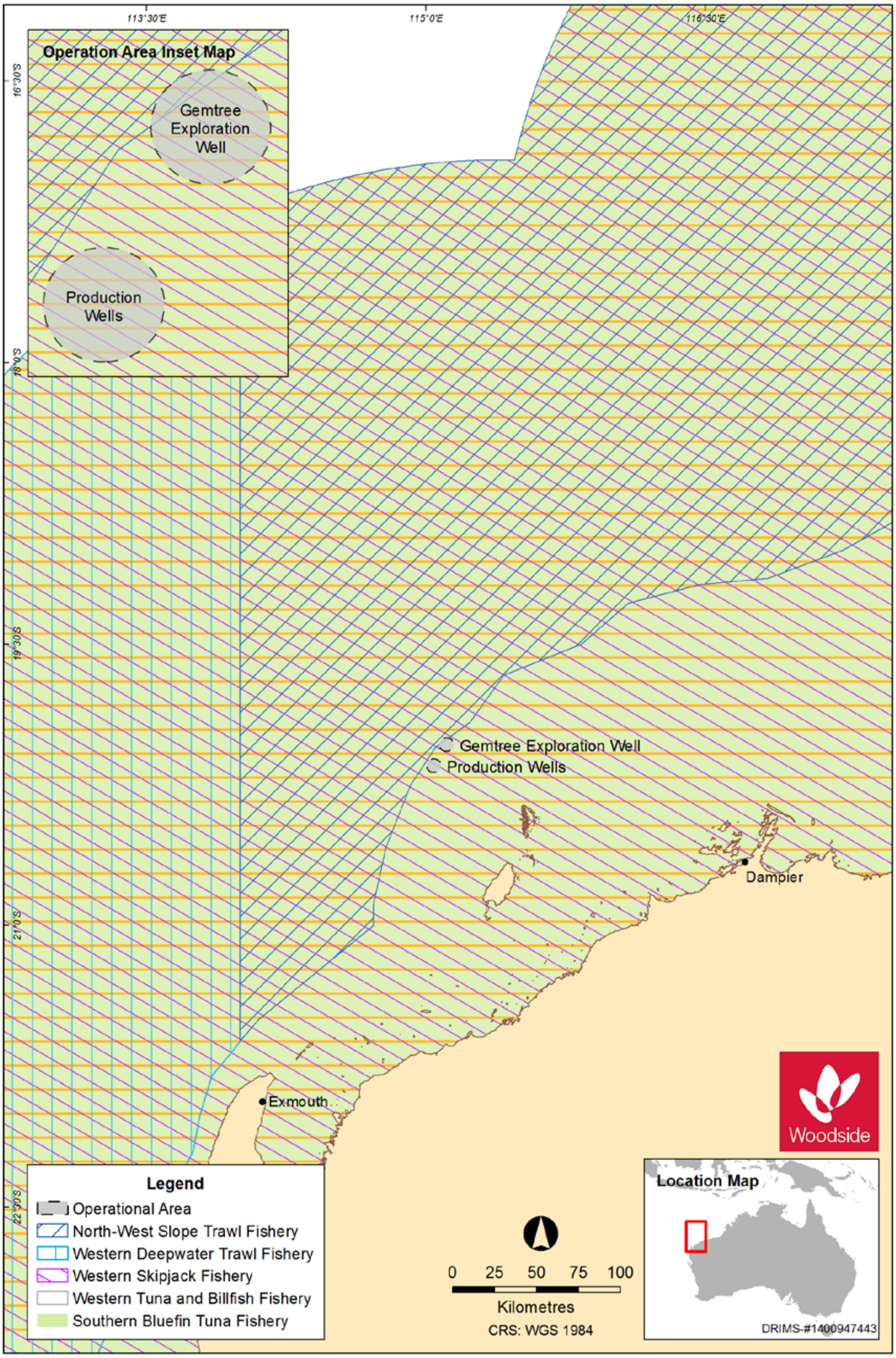
Please be aware that your feedback will be communicated to the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA), as is required under legislation.

We look forward to hearing from you.

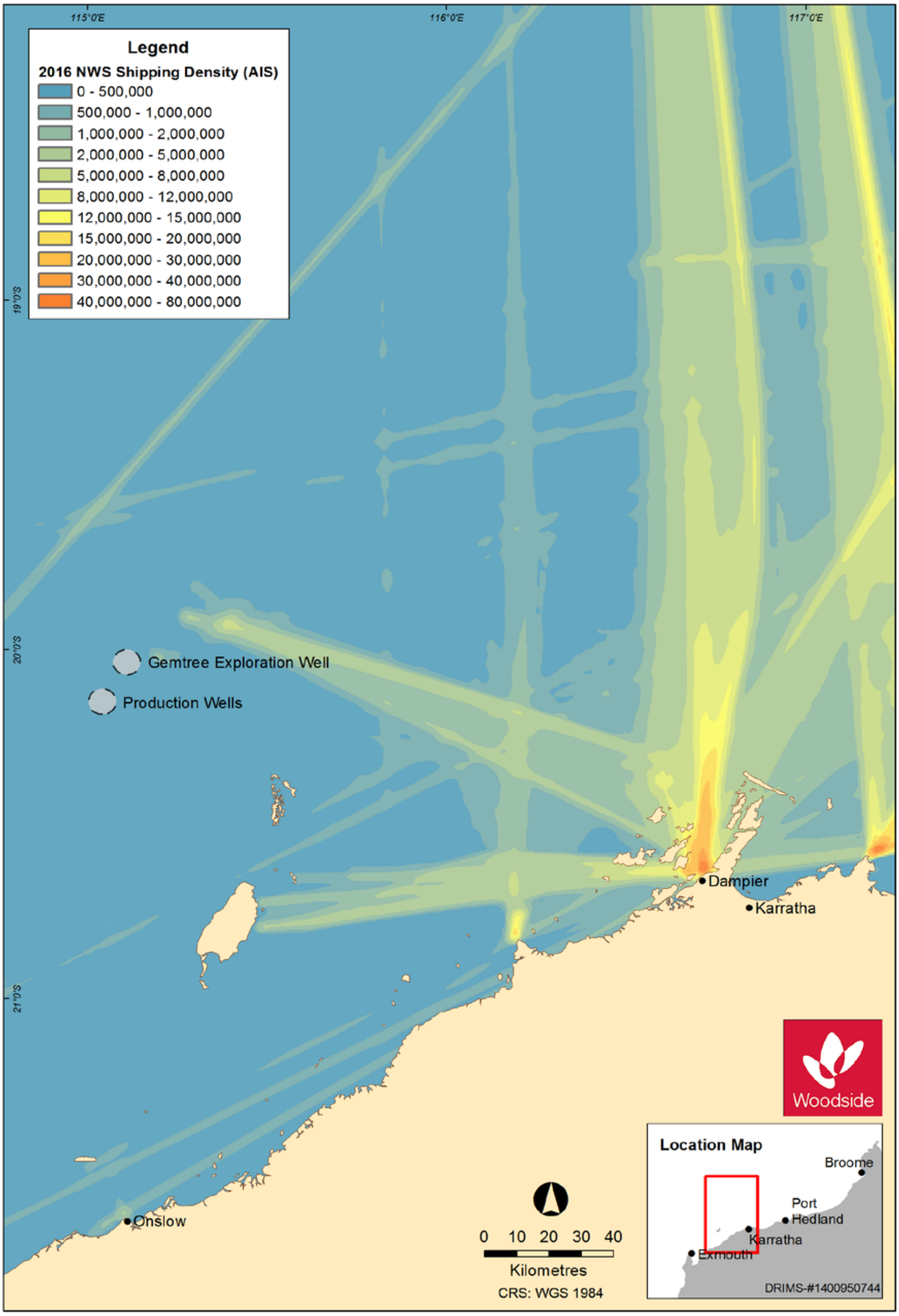
Regards

Hydrocarbon Spill Adviser | Security & Emergency Management
Woodside Energy Ltd

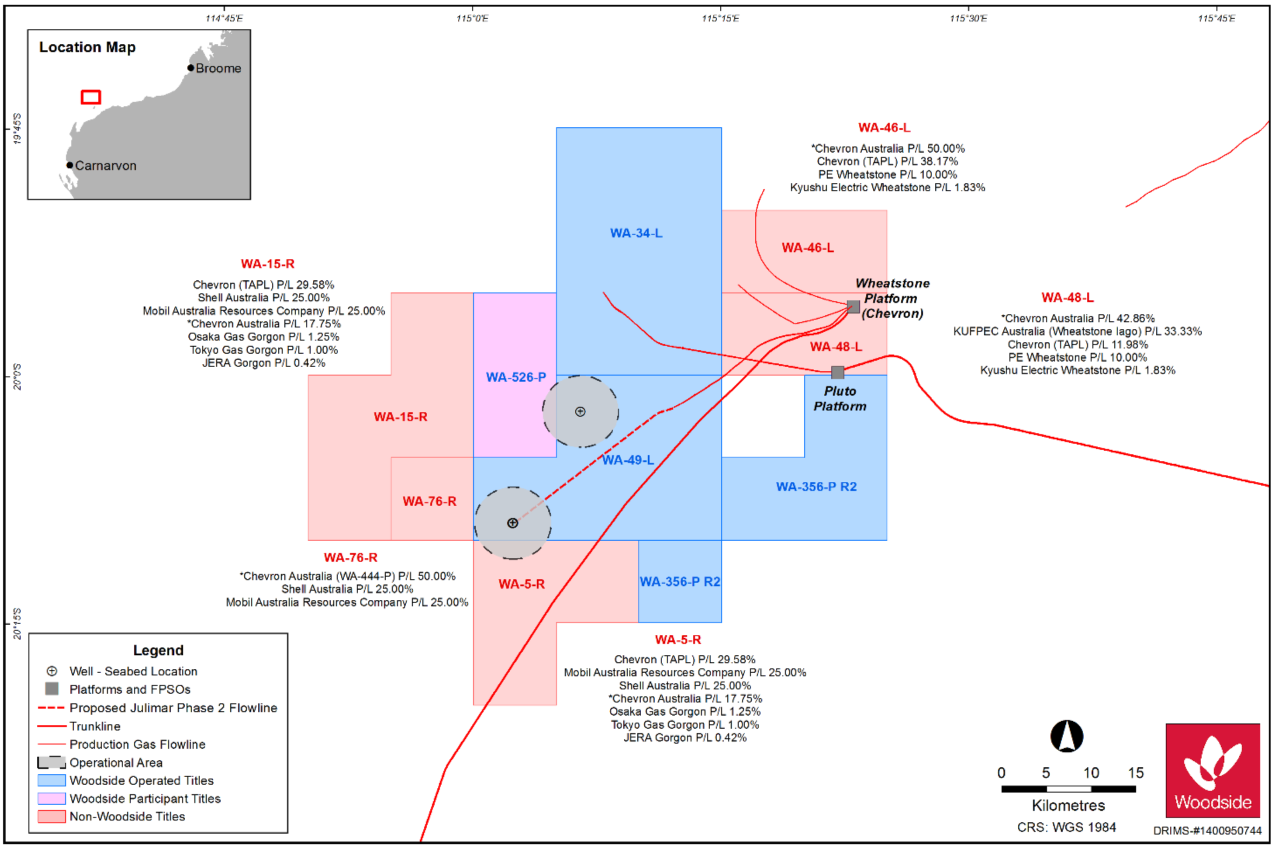
Commonwealth Fishery map provided to AFMA and Commonwealth Fisheries Association



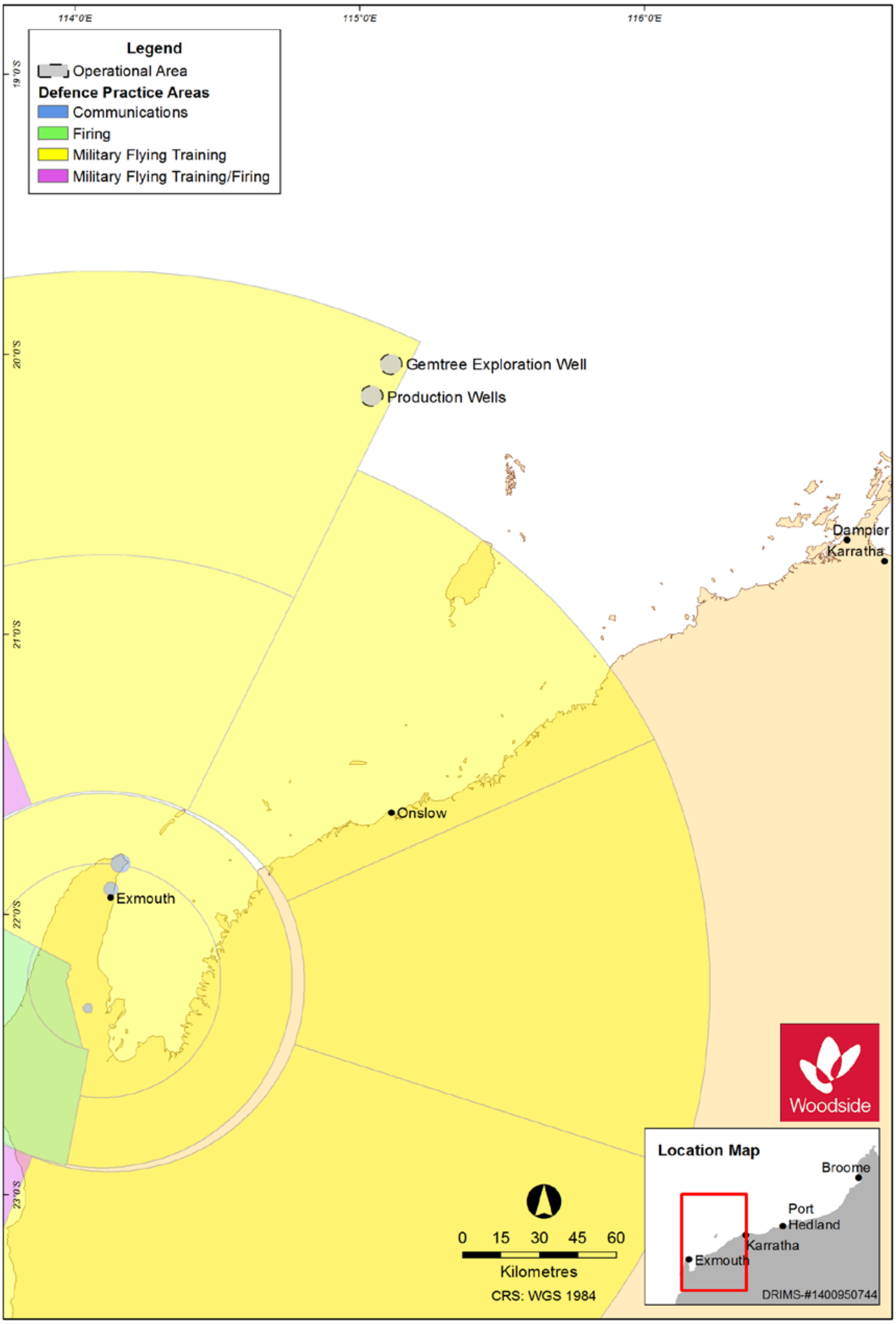
Shipping lane map provided to AMSA and AHO – 8 February 2019



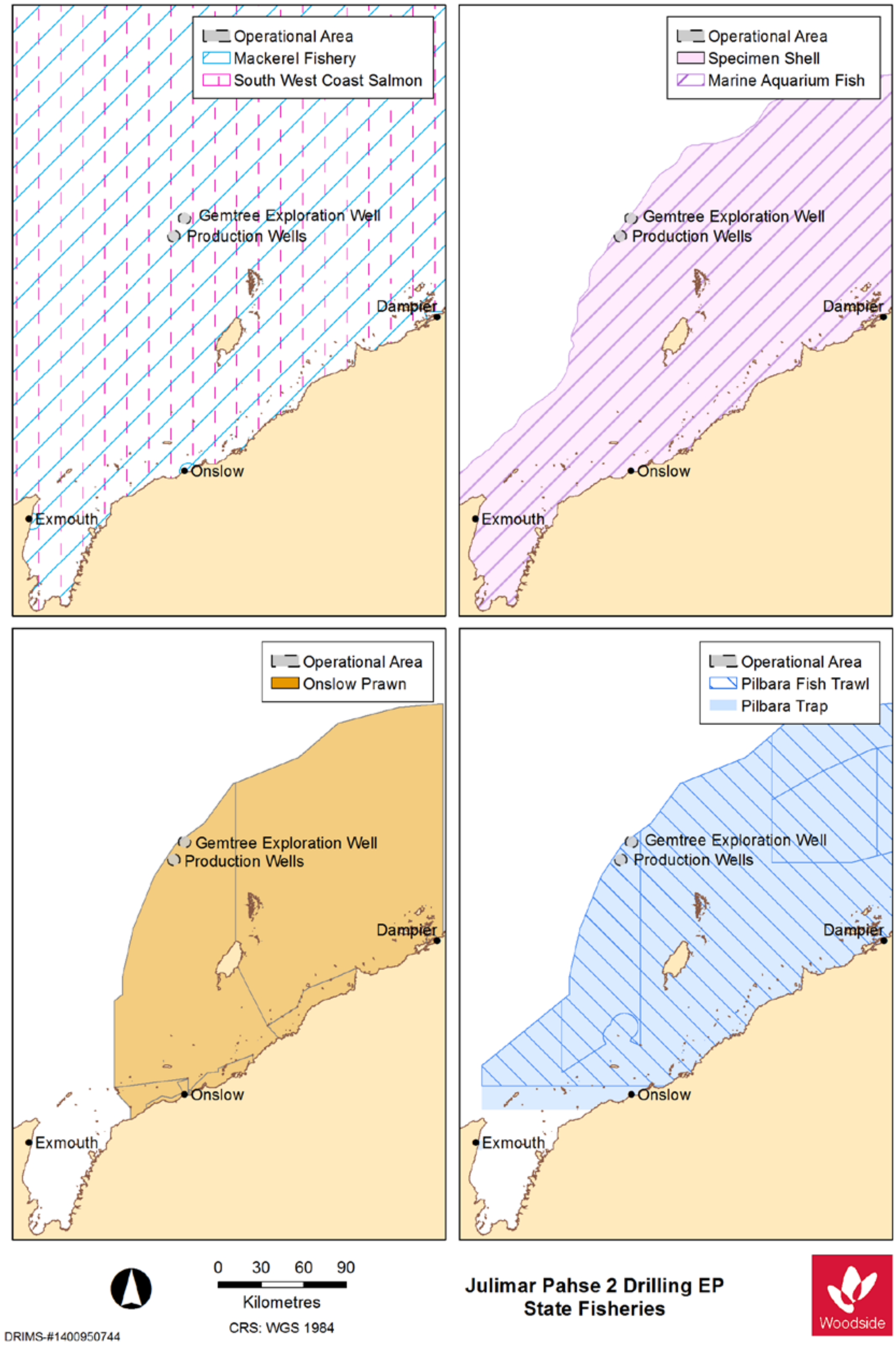
Titleholders map provided to Chevron – 8 February 2019



Defence area map provided to DoD – 8 February 2019



State Fishery map provided to DPIRD, WAFIC, PPA, Recfishwest and fishing licence holders – 8 February 2019



APPENDIX G: DEPARTMENT OF ABORIGINAL AFFAIRS HERITAGE INQUIRY SYSTEM RESULTS

Department of Aboriginal Affairs Heritage Inquiry System Results (Registered Sites)

For each search area (Figure H-1 to Figure H-3), a list of registered sites was collated from the Department of Aboriginal Affairs (DAA) Heritage Inquiry System. A high level visual assessment was undertaken of the level of disturbance at each site within 2 km of the coastline. This visual assessment was based on aerial photography available on the DAA Heritage Inquiry System (Landgate (2015), 50 cm resolution, captured between 2007 and 2013). A summary of the registered sites identified in the DAA Heritage Inquiry System are outlined in Table H-1 to Table H-3.

The location of the site relevant to the coast was recorded as the distance from the closest edge of the site boundary to the closest point where the ocean intersects the beach/land. If the site boundary intersects the beach/land adjacent to the ocean, the site is recorded as being 'on the coast'. Where this location is unreliable due to the site classification by DAA, this is noted.

The disturbance level noted from aerial photo was classified as follows:

- low disturbance: some tracks or minor road visible, no buildings or bitumen roads present
- moderate disturbance: evidence of sparse/low density human development (e.g. caravan parks, bitumen roads, buildings)
- highly disturbed: significant human development/urbanised/industrialised area
- n/a: not assessed, as further than 2 km from coast.

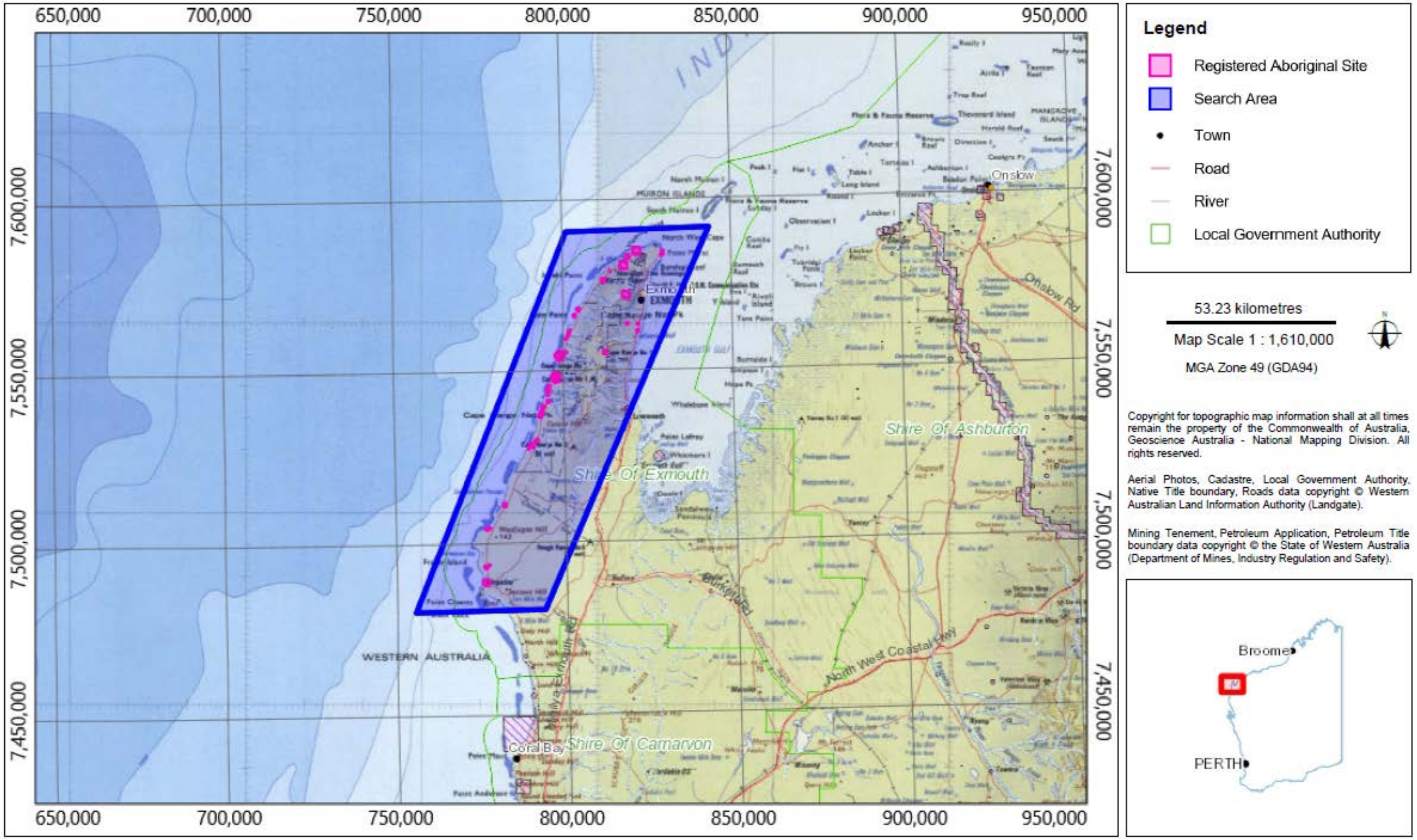
Department of Planning, Lands and Heritage

GOVERNMENT OF WESTERN AUSTRALIA

Aboriginal Heritage Inquiry System

For further important information on using this information please see the Department of Planning, Lands and Heritage's Disclaimer statement at https://www.dplh.wa.gov.au/about-this-website

Map of Registered Aboriginal Sites



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Identifier: 382608

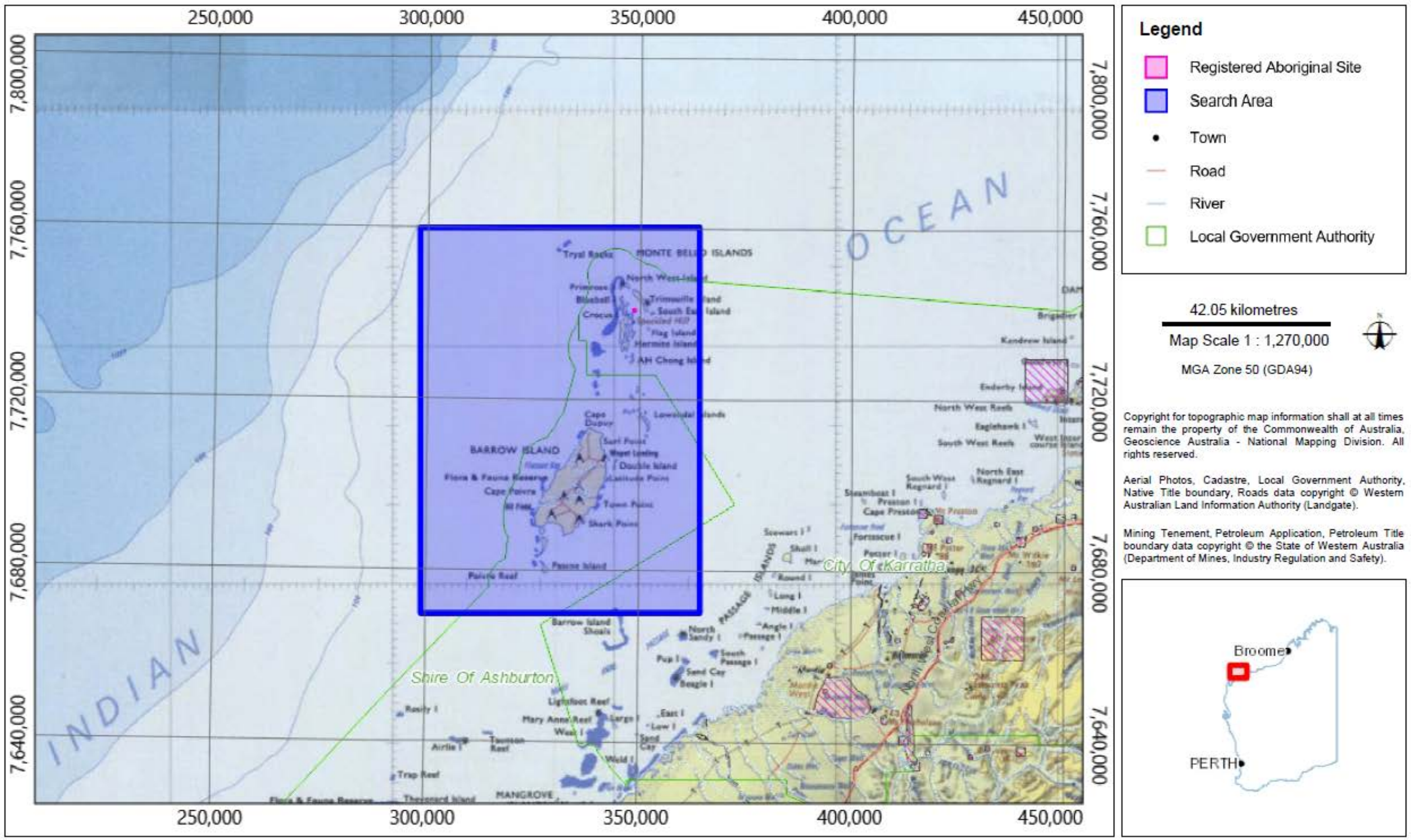
Figure H-1 DAA Heritage Inquiry: Ningaloo Coast and Northwest Cape

Department of Planning, Lands and Heritage

Aboriginal Heritage Inquiry System

Map of Registered Aboriginal Sites

For further important information on using this information please see the Department of Planning, Lands and Heritage's Disclaimer statement at https://www.dplh.wa.gov.au/about-this-website



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Identifier: 382606

Figure H-2 DAA Heritage Inquiry: Barrow Island and Montebello Islands

Department of Planning, Lands and Heritage

Aboriginal Heritage Inquiry System

Map of Registered Aboriginal Sites

For further important information on using this information please see the Department of Planning, Lands and Heritage's Disclaimer statement at https://www.dplh.wa.gov.au/about-this-website

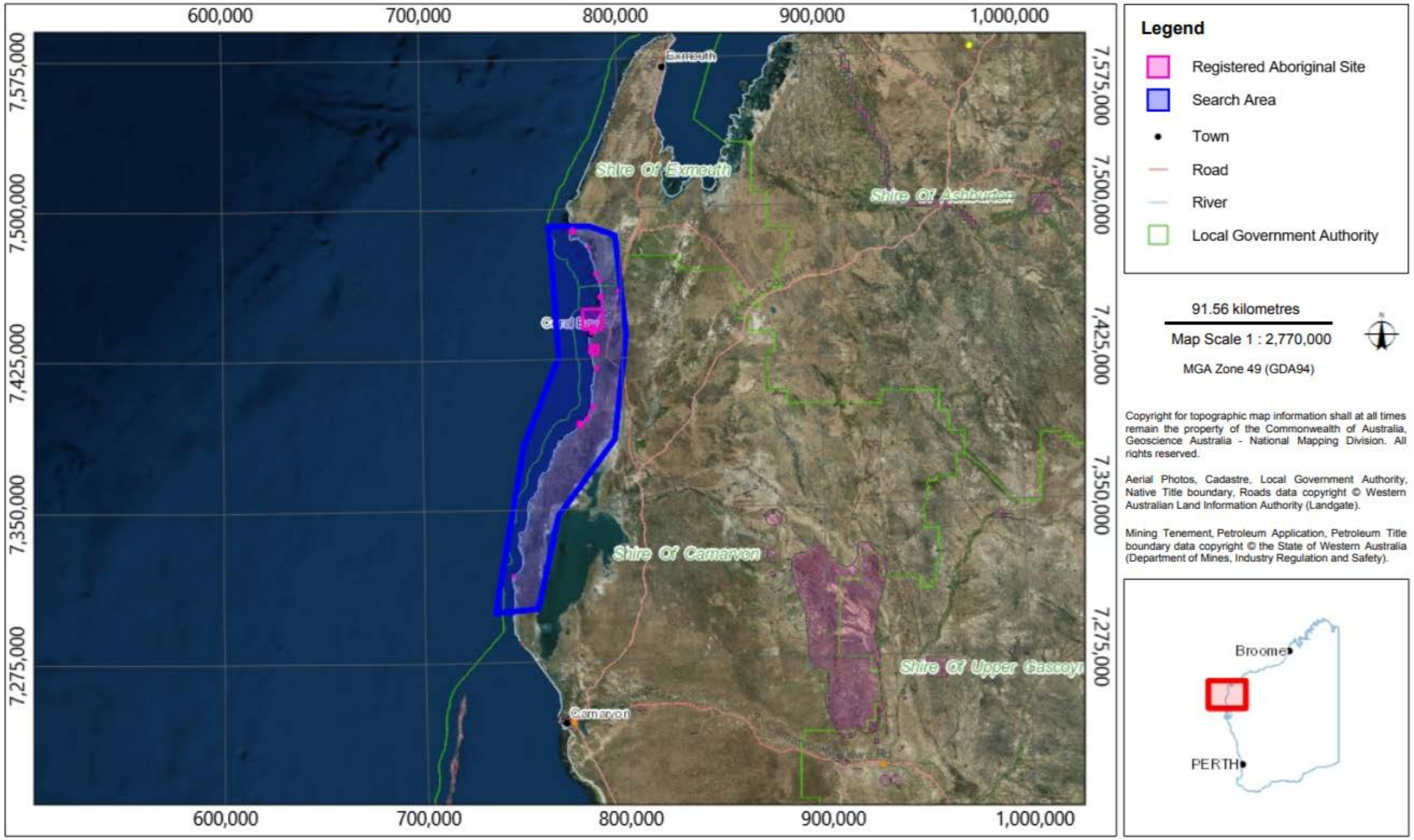

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Figure H-3 DAA Heritage Inquiry: Ningaloo to Cape Curvier

Table H-1: Registered Sites

Name (site ID)	Site Type	Coordinates and Reliability	Location relative to coast	Notes from aerial photo (if within 2km of coast)
Ningaloo Coast and Northwest Cape Search Area				
Point Murat 03 (508)	Artefacts /Scatter, Midden/ Scatter	209042mE 7584688mN Zone 50 [Reliable]	On the coast	Low disturbance, some tracks present, close to highly disturbed areas (Murat Road). Possible that the area is utilised by the public (beach area)
Point Murat 04 (509)	Artefacts /Scatter	208690mE 7584604mN Zone 50 [Reliable]	On the coast	See comment above as the site is adjacent to site ID 508.
Mowbowra Creek 01 (561)	Artefacts /Scatter	198764mE 7564207mN Zone 50 [Reliable]	Approx 3.7km from the coast.	n/a
Mowbowra Creek 02 (562)	Artefacts /Scatter	199217mE 7564242mN Zone 50 [Reliable]	Approx 3.7km from the coast.	n/a
Point Murat 01 (563)	Artefacts /Scatter, Midden/ Scatter	208716mE 7585665mN Zone 50 [Reliable]	On the coast	Low disturbance, some tracks present. Possible that the area is utilised by the public (beach area)
Point Murat 02 (564)	Artefacts /Scatter, Midden/ Scatter	209079mE 7585539mN Zone 50 [Reliable]	On the coast	Low disturbance, some tracks present. Possible that the area is utilised by the public (beach area)
Camp Thirteen Burial (628)	Skeletal Material / Burial	800392mE 7559449mN Zone 49 [Reliable]	On the coast	Low disturbance, vehicle tracks present. Possible that the area is utilised by the public (beach area)
Winpikanya (756)	Ceremonial, Engraving, Grinding Patches / Grooves, Mythological	Restricted location, female access only	Inland	n/a

Name (site ID)	Site Type	Coordinates and Reliability	Location relative to coast	Notes from aerial photo (if within 2km of coast)
Yardie Creek Caravan Burial (6017)	Skeletal Material / Burial	191538mE 7576555mN Zone 50 [Unreliable]	Approx 1.7km from coast (Unreliable)	May be within highly disturbed area (Yardie Creek Caravan Park)
Mowbowra Pool (6117)	Grinding Patches /Grooves	202138mE 7564155mN Zone 50 [Reliable]	Approx 680m from coast	Low disturbance. Approx 6.5km south of Exmouth townsite..
Qualing Pool (6118)	-	202138mE 7562155mN Zone 50 [Reliable]	Approx 130m from coast	Low disturbance, some vehicle tracks present.
Point Murat (6311)	Artefacts /Scatter, Midden/ Scatter, Skeletal Material / Burial	208538mE 7584405mN Zone 50 [Reliable]	On the coast	Low disturbance, sand dune area with limited vegetation.
Osprey Bay 6 (6754)	Artefacts /Scatter, Midden/ Scatter	792942mE 7538749mN Zone 49 [Reliable]	On the coast	Low disturbance. Part of the area appears to contain a road and parking/camping area.
Osprey Bay Interdunal 1 (6755)	Artefacts /Scatter, Midden/ Scatter	792342mE 7537149mN Zone 49 [Unreliable]	On the coast (Unreliable)	Low disturbance. Part of the area contains a road.
Osprey Bay Interdunal 2 (6756)	Midden /Scatter	792642mE 7537149mN Zone 49 [Reliable]	On the coast	Low disturbance. Part of the area contains a road and parking area.
Bloodwood Creek Midden 1 (6757)	Artefacts /Scatter, Midden/ Scatter	794942mE 7544549mN Zone 49 [Reliable]	On the coast	Low disturbance. Part of the area appears to contain a road and parking/camping area.
Bloodwood Creek Midden 2 (6758)	Artefacts /Scatter, Midden/ Scatter	794942mE 7545049mN Zone 49 [Reliable]	On the coast	Low disturbance. Part of the area appears to contain a road and parking/camping area.

Name (site ID)	Site Type	Coordinates and Reliability	Location relative to coast	Notes from aerial photo (if within 2km of coast)
Bloodwood Creek Midden 3 (6759)	Artefacts /Scatter, Midden/ Scatter	795142mE 7544949mN Zone 49 [Reliable]	On the coast	Low disturbance. Part of the area appears to contain a road and parking/camping area.
Bloodwood Creek Shoreline (6760)	Artefacts /Scatter, Midden/ Scatter	794942mE 7545249mN Zone 49 [Reliable]	On the coast	Low disturbance. Part of the area appears to contain a road and parking/camping area.
Low Point Midden (6761)	Artefacts /Scatter, Midden/ Scatter	802992mE 7566299mN Zone 49 [Reliable]	On the coast	Low disturbance. Part of the area appears to contain a road and parking/camping area.
Milyering Midden (6762)	Artefacts /Scatter, Midden/ Scatter	801342mE 7561449mN Zone 49 [Reliable]	On the coast	Low disturbance. Part of the area appears to contain a road/track
Yardie Rockshelters North (6763)	Artefacts /Scatter, Midden/ Scatter, Rockshelter	791542mE 7530249mN Zone 49 [Unreliable]	Approx 700m from the coast (Unreliable)	Low disturbance
Camp 17 South Middens (6764)	Artefacts /Scatter, Midden/ Scatter	799042mE 7555649mN Zone 49 [Unreliable]	On the coast (Unreliable)	Low disturbance. Part of the area appears to contain a road and parking/camping area.
Camp 17 North Middens (6765)	Artefacts /Scatter, Midden/ Scatter	799042mE 7555849mN Zone 49 [Unreliable]	On the coast (Unreliable)	Low disturbance. Part of the area appears to contain a road and parking/camping area.
28 Mile Creek North 1 (6782)	Artefacts /Scatter, Midden/ Scatter	795242mE 7545949mN Zone 49 [Unreliable]	On the coast (Unreliable)	Low disturbance. Part of the area appears to contain a road/track
Mandu Mandu Creek South (6784)	Artefacts /Scatter, Midden/ Scatter	796642mE 7548649mN Zone 49 [Unreliable]	On the coast (Unreliable)	Low disturbance. Part of the area contains a road
Mandu Mandu Creek North (6785)	Artefacts /Scatter, Midden/ Scatter	796642mE 7548649mN Zone 49 [Unreliable]	On the coast (Unreliable)	Low disturbance. Part of the area contains a road

Name (site ID)	Site Type	Coordinates and Reliability	Location relative to coast	Notes from aerial photo (if within 2km of coast)
Mandu Mandu Rockshelters. (6787)	Artefacts /Scatter, Midden/ Scatter, Rockshelter	797242mE 7547449mN Zone 49 [Reliable]	Approx 980m from the coast	Low disturbance. Part of the area appears to some tracks
Yardie Creek South 1 (6790)	Artefacts /Scatter, Midden/ Scatter	788942mE 7527749mN Zone 49 [Reliable]	On the coast	Low disturbance
Yardie Creek South 2 (6791)	Artefacts /Scatter, Midden/ Scatter	790342mE 7528149mN Zone 49 [Reliable]	Approx 680m from the coast	Area is part of Yardie Creek. Low disturbance, some tracks present.
Road Alignment 1 (6793)	Artefacts /Scatter, Midden/ Scatter	794942mE 7541649mN Zone 49 [Unreliable]	Approx 630m from the coast (Unreliable)	Low disturbance, Yardie Creek Road intersects the site
Road Alignment 2 (6794)	Artefacts /Scatter, Midden/ Scatter	794942mE 7541449mN Zone 49 [Unreliable]	Approx 630m from the coast (Unreliable)	Low disturbance, Yardie Creek Road intersects the site
Road Alignment 3 (6795)	Midden /Scatter	794842mE 7541249mN Zone 49 [Reliable]	Approx 630m from the coast	Low disturbance, Yardie Creek Road intersects the site
Yardie Well Rockshelter. (6797)	Artefacts /Scatter, Midden/ Scatter, Rockshelter	791542mE 7530449mN Zone 49 [Reliable]	Approx 740m from the coast	Low disturbance, Yardie Creek Road intersects the site
Yardie Interdunal Swale (6798)	Artefacts /Scatter, Midden/ Scatter	789942mE 7528849mN Zone 49 [Reliable]	On the coast.	Moderate disturbance, Yardie Creek Road and parking/camping areas present in the site.
Yardie Beach Midden (6799)	Artefacts /Scatter, Midden/ Scatter	789842mE 7529049mN Zone 49 [Reliable]	On the coast.	Moderate disturbance, Yardie Creek Road and parking/camping areas present in the site.
Oyster Stacks Midden (6800)	Artefacts / Scatter, Midden/ Scatter	797042mE 7549849mN	On the coast.	Low disturbance, Road/tracks present.

Name (site ID)	Site Type	Coordinates and Reliability	Location relative to coast	Notes from aerial photo (if within 2km of coast)
		Zone 49 [Reliable]		
North T-Bone Bay (6801)	Artefacts /Scatter, Midden/ Scatter	800642mE 7561649mN Zone 49 [Unreliable]	On the coast/near the coast (Unreliable).	Low disturbance, appears to be located in the nearshore reef area (location unreliable).
Osprey Bay 1 (6802)	Artefacts /Scatter, Midden/ Scatter	792742mE 7538149mN Zone 49 [Reliable]	On the coast.	Moderate disturbance, road/track and parking/camping areas present in the site.
Osprey Bay 2 (6803)	Artefacts /Scatter, Midden/ Scatter	792742mE 7538049mN Zone 49 [Reliable]	On the coast.	Moderate disturbance, road/track and parking/camping areas present in the site.
Osprey Bay 3 (6804)	Artefacts /Scatter, Midden/ Scatter	792542mE 7537849mN Zone 49 [Reliable]	On the coast.	Moderate disturbance, road/track and parking/camping areas present in the site.
Osprey Bay 4 (6805)	Artefacts /Scatter, Midden/ Scatter	792342mE 7537049mN Zone 49 [Reliable]	On the coast.	Low disturbance, Road/tracks present.
Osprey Bay 5 (6806)	Artefacts /Scatter, Midden/ Scatter	792742mE 7538149mN Zone 49 [Reliable]	On the coast.	Moderate disturbance, road/track and parking/camping areas present in the site.
Mesa Camp (7126)	Artefacts /Scatter, Midden / Scatter	798442mE 7554749mN Zone 49 [Unreliable]	On the coast. (Unreliable)	Low disturbance, Road/tracks present.
Sandy Bay North (7254)	Artefacts /Scatter, Midden/ Scatter	793442mE 7539949mN Zone 49 [Reliable]	On the coast.	Low disturbance, Road/tracks present.
Lake Side View (7265)	Artefacts /Scatter, Midden/ Scatter	800942mE 7560549mN Zone 49 [Reliable]	On the coast.	Moderate disturbance, road/track and parking/camping areas present in the site.
Walking Trail Site 1 (7266)	Artefacts /Scatter	192638mE 7555655mN Zone 50 [Unreliable]	Approx 7.7km from the coast (Unreliable)	n/a

Name (site ID)	Site Type	Coordinates and Reliability	Location relative to coast	Notes from aerial photo (if within 2km of coast)
Yardie Creek Rockshelters (7298)	Artefacts /Scatter	790635mE 7529704mN Zone 49 [Reliable]	Approx 200m from coast	Low disturbance, Road/tracks present.
Yardie Creek (7299)	Artefacts /Scatter, Midden/ Scatter	789642mE 7528649mN Zone 49 [Unreliable]	On the coast (Unreliable)	Moderate disturbance, Yardie Creek Road and parking/camping areas present in the site, adjacent to Yardie Creek.
Mandu Mandu Ck Rockshelters (7300)	Artefacts /Scatter	Restricted location	On the coast/near the coast (Unreliable).	Low disturbance, Road/tracks present.
Camp 17 Creek East (7301)	Artefacts /Scatter, Midden / Scatter	800342mE 7555749mN Zone 49 [Reliable]	Approx 1m from the coast	Low disturbance, some tracks present
Tulki Well Midden (7303)	Artefacts /Scatter, Midden/ Scatter	798642mE 7554249mN Zone 49 [Reliable]	On the coast.	Low disturbance, some tracks present.
Pilgramunna Bay Midden (7304)	Artefacts /Scatter, Midden/ Scatter	794642mE 7543349mN Zone 49 [Reliable]	On the coast.	Low disturbance
Mangrove Bay (7305)	Artefacts /Scatter, Midden/ Scatter, Skeletal Material / Burial	804142mE 7568149mN Zone 49 [Reliable]	On the coast.	Low disturbance, some tracks present.
Ningaloo Station (8301)	Artefacts /Scatter	775891mE 7493649mN Zone 49 [Unreliable]	Approx 880 m from the coast	Low disturbance
Vlaming Head (10381)	Ceremonial, Mythological	Restricted location	On the coast (Unreliable).	Moderate disturbance, small settlement/caravan park appears to be within the site.

Name (site ID)	Site Type	Coordinates and Reliability	Location relative to coast	Notes from aerial photo (if within 2km of coast)
Yardie Creek Station (11400)	Engraving	191638mE 7576655mN Zone 50 [Unreliable]	Approx 1.7km from the coast (Unreliable).	Moderate disturbance, small settlement/caravan park appears to be within the site.
5 Mile Well (Cape Range) (11401)	Artefacts /Scatter, Engraving, Painting, Quarry	198638mE 7583655mN Zone 50 [Unreliable]	Approx 42m from the coast (Unreliable).	Low disturbance, Road/tracks present.
Ningaloo (near) (11458)	Painting	781642mE 7511649mN Zone 49 [Unreliable]	Approx 350 m from the coast	Low disturbance
Padjari Manu Cave (Formerly Bunbury Cave) (11885)	Artefacts /Scatter, Ceremonial, Engraving, Painting	Restricted location	Approx 1km from the coast (Unreliable).	Low disturbance, Road/tracks present.
Point Murat/White Opal (15322)	Artefacts /Scatter, Midden / Scatter	209012mE 7585213mN Zone 50 [Reliable]	Approx 230m from the coast	Low disturbance, some tracks present.
Coral Bay to Yardie Creek 3 (16596)	Artefacts /Scatter	776901mE 7494189mN Zone 49 [Reliable]	Approx 2.2 km from the coast	Low disturbance
Ningaloo Station (17193)	Skeletal Material / Burial	775891mE 7489149mN Zone 49 [Unreliable]	Approx 410 m from the coast	Low disturbance, Road/tracks present.
Exmouth Station (17192)	Skeletal Material / Burial	209138mE 7525654mN Zone 50 [Unreliable]	On the coast (Unreliable).	Low disturbance.
Pap Hill Ochre (17447)	Ceremonial, Grinding Patches /Grooves, Rockshelter	198327mE 7581741mN Zone 50 [Reliable]	Approx 1.8km from coast	Low disturbance.

Name (site ID)	Site Type	Coordinates and Reliability	Location relative to coast	Notes from aerial photo (if within 2km of coast)
Chugori Rockhole (17448)	Ceremonial, Grinding Patches /Grooves, Man-Made Structure, Mythological	193492mE 7579323mN Zone 50 [Reliable]	Approx 1.4km from coast	Low disturbance.
Montebello Islands Search Area				
Montebello Is: Noala Cave (873)	Artefacts / Scatter, Midden / Scatter, Rockshelter, BP Dating: 27,220 +/- 640	348188mE 7741053mN Zone 50 [Reliable]	On the coast	Low disturbance.
Montebello Is: Haynes Cave (926)	Artefacts / Scatter, Midden / Scatter, Rockshelter, Arch Deposit	348289mE 7741005mN Zone 50 [Reliable]	On the coast	Low disturbance.
Ningaloo to Cape Cuvier Search Area				
Coral Bay 02 (159)	Artefacts / Scatter, Midden / Scatter	785242mE 7438548mN Zone 49 [Reliable]	Approx 1.4 km from the coast	Moderate disturbance, cleared vegetation surrounding the site, approx. 1 km from Coral Bay town site.
Upper Bulbarli Well 2 (Upper Bulbarli Well 2)	Artefacts / Scatter, Midden / Scatter, Skeletal Material / Burial	782842mE 7398748mN Zone 49 [Reliable]	Approx 280 m from the coast	Low disturbance
Cape Cuvier (6060)	Artefacts / Scatter, Midden / Scatter	743392mE 7318648mN Zone 49 [Reliable]	Approx 140 m from the coast	High disturbance, location within an industrial site
Point Anderson (6596)	Artefacts / Scatter, Midden / Scatter, Camp, Hunting Place, Shell, Water Source	Not available when location is restricted	n/a	n/a
Coral Bay Access 2 (6616)	Artefacts / Scatter, Midden / Scatter	784342mE 7438148mN Zone 49 [Unreliable]	Approx 550 m from the coast	Moderate disturbance, nearby road

Name (site ID)	Site Type	Coordinates and Reliability	Location relative to coast	Notes from aerial photo (if within 2km of coast)
Mulanda 2 (6723)	Artefacts / Scatter, Midden / Scatter	784742mE 7441148mN Zone 49 [Unreliable]	Approx 190 km from the coast	Low disturbance, some tracks present.
Mulanda 3 (6723)	Artefacts / Scatter, Midden / Scatter	784842mE 7441248mN Zone 49 [Unreliable]	Approx 140 km from the coast	Low disturbance, some tracks present.
Mulanda 4 (6725)	Midden / Scatter	785541mE 7441198mN Zone 49 [Unreliable]	Approx 500 m from the coast	Low disturbance
Mulanda 1 (6769)	Artefacts / Scatter, Midden / Scatter	784550mE 7441050mN Zone 49 [Reliable]	Approx 170 m from the coast	Low disturbance, some tracks present.
Coral Bay Skeleton (6827)	Skeletal Material / Burial	785143mE 7445149mN Zone 49 [Unreliable]	n/a	Listed location in the ocean (unreliable)
Bauboodjoo Point (Bruboodjoo Midden Site) (7203)	Artefacts / Scatter, Midden / Scatter, Camp, Hunting Place	789242mE 7456149mN Zone 49 [Reliable]	Approx 130 m from the coast	Low disturbance
Twin Hill Fishing Place (7203)	Hunting Place	787042mE 7467649mN Zone 49 [Unreliable]	On the coast	Low disturbance, some tracks present.
Bulbarli Point Complex (7209)	Artefacts / Scatter, Midden / Scatter, Camp, Water Source	778042mE 7393048mN Zone 49 [Reliable]	Approx 120 m from the coast	Low disturbance
Maud Landing (7211)	Skeletal Material / Burial, Camp, Meeting Place, Water Source	784292mE 7441048mN Zone 49 [Unreliable]	On the coast	Low disturbance, some tracks present.
Coral Bay (8300)	Skeletal Material / Burial	784442mE 7430398mN Zone 49 [Unreliable]	Approx 610 m from the coast	Low disturbance

Name (site ID)	Site Type	Coordinates and Reliability	Location relative to coast	Notes from aerial photo (if within 2km of coast)
Warroora (8301)	Artefacts / Scatter, Midden / Scatter	786642mE 7420648mN Zone 49 [Unreliable]	Approx 800 m from the coast	Low disturbance
Ten Mile Well Burial (8927)	Skeletal Material / Burial	783642mE 7480649mN Zone 49 [Reliable]	Approx 570 m from the coast	Low disturbance
Warroora Station (11460)	Skeletal Material / Burial	784642mE 7401648mN Zone 49 [Unreliable]	Approx 680 m from the coast	Low disturbance
Bulbarli Well (11461)	Artefacts / Scatter, Midden / Scatter, Skeletal Material / Burial, Camp, Hunting Place	781542mE 7395648mN Zone 49 [Unreliable]	On the coast	Low disturbance
Cardabia Station (16594)	Midden / Scatter, Shell	790319mE 7453138mN Zone 49 [Reliable]	Approx 410 m from the coast	Low disturbance, some tracks present.
Baler Bluff (16597)	Artefacts / Scatter, Midden / Scatter, Shell	788977mE 7464149mN Zone 49 [Reliable]	Approx 140 m from the coast	Low disturbance, some tracks present.