Nganhurra Operations Cessation Environment Plan

Developments Division
Revision 3
December 2019

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1 INTRODUCTION

1.1 Overview

Woodside Energy Ltd (Woodside), as Titleholder, under the *Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009* Cth) (referred to as the Environment Regulations), operates the Enfield field within Production Licence Area WA-28-L (herein referred to as WA-28-L).

In 2018 the Nganhurra floating production, storage and offtake facility (FPSO) was utilised to flush, isolate and preserve the riser turret mooring (RTM) and the subsea infrastructure, before the FPSO was disconnected and removed from the Enfield field.

Woodside proposes to undertake the following activities in preparation for future decommissioning activities:

- inspection, monitoring and maintenance of the RTM while it remains on station
- removal of the RTM from WA-28-L following disconnection of mooring lines
- implementation of an inspection regime during preservation period until all wells are abandoned and subsea infrastructure is decommissioned (which will be subject to a future, separate Environment Plan (EP))
- well intervention.

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

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 WA-28-L comprises petroleum activities as defined in Regulation 4 of the Environment Regulations. As such, an EP is required.

During the activities undertaken in the Enfield field in 2018, it was determined that modification to the activities as described under Revision 2 of this EP, accepted by NOPSEMA in 2017 are required. As such, a revision of the EP is required under the Environment Regulations.

This EP revision has been prepared in accordance with the requirements of Regulation 17(5) of the Environment Regulations. Activities that have already been completed have been removed from this revised EP.

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 and risks (planned (routine and non-routine) and unplanned) 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 carried out 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 (EPSs) and measurement criteria (MC). 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

This EP covers an Operational Area (as defined in **Section 3.3.1**) which represents the area in which the Petroleum Activities Program is to be undertaken. The Petroleum Activities Program is described in detail in **Section 3**.

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

Transit to and from the Operational Area by a Primary Installation Vessel (PIV), Mobile Offshore Drilling Unit (MODU), intervention vessel and support vessels, as well as port activities associated with these vessels, are not within the scope of this EP. 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 WA-28-L Nganhurra Operations Cessation EP summary has been prepared based on the 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

EP summary material requirement	Relevant section of EP containing EP summary material
The location of the activity	**Section 3.3**, pages 40–41
A description of the receiving environment	**Section 4**, pages 80–181
A description of the activity	**Section 3**, pages 39– 80
Details of the environmental impacts and risks	**Section 6**, pages 198–328
The control measures for the activity	**Section 6**, pages 198–328
The arrangements for ongoing monitoring of the titleholder's environmental performance	**Section 7.5**, pages 333–334
Response arrangements in the oil pollution emergency plan	**Section 7.9**, pages 342–345, and **Appendix D**
Consultation already undertaken and plans for ongoing consultation	**Section 5**, pages 182–197
Details of the titleholder's nominated liaison person for the activity	**Section 1.8**, page 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 process phases, applicable regulations and relevant section of EP

Criteria for acceptance	Content Requirements/ Relevant Regulations	Elements	Section of EP
Regulation 10A(a) *is appropriate for the nature and scale of the activity*	Regulation 13 *Environmental Assessment*	The principle of 'nature and scale' is applicable throughout the EP	**Section 2** **Section 3** **Section 4** **Section 5** **Section 6** **Section 7**
	Regulation 14 *Implementation strategy for the environment plan*		
	Regulation 16 *Other information in the environment plan*		
Regulation 10A(b) *demonstrates that the environmental impacts and risks of the activity will be reduced to as low as reasonably practicable*	Regulation 13(1) – 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) – 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 to nature and scale Detail the control measures – ALARP and acceptable	**Section 1** **Section 2** **Section 3** **Section 4** **Section 5** **Section 3.6** **Section 6** **Section 7**
Regulation 10A(c) *demonstrates that the environmental impacts and risks of the activity will be of an acceptable level*			
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: EMS Performance monitoring Oil Pollution Emergency Plan (OPEP) and scientific monitoring Ongoing consultation	**Section 7** **Appendix D**
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) – 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;*	No activity, or part of the activity, undertaken in any part of a declared World Heritage property.	**Section 3** **Section 4** **Section 6**

Criteria for acceptance	Content Requirements/ Relevant Regulations	Elements	Section of EP
	(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.*		
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 in 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

Woodside Energy Ltd (Woodside) is the operator (nominated titleholder) of WA-28-L, including the associated infrastructure of the Greater Enfield Project (Australia Oil) Joint Venture, on behalf of itself and joint venture participant Mitsui E&P Australia 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, it is 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 liquefied natural gas (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 Activity Contact

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

1.8.1 Titleholder

Woodside Energy Ltd
11 Mount Street, Perth, Western Australia
Telephone: 08 9348 4000
Fax: 08 9214 2777
ACN - 005 482 986
ABN - 63 005 482 986

1.8.2 Activity Contact

Gerard Ransom
Asset Manager, Australia Oil
11 Mount Street, Perth, Western Australia
Phone: 08 9348 4000
Fax Number: 08 9214 2777
gerard.ransom@woodside.com.au

1.8.3 Liaison Person

Daniel Clery
Corporate Affairs Manager
11 Mount Street, Perth, Western Australia
Phone: 08 9348 4000
Fax Number: 08 9214 2777
feedback@woodside.com.au

1.8.4 Arrangements for Notifying of Change

Should the titleholder, titleholder’s nominated liaison person or the contact details for either change, NOPSEMA is to be notified of the change 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 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 development of 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 are required to carry out 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 taken into consideration; or, how to use tools and systems.

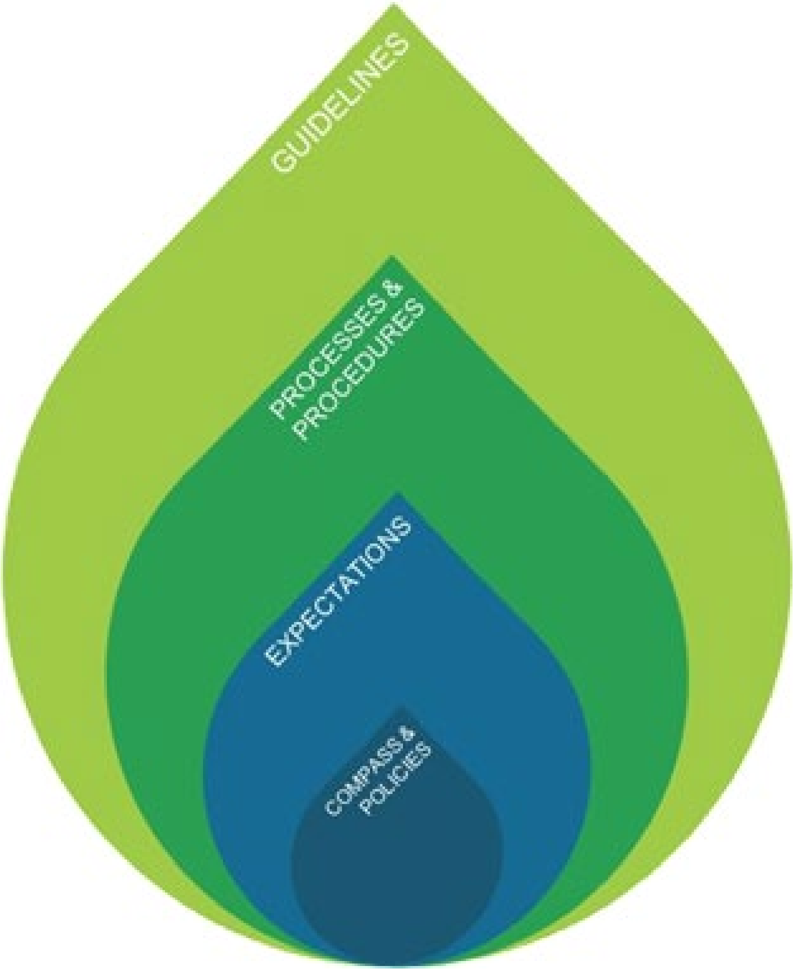

Figure 1-1: The four major elements of the WMS Seed

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** below. 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.

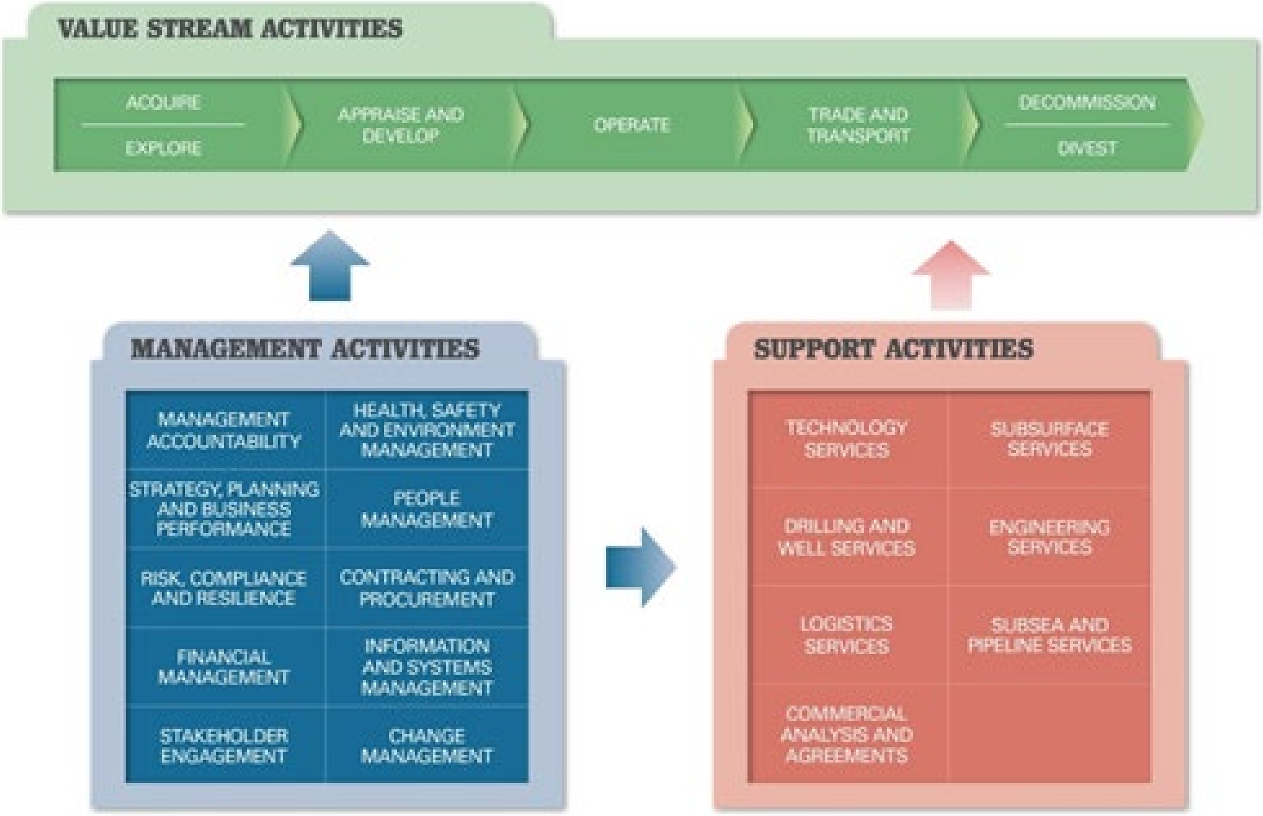

Figure 1-2: The WMS business process hierarchy

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, are detailed 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 the NOPSEMA.

The objectives of the Environment Regulations include provisions to ensure petroleum activities are carried out 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.

As part of NOPSEMA's assessment of an Environment Plan, it must be shown that the Petroleum Activity does not contravene the values and objectives set out for any sensitive feature of the environment proclaimed under the EPBC Act, including for Australian Marine Parks (AMPs) and World Heritage Properties (WHPs).

1.10.1.1 Environment Protection and Biodiversity Conservation Act 1999

The EPBC Act is administered by the Commonwealth Department of the Environment and Energy (DoEE) (formerly the Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC)). The EPBC Act protects matters of national environmental significance (MNES) across Australia and protects the environment in relation to actions on (or impacting upon) Commonwealth land or waters. When a person proposes to take an action that they believe may need approval under the EPBC Act, they must refer the proposal to the Commonwealth Minister for Environment.

Woodside referred the Nganhurra facility (Enfield – WA-271-P) development proposal to DSEWPaC in April 2001 (Referral Reference 2001/257). The activity was determined to be a 'controlled action' under the EPBC Act and set the level of assessment at 'Environmental Impact Statement' (EIS) in June 2001. The development was approved with conditions in July 2003 (EPBC Approval 2001/257). Conditions in relation to the referral (EPBC 2001/257) that are considered to be relevant to this EP are provided in **Table 1-3**.

This EP meets the requirements of condition 3 in relation to the referral (EPBC 2001/257). As required by condition 3; this includes adequate insurance in relation to oil spills, as detailed by the financial assurance details of the EP submissions (as modified by condition 11 of the referral).

This EP, and any future EP(s), in relation to the decommissioning of the Nganhurra facility (including subsea infrastructure above the seabed), will meet the requirements of condition 5 of the referral (EPBC 2001/257) (as modified by condition 11 of the referral).

Table 1-3: Conditions from Enfield Full Field Development referral (EPBC 2001/257) relevant to Nganhurra operations cessation

Condition Number	Condition
3	The person taking the action must submit for the Minister's approval an oil spill contingency plan detailing the strategy to mitigate the environmental effects of any hydrocarbon spills. The plan must include details of the insurance arrangements that the person taking the action has made or will make in respect of the costs associated with repairing any environmental damage arising from potential hydrocarbon spills. Operations may not commence until the plan is approved. The approved plan must be implemented.
5	The person taking the action must submit a decommissioning plan (or plans) for approval by the Minister one year prior to decommissioning any subsea wells, flowlines, or any associated infrastructure. The plan (or plans) must consider the complete removal of all structures and components above the sea floor. The approved plan must be implemented.
11	A plan required by condition 1, 2, 3, 4, 5 or 8 is automatically deemed to have been submitted to, and approved by, the Minister if the measures (as specified in the relevant condition) are included in an environment plan (or environment plans) relating to the taking of the action that: a) was submitted to NOPSEMA after 27 February 2014; and b) either: i. is in force under the OPGGS Environment Regulations; or ii. has ended in accordance with regulation 25A of the OPGGS Environment Regulations.

1.10.1.2 Environmental Protection (Sea Dumping) Act 1981

Australia regulates the loading and dumping of waste at sea under the *Environment Protection (Sea Dumping) Act 1981* (the Sea Dumping Act). This Act also fulfils Australia's international obligations under the London Protocol to prevent marine pollution by controlling dumping of wastes and other matter. Under the Sea Dumping Act, the Commonwealth aims to minimise pollution threats by:

- prohibiting ocean disposal of waste considered too harmful to be released in the marine environment
- regulating permitted waste disposal to ensure environmental impacts are minimised.

Permits are required from the Commonwealth Department of Environment and Energy (DoEE) for all ocean disposal activities. Permits include for dredging operations, the creation of artificial reefs, dumping of vessels and platforms or other man-made structures. There are circumstances where the abandonment of structures or components associated with oil and gas platforms will not constitute dumping for the purposes of the Sea Dumping Act. In determining whether the abandonment of such structures or components falls outside of the definition of dumping the following criteria must be met:

1. The component or structure must be associated with a platform (i.e. a principal or overarching platform facility) or other man-made structure. This criterion is derived from the specific linkage between Articles 1.4.1.4 and 1.4.2.3 of the London Protocol. As neither ‘platform’ or ‘man-made structure’ are defined by the London Protocol, the Department has considered guidance provided by the IMO, which:
    a) defines ‘platforms’ as ‘facilities designed and operated for the purpose of producing, processing, storing or supporting the production of mineral resources’
    b) notes that other man-made structures could include ‘any man-made structures at sea, such as lighthouses, buoys, offshore transfer facilities and windmills’ (see IMO, LC 22/14 ‘Report of the Twenty-Second Consultative Meeting,’ 25 October 2000, Annex 7, para 4.4).

    Having regard to the examples in the IMO guidance, the DoEE considers that ‘other man-made structures’ refers to principal structures only, such as those mentioned above.
2. The component or structure must not constitute a platform or other principal structure itself. In accordance with Article 1.4.1.4 of the London Protocol and the definition of ‘man-made structure’ above, abandonment or toppling of these structures would likely constitute dumping.
3. The component or structure must have been placed in the particular position where it will be left for a purpose other than disposal i.e. it is left in the place where it served a function in connection with the operation of the platform or man-made structure. If components or structures will be moved from their original position at the point of abandonment, then the abandonment of that matter may fall within the definition of dumping, and therefore require approval under the Sea Dumping Act.

1.10.1.3 Australian Marine Parks

Under the EPBC Act, AMPs, formally known as Commonwealth Marine Reserves, are recognised for conserving marine habitats and the species that live and rely on these habitats. The Director of Marine Parks (DNP) is responsible for managing AMPs (supported by Parks Australia), and is required to publish management plans for them. Other parts of the Australian Government must not perform functions or exercise powers in relation to these parks that are inconsistent with management plans (s.362 of the EPBC Act). Relevant AMPs are described in **Section 4.7**. The North-west Marine Parks Network Management Plan describes the requirements for management (DoEE, 2018a).

- Specific zones within AMPs have been allocated conservation objectives in the North-west Marine Parks Network Management Plan (DoEE, 2018a)) which are based on the Australian (International Union for Conservation of Nature (IUCN) reserve management principles prescribed in Schedule 8 of the *EPBC Regulations 2000*. Management objectives for each zone include: Special Purpose Zone (IUCN category VI)—managed to allow specific activities though special purpose management arrangements while conserving ecosystems, habitats and native species. The zone allows or prohibits specific activities.

- Sanctuary Zone (IUCN category Ia)—managed to conserve ecosystems, habitats and native species in as natural and undisturbed a state as possible. The zone allows only authorised scientific research and monitoring.
- National Park Zone (IUCN category II)—managed to protect and conserve ecosystems, habitats and native species in as natural a state as possible. The zone only allows non-extractive activities unless authorised for research and monitoring.
- Recreational Use Zone (IUCN category IV)—managed to allow recreational use, while conserving ecosystems, habitats and native species in as natural a state as possible. The zone allows for recreational fishing, but not commercial fishing.
- Habitat Protection Zone (IUCN category IV)—managed to allow activities that do not harm or cause destruction to seafloor habitats, while conserving ecosystems, habitats and native species in as natural a state as possible.
- Multiple Use Zone (IUCN category VI)—managed to allow ecologically sustainable use while conserving ecosystems, habitats and native species. The zone allows for a range of sustainable uses, including commercial fishing and mining where they are consistent with park values.

1.10.1.4 World Heritage Properties

Australian World Heritage management principles are prescribed in Schedule 5 of the *EPBC Regulations 2000*. Management principles that are considered relevant to the scope of this EP are provided in **Table 1-4.**

Table 1-4: Relevant Management Principles under Schedule 5—Australian World Heritage management principles of the EPBC Act

Number	Principle	Relevant Section of the EP
3	Environmental impact assessment and approval 3.01 This principle applies to the assessment of an action that is likely to have a significant impact on the World Heritage values of a property (whether the action is to occur inside the property or not). 3.02 Before the action is taken, the likely impact of the action on the World Heritage values of the property should be assessed under a statutory environmental impact assessment and approval process. 3.03 The assessment process should: (a) identify the World Heritage values of the property that are likely to be affected by the action; and (b) examine how the World Heritage values of the property might be affected; and (c) provide for adequate opportunity for public consultation. 3.04 An action should not be approved if it would be inconsistent with the protection, conservation, presentation or transmission to future generations of the World Heritage values of the property. 3.05 Approval of the action should be subject to conditions that are necessary to ensure protection, conservation, presentation or transmission to future generations of the World Heritage values of the property. 3.06 The action should be monitored by the authority responsible for giving the approval (or another appropriate authority) and, if necessary, enforcement action should be taken to ensure compliance with the conditions of the approval.	3.01 and 3.02: Assessment of whether Petroleum Activity will have a significant impact on the World Heritage values of the Ningaloo World Heritage Property, including controls to manage any predicted impact is included in **Section 6.** Principles are met by the submitted EP. 3.03 (a) and (b): World Heritage values are identified in **Section 4** and considered in the assessment of impacts and risks for the Petroleum Activity in **Section 6.** 3.03 (c): Relevant stakeholder consultation and feedback received in relation to impacts and risks to the Ningaloo World Heritage Property are outlined in **Section 5.** 3.04, 3.05 and 3.06: Principles are considered to be met by the acceptance of this EP.

Note that Section 1 – General Principles and 2 – Management Planning of Schedule 5 are not considered relevant to the scope of this EP and, therefore, have not been included.

2 ENVIRONMENT PLAN PROCESS

2.1 Overview

This section outlines the process that Woodside undertake 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 EPOs and EPSs. 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 the detailing of environmental impacts and risks, and evaluation 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 determine if the impact or risk level is acceptable.

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

- planned activities (routine and non-routine) 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 that effectively managing risk 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 procedure, guidelines and tools provide guidance on specific techniques for managing risk, tailored for particular areas of risk within certain business processes. Three such procedures applied for environmental risk management include Woodside's:

1. Health Safety and Environment Management Procedure
2. Impact Assessment Procedure
3. Process Safety Management Procedure.

The risk management methodology provides a framework to demonstrate that the 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 **2.10**.

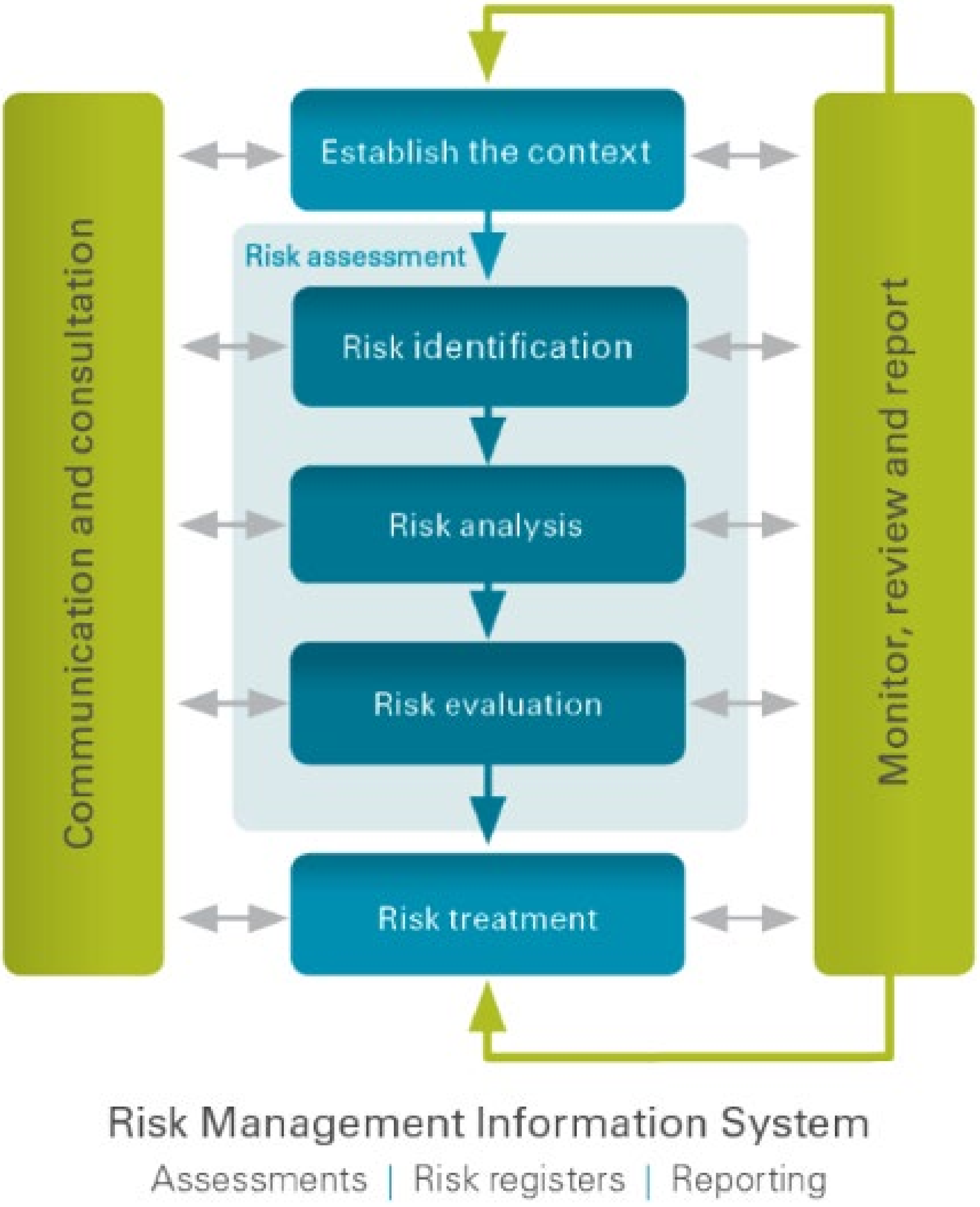

Figure 2-1: Woodside's risk management process

2.2.2 Health, Safety and Environment Management Procedure

Woodside's Health, Safety and Environment Management Procedure provides the 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 by ensuring impacts are assessed 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.

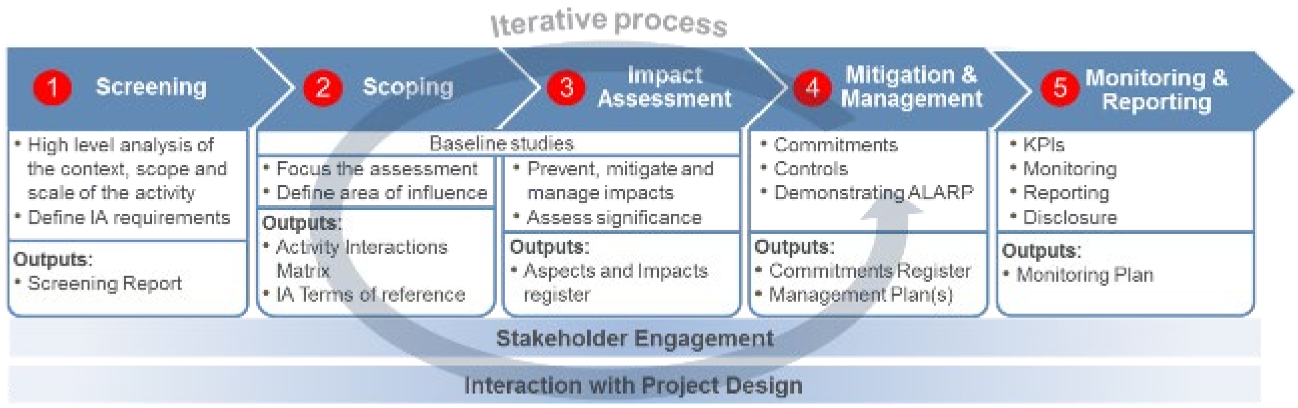

Figure 2-2: Woodside's impact assessment process

2.3 Environmental Plan Process

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

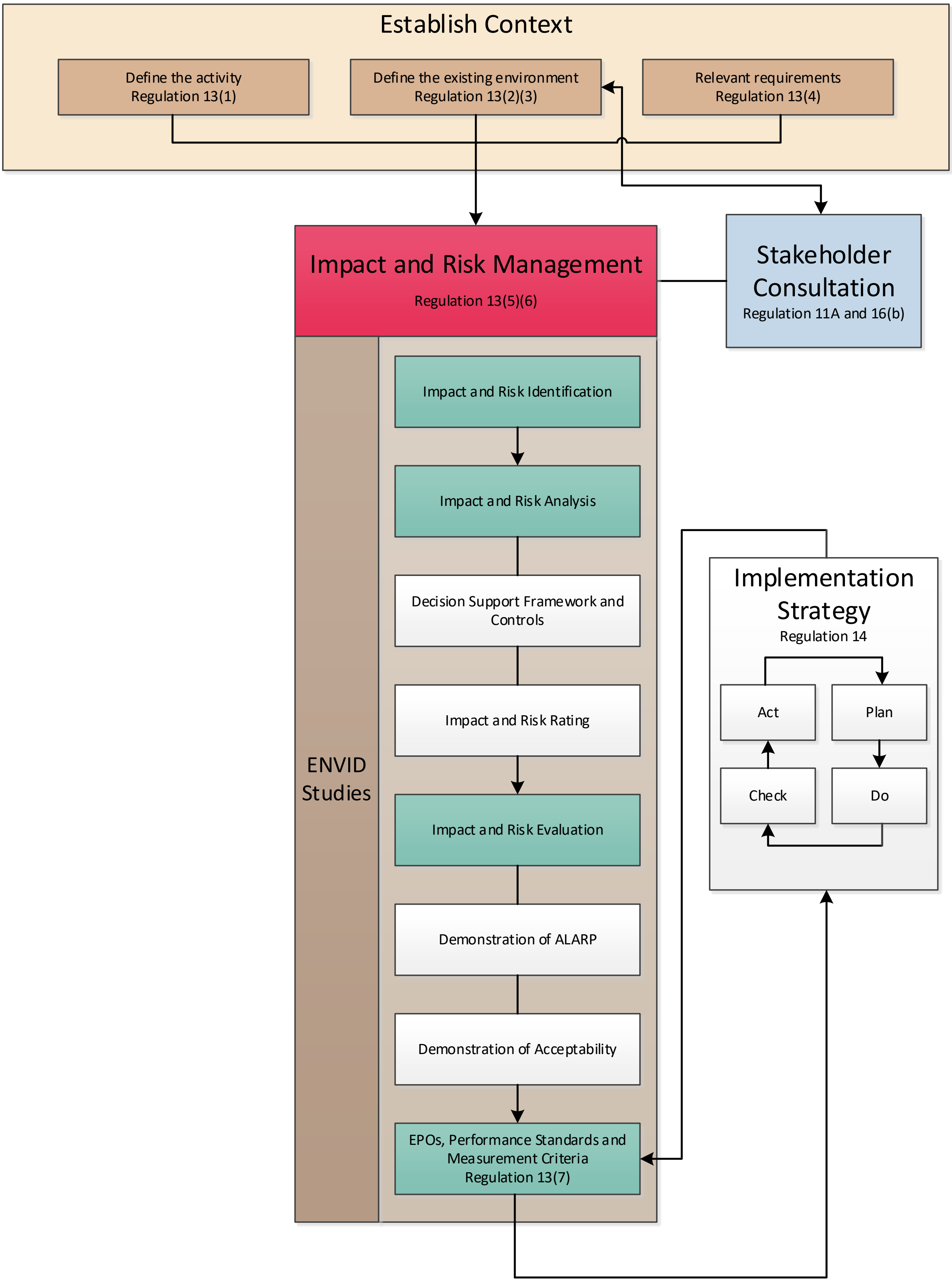

Figure 2-3: Environment plan development process

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 Defining 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 of the activities). The existing environment that may potentially be impacted directly or indirectly by planned and unplanned[2] events.

The Existing Environment section is structured to define 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 Permit Area (planned events) and the Environment that May Be Affected (EMBA) of unplanned events[2]. Potential impacts to MNES as defined within the EPBC Act are addressed through Woodside's impact and risk assessment process (**Section 2.9**).
- Relevant values and sensitivities, which may include world or national heritage listed areas, Ramsar wetlands, listed threatened species or ecological communities, listed migratory species, and sensitive values that exist in or in relation to Commonwealth marine area or land.

In categorising the environmental values potentially impacted by the Petroleum Activities Program (as presented in **Table 2-1**), there is standardisation of information relevant to understanding the

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[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 Environment that May Be Affected (EMBA) for the release, which defines the spatial scale of the environment that may be potentially impacted for the Petroleum Activities Program, which provides context to the 'nature and scale' of the existing environment.

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: Environment values potentially impacted by the Petroleum Activities Program which are assessed within the EP

Environmental Value Potentially Impacted Regulations 13(2)(3)						
Soil and Groundwater	***Marine Sediment***	***Water Quality***	***Air Quality (including 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, condition and standards that apply to the Petroleum Activities Program have been 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 performed 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 done by defining the activity and identifying that an aspect is not applicable.

The impact and risk information is then 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 (including 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, review of relevant studies, reviews of past performance, external stakeholder consultation feedback and review of the existing environment.

The key steps performed for each risk identified during the risk assessment were:

1. identify the decision type in accordance with the decision support framework
2. identify appropriate control measures (preventative and mitigation) aligned with the decision type
3. 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 the principles set out in the Guidance on Risk Related Decision Making (Oil and Gas UK 2014). The 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 ALARP and acceptable (**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 manage the risks based on the uncertainty of the risk, the complexity and risk rating (i.e. potential higher order environmental impacts are subject to further evaluation/assessment).

The framework provides appropriate tools, commensurate to the level of uncertainty or novelty associated with the risk (referred to as the 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.

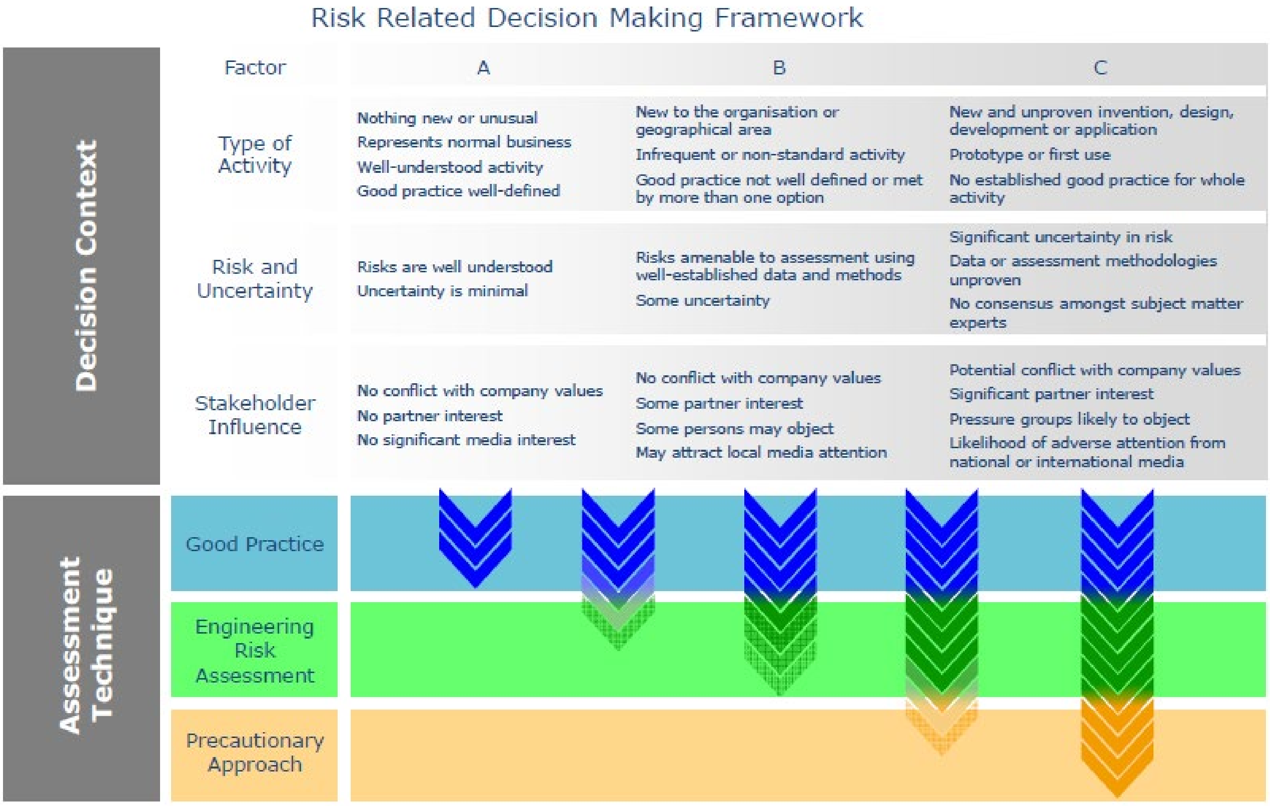
2.6.1.2 Decision Type B

Risks classified as a Decision Type B typically involve greater uncertainty and complexity. These risks may deviate from established practice or have some lifecycle implications and therefore require further engineering risk assessment in order to support the decision and ensure that 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 a Decision Type C typically have significant risks related to environmental performance. Such risks typically involve sufficient complexity and uncertainty, therefore requiring adoption of the 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.


Risk Related Decision Making Framework

Decision Context	Factor	A	B	C
	Type of Activity	Nothing new or unusual Represents normal business Well-understood activity Good practice well-defined	New to the organisation or geographical area Infrequent or non-standard activity Good practice not well defined or met by more than one option	New and unproven invention, design, development or application Prototype or first use No established good practice for whole activity
	Risk and Uncertainty	Risks are well understood Uncertainty is minimal	Risks amenable to assessment using well-established data and methods Some uncertainty	Significant uncertainty in risk Data or assessment methodologies unproven No consensus amongst subject matter experts
	Stakeholder Influence	No conflict with company values No partner interest No significant media interest	No conflict with company values Some partner interest Some persons may object May attract local media attention	Potential conflict with company values Significant partner interest Pressure groups likely to object Likelihood of adverse attention from national or international media

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 that 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 identified 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 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 selection of alternatives and the 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 benchmark 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 following the realisation of a hazardous event.
- **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 to 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**).

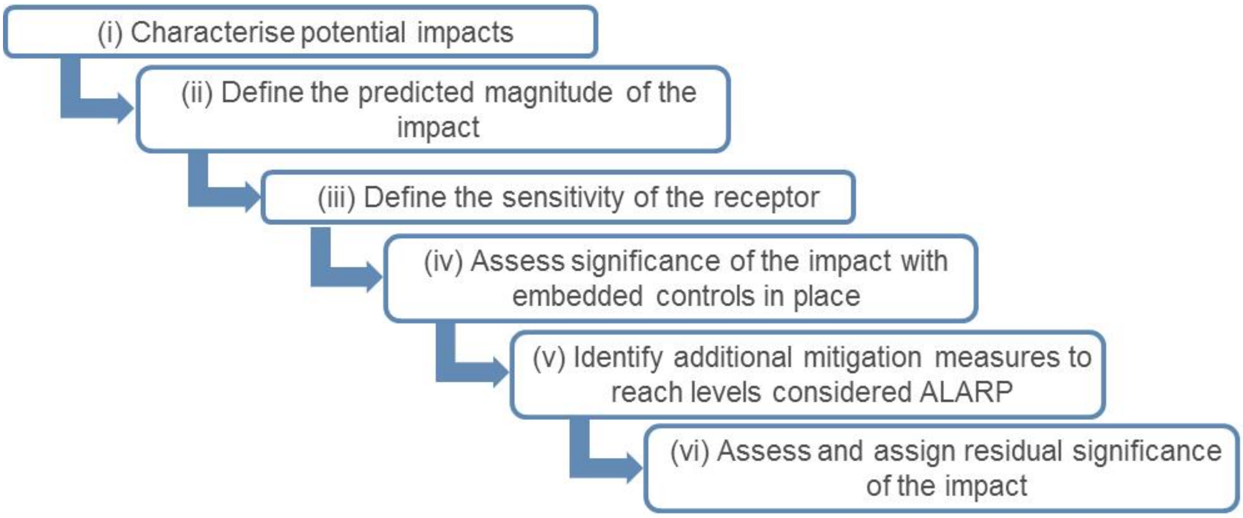


Figure 2-5: Environmental impact and risk analysis

Impacts are classified in accordance with the consequence (**Section 2.6.3**) outlined in the 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 in **Table 2-3**, evaluated for each planned activity and unplanned event.

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 ecosystem's 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 ecosystem's 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 performed 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 (**Figure 2-6**). The risk rating process is performed using the following steps:

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, select the highest severity consequence level.

Select the Likelihood Level

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

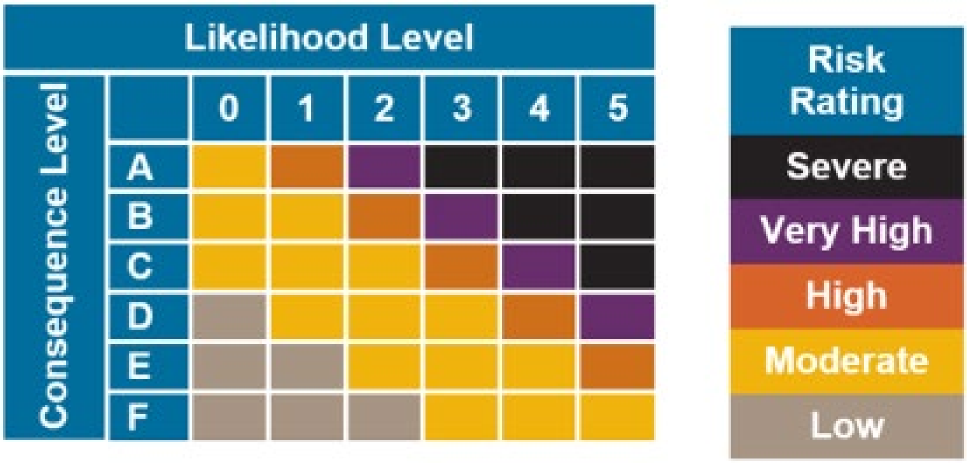
Table 2-4: Woodside risk matrix likelihood levels

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 at 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

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.



	Likelihood Level					
Consequence Level	0	1	2	3	4	5
A	🟨	🟧	🟪	⬛	⬛	⬛
B	🟨	🟨	🟧	🟪	⬛	⬛
C	🟨	🟨	🟨	🟧	🟪	⬛
D	▨	🟨	🟨	🟨	🟧	🟪
E	▨	▨	🟨	🟨	🟨	🟧
F	▨	▨	▨	🟨	🟨	🟨

Risk Rating	
⬛	Severe
🟪	Very High
🟧	High
🟨	Moderate
▨	Low

Figure 2-6: Woodside risk matrix: risk level

In support of ongoing risk management (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 the controls that are currently in place and regularly effective. Current risk rating 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 the communication and visibility of the risk events, and ensure 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 wide 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 an impact or risk 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 Regulations 10A(a), 10A(b), 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 different risks, impacts and Decision Types identified within the EP are ALARP.

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

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) that: • 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

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 'broadly acceptable' if they meet legislative requirements, industry codes and standards, applicable company requirements and industry guidelines. Further effort towards risk reduction (beyond employing opportunistic measures) is not reasonably practicable without sacrifices grossly disproportionate to the benefit gained.		

<table>
<tr><th>Risk</th><th>Impact</th><th>Decision Type</th></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 – consideration of the environment consequence (**Section 6**) and stakeholder acceptability (**Section 5**)
• other requirements – the proposed controls and consequence/risk level are consistent with national and international industry standards, laws and policies and consideration of applicable plans for management and conservation advice, conventions, and significant impact guidelines (e.g. for MNES).
Additionally, Very High and Severe risks require ‘Escalated Investigation’ and mitigation to reduce the risk to a lower and more acceptable level. If after further investigation the risk remains in the Very High or Severe category, the risk requires appropriate business engagement in accordance with Woodside’s Risk Management Procedure to accept the risk. This includes due consideration of regulatory requirements.</td></tr>
</table>

LEVEL	0	1	2	3	4	5
A	A0	A1	A2	A3	A4	A5
B	B0	B1	B2	B3	B4	B5
C	C0	C1	C2	C3	C4	C5
D	D0	D1	D2	D3	D4	D5
E	E0	E1	E2	E3	E4	E5
F	F0	F1	F2	F3	F4	F5

Figure 2-7: Environmental risk evaluation

2.8 Environmental Performance Objectives/Outcomes, Standards and Measurement Criteria

EPOs/EPSs and measurement criteria have been defined to address the potential environmental impacts and risks and are presented in **Section 6**.

2.9 Implementation, Monitoring, Review and Reporting

An implementation Strategy for the Petroleum Activity Program is developed which describes the specific measures and arrangements to be implemented for the duration of the Petroleum Activity 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 Activity 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 Activity Program are continually identified and reduced to ALARP and acceptable levels.
- Roles and responsibilities are clearly defined, and personnel are competent and appropriately trained to implement the EP, including in emergencies or potential emergencies.
- Arrangements are in place for oil pollution emergencies to respond to, and monitor impacts.
- Environmental reporting requirements, including ‘reportable incidents’, are met.
- 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 undertaken 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 undertaken as part of the Petroleum Activities Program under this EP.

3.2 Project Overview

The Enfield reservoir has reached the end of its economic production life. Options and timing for operations cessation were developed, in line with Woodside strategy and regulatory requirements, to allow for the Nganhurra FPSO to be removed from the field following cessation of production.

Initial cessation activities were undertaken in the Enfield field between November 2018 and March 2019, as described under Revision 2 of this EP. The activities that have already been completed, and thus removed from the EP include:

- disconnection of FPSO and sail away from the Operational Area
- isolation of wells at the flow base
- flushing and preservation of the subsea system
- disconnection of risers/electro-hydraulic umbilical (EHU) and removal of buoyancy modules
- re-lay risers/electro-hydraulic umbilical on seabed until final decommissioning.

The RTM was planned to be removed as part of these activities, however during the initial cessation activities, it was determined that the RTM could not be ballasted to manoeuvre horizontally as originally planned. Revision 2 of this EP has been revised to cover the change in disposal plan for the RTM.

The remaining activities covered under this revised EP in preparation for future decommissioning include:

- inspection, monitoring, maintenance and repair (IMMR) of the RTM while it remains on station
- disconnection of mooring lines from RTM and lay on seabed (accepted as part of Revision 2)
- removal of RTM from field
- IMMR activities to ensure integrity of subsea infrastructure
- periodic inspections of wells and subsea infrastructure (including well intervention) may be undertaken on all or selected wells where there is a rig or vessel of opportunity available.

There is no well integrity driver for immediate intervention of any wells. Any intervention activities that may be undertaken would be opportunistic, to set up for a more cost effective and efficient abandonment program at a later time. For example, intervention to set additional barriers such as deep set temporary plugs may open up subsequent permanent abandonment of wells to a wider range of vessels/rigs.

Woodside is currently planning for the plugging for abandoning of the wells, which along with decommissioning related scopes, will be the subject of separate EP(s) and is beyond the scope of this EP.

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

Table 3-1: Petroleum Activities Program overview

Item	Description
Permit Area	WA-28-L
Location	Exmouth Sub-basin
Water depth	Approximately 400-600 m
Number of wells	Eight production wells Eight water injection wells Two gas injection wells
Subsea infrastructure	Four production manifolds (EDC1, EDC2, EDC3 and EDC5) 18 subsea Xmas trees Two 9-inch production flowlines and risers One 8-inch production test flowline and riser One 10-inch water re-injection flowline and riser One 6-inch gas injection flowline and riser One 6-inch gas lift flowline and riser
Vessels	Primary Installation Vessel (PIV) for RTM removal Intervention vessel for well intervention activities Support vessels including anchor handling vessel(s) and general supply/support vessels.
MODU	Semi-submersible moored MODU or dynamically positioned (DP) MODU, depending on availability.
Key activities	IMMR activities on the RTM while it remains on station Disconnection of mooring lines from RTM and lay lines on seabed Removal of RTM from field IMMR activities on subsea infrastructure including wells Opportunistic well interventions

3.3 Location

The Petroleum Activities Program is located in Commonwealth waters in the Exmouth Sub-basin, within WA-28-L. It is located approximately 38 km north of the North West Cape of Western Australia about 2 km to the east of the Enfield reservoir. The water depth across WA-28-L varies from 200 m in the east to over 2000 m to the west. Water depth of the Operational Area is approximately 400 - 600 m.

The Petroleum Activities Program does not overlap with any established or proposed marine protected areas. The closest nearshore sensitive habitats to the Petroleum Activities Program is the Commonwealth boundary of the Ningaloo Reef Australian Marine Park approximately 16 km to the south, the Gascoyne Australian Marine Park approximately 18 km to the west, and the Muiron Islands Marine Management and Conservation Area approximately 31 km to the south-east. The Ningaloo Reef Australian Marine Park and the Muiron Islands Marine Management Area lie within the Ningaloo World Heritage Area (approximately 16 km south of the Petroleum Activities Program). The surrounding environment and associated sensitive habitats are discussed in detail in **Section 4**. The potential environmental impacts from planned and unplanned activities are discussed in **Section 4**.

The locations of the Petroleum Activities Program located within WA-28-L are presented in **Table 3-2.**

Table 3-2: RTM and subsea infrastructure coordinates and depth

Structure	Latitude	Longitude	Water Depth (m)
RTM	21° 28' 53.268" S	114° 00' 29.249" E	396
Production Well ENA01	21° 28' 54.064" S	113° 59' 21.678" E	513
Production Well ENA02	21° 28' 53.564" S	113° 59' 21.236" E	513
Production Well ENA03	21° 28' 54.289" S	113° 59' 20.402" E	515
Production Well ENA04	21° 28' 55.221" S	113° 59' 21.573" E	513
Production Well ENA05	21° 28' 54.803" S	113° 59' 21.012" E	513
Production Well ENE01	21° 28' 53.335" S	113° 59' 17.083" E	550
Production Well ENE02	21° 28' 53.958" S	113° 59' 17.693" E	520
Production Well ENE03	21° 28' 52.842" S	113° 59' 17.851" E	520
Water Injection Well ENB01	21° 27' 55.752" S	113° 59' 34.297" E	495
Water Injection Well ENB02	21° 27' 55.337" S	113° 59' 34.719" E	495
Water Injection Well ENB03	21° 27' 56.005" S	113° 59' 35.450" E	495
Water Injection Well ENC01	21° 29' 14.814" S	113° 58' 30.698" E	550
Water Injection Well ENC02	21° 29' 15.281" S	113° 58' 30.267" E	550
Water Injection Well ENC03	21° 29' 15.457" S	113° 58' 31.396" E	550
Water Injection Well ENC04	21° 29' 14.920" S	113° 58' 30.020" E	550
Water Injection Well ENC05	21° 29' 15.920" S	113° 58' 31.392" E	550
Gas Injection Well END01	21° 30' 3.582" S	113° 57' 51.152" E	550
Gas Injection Well END02	21° 30' 3.853" S	113° 57' 50.826" E	550

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 MODU/vessel-related petroleum activities within the Operational Area. MODU/Vessels supporting the Petroleum Activities Program when outside the Operational Area will adhere to all applicable maritime regulations and other requirements and are not managed by this EP. The Operational Area (

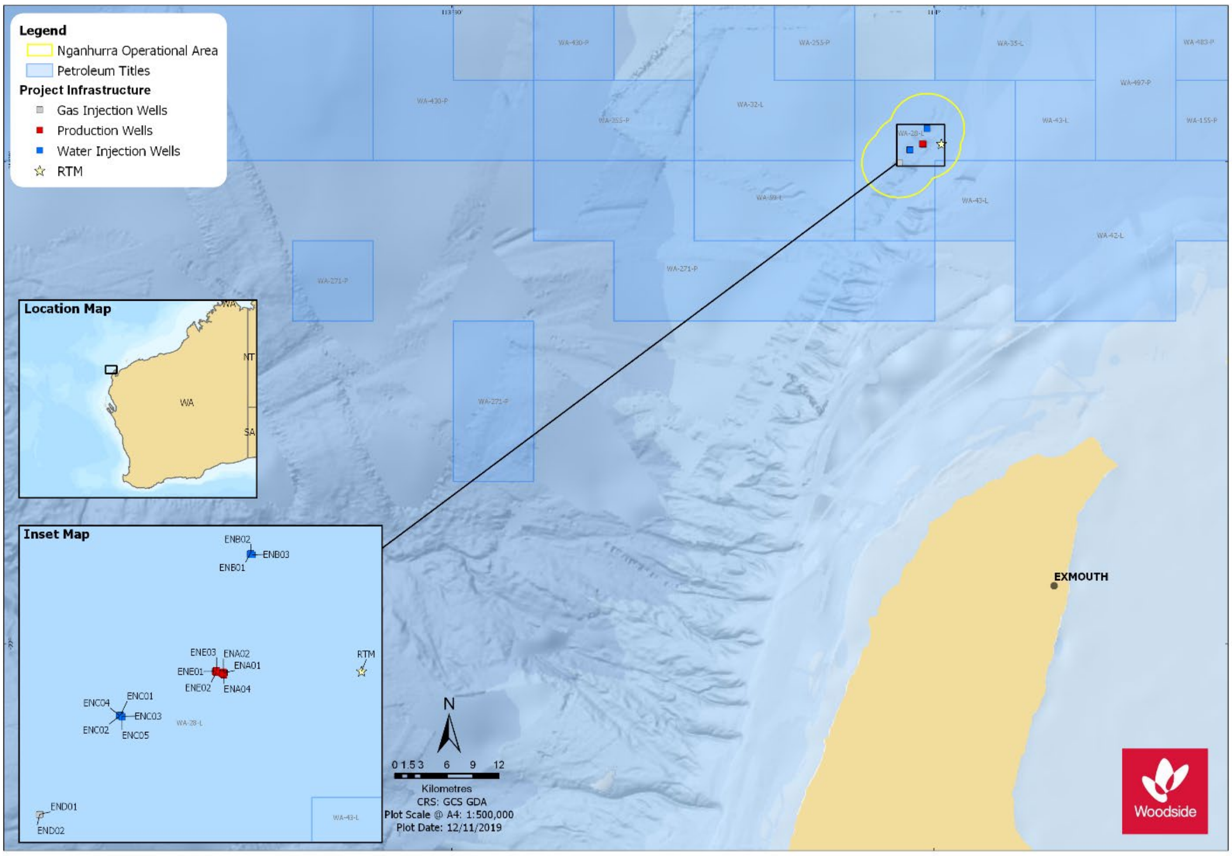


Figure 3-1) is representative of the combined delineated distances from the greater of the following:

- 1500 m radius around the RTM to allow for IMMR activities and for the disconnected anchor chains to be laid on the seabed.
- 4000 m radius around all wells which allows for a moored MODU to undertake well intervention-related petroleum activities.
- 500 m area around flowlines to allow for subsea IMMR activities to be undertaken.

There is a 500 m petroleum safety zone around the RTM. This will remain in place until the RTM is removed from the Operational Area. The Operational Area for intervention activities includes a 500 m petroleum safety zone around the Intervention Vessel or MODU to manage vessel movements.

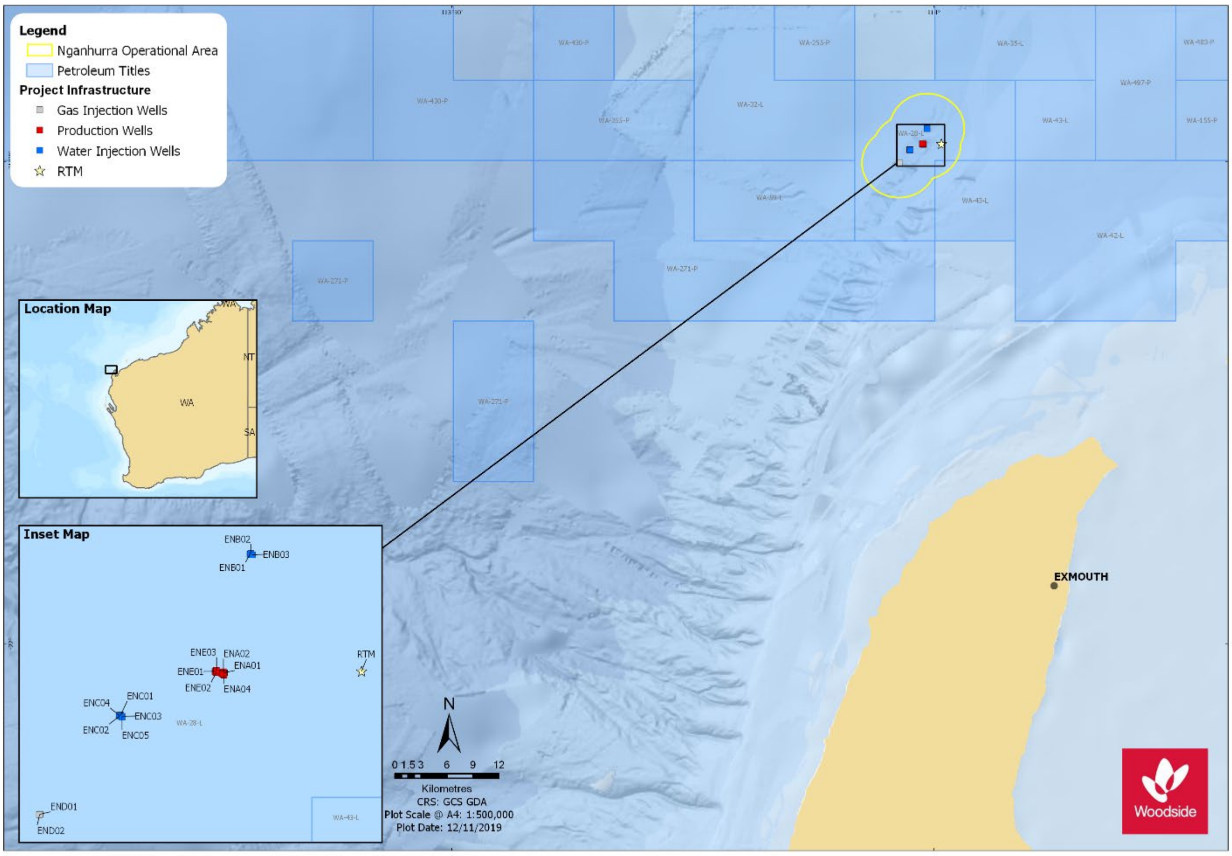


Figure 3-1: Operations Cessation Operational Area

3.4 Timing

The Petroleum Activities Program commenced in Q4 2018 and the preservation of the subsea systems and RTM is ongoing. The RTM removal is planned to be completed between Q4 2020 and end April 2021 and is estimated to take 30 days (with potential for a cumulative 90 days when accounting for potential IMMR activities and limiting operations to periods of suitable weather conditions i.e. within cyclone season).

Well intervention activities may commence from 2021, depending on vessel/MODU availability. Well intervention is estimated to take about 10-20 days per well. If undertaken as a campaign, the cumulative duration is expected to be 18 months (including mobilisation and demobilisation), and may be performed over multiple campaigns.

When underway, activities will be 24 hours per day, seven days per week. Concurrent well intervention activities may occur under the EP based on operational synergies with an intervention vessel and a MODU. Simultaneous Operations (SIMOPS) activities with the RTM removal may also occur.

The current schedule of the Petroleum Activity Program is outlined in **Table 3-3**. This EP has assessed risks and impacts relevant to the activities throughout the year (all seasons), to provide operational flexibility in the event of project schedule changes. The schedule and timeframe presented in the EP may be subject to change due to operational requirements and external influences such as contract award, vessel/MODU/equipment/materials availability and/or metocean conditions.

Table 3-3: Indicative timing of Petroleum Activities Program

Activity	Indicative Timing	Duration (Cumulative Duration)	Comment	Status
RTM removal	Anticipated between Q4 2020 and end April 2021	Planned duration of 30 days (up to 90 days).	RTM removal delayed until disposal option determined and all appropriate approvals in place.	Activity description updated in **Section 3.5.1** and ALARP assessment detailed in **Section 3.6**.
RTM and subsea IMMR Activities	Ongoing until RTM removal and field decommissioning.	Ongoing	IMMR activities on the RTM undertaken to minimise risk or the RTM sinking and ensure RTM can be removed. The subsea system preservation period will extend until wells are abandoned and remaining subsea infrastructure is decommissioned.	Ongoing
Well intervention	Opportunistically, prior to field decommissioning.	10-20 days per well is expected (up to 18 months)	All 18 wells may be intervened (as required)	Updated to allow for intervention on all 18 wells.

3.4.1 SIMOPS

SIMOPS may occur throughout the Petroleum Activities Program, should vessel and equipment availabilities permit. A SIMOPS plan will be developed for the Petroleum Activities Program. Execution of the Petroleum Activities Program around existing infrastructure has been included in the scope of risk assessment for this EP (**Section 6.6.1**).

3.5 Infrastructure Overview

This section provides a high level overview of the infrastructure relevant to consideration of the environmental risks and impacts of the Petroleum Activities Program. The subsea layout of the Enfield field is provided in **Figure 3-2**. Further details of the infrastructure and field layout are provided in the sections which follow.

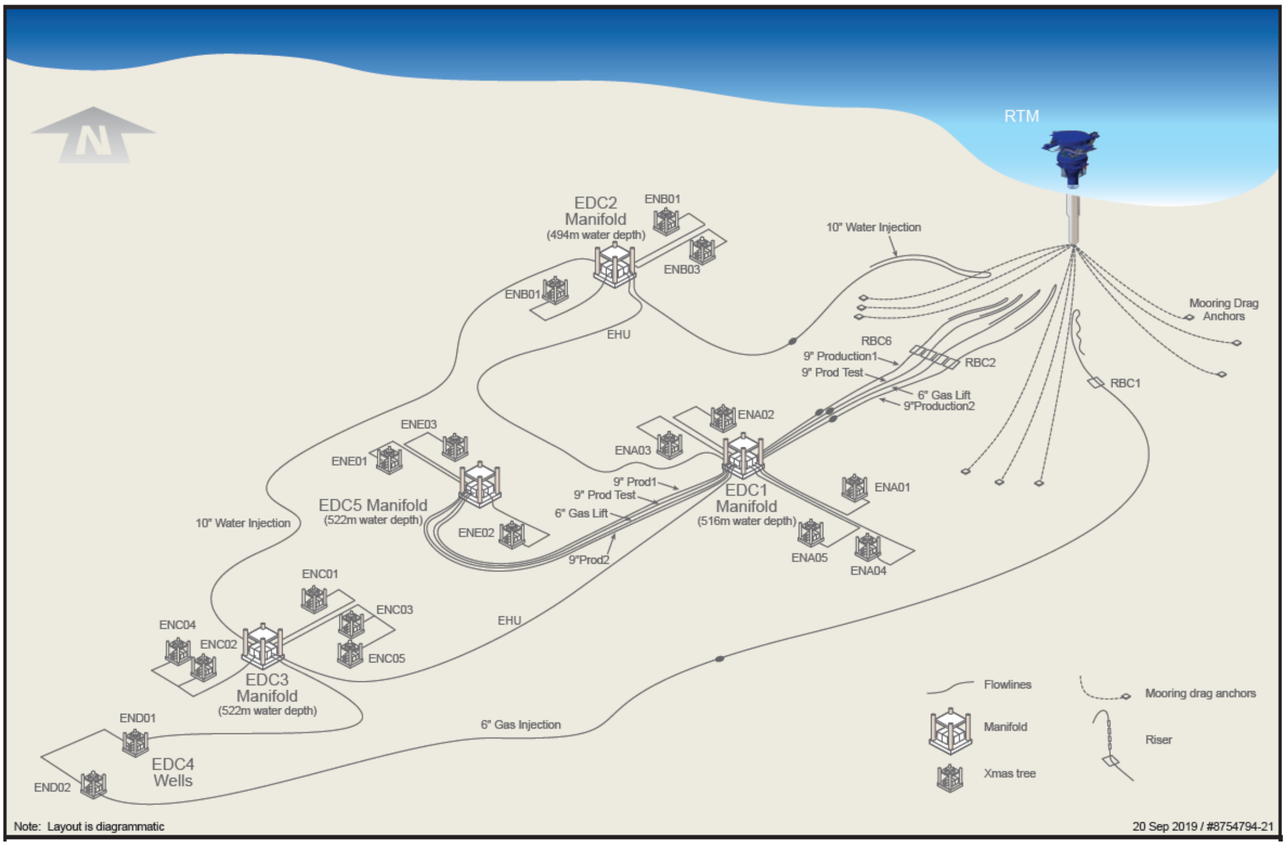


Figure 3-2: Enfield field subsea layout

3.5.1 RTM

The RTM consists of a riser column which is anchored to the seabed by three sets of three catenary anchor mooring chains. The lower end of each mooring chain is connected to a drag anchor embedded into the seabed.

The RTM is approximately 83 m in length and between 4.5 m and 8.5 m in diameter below the waterline, with three decks up to 12 m wide above the waterline (**Figure 3-3**). The riser column extends approximately 6.5 m above the waterline and weighs approximately 2452 tonnes, which includes solid and seawater ballast.

The RTM has 14 compartments, 11 of which are ballastable separated by horizontal watertight bulkheads. The bottom compartment is partially filled with approximately 396 tonnes of iron ore and seawater. The second bottom compartment (compartment 2) contains seawater ballast which was designed to manage RTM draft should additional risers be added. Compartment 3 has had water added. Compartment 13 (at the waterline) contains approximately 65 m^3 of polyurethane foam. The remaining compartments are ballastable through a ballast piping system. The layout of the RTM is shown in **Figure 3-3.**

The risers connected to the RTM were flushed during the subsea flowline and riser flushing described in **Section 3.5.2.2**. In Q4 2018 they were cut approximately 10 m below the RTM and the flowline end connected to the subsea infrastructure was capped with an environmental plug to contain the preservation fluid. All buoyancy modules were removed and the risers were laid on the seabed (**Figure 3-2**). The RTM remains, held in place by three sets of three catenary anchor chains.

The RTM was planned to be removed post FPSO sail away as part of the same campaign. As this was unable to be completed, a revised removal period is planned (see **Section 3.8.2**). Further analysis of the options assessed is presented in **Section 3.6**.

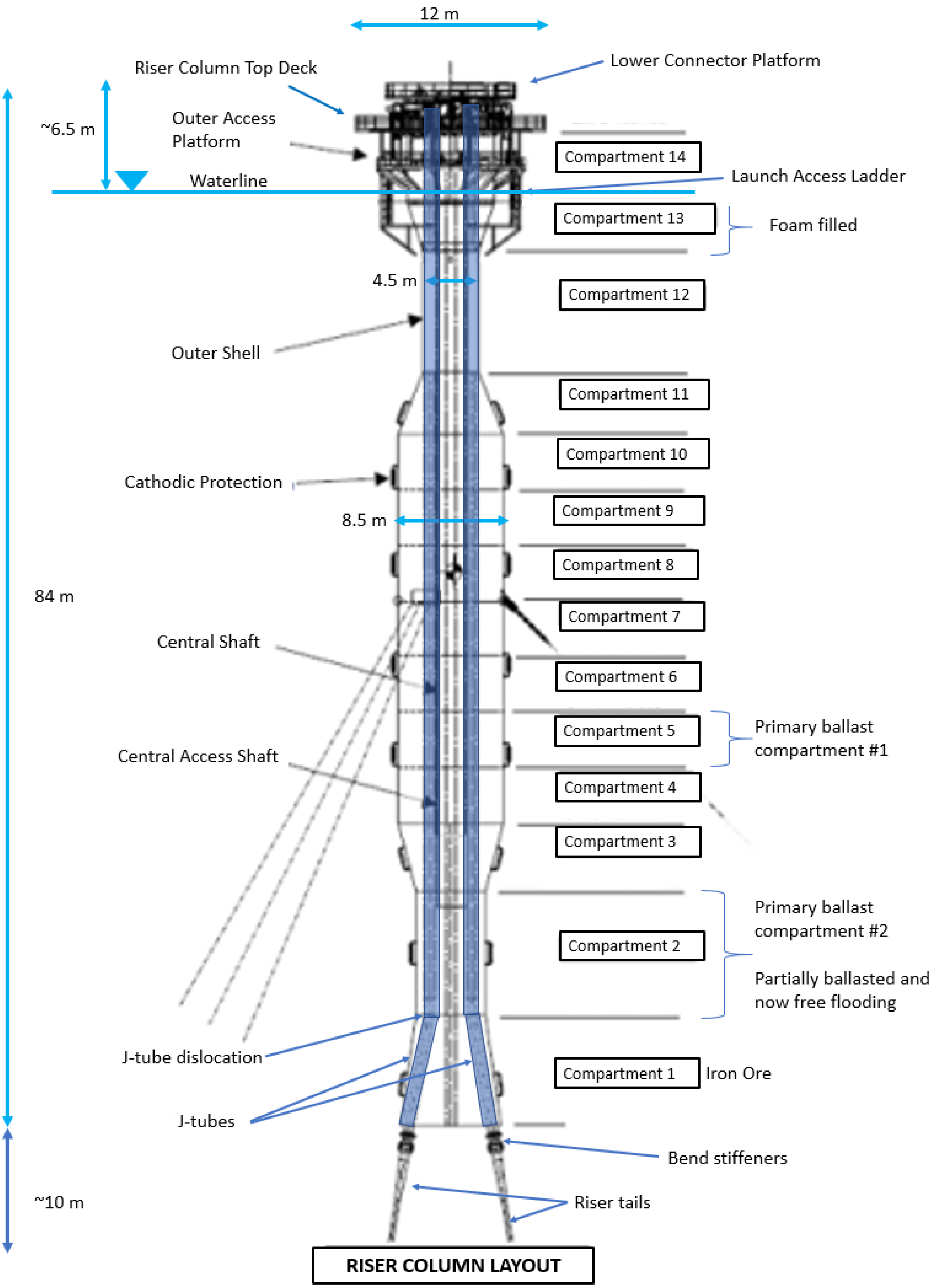


Figure 3-3: RTM layout

The RTM has a navigation lighting system consisting of solar-powered marine warning lights and a passive radar reflector to enhance marine radar detectability (**Figure 3-4**). The RTM is being monitored from the Ngujima Yin FPSO located approximately 8 km north-east and is being maintained until removal. The RTM also maintains a 500 m petroleum safety zone around the structure, which will be removed once the RTM has left the Operational Area.

Figure 3-4: Topsides section of the RTM

3.5.2 Subsea Infrastructure

During operation, the subsea system facilitated the production of Enfield reservoir fluids and transported these fluids to the FPSO, with reinjection of produced formation water (PFW) and gas back into the reservoir. The subsea system is in a state of preservation.

The subsea system in the Operational Area consists of:

- trees/wells
- rigid spools
- manifolds
- electric and hydraulic jumpers
- flexible flowlines
- umbilicals
- risers.

The disconnected infrastructure will be left in situ on the seabed for future field decommissioning.

3.5.2.1 Well Configuration

Oil from the Enfield reservoir was produced through six horizontal wells and two deviated wells, configured in a cluster arrangement around two production manifolds. Reservoir lift was facilitated through eight water injection wells with two manifolds, and two gas injection wells, that were tied back to the NGA facility. Coordinates of wells are provided in **Table 3-2**.

Wells were controlled by a multiplexed subsea control system and electro-hydraulic umbilicals connected via the manifolds to the FPSO, and were operated from the integrated control system in the Central Control Room. Each well is completed with a subsea tree incorporating wellhead controls for opening and closing the valves to isolate and regulate flow. The primary down-hole safety system is surface controlled sub-surface safety valves (SCSSSV) on each well, which are installed in the production tubing approximately 100 m below the mudline.

The wells were shut-in in Q4 2018 and are currently in a state of preservation. Shut-in of the wells consists of the SCSSSV being closed and a minimum of two Xmas tree valves being closed, which have been tested and verified. A mechanical barrier (blind seal plate) between the production tubing and the production/gas injection spools was installed by ROV. The blind seal plates provide positive isolation between the production (and gas/water injection) systems and the flushed manifold, flowline and riser system. These blind seal plates provide positive isolation to support the well isolations but are not considered a well barrier. Well integrity of subsea production, gas injector and water injector wells has been completed in accordance with the current Well Operations Management Plan (WOMP) for suspension for an extended period of time.

3.5.2.2 Flowline and Riser System

The production fluids were transported to the FPSO via two 9-inch production flowlines. There is also one 8-inch production test flowline, one 10-inch water re-injection flowline, one 6-inch gas injection flowline and one 6-inch gas lift flowline. There are two production dynamic risers, one test dynamic riser, one water reinjection, one gas lift and one gas reinjection dynamic riser.

The flowline and riser system has been flushed and cleaned of hydrocarbons to ALARP, and put into a state of preservation with treated seawater and laid on the seabed.

The flowline and riser system were redirected into a loop such that the loop could be flushed from the FPSO, with flushing fluids returning to the FPSO for testing and the water processed through the topsides processing system to remove the hydrocarbons. Two loops were created and flushed and cleaned of hydrocarbons to ALARP concentrations in Q4 2018. A final flush with treated seawater was completed to preserve the risers and flowlines until final decommissioning. The gas injection riser was unable to be looped, and was flushed with pure seawater.

All flushing water was then re-injected using the water injection flowline, which was also flushed with treated seawater. Flushing until an ALARP concentration had been reached was determined by monitoring hydrocarbon concentrations in the flushed water as it returned to the FPSO. The ALARP position was defined and implemented as follows: Flushing was continued until the concentration approached an asymptote and hydrocarbon concentrations in the flushed water were no longer decreasing.

Final oil in water (OIW) concentrations of the subsea flowline and riser system are provided in **Table 3-4.**

Table 3-4: ALARP oil in water concentrations measured from subsea flushing

Flowline or Riser	OIW (mg/L)
Production Test Flowline to Production Flowline 1	28.2
Gas Lift Flowline to Production Flowline 2	42.2
Gas Injection Flowline	19.7
Water Injection Flowline	Residual*

** Unable to be measured as the flushing water was injected into the reservoir via this flowline and there is no ability to take a water sample at the well end to measure the residual OIW concentration.*

3.6 RTM Removal and Disposal Method Options

3.6.1 Introduction

As part of initial cessation activities, it was planned to remove the NGA RTM by disconnecting the mooring chains after the risers had been disconnected, reballasting the RTM from vertical to horizontal and towing it for onshore disposal at Henderson, Western Australia. During the initial cessation activities, the integrity of a primary water ballast compartment (compartment 2) was found to be compromised and tests demonstrated communication from the compartment to a j-tube. This compartment could therefore not be emptied of water in order to create buoyancy. As a result, the RTM was left anchored on location and decommissioning activities suspended to allow further assessment of the failure mechanism and the impact on the onshore disposal option.

Further assessment concluded that without repair to compartment 2, the achievable minimum draft had increased from a planned draft of ~9.5 m including riser stubs to 18.5 m if compartment 11 is made to free-flood (**Table 3-5**). As the achievable draft now exceeds the maximum draft of the Henderson ship-lift (10 m) and the repair scope carries new safety risks associated with personnel transfers, diving activities, and marine vessel operations near the RTM buoy, this assessment reconsiders the options for decommissioning the RTM. A number of options have been evaluated, including complete removal from the permit area for onshore disposal or complete removal from the permit area and offshore disposal or repurposing as an artificial reef; and sinking the RTM in the permit area.

The scope of this assessment is to determine the current ALARP safety and environmental risk option for the decommissioning of the NGA RTM buoy using Woodside's ALARP Demonstration Procedure.

3.6.1.1 Overview

An overview of the RTM is presented in **Section 3.5.1** and the RTM is shown in **Figure 3-3**.

The RTM has 11 ballast compartments separated by horizontal watertight bulkheads. The upper compartment (compartment 13) contains approximately 65 m^3 of polyurethane foam. The bottom compartment (compartment 1) is partially filled with approximately 396 tonnes of iron ore and seawater. The second bottom compartment (compartment 2) contains seawater ballast. Compartment 2 is a primary ballast compartment, required by design, along with compartment 5 to be the only two compartments required to be deballasted/ ballasted for upending the RTM from vertical to horizontal to achieve the minimum draft for onshore disposal (**Figure 3-5**).

The RTM contains 11 j-tubes that run the length of the RTM, seven of which are occupied by six risers and one EHU. The j-tubes are tubular conduits that have the shape of the letter "J". The tubes are used to protect and route the risers and EHU through the inside of the RTM. A specialised video inspection inside empty j-tube #11 in March 2019 showed the cause of the water communication in compartment 2 was a dislocation of the j-tube within the primary compartment due to a failed weld. As a result of the water communication through the gap in the j-tube, compartment 2 cannot be reballasted and the RTM cannot be up-ended to horizontal without repair.

The reason for the failed weld is an established isolated galvanic corrosion event on the weld in the j-tube located in compartment 2.

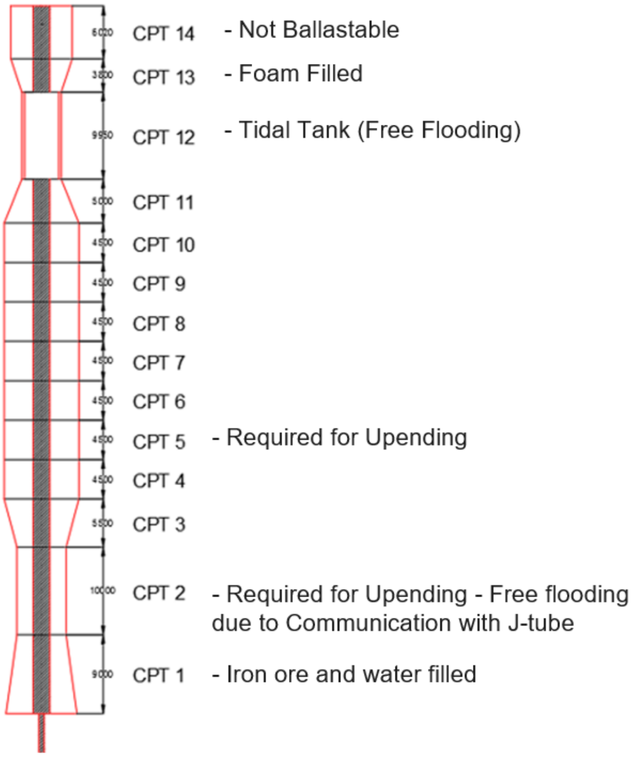


Figure 3-5: RTM compartment status

Dynamic modelling of the RTM in its current condition has predicted that if the RTM were to be reballasted in its current condition, a maximum draft of around 18.5 m to 22.5 m would be achievable (including riser stubs). This is shown in **Table** 3-5. The depth of the draft plays a significant factor in assessing the options for removal and disposal of the RTM.

The RTM is not designed for extended work campaigns and only accommodates approximately four people for working and does not have any facilities. Personnel are required to be transferred to the RTM by either boat or enclosed transfer capsule to undertake work.

Table 3-5: RTM drafts estimated if RTM reballasted to horizontal (values are approximate)

Scenario	RTM Main Body Draft	Riser Stubs Draft*
No remediation	19.0 m	22.5 m
Compartment 11 made to free-flood	15.6 m	18.5 m
Compartment 2 repaired and compartment 11 made to free-flood	8.5 m	10.2 m
Original ‘planned’ RTM ballasting	7.9 m	9.5 m
Ship-Lift Max Draft Capacity (at LAT)	9.99 m	

** The riser stubs are the bottom end of the risers. To remove the risers, see step 2 of **Section 3.6.5.1.1**.*

3.6.2 Legal Framework

In addition to the Environment Regulations discussed in **Section 1**, the following legislation is relevant to the selection of the decommissioning option for the RTM.

3.6.2.1 Decommissioning

The Australian Government Department of Industry, Innovation and Science (DIIS) states that the complete removal of infrastructure and the plugging and abandonment of wells is the default decommissioning requirement under the OPGGS Act (DIIS, 2018). Options other than complete removal may be considered, however the titleholder must demonstrate that alternative decommissioning approach delivers equal or better environmental, safety and well integrity outcomes to complete removal and that that approach complies with all other legislative requirements (DIIS, 2018). Titleholders can demonstrate these matters through submission of permissioning documents under the OPGGS regulations. Permissioning documents include an Environment Plan, prepared and submitted in accordance with the Environment Regulations and a Safety Case, prepared and submitted in accordance with the *OPGGS (Safety) Regulations 2009* (Safety Regulations) (DIIS, 2018).

3.6.2.2 Sea Dumping

As outlined in **Section 1.10.1.2**, in Australia disposal at sea of platforms, vessels, aircraft and other man-made items is regulated by the *Environment Protection (Sea Dumping) Act 1981* (Sea Dumping Act). In relation to the Enfield infrastructure, if the RTM is to be permanently disposed of at sea, it will require a sea dumping permit. If the RTM were to be repurposed into an integrated artificial reef (IAR), a sea dumping permit for an artificial reef would be required. There are precedents of permission for RTMs to be purposefully sunk under accepted sea dumping permits in Australia. The two most recent are the Jabiru RTM buoy and the Challis Single Anchor Leg Rigid Arm Mooring (SALRAM) (PTTEP Australia, 2015). No precedents of permission of RTMs to be repurposed into IARs were found.

Prior to receiving a permit, items for disposal require assessment for suitability and acceptability under the Sea Dumping Act and where available, associated policies and guidelines. The item must be cleared of material which may pose an environmental, safety or quarantine risk. An initial assessment of the RTM shows that it meets the requirements under the Sea Dumping Act, but a final assessment demonstrating the suitability and acceptability would need to be made.

There is a requirement under the Sea Dumping Act to demonstrate that consideration has been given to the hierarchy of waste management options, which includes re-use (DoEE, 2019a).

If the RTM is to be sunk for the sole purpose of disposal, the recommendations for selecting a sea dumping location are "*a location with waters at least 2,000m deep, at least 50 nm from the coast and at least 20 nm from the nearest historic shipwreck, sub-sea cable, pipeline, oil/gas well, reef, seamount, bank or shoal. The site would also be clear of normal shipping routes and active marine fauna migration routes and breeding areas*." (DoEE, 2019b).

The use of infrastructure to create artificial reefs is also legislated under the Sea Dumping Act. This is done via a separate permit, called an Artificial Reef Permit, which requires selection of a suitable site, stakeholder consultation and assessment of social, economic and environmental considerations (DoEE, 2019c). Typical requirements are to select a coastal water location, within a reasonable distance of public access points such as a boat ramp (if the purpose is for recreational purposes and not solely for habitat enhancement), and away from locations where it could pose a hazard to shipping traffic or other marine users.

3.6.2.3 Safety Regulations

A facility cannot be constructed, installed, operated, modified or decommissioned without a safety case in force for that stage in the life of the facility (NOPSEMA, 2018). A safety case is a document produced by the operator of a facility which identifies the hazards and risks, describes how the risks are controlled and describes the safety management system in place to ensure the controls are effectively and consistently applied, in accordance with the Safety Regulations. Safety Cases are regulated by NOPSEMA. NOPSEMA assesses safety cases and accepts a safety case if it is satisfied that the arrangements set out in the document demonstrate that the risks will be reduced to ALARP (NOPSEMA, 2018).

A safety case was accepted in October 2016 by NOPSEMA for the proposed NGA CoP activities. A revised safety case would likely be required for any of the onshore disposal options (**Section 3.6.5.1**). This is due to the increase in risk associated with activities against those contemplated in the existing safety case.

3.6.2.4 Decision Making Framework

This assessment has been made using the Oil and Gas UK Guidance on Decision Making (**Figure 2-4**) for safety and environmental risks.

This decision is considered a combination of B and C Decision Types (**Section 2.6.1.2** and **2.6.1.3**). The potential repairs to the RTM required for onshore disposal are considered an infrequent or non-standard activity with some new and unproven methods and a number of associated safety risks. The environmental impact of RTM re-use or disposal is amenable to assessment using well established data and methods, however stakeholder views require additional consideration. Given this, a number of tools have been used in the ALARP evaluation, including:

- Codes and Standards
- Good Industry Practice
- Engineering Risk Assessment
- Societal Values
- Company Values.

3.6.3 Assessment of Options

3.6.3.1 Overview

There are a number of options for removal and disposal of the RTM. Consistent with the OPGGS Act, the first consideration is whether to completely remove the RTM from WA-28-L (base case), or leave the RTM in the permit area. As there is only one option identified for leaving the RTM in the permit area, this has been assessed first. All options for removal of the RTM from the permit area meet the base case of the OPGGS Act and the Decommissioning Guidelines of complete removal (DIIS, 2018). If the RTM is completely removed from the permit area, there are options for either onshore or offshore disposal.

- Not complete removal
    1. Offshore disposal infield (within permit area)
- Complete removal from permit area
    2. Onshore disposal
        a) Repair, reballast to horizontal and tow to shore for disposal
        b) Repair, reballast to horizontal and utilise a semi-submersible vessel to dry-tow to shore for disposal
        c) Reballast to semi-horizontal and utilise a transport heavy lift vessel (HLV) or heavy construction vessel (HCV) to lift RTM onto a barge to dry-tow to shore for disposal
        d) Ballast to semi-horizontal and tow to deepwater port
    3. Remove from location for offshore disposal
        a) Offshore disposal in much deeper water (outside of permit area)

b) Re-use (repurposing into habitat augmentation as an integrated artificial reef)

The timeframe for the completion of these activities is highly dependent on the prevailing metocean conditions, which can impact the accessibility of the RTM, and the ability to execute the work. Based on metocean conditions for the Enfield field, suitable weather windows only occur during approximately January to April. Therefore, an additional contingency wet season may be needed for execution if an option's complexity, planning or vessel requirements renders the option unable to meet the suitable weather window at year end 2020/21.

3.6.4 Not Complete Removal

3.6.4.1 Option 1: Offshore disposal in field (within permit area)

Planned sinking of the RTM within WA-28-L is technically the most feasible and lowest safety risk option as it requires no remediation or repairs of the RTM and very little, if any, towing to a suitable location within the permit area. The option requires engineering and analysis to ensure long-term stability once on the seabed and must ensure before disposal that it has been cleared of material which may pose an environmental, safety or quarantine risk (DoEE, 2019b).

The steps required for this option would involve:

1. Assessment and management plan for RTM material which may pose an environmental, safety or quarantine risk.
2. Identify a suitable permanent abandonment location for the RTM within the permit area.
3. Seeking acceptance of a sea dumping permit for permanent disposal of the RTM in the permit area.
4. Preparing the RTM topsides for scuttling by removing life rings, wiring, navigation lights, etc. as part of executing the material management plan. This would likely require personnel to be transferred to the RTM to complete the works and is estimated would take approximately three days and ~60 personnel transfers. Personnel transfers to/from the RTM are a medium safety risk for personnel due to limited egress and access (enclosed personnel transferor vessel-to-vessel) and frequency of the activity (minimum of four times a day onto and off the RTM as there are no facilities on the RTM).
5. Use an ROV to pierce and flood ballast compartments to counter act the weight of the mooring chains.
6. Cut the mooring chains and tow in a vertical orientation to a suitable location within the permit area. Depending on the location, it may be possible to scuttle on location with the chains attached.
7. Scuttle the RTM which would involve controlled free-flooding of the RTM using an ROV to pierce selected ballast compartments.
8. Once the RTM is on the seabed, complete any other material management requirements, e.g. the foam in compartment 13 will have compressed due to external water pressure which will allow it to be encapsulated by grout thus preventing foam from escaping once corrosion of that compartment occurs. At this time, any other activities required to ensure long term stability would be undertaken.

The key advantages for this option include: it provides one of the options with the lowest safety risks as no repairs of the RTM are required; no repair of the RTM is needed; and there is minimal or no/minimal towing of the RTM required. Given the short duration associated with preparing the RTM for disposal in the permit area, it is likely that this option could be undertaken all year round, although November to April have the most suitable conditions.

The main disadvantage is that it does not meet the base case requirement under the OPGGS Act of complete removal from the permit area. To pursue this option, it must be demonstrated that it provides equal or better environmental, safety and well integrity outcomes when compared to complete removal (DIIS, 2018).

In addition, while this option is technically feasible, given water depths in the permit area are approximately 200 m in the east to 2000 m in the west (**Section 3.3**) it does not meet the recommended depth for a sea dumping permit outlined in **Section 3.6.2.2** above.

The other disadvantage is the requirement to seek and secure acceptance for a sea dumping permit for permanent disposal, which requires demonstration that consideration has been given to the hierarchy of waste management options, which include re-use (DoEE, 2019a). As such, re-use of the RTM must be investigated.

3.6.5 Complete Removal from Permit Area

3.6.5.1 Onshore Disposal

3.6.5.1.1 Option 2a: Repair, reballast to horizontal and tow to shore for disposal

To achieve onshore disposal, options to repair the RTM to enable complete ballasting to horizontal have been investigated. The most feasible option is to use grout to fill the j-tube and plug the gap created by the weld failure. As common mode failure of the welds in the other j-tubes cannot be ruled out, the other j-tubes would also need to be grouted. The risers would also need to be removed prior to grouting (grouting with the j-tubes in place was ruled out, see ‘Alternative considerations assessed and not pursued’ below). To achieve this option would require:

1. Undertaking grouting trials to assess the feasibility of successfully plugging the gap in j-tube 11. Grouting the j-tubes would only be pursued further if the grouting trials were successful.
2. Sealing the hole in the j-tube in compartment 2 by installing a sleeve inside the j-tube across the gap and inserting grout into the j-tube to fill the j-tube and plug the gap. The six risers and EHU would need to be removed from the top of the RTM using a vessel equipped with a crane approximately 100 m high (as each riser is around 90 m long, and weights approximately 27 tonnes). Grout would then be installed in the remaining j-tubes to avoid dislocation and gaps forming in other j-tubes. The offshore work scope would take approximately 50-110 days, requiring between ~1200-2560 personnel transfers to and from the RTM during this time to complete the work. The transfers create a high safety risk for personnel due to limited egress and access (transfer by frog or vessel-to-vessel) and frequency of the activity (minimum of four times a day to and from the RTM as there are no facilities on the RTM).
3. Once complete, reballasting the RTM and upending from vertical to horizontal.
4. Towing the RTM to an onshore port location. Maximum depth of RTM would need to be approximately 9.5 m for use of a typical ship lift (e.g. at Henderson).
5. RTM onshore disposal at Henderson (or alternative) requiring onshore de-construction. Onshore disposal will be dependent on availability of a suitably sized berth, and the ability to achieve a maximum draft of the RTM of 9.5 m as most ship lifts are designed around a Panamax ship which has a draft of 10 m (e.g. **Table 3-5**). Towing a minimum of 2000 km to Henderson carries the risk of the RTM sinking during tow to shore or loss of control during the tow including in shipping channels or in the port.

This option has many technical challenges, and while it would achieve the accepted scope of the previous revision of this EP, there is residual uncertainty regarding the success of the repair (estimated between a ‘2’ and ‘3’ on the Woodside risk matrix i.e. Unlikely or Possible). Therefore, it carries the risk that the repair may fail during upending or during tow and the RTM draft increasing to the compartment 2 flooded condition (~18.5 m). The risk of the repair failure would be better understood through testing of the grout plugs (a 6-12 month technology qualification exercise). Failure of the repair may result in the RTM draft being too great to enter the ship lift, it may result in grounding of the RTM in port or a shipping channel, and may also restrict access to sheltered waters where contingency repairs could be attempted. In addition, the complex offshore execution duration introduces high safety risks for an extended duration of time.

The offshore repair work scope for this option would take approximately 1200-2560 personnel transfers to/from the RTM to complete the work. It should be noted that from experience, personnel transfers to the RTM to execute repairs require sea states less than 1.5 m. Based on metocean conditions, there is a limited annual window from January to April when conditions are suitable to execute extended work campaigns, and there is still expected to be significant weather downtime during this period, including the potential for cyclones. Given this, it may be challenging to complete the required repairs during the annual weather window. This weather window also applies to Options 2b and 2c.

Alternative considerations assessed and not pursued:

- **Grouting the j-tubes with the risers and EHU in place.** This was not deemed practicable as it could result in some localised thin areas of the grout and thus a thin barrier where, due to the j-tube profile and the riser/EHU stiffness, the risers and EHU may naturally sits close to the side of the j-tube. This thinning would result in the risk of the grout failing under load as the RTM was reballasted from vertical to horizontal, or during the tow.
- **Removal of the risers and EHU from the bottom of the RTM**. This is not practicable as there is a one-way latch mechanism inside each j-tube at the bend stiffener, preventing lowering the risers down from the top of the RTM. This stiffener latch is mechanically activated and is spring set with a hydraulic over-ride, the design being that hydraulic pressure is applied to the latch to back it off and allow the bend stiffener to fall away. Manufacturers operational over-ride procedure are for bolt tensioners to be installed, which would need to be installed by divers. Industry alignment on this approach has been for saturation divers to facilitate removal of the risers by bolt tensioner over-ride. As such, removal from the top is the preferred option. Even if diving was selected as the preferred option for riser removal, the Option 2a) still carries residual uncertainty regarding the success of the j-tube repair as described above.
- **Alternative method for riser removal from the top of the RTM**. Alternative methods of riser handling, such as a handling frame and stepper jacks being installed onto the RTM, have been considered. These require additional personnel intervention on the RTM and as such add additional exposure to personnel. The use of a high crane as described in Option 2a above minimises personnel exposure.
- **Adding internal buoyancy (injected foam or pumpable buoyancy) to the RTM to achieve minimum draft required for the ship lifter**. Internal foam or pumpable buoyancy would not provide adequate buoyancy on its own, so was also looked at in conjunction with external buoyancy.
- **Adding external buoyancy.** The volume of external buoyancy required to be added to achieve the maximum draft for the intended ship lift would result in the RTM with external floatation wider than the ship lift. This was the case, even if internal buoyancy was used in conjunction with external buoyancy.
- **Alternate port locations with deeper draft ship lift capabilities or heavy lift capabilities able to accommodate the RTM with a deeper draft when horizontal**. Regional port capacity is based around Panamax vessels which have a maximum draft of 10 m. Most ports would therefore require the RTM to be repaired to enable this draft to be achieved. Even if an alternate port with a deeper draft was able to be identified, the option would require the RTM to be towed through busy commercial shipping lanes with a risk of the grout repair failing in the j-tubes and the RTM taking on water in compartment 2 and resulting in a draft of at least 18.5 m.

3.6.5.1.2 Option 2b: Repair, reballast to horizontal and utilise a semi-submersible vessel to dry-tow to shore for disposal

The use of a semi-submersible vessel which could be submerged and the RTM floated onto the vessel was investigated. The RTM would need to be repaired in order to achieve the maximum draft for the deepest semi-submersible vessel, but it could then be floated onto the vessel and lifted out of the water and dry-towed to port to be lifted onshore for disposal. To achieve this option would require:

1. Execution of the same repair scope as for Option 2a). Carries the same safety risk due to personnel transfers and lifting operations for risers.
2. Ballast RTM, cut mooring chains and upend from vertical to horizontal and achieve a maximum draft requirement of the deepest semi-submersible vessel of approximately 16 m.
3. Horizontal tow to sheltered water location and float onto semi-submersible vessel.
4. The RTM could then be dry-towed to a port for onshore disposal without the risk of it sinking during transport to shore or loss of control of the RTM during tow. Requires onshore de-construction.

This option has the benefit of reducing the wet tow duration as compared to Option 2a.

A semi-submersible vessel requires the RTM to be repaired in order to be ballasted to horizontal to meet draft requirements (~10-16m). This size vessel also requires a minimum water depth for the vessel ballasting process to occur to allow for the depth of the submerged keel. For example, the COSCO-HT's Xin Guang Hua can submerge the deck up to 16 m, but in doing so has a draft depth of 30.5 m due to the deck being 14.5 m thick. An allowance of 1-2 m underkeel clearance would also be required, and the operation must also occur in calm waters. There are no nearby locations that have the potential to meet the water depth and sheltered waters criteria. Only one potential location has been identified, north east of Legendre Island near the Dampier Peninsula with a water depth of >32 m. This is an approximately 400 km tow from the current RTM location, which carries a risk of loss of control of the RTM during tow. The option also carries residual uncertainty regarding the success of the repair. Therefore it carries a possible risk that the repair fails during upending or during tow to sheltered waters and the RTM draft increasing to the compartment 2 flooded condition. Failure of the repair may result in the RTM draft being too great to enter the semi-submersible vessel and may also restrict access to sheltered waters where contingency repairs could be attempted.

3.6.5.1.3 Option 2c: Reballast to near horizontal and utilise a HLV to lift onto a barge to dry-tow to shore for disposal

This option does not require repair of the RTM and would mean the RTM could be dry-towed to shore for disposal with no risk of it sinking during the transit to port or loosing control of the RTM during tow. The option would involve:

1. No repairs to the RTM j-tubes would be required, and the risers and EHU can remain inside the j-tubes, however a lifting cradle would need to be installed around the RTM to support it during the lift and while on the deck of a transport barge. Installation of the cradle would require saturation diving to securely weld the cradle onto the RTM and install lifting slings for the HLV lift. This would involve divers working under/around a suspended load (the cradle) in order to weld in place before installing the lifting slings. Saturation diving is a high risk activity, and working in and under a significant suspended load presents a significant safety risk to personnel.
2. Once installed, the RTM could be reballasted to a semi-horizontal position using the functional ballast compartments (compartment 2 would remain full). Both steps 1 and 2 would take approximately 10 days to execute offshore and ~250 personnel transfers.
3. The RTM would then be lifted using the HLV onto a barge. Use of a transport HLV (with dual crane) to lift the RTM onto a barge would be challenging as the RTM was not designed to be lifted with compartments ballasted. This could result in the RTM structure failing during the lift .

This would be a complex operation involving multiple vessels (a HLV, a transport barge and two to three tow tugs to control the release of the RTM from the anchor chains) and thus complex SIMOPS.. A suitable transport HLV with cranes with sufficient capacity to undertake this lift was not able to be identified.

4. Once secured on the barge, the RTM could be transported (dry-towed) to shore for disposal without the risk of it either sinking during transport or loss of control during tow. RTM then de-constructed onshore.

Additional removal and onshore disposal options considered but not pursued

- **Utilise a HLV to lift the RTM vertically from the water and place onto a barge to dry-tow to shore for disposal**. This is an alternative to Option 2c using a derrick crane HLV rather than a transport HLV. However, it is considered infeasible for a pure vertical lift of this size (around 92 m length) and weight (around 2452 tonnes). The handling of the RTM when clear of the water is extremely challenging due to the very low centre of gravity which will make stability control difficult during RTM laydown. In addition, the RTM is not designed for this option and there is no lift point available for this type of operation nor is there certainty in the ability to install one.
- **Install a 'lifting donut' at the bottom of the RTM and a lifting trunnion on the top of the RTM to undertake a lift by a HCV to lift out of the water and place onto a barge to dry-tow to shore.** This option would require a HCV with dual hook and block crane single boom with two lines and hooks, one to attach to the lifting donut at the bottom and one to attach to the lifting trunnion on the top) for lifting the RTM. A 'lifting donut' would be installed at the bottom of the RTM using a crane which would eliminate the need for divers for installation. The topsides would require major works including removal of topsides handrails and installation of a lifting trunnion. The mooring chains would then be cut, and the RTM would then sit ~20 m out of the water with mooring chain weight removed. The two lifting points would then need to be connected to the HCV crane. The dual connections would then be used to complete a controlled lift and tilt of the RTM from a vertical position to horizontal and placed onto a transport barge for dry-tow to shore. This option involves significant topsides work on the RTM to install the lifting trunnion, with safety risks including: working at heights if the mooring lines are required to be disconnected before all work on the RTM is completed; complex lifting methods outside of the original RTM design; and multiple vessel operations; or involve unqualified technology, which would have an extended schedule duration. The timeframe for the completion of these activities is highly dependent on the prevailing metocean conditions which can impact the accessibility of the RTM, and the ability to execute the complex and novel lift.
- **Disconnection of lower compartments from RTM.** Iron ore was installed in compartment 1 as permanent ballast. The total weight is 396 tonnes which must be counterbalanced with buoyancy to achieve a required draft. Options for removal of the iron ore ballast to reduce the counterbalancing requirement have been investigated, however compartments 1 and 2 comprise thick plate walls (around 30 mm), which would require a combination of mechanical and oxy-arc cutting solutions (the cut is technically difficult at 65-70 m below sea surface) or use of high explosive shaped charges. In addition, the j-tubes run external to the central column, so not only would the outer walls of the RTM need to be cut, each j-tube runs through the centre of each compartment, so would need to be cut through, as well as the central column (**Figure 3-3**).

3.6.5.1.4 *Option 2d: Ballast to semi-horizontal and tow to deepwater port*

This option involves ballasting the RTM to the minimum achievable draft without repair and towing to a deepwater port. The port is required to be within a reasonable towing distance to mitigate the risk of loss of control of the RTM during the tow; have a quay with sufficient draft to take the RTM and lifting facilities on the quay to accommodate lifting the ~2452 tonne weight. This option would involve:

1. Free flood compartment #11 and ballasting the RTM to a semi-horizontal position. This would achieve and estimated draft of ~18.5 m.
2. Semi-horizontally tow to a deepwater port.
3. Lift out of the water and disposal of the RTM onshore requiring onshore de-construction.

An investigation into deepwater port options in South East Asia was undertaken with ports investigated as far away as South Korea. This did not identify any suitable ports with quayside berths with sufficient depth. The deepest alongside berths identified overall were in container and bulk handling ports, the deepest being 18 m located in Malaysia, India, Sri Lanka and East Coast Australia although in some of these cases, access channel depth is shallower than the berth. In any case, this is not deep enough to accommodate the RTM draft when minimum under-keel clearance is taken into account. As a result, this option has not been further evaluated.

3.6.5.2 Offshore Disposal Options Outside Permit Area

3.6.5.2.1 Option 3a: Offshore disposal in much deeper water (outside of permit area)

This option avoids any repairs to the RTM, and would require the RTM to be towed vertically once mooring chains were cut. The vertical orientation significantly limits the towing speed and travel distance of the RTM. To achieve this option the following would be involved:

1. Assessment and management plan for RTM material which may pose an environmental, safety or quarantine risk.
2. Identification of a suitable deep water location and completion of a baseline environmental survey. DoEE guidance of a preferred disposal location: nominally be in >2000 m water depth, at least 50 nm from the coast and at least 20 nm from the nearest historic shipwreck, subsea cable, pipeline, oil/gas well, reef, seamount, bank or shoal. The site would also be clear of normal shipping routes and active marine fauna migration routes and breeding areas (DoEE, 2019b).
3. Application for sea dumping permit approval from the DoEE, which would include detailed plans for scuttling and ensuring the long-term stability of the RTM on the seabed.
4. Preparation of the RTM topsides for scuttling by removing life rings, wiring, navigation lights, etc as part of executing the material management plan. It is estimated this would take approximately three days, and would likely require ~60 personnel transfers to complete the tasks. Personnel transfer to the RTM is a high risk to personnel due to limited egress and access (transfer by frog or vessel-to-vessel) and frequency of the activity (minimum of four times a day to and from the RTM as there are no facilities on the RTM).
5. After preparation, cutting the mooring chains and towing the RTM in a vertical orientation to approved disposal location.
6. Scuttling the RTM which would involve controlled free-flooding of the RTM using an ROV to pierce selected ballast compartments.
7. Once the RTM was on the seabed, complete any other material management requirements, e.g. the foam in compartment 13 would be secured to prevent it from escaping; as well as any other requirements identified during the sea dumping permit application process. This includes ensuring long-term RTM stability on the seabed.

The RTM would need to be towed vertically, which requires a very slow speed to maintain structural integrity and increases the risk of loss of control of the RTM during tow when compared to horizontal towing. The distance the RTM should be towed in this orientation is limited, nominally no more than approximately 400 km. The nearest sites that could meet the requirements of a preferred disposal location, and are within the required tow distance are either approximately 380 km north-west of the permit area between the 2000 m and 3000 m bathymetry contours, but within the Australian

Exclusive Economic Zone (EEZ); or 220 km south-west between 2000 m and around 3000 m bathymetry contours, a suitable distance south of the Gascoyne AMP to ensure the AMP is not impacted[3].

While this option would be expected to meet the ‘preferred disposal location’ requirements of a sea dumping permit for permanent disposal, the sea dumping permit application process also requires demonstration that consideration has been given to the hierarchy of waste management options, which includes re-use (see **Section 3.6.4.1**). As such, the ability to re-use or repurpose the RTM is to be investigated in order to progress this option.

3.6.5.2.2 Option 3b: Re-use (habitat augmentation as an integrated artificial reef)

This option follows the successful execution of the Exmouth IAR “King Reef” in June 2018 (DPIRD, 2019c). The option has the potential opportunity for a net positive outcome by repurposing the RTM into an integrated artificial reef for habitat augmentation. This option also needs to be investigated to determine whether Option 1 or Option 3a could be pursued, because in order to secure acceptance for a sea dumping permit for permanent disposal, demonstration that consideration has been given to the hierarchy of waste management options, which include re-use is required (DoEE, 2019a). As described in **Section 1.10.1.2**, in Australia the placement and construction of artificial reefs are regulated under the Sea Dumping Act and therefore, organisations wishing to create an artificial reef will require a sea dumping permit.

Artificial reefs are usually constructed for (DoEE, 2019c):

- recreational use (e.g. scuba diving, fishing)
- increasing or concentrating populations of marine plants and animals.

To meet the requirements for an artificial reef, an appropriate site must be selected, materials used must be suitable and appropriately prepared, there must be no significant adverse impacts on the marine environment and the reef must not pose a danger to marine users (DoEE, 2019c). An initial assessment of the suitability has been completed (**Section 3.6.2.2**) and the RTM appears suitable for disposal or repurposing, however, the RTM IAR will only be acceptable if it can be created for legitimate purposes (i.e. not waste disposal) and cannot pose a significant threat to users or surrounding environments (DoEE, 2019c).

Key phases identified by DoEE for preparing an IAR for placement and for preparing a sea dumping permit application for an artificial reef include:

- evaluation and securing of adequate resources
- stakeholder consultations
- site selection
- material preparation
- determining the method of placement
- preparing for post-placement monitoring and management.

Given the above, this option would involve:

1. An assessment and confirmation of suitability and acceptability of the RTM to be repurposed into an artificial reef. This step would involve ensuring that there is an assessment and management plan for RTM material which may pose an environmental, safety or quarantine risk. Emphasis would be placed on there being no contaminants which can cause significant adverse impacts to users or surrounding environments. Further assessment is also required into

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[3] This would be determined through the Sea Dumping Permit for Disposal application process.

the likelihood of achieving the purpose of an artificial reef. This includes investigation into an IAR which would involve augmenting the RTM with purpose-built reef structures (e.g. concrete reef towers) to further enhance the structural benefit provided by the RTM. In this instance an IAR is the most likely outcome.

2. Assessment and selection of a suitable location for the IAR site completed in conjunction with stakeholders through appropriate consultation as required under the Sea Dumping Act and in line with relevant State requirements (DoF, 2012b).
3. Undertaking site environmental and geotechnical baseline survey to confirm a suitable location.
4. Designing the IAR for the location, developing the suitable execution and monitoring plan; and application for an artificial reef permit.
5. Preparation of the RTM topsides for execution of an IAR by removal of life rings, wiring, navigation lights, etc. as part of executing the material management plan. It is estimated this would take approximately three days and would likely require ~60 personnel transfers to complete the tasks. Personnel transfer to the RTM is a high risk to personnel due to limited egress and access (transfer by frog or vessel-to-vessel) and frequency of the activity (minimum of four times a day to and from the RTM as there are no facilities on the RTM).
6. After preparation, cutting of the mooring chains and towing of the RTM in a vertical orientation to the approved reef location.
7. Scuttling the RTM, which would involve controlled free-flooding of the RTM using an ROV to pierce selected ballast compartments.
8. Once the RTM is on the seabed, complete any other material management requirements, e.g. grout the foam in compartment 13 in place to prevent it from escaping. Any other requirements identified during the sea dumping permit application process would be undertaken, to transform the RTM into a functional part of an IAR including ensuring long-term RTM stability on seabed.
9. Adding additional purpose-built reef structures to achieve an IAR.
10. Monitoring as per the requirements of the approved sea dumping permit for the IAR.

Even if the RTM shape is not ideal as a reef on its own, the structure can be augmented with purpose-built reef structures to achieve a suitable IAR design such as the “King Reef” (Recfishwest, 2018) to achieve an overall improved outcome relative to use of either isolation. The IAR can be planned and designed to include long-term stability as well as habitat augmentation to target the support of specific fish species to offset the environmental impact of installing the IAR. The purpose would be to achieve long-term socio-economic and ecological benefits.

3.6.6 Codes and Standards

There are no specific codes and standards for decommissioning. Work will be carried out consistent with DNVGL-ST-N001 Marine operations and marine warranty standard and DNV-RP-H102 Marine Operations During Removal of Offshore Installations. These standards relate to how marine operations will be undertaken and do not have a bearing on which decommissioning removal option is selected and are therefore the standards have been determined not relevant to this assessment.

3.6.7 Good Practice

Good practice for decommissioning generally involves the evaluation of multiple options including full removal, which is the base case under the OPGGS Act (DIIS, 2018). The APPEA Offshore Oil and Gas Decommissioning Decision-Making Guidelines (APPEA, 2016) recommends evaluating the merits of different decommissioning options on a case-by-case basis due to the diversity of facility types and locations. Decommissioning options identified included disposing onshore, toppling on site, placing in deep water, leaving on site, artificial reef, re-use in another location and re-use for another scope. Methods for evaluating options include risk assessment, feasibility assessment and comparative assessment.

The benefits of leaving structures in place or 'in situ' has been demonstrated in several parts of the world, notably in the US Gulf of Mexico, where the facilities frequently become artificial reefs (BSEE, 2019). An IAR has also recently been created in Exmouth. Six steel structures (mid-rise buoys) from BHP's Griffin oil and gas facility were decommissioned, cleaned, repurposed and deployed on the ocean floor within the Exmouth Gulf along with 49 purpose-built concrete modules. This is known as King Reef, and has created more than 27,000 cubic metres of new underwater habitat, providing food and shelter for more than 50 different types of marine life, including a variety of fish, sea turtles, sea snakes, sharks and rays (Recfishwest, 2018).

For RTMs specifically, there is no single good practice, and previous practice is consistent with the principles of case-by-case evaluation. The Balnaves RTM was removed for onshore disposal (Mos Engineering, 2016). The Jabiru RTM and Challis Single Leg Rigid Arm mooring were sea-dumped, following an extensive evaluation including safety, environment, cost and stakeholder consultation (PTTEP Australia, 2015). Options for the Stybarrow field spider buoy and Griffin RTM are still under evaluation (BHP Billiton Petroleum, 2017a,b).

3.6.8 Engineering Risk Assessment

An engineering risk assessment of each of the options has been conducted to assess risks associated with each of the options. The key decision criteria are as follows:

- management of risks to human health and safety to a level that is considered ALARP
- management of risks to the environment to a level that is considered ALARP
- schedule duration (to mitigate the risk of the RTM unexpectedly sinking)
- execution risk (impact on ability to achieve option decommissioning objective).

Risks have been ranked using the Woodside Risk Matrix and impacts assessed using the Woodside Environment Risk and Impact Assessment Guidance Tool. A summary of the outcomes of the engineering risk assessment area presented in **Table 3-6** below.

Table 3-6: ALARP assessment summary of RTM removal and disposal options

		Not Full Removal	**Full Removal**				
		Offshore	**Onshore Disposal**			**Offshore Disposal**	
		Option 1	**Option 2a**	**Option 2b**	**Option 2c**	**Option 3a**	**Option 3b**
Health and Safety Risk	**Personnel Transfers***	B1 – Moderate	B2 – High	B2 – High	B1 – Moderate	B1 – Moderate	B1 – Moderate
	Dropped Objects	NA	B1 – Moderate	B1 – Moderate	B1 – Moderate	NA	NA
	Diving	NA	B1 – Moderate	B1 – Moderate	B2 - High	NA	NA
	Ship Impact – Direct**	B1 – Moderate	B1 – Moderate	B1 – Moderate	B1 – Moderate	B1 – Moderate	B1 – Moderate
	Ship Impact RTM**	B1 – Moderate	B1 – Moderate	B1 – Moderate	B1 – Moderate	B1 – Moderate	B1 – Moderate
	Occupational Injury	C1 – Moderate	C2 – Moderate	C2 – Moderate	C2 – Moderate	C1 - Moderate	C1 – Moderate
Environ-ment	**Vessel Collision Resulting in Spill**	D1 – Moderate	D1 – Moderate	D1 – Moderate	D1 – Moderate	D1 – Moderate	D1 – Moderate

		Not Full Removal	**Full Removal**				
		Offshore	**Onshore Disposal**			**Offshore Disposal**	
		Option 1	**Option 2a**	**Option 2b**	**Option 2c**	**Option 3a**	**Option 3b**
	Inadvertent Sinking	E1 – Low	E2 – Moderate	E2 – Moderate	E2 – Moderate	E1 - Low	E1 - Low
	Final Disposal	E – Slight	N/A	N/A	N/A	E - Slight	E - Slight
Execution Risk		- Contamination assessment Stakeholder support - Potential vertical tow - Sea Dumping Permit approval	- May need to clean part of j-tubes for grouting success - Limited chance of repair success - Unable to upend the RTM due to grout failure or other structural failure		- Lift novel and complex - HLV availability - Complicated SIMOPS - Disposal port availability - Onsore disposal location suitability	- Contamination assessment - Suitable location - Sea dumping permit approval - Stakeholder support - Loss of control of RTM during vertical tow to deep water location	- Contamination assessment - Suitable location - Sea dumping permit approval - Stakeholder support - Loss of control of RTM during vertical tow to IAR location (minimised as a much shorter tow than Option 3a)
			- Repair failure leading to reflooding of compartment 2 and draft depth increasing to 22.5 m preventing execution onshore	- Vessel availability - Repair failure leading to reflooding of compartment 2 and draft depth increasing to 22.5 m preventing execution			
Schedule Duration	**Target (mths)**	8-18	14-18	14-18	26-30	8-18	8-18
	Contingency***		8-12	8-12	8-12		
	Field Execution duration (months)	Up to 1	3	3	Up to 1	Up to 1	Up to 1

** Assumes enclosed personnel transfer, offshore disposal ranked conservatively as B1, however may be B0*

*** All options ranked B1 as insufficient information to fully assess difference – risk associated with onshore disposal activities higher due to longer duration and larger number of vessels required.*

**** Assumes field execution during wet season (Jan - April) due to weather requirements, requiring an additional contingency if unable to meet weather window at year end 2020/21.*

The engineering risk assessment determined that the key differentiators between the options and their ability to meet the associated decommissioning objective (onshore disposal/ offshore disposal/ offshore repurposing) and achieve an ALARP outcome are safety risks, execution risks and schedule. Environmental risks associated with all options are similar and environmental impacts of offshore disposal or repurposing are slight and there is potential for an environmental benefit with an IAR.

The onshore disposal options poses higher safety risks as compared to offshore disposal or repurposing due to the personnel transfers and/or diving for repairs or lifting. This risk exposure is reduced for offshore disposal or repurposing as the RTM can be towed in its current state, significantly reducing personnel exposure. Whilst the overall risk ranking for vessel collision is the same for all options, the risk is expected to be greater for onshore disposal due to the longer execution duration and greater number of vessels. Only the option of repurposing as an artificial reef would have ecological and socio-economic benefits to offset the environmental impacts (see **Section 3.6.5.2.2**). The schedule for Option 2c is also far greater than the other options due to the timeline for contracting, vessel availability, detailed engineering and meeting weather windows.

3.6.9 Societal Values

Woodside recognises that its regulatory and social licence to operate is based on historical performance, complying with appropriate policies, standards and procedures and understanding the expectations of external stakeholders.

An initial review of stakeholder views and science priorities for decommissioning in WA was published in 2017 (WAMSI, 2017). The draft report summarised that *"Nearly all stakeholders identified that there should be clear evidence of the environmental acceptability of different decommissioning options before they are supported. Many stakeholders held the view that, if shown to be environmentally acceptable, alternative uses such as 'reefing' could provide socio-economic and environmental benefits, but wanted the evidence to support these assumptions."* (WAMSI, 2017).

Offshore decommissioning is recognised as an emerging area in Australia, and only a number of smaller decommissioning activities have occurred (DIIS, 2019). Australia has a robust approvals process in place, however as the Australian offshore petroleum sector continues to mature, an increasing number of offshore petroleum projects will need to be decommissioned. To best prepare for increased and larger scale decommissioning activity, the Australian Government is currently reviewing the policy, regulatory and legislative framework for decommissioning offshore petroleum infrastructure in Commonwealth waters. This will ensure it is fit-for-purpose and positions Australia to respond to decommissioning challenges and opportunities now and into the future (DIIS, 2019).

This review commenced with the release of a Decommissioning Discussion Paper in October 2018, with the public invited to comment. Views provided in response to the Paper were widely varying (DIIS, 2019).

Given the above, Woodside has engaged an independent company to assist in the evaluation of the potential development of an IAR using the RTM in the Exmouth region for the benefit of the local community and recreational fishing in Western Australia. The assessment includes assessment of acceptability and suitability, as well as an independent assessment of contaminants and investigation into potential stakeholder support, i.e. if the RTM as an IAR would have a purpose and long-term value. Given the economic value of recreational fishing in WA was estimated at $2.4 billion in 2015/16 with regional spend of $27.5 million in the Gascoyne region (McLeod and Lindner, 2018), and the social and recreational benefits of recreational fishing, the option is worth investigation.

The initial feedback supports the acceptability and suitability of repurposing the NGA RTM into an IAR. For specific stakeholder engagement in relation to this EP, see **Section 5**.

3.6.10 Company Values

Woodside is committed to sustainability and a robust environmental risk management approach. Credible science, transparency, strong partnerships, robust impact assessment and risk management are key elements of Woodside's approach to the environment. Woodside seeks to manage the health, safety and environment risks and impacts of its activities to as low as reasonably practicable.

Woodside seeks to build relationships with stakeholders who are interested in and affected by our activities and also to leave a positive legacy for the community where practicable to do so.

3.6.11 Comparison of Options Summary

Good practice for the RTM decommissioning supports evaluation on a case by case basis, and that onshore disposal or offshore disposal or repurposing may be acceptable. There are no relevant codes and standards for the evaluation of decommissioning options.

The engineering risk assessment determined that the key differentiators between the options and their ability to meet the associated decommissioning objective (onshore disposal/ offshore disposal/

offshore repurposing) and achieve an ALARP outcome are safety risk, execution risks and schedule. Environmental risks associated with all options are similar (slightly lower for offshore repurposing or disposal) and environmental impacts of offshore disposal or repurposing are slight and there is potential for an environmental benefit with an IAR. Company values and societal values are primarily relevant to offshore disposal and repurposing. Each option is discussed further below.

Table 3-7: Summary of not complete removal from permit area

Option	Strengths	Weaknesses	Conclusion
Option 1 – Offshore disposal Infield (within permit area)	+Technically feasible and limited/no towing required	-Doesn't meet guidelines for sea dumping permit due to water depth -Not expected to receive stakeholder support	Not recommended as does not meet guidelines for preferred sea dumping location and is not expected to receive stakeholder support.

Disposal in the permit area is not recommended as it does not meet the guidelines for a preferred sea dumping location and is not expected to receive stakeholder support.

Table 3-8: Summary of complete removal from permit area and onshore disposal

Option	Strengths	Weaknesses	Conclusion
Option 2a - Repair, ballast to horizontal and tow	+Achieves original project plan	-Large number of personnel transfers with associated high safety risks -Additional safety risks associated with dropped objects and vessel collision and onshore de-construction -Risk of repair failure in field or during tow -Ability to complete scope in weather window (Jan-April) -Approximately 2000km tow -Risk of loss of control of RTM during tow -Risk of inadvertent sinking of RTM during tow in high vessel traffic area. -Availability of onshore disposal location	Not recommended due to likelihood of repair being unsuccessful, failing during tow or not able to be completed in weather window. In addition there are high safety risks associated with personnel transfers.
Option 2b - Repair, ballast to horizontal and utilise a Semisubmersible to dry-tow to shore for disposal	+Achieves original project plan +Dry Tow	-Nearest suitable location to execute float onto semisubmersible is 400km tow -Large number of personnel transfers with associated high safety risks -Additional safety risks associated with dropped objects, vessel collision and onshore de-construction -Risk of repair failure in field or during tow	Not recommended as there is only one potential suitable location to execute this option and the option still requires the RTM to be repaired, which is not recommended due to the likelihood of repair being unsuccessful, failing during tow or not being able to be completed during weather window. In addition, there are high safety risks associated with personnel transfers.

Option	Strengths	Weaknesses	Conclusion
		-Ability to complete scope in weather window (Jan-April)	
Option 2c - Ballast to semi-horizontal and utilise a transport HLV or HCV to lift onto a barge to dry tow to shore for disposal	+Achieves original project plan +Reduced number of personnel transfers versus Options 2a and 2b. +Dry Tow	-Unable to identify transport HLV with sufficient capacity to undertake lift -Alternative of HCV lift using either lifting trunnion installed topsides or applying tension to bottom tow padeye has risk of RTM structural failure or lifting point. -Complex vessel simultaneous operations -HCV with topsides lifting trunnion has complex topsides RTM installation scope with associated personnel safety risks -26-30 months schedule due to contracting, vessel availability, detailed engineering and meeting weather windows -Diving required for transport HLV option	Not recommended. Use of a HCV results in either a complex topsides lifting point installation scope with associated safety risks or use of the bottom tow padeye with risk of lifting point failure. Use of HCV also has risk of RTM structural failure due to out of plan lifting. Unable to identify transport HLV with sufficient crane capacity.
Option 2d - Ballast to semi-horizontal and tow to deepwater port	+Achieves original project plan +Does not require RTM repair or lifting in field	-No suitable port location with sufficient draft identified in study of South East Asian ports -Semi-horizontal tow	Not recommended as no suitable port location identified.

Onshore disposal is not recommended as there are a number of execution risks that impact the ability to successfully achieve onshore disposal as described above. In addition, onshore disposal does not manage safety and environmental risks to ALARP, as safety risks are significantly higher than for offshore disposal or repurposing and there is not a significant environmental impact reduction for onshore disposal. While these safety risks are tolerable and management measures could be put in place to mitigate these safety risks, based on the hierarchy of controls, elimination of the risk is preferred, which can be achieved by progressing offshore repurposing or disposal.

For repair and onshore disposal (Options 2a and 2b), there are number of high safety risks associated with repairing the RTM in order to upend for tow, including a high safety risk for a large number of personnel transfers, along with a number of other risks including diving, dropped objects and vessel collision. The high safety risk from personnel transfers for onshore disposal can be reduced by using an HLV to lift the RTM directly from the water without repairs (Option 2c), however this introduces new risks associated with diving, lifting and dropped objects and SIMOPS in the field. The options were investigated for Option 2c: eliminated diving was offset by increased risks associated with personnel transfers and confined work space on the RTM and complex out of design lifts. The option of not repairing or lifting the RTM and instead free flooding compartment 11 to achieve the minimum draft without repair (Option 2d) was also tested, however a port in South East Asia and as far away as South Korea, with sufficient draft to take the RTM was unable to be identified.

While different options and methods have been identified by Woodside, none have been able to reduce the safety risk levels of onshore disposal when compared offshore disposal or repurposing.

It should be noted that the risks associated with onshore disposal are increased from the original base case of onshore disposal as without the J-tube dislocation in compartment 2, the RTM would be able to be ballasted and towed with similar safety risks associated with removal from the permit area as described for offshore repurposing and disposal.

The key environmental risks associated with onshore disposal are vessel collision during site activities resulting in a spill to sea and inadvertent sinking of the RTM during field activities or the tow. All options have a risk of vessel collision resulting in a spill during offshore activities. While these risks are ranked the same as offshore repurposing and disposal, the risk is greater for onshore disposal due to a greater number of vessels and longer duration of activities.

Table 3-9: Summary of complete removal from permit area and offshore disposal or repurposing

Option	Strengths	Weaknesses	Conclusion
Option 3a - Offshore disposal into much deeper water (outside permit area)	+No repair or lifting required +Lower safety risks associated with personnel transfers, vessel operations and no onshore deconstruction +Target schedule able to achieve removal by April 2021; shorter field operations reduce schedule risk	-Execution risks associated with meeting acceptable contamination levels, finding a suitable location, stakeholder engagement regulator permit approval -Vertical tow -Offshore disposal (slight impact)	Recommended as potential contingency option to Option 3b.
Option 3b - Offshore repurposing (habitat augmentation as an integrated artificial reef)	+No repair or lifting required +Lower safety risks associated with personnel transfers, vessel operations and no onshore de-construction +Environmental/ community benefit associated with integrated artificial reef +Target schedule able to achieve removal by April 2021; shorter field operations reduce schedule risk	-Execution risks association with meeting acceptable contamination levels, finding a suitable location, stakeholder engagement, regulator permit approval -Vertical tow	Recommended – Lower execution and safety risks than onshore disposal with potential environmental and community benefit associated with integrated artificial reef. Initial consultation indicates that an IAR likely to be supported by community and fishing industry, however there is potential for opposition.

Offshore disposal has a lower safety risk when compared to onshore disposal due to the RTM not required to be repaired or lifted, and there are no onshore de-construction activities. Offshore disposal is aligned with applying the risk hierarchy of controls to safety risks as it eliminates a number of activities with high safety risk.

The key environmental risks associated with offshore disposal are vessel collision during site activities resulting in a spill to sea and sinking of the RTM during tow. The risks associated with the RTM during tow (i.e. loss of control or sinking) are lower because if either did occur it is likely to be in an area with lower vessel traffic and along a tow route selected to minimise environmental impact if sinking did occur (e.g. not through a marine park). The impact of offshore disposal or repurposing is assessed to be slight (E consequence), based on preliminary assessment of the RTM materials and given that the footprint of the RTM is small relative to the regional environment. There is also potential for an environmental benefit associated with an IAR (Option 3b).

The key execution risks associated with offshore disposal or repurposing are meeting acceptable material requirements, finding a suitable location and regulator approval of the required Artificial Reef Permit or Sea Dumping Permit. A preliminary assessment by Recfishwest indicates that the RTM is suitable and acceptable with appropriate control measures (eg. grouting foam in place).

Offshore repurposing into an artificial reef is approved practise in other locations due to the socio-economic benefits. In WA, $27.5 million was spent in the Gascoyne region on recreational fishing in 2015/16 and this brings both social and recreational benefits from recreational fishing. While the creation of an IAR has permit approval uncertainty, this option provides long term environmental benefit and is likely to be more favourable than deep water disposal. An IAR has also been successfully created in the Exmouth Gulf using petroleum infrastructure. Initial consultation indicates that an IAR is likely to be supported by community and fishing industry, however there is potential for opposition.

3.6.12 Recommendation

As a result of this assessment, offshore repurposing or disposal outside of the permit area is recommended, with a preference to pursue offshore repurposing as an IAR (Option 3b). The target timing for removal of the RTM from the permit area is during the next wet season (Jan 2020 to April 2021), however options to expedite this are being investigated.

As such, this EP covers the activities required to be undertaken within the permit area, and Woodside will seek a sea dumping permit for an IAR under the Artificial Reef application to the DoEE. This application will be undertaken as a separate process (under the Sea Dumping Act) and is not included in this EP.

It is noted here that the option to turn the RTM into an IAR is dependent on finding a suitable location, successful stakeholder engagement and gaining required regulatory approval. Should this be unsuccessful, the preferred alternative is deep water disposal. Woodside have consulted with the DoEE regarding the potential for a contingency plan for a sea dumping permit for the disposal of the RTM at sea in very deep water, if application for an IAR permit is not granted. If the application for an IAR is unsuccessful, an application for a deep water disposal will be undertaken. This will also be undertaken as a separate process and is not included in this EP.

Based on the assessment in this section (**Section 3.6**), it is concluded that the risks associated with removal of the RTM from the permit area and repurposed or deep water disposed are reduced to a level that is ALARP, and that this risk is acceptable.

In the interim the RTM will continue to stay in location with appropriate risk and impact mitigation and management measures in place (**Section 6**).

3.7 RTM Activities

3.7.1 RTM IMMR Activities

The frequency and type of IMMR activities undertaken will be in accordance with Lloyds Rules and Regulations for the Classification of a Floating Offshore Installation at a Fixed Location (Class rules). This will include:

- subsea inspection of the riser column and mooring legs
- topside structural inspection
- navigation aids check and maintenance.

With the FPSO off-station, RTM above waterline monitoring can be performed routinely in way of visual checks including the navigation lights.

The approximate frequencies and potential locations of inspection and maintenance activities planned during the Petroleum Activities Program are presented in **Table 3-10**. These have been developed based on experience and input from subject matter experts.

The last offshore in-water survey of the structure below waterline was undertaken in December 2018 during the CoP activities. Selective surveying of some of the mooring chains was completed at this time. The last 5-yearly inspection was completed in 2016 with the next 5-yearly in-water survey is due in 2021. The survey is planned to cover both the visual inspection of the RTM structure above/below the waterline and the mooring lines and anchors. To ensure that the mooring chains are in good condition and repair, additional inspections and engineering analysis including, but not limited to, in water surveys of the moorings including marine growth removal and inspection of load bearing areas may be undertaken prior to 2021.

The last visual inspection of the RTM topsides and navigation aids was undertaken in March 2019. This included addition of an extra navigation lighting system as redundancy to the existing system and installation of warning signage. No significant anomalies were identified. The next topsides and navigation aid inspection in planned in Q1 2020. In addition to this, visual checks are routinely conducted for the RTM navigation lights and passive reflective radar from the Ngujima Yin FPSO located approximately 8 km north-east of the RTM. This is also to check for submergence. Visual survey of the NGA RTM using a drone was also completed in November 2019.

Table 3-10: RTM IMMR activities and frequencies

Activity	Location	Description	Approximate Frequency
Offshore In-water Survey	RTM structure below waterline	Routine visual inspection of riser column and upper section of mooring legs using a support vessel and ROV (as required)	2.5-yearly
Offshore In-water Survey	Mooring lines and anchors	Routine visual inspection of riser column and mooring legs using a support vessel and ROV (as required)	5-yearly
Visual Inspection	RTM topsides	Routine visual inspection of topsides structure and appurtenances	Annual
Testing	Navigation aids	Routine testing of the navigation aids	Annual
Submergence and Navigation Aids Check	RTM above waterline and navigation aids	Routine confirmation of submergence of RTM and navigation aids are operational	1 weekly
Visual Inspection	RTM and navigation aids	For-cause inspection, e.g. following a cyclone, or in the event of navigation light failure etc.	As required

3.7.2 RTM Removal

The RTM will be prepared for removal. This will include, but is not limited to, removal of life-rings, navigation lights, and wiring. Once complete, a PIV together with anchor handling vessels equipped with Remotely Operated Vehicles (ROV) will be used to complete the scope to disconnect the RTM from its anchor chains. The RTM will then be towed from the Operational Area.

3.7.3 As Left Status

The disconnected anchor lines and anchors will be left in situ and laid down on the seabed for future field decommissioning.

3.8 Subsea IMMR Activities

3.8.1 Overview

Subsea infrastructure has been designed and left in a state of preservation that will not require any significant degree of intervention. However, IMMR is undertaken to ensure the integrity of the infrastructure for future decommissioning and to identify and respond to any problems before they present a risk of loss of containment. IMMR activities are typically undertaken from a diving support vessel (DSV) or installation support vessel (ISV) via ROV and/or divers.

IMMR activities often require deployment frames/baskets which are temporarily placed on the seabed. These frames/baskets typically have a perforated base with a seabed footprint of approximately 15 m^2. The frames/baskets are recovered to the vessel at the end of the activity.

3.8.2 Frequencies

The frequency and type of IMMR activities will be subject to a risk-based inspection (RBI) program. The RBI program is undertaken by subject matter experts to determine what future activities are required and at what frequency. Frequencies are designed to suit the isolated and shut-in condition of the wells and flushed condition of the flowlines, risers, and structures. With the FPSO off-station, online monitoring of the subsea system is redundant and therefore condition monitoring is reduced to visual inspections.

It is not possible to precisely determine timing, frequency and location of inspection and maintenance activities during the preservation period, however, all work is planned to be immediately adjacent to subsea infrastructure and in typically short-duration scopes. Based on experience and input from subject matter experts, the approximate frequencies and potential locations of inspection and maintenance activities planned during the Petroleum Activities Program are presented in **Table 3-11**. Inspection and maintenance activities and frequency are subject to RBI evaluation and assessment.

Subsea well inspection will be managed under the accepted WOMP which outlines the approach to inspection and maintenance activities to verify the ongoing integrity of the wells. An ongoing risk-based process is prescribed under the WOMP. This process involves assessment of inspection data, used to re-evaluate risks and define inspection frequencies and if maintenance or repair is required.

Table 3-11: Subsea IMMR activities and frequencies

Activity	Location	Description	Approximate Frequency
Visual inspection	Subsea wells	Routine visual inspection of subsea wells undertaken using a support vessel and ROV (as required).	Five-yearly
Pressure testing	Subsea infrastructure	Within the scope of this EP, pressure testing is unlikely to be required other than for isolation verification following an event requiring intrusive intervention to rectify.	Five-yearly
Marine growth removal	Subsea infrastructure Subsea wells	It may be necessary to remove excess marine growth prior to undertaking subsea inspections; RTM external hull and mooring system inspections; and maintenance activities (**Section 3.8**).	Five-yearly
Sediment relocation	Subsea infrastructure	If sediment builds up around a flowline or other subsea infrastructure, an ROV-mounted suction pump/dredging unit may be used to relocate sediment to allow inspection/intervention works to be undertaken.	Five-yearly

Activity	Location	Description	Approximate Frequency
Subsea intervention	Subsea infrastructure	Within the scope of this EP, an intervention would only be required to rectify/repair an anomaly or event that has occurred or where proactive intervention for equipment recovery is required for analysis.	Five-yearly
Corrosion Surveys	Subsea infrastructure	Surveys are undertaken using probes (e.g. electrical resistance probes) to assess the effectiveness of corrosion protection (e.g. corrosion protection layers or anode skids).	Five-yearly
Tree cap replacement	Subsea infrastructure	Not required in this EP unless an inspection found an anomaly or point of concern.	-
Repair	Subsea infrastructure Subsea wells	Repair activities are those required when a subsea system or component is degraded, damaged or has deteriorated to a level outside of acceptance limits. Damage sustained may not necessarily pose an immediate threat to continued system integrity, but presents an elevated level of risk to safety, and environment. Subsea repair activities are not anticipated during the Petroleum Activities Program as the wells have been shut in and the subsea system preserved, however, if required to prepare for well intervention or future activities such as permanent plugging for abandonment or decommissioning, repairs may be undertaken.	-

3.8.3 Management of IMMR Activities

All planned IMMR activities are completed using a defined framework and process, used to understand the potential environmental impact and if additional regulatory approvals are required. Project information is used to determine if further assessment is required. For projects that have the potential for environmental impact, an assessment is undertaken against this EP and other Woodside environmental requirements. If determined, an EP Management of Change (MoC) review (**Section 7.6**) may be triggered to confirm if the level of environmental risk warrants revision and resubmission of an EP.

3.8.4 Subsea Chemical Usage

Planned chemical discharges may occur during IMMR activities. However, these are discharged in small volumes (**Table 3-12**). Operational chemicals that may be used on the Enfield subsea infrastructure are selected and assessed using Woodside's chemical selection and assessment procedures, as detailed in **Section 3.13**. Chemicals used in the subsea infrastructure may be released during IMMR activities; these include, but are not limited to:

- control fluid – a water-glycol based control fluid. The subsea control system is an open-loop system that releases hydraulic fluid during valve functioning
- hydrate control – monoethylene glycol (MEG) and triethylene glycol (TEG) are used for hydrate control
- scale inhibitor – scale inhibitor manages and prevents scale build-up within subsea equipment
- biocide – biocides prevent bacterial growth in flowlines and risers that may cause corrosion
- dye – chemical dyes incorporated in the control fluid identify the source of a leak
- acid – sulphamic (or equivalent) acid removes calcium deposits

- oxygen scavenger – oxygen scavenger de-oxygenates the pipeline to prevent corrosion and aerobic bacterial growth
- grout – the material used in grout, mattresses, and rock is typically concrete-based.

Table 3-12: Typical discharge volumes during different IMMR activities

Activity	Typical Discharge
Pressure/leak testing	Chemical dye incorporated into control fluid at ≤1%
Valve functioning	0.5 L to 6 L per valve actuation
Flushing	Residual hydrocarbon or chemical releases volume depends on injection port size, component geometry, and pumping rates
Hot stab change out	Hydrocarbons or control fluid <10 L
Subsea control module changeout	A typical release of acid is estimated to be 400 L and of control fluid is estimated to be 10 L
Jumper and umbilical replacement	Typical releases of hydraulic fluid, MEG, and corrosion inhibitor are estimated to be <10 L each
Choke change out	Release of hydrocarbons <10 L and a typical release of MEG is estimated to be 280 L
Spools repair, replacement, and recovery	Typical release of hydrocarbon or other chemicals depends on equipment configuration and flushing ability. This will be subject to an ALARP determination for the activity, as per normal practice.

3.9 Well Intervention

During the preservation period, several wells may be intervened on prior to undertaking permanent abandonment activities at a later date, as subject to a subsequent EP. The decision on whether a well is intervened on will be based on the availability of a MODU or intervention vessel of opportunity. There is no well integrity driver for intervention on any wells. Any intervention activities that may be undertaken would be opportunistic (e.g. a contracted rig/vessel on standby), to setup for a more cost-effective and efficient well abandonment program at a later time. For example, intervention to set additional barriers such as deep-set temporary plugs may open up subsequent final decommissioning/abandonment scope to a wider range of vessels/rigs.

Well intervention involves re-establishing barriers via a MODU or intervention vessel. During well intervention, barriers will be established via the installation of wireline plugs, cement plugs, or a combination of both. The operations will be conducted through a blow-out preventer (BOP) and marine riser or subsea lubricator. The installation of the barriers will require killing the well using kill weight brine and corrosion inhibitors. Production tubing may be cut and recovered to surface to allow the placement of barriers. The casing strings and wellhead will be left in place for future final abandonment. The tubing and annulus fluids will either be re-injected downhole, taken back to the mainland for processing and disposal or treated and disposed of overboard.

3.9.1 Well Intervention Fluids

3.9.1.1 Cement

Cementing operations may be undertaken to either suspend or temporarily plug selected wells. Cementing fluids will generally consist of Portland cement with additives (such as inorganic salts, lignins, bentonite, barite, defoamers and surfactants). Cementing fluids are not routinely discharged to the marine environment, however, volumes of approximately 2 m^3 per well will be released when surplus fluids require disposal after cementing operations at the surface. Cement spacers can be used as part of the cementing process within the well casing to assist with cleaning of the casing sections prior to cement flow-through. The spacers may consist of either seawater or a mixture of seawater and suitable dye. The dye is used to provide a pre-indicator of cement overflow to the seabed surface, to ensure adequate cement height. Such a solution is typically used in turbid or strong current conditions where cement overflow from the casing to the seabed is not visually obvious.

Excess cement may be held on board for use on subsequent wells, provided to the next operator at the end of the well intervention program or, is infrequently discharged to the marine environment below the sea surface, if it does not meet technical requirements as a result of contamination.

3.9.1.2 Well Fluids

Production wells may have residual hydrocarbons in the well and there is the potential that the well intervention fluids will become contaminated with hydrocarbons. If hydrocarbon contamination of the well intervention fluids has occurred, treatment of the fluid will occur on the MODU/intervention vessel, to ensure hydrocarbon content prior to discharge is 1% by volume, or less.

3.9.1.3 BOP Control Fluids

The BOP is required to be regularly function tested when on the well, as defined by legislative requirements. The BOP is also function tested during assembly and maintenance. As part of the testing process, when subsea, 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 hydraulic control fluid used for the operation of the BOP rams is likely to be similar to StackMagic (commercial name), which is fully biodegradable. Approximately 300 to 350 litres of the base chemical diluted in water (at 2% maximum) may be discharged to the marine environment during well intervention.

3.9.1.4 Chemical Use and Discharges

Interventions typically involve the use and discharge of chemicals which may include, but are not limited to:

- glycol
- high viscous (hi-vis) polymer pills or sweeps
- surfactant and/or solvent pills or sweeps
- fluid loss control (FLC) and/or lost circulation material (LCM) pills
- seawater, raw or inhibited with any combinations including biocide, oxygen scavenger, caustic or soda ash
- brine, KCl/NaCl, raw or inhibited with any combinations including biocide, oxygen scavenger, caustic or soda ash
- cementing fluids and cement spacers of seawater and dye
- small quantities of BOP control fluid.

3.9.2 Unplanned Activities

3.9.2.1 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 the movement of the MODU outside of its operating circle (e.g. failure of one or more of the moorings) or the movement of the MODU to avoid a vessel collision (e.g. third-party vessel on collision course with the MODU). EDS aims to leave the wellhead in a secure condition, but will result in the loss of the fluids in the riser following disconnection.

3.10 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 following section and will include:

- A dynamically positioned (DP) PIV supported by two DP support vessels will be used to disconnect the RTM from the anchor chains and remove it from the Operational Area.
- Support vessels may be used to undertake IMMR activities for preservation, as well as to support RTM removal or well intervention activities.
- A DP intervention vessel may be used for operations to install temporary plugs into wells to support a more cost effective and efficient abandonment program.
- A MODU may be used for well intervention activities depending on availability and suitability for the well location (e.g. water depth). In this EP, the term MODU refers to any mobile offshore drilling unit; options include a semi-submersible moored MODU, DP drillship or DP MODU. All MODU options are risk-assessed and managed under this EP.
- Support vessels including
  - Anchor Handling Vessels (AHVs) required to set anchors and support the intervention vessel and/or MODU during operations
  - Activity Support Vessels for transporting hardware from port/staging area to the Operational Area, and for general re-supply and support for the PIV, intervention vessel or MODU and support vessels.

All project vessels (MODU, intervention vessel, PIV and support vessels), which have not yet been confirmed, 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 include 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 6**. Some support vessels may be required on an ad-hoc basis 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.

3.10.1 Primary Installation Vessel

The Petroleum Activities Program will require a PIV to support for the RTM removal scope, including disconnection of the RTM from its anchor chains, and towing the RTM from the Operational Area. A PIV is yet to be assigned, however, the vessel is likely to have similar specifications to that referenced above in **Section 3.10**

3.10.2 MODU

The Petroleum Activities Program may utilise a MODU instead of or as well as an Intervention Vessel. This may be a moored or DP semi-submersible MODU or drill ship. Typical specifications for these MODU types are provided in **Table 3-13** and **Table 3-14** respectively. These are collectively referred to as MODU for the remainder of the document, unless specific risks for different MODU types have been identified.

Table 3-13: Typical DP MODU specifications

Component	Specification Range
Rig Type/Design/Class	Ultra deepwater semi-submersible MODU
Accommodation	200 persons (maximum persons on board)
Station Keeping	Dynamically positioned
Bulk Mud and Cement Storage Capacity	1000 m^3
Liquid Mud Storage Capacity	2663 m^3
Fuel Oil Storage Capacity	3640 m^3
Drill Water Storage Capacity	3482 m^3

Table 3-14: Typical moored MODU specifications

Component	Specification Range
Rig Type/Design/Class	Semi-submersible MODU
Accommodation	120 to 200 persons (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

3.10.3 Intervention Vessel

The intervention vessel has not been assigned but is likely to have similar specifications to that detailed in **Table 3-15**.

A typical intervention vessel will be a dynamically positioned vessel (DP2 Class) equipped with a primary differential global positioning system (DGPS) and an independent secondary DGPS backup system.

Table 3-15: Specifications for *typical intervention vessel*

Particulars	
Type	DP2 class as a minimum
Draft	Approximately 6.9 m
Dead weight tonnage	Approximately 6500 mt
Accommodation	Approximately 120 personnel
Capacities	
Fuel	Approximately 1000 – 2200 m^2
Potable water	Approximately 800 – 1200 m^3
Lube oil	Approximately 35 m^2

Deck area	Approximately 1300 to 1900 m^2

3.10.4 Support and Other Vessels

During the Petroleum Activities Program, the PIV and MODU/intervention vessel will be supported by other vessels, such as anchor handling and support vessels. Support vessels are required for activities such as transport equipment and materials from port to the PIV or MODU/intervention vessel, and re-supply and support the PIV and the MODU/intervention vessel, during the Petroleum Activities Program.

Support vessels will not anchor within the Operational Area during the activities due to water depth; instead the vessels use DP systems.

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

3.10.5 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.

3.11 Project Vessel Support Based Activities

A variety of materials are routinely bulk transferred from support vessels to the PIV and MODU/intervention vessels including equipment, well intervention fluids and cements. A range of 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 well intervention fluids and waste oil to the support vessel, for back loading and disposal on shore.

The loading and back-loading of equipment, materials and wastes will be one of the most common supporting activities conducted during the Petroleum Activities Program. Loading and back-loading is undertaken using cranes to lift materials in appropriate offshore rated containers (ISO tanks, skip bins, containers) to a support vessel.

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

The vessels will also discharge deck drainage from open drainage areas, bilge water from closed drainage areas, putrescible waste and treated sewage and grey water. Hazardous and non-hazardous waste generated are removed from the vessels and disposed of on shore.

3.11.1 Refuelling

The PIV and MODU/intervention vessels will utilise diesel-powered generators for power generation and will be refuelled via support vessels, approximately weekly during activities. This activity will take place within the Operational Area of the Petroleum Activities Program and has been included in the risk assessment for this EP. Other fuel transfers that may occur on board the PIV and MODU/intervention vessels include refuelling of cranes, helicopters or other equipment as required (**Section 3.10**).

3.11.2 Mooring Installation and Anchor Holding Testing

MODU mooring uses a system of chains/ropes and anchors, which may be pre-laid before the MODU arrives at the location, to maintain position during intervention activities. A mooring analysis will be undertaken to determine the appropriate mooring system for the Petroleum Activities

Program. The mooring analysis will identify whether the mooring system be pre-laid, proof tension values, or using synthetic fibre mooring ropes are appropriate. A pre-laid system can withstand higher sea states, to account for loads associated with cyclones if operations were to occur during cyclone season.

Installation and proof tensioning of anchors involves some disturbance to the seabed. Anchor handling vessels (AHV) are used in the deployment and recovery of the mooring system.

As part of mooring preparations, anchor holding testing may be conducted at the well locations. Anchor holding testing would be undertaken if Woodside decides that further assurance is required to ensure a robust mooring design.

Anchor holding 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 location. This may have to be repeated several times at each location. A ROV may also be utilised to judge how deep the anchor has embedded and independently verify the seabed condition. Anchor holding testing activities would occur prior to the MODU arriving on location.

Suction piling may be required and will be reviewed with the MODU contractor.

In addition, tethers may be required for maintaining BOP stability on the X-mas tree. The tethers would also require anchors, that may be pre-laid or installed at the time of BOP connection.

3.11.3 Holding Station: Dynamic Positioning

DP uses satellite navigation and radio transponders in conjunction with thrusters to maintain position at the required location. Information about the position of the project or support vessel is provided via a number of seabed transponders, which emit signals that are detected by receivers on the vessel and used to calculate position. The transponders are typically deployed in an array on the seabed, using clump weights comprising concrete, for the duration of well intervention at each well, and are recovered at the end, generally by ROV. Clump weights are recovered if practicable to do so or may be left in situ.

3.11.4 Holding Station: Mooring Installation and Anchor Hold Testing

Mooring uses a system of chains/ropes and anchors, which may be pre-laid before the Intervention Vessel or MODU arrives at the location, to maintain position during well intervention activities. 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 Intervention Vessel/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 activities would occur before the Intervention Vessel and/or MODU arrives on location.

3.12 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 of the PIV and MODU/intervention vessel. 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.

3.13 Assessment of Project Fluids

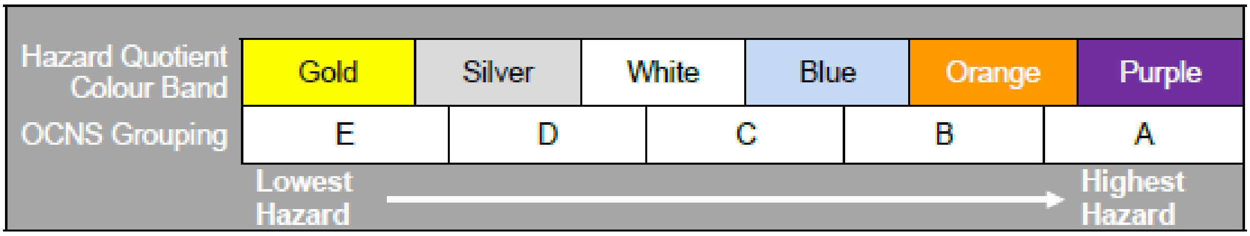
All chemicals that may be operationally released or discharged to the marine environment by the Petroleum Activities Program were evaluated using a defined framework and set of tools to ensure the potential impacts are acceptable, ALARP and meet Woodside's expectation for environmental performance.

All approved drilling and completion chemicals (including well intervention fluids) 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 **Figure 3-6**):

- **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.



Hazard Quotient Colour Band	Gold	Silver	White	Blue	Orange	Purple
OCNS Grouping	E	D	C	B	A	

Figure 3-6: 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.

3.13.1 Further Assessment/ALARP Justification

This includes assessment of the ecotoxicity, biodegradation and bioaccumulation of the chemicals in the marine environment in accordance with the Environment, Fisheries and Aquaculture Science (CEFAS) Hazard assessment and the Department of Mines and Petroleum (DMP) Chemical

Assessment Guide: *Environmental Risk Assessment of Chemicals used in WA Petroleum Activities Guideline*.

Alternatives

If no environmental data are available for a chemical or if the environmental data do not meet the acceptability criteria outlined below, potential alternatives for the chemical will be investigated, with preference for options with an HQ band of Gold or Silver, or are 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.

3.13.1.1 Ecotoxicity

Chemical ecotoxicity is assessed using the criteria used by CEFAS to group chemicals based on ecotoxicity results (**Table 3-16**). 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 3-16: 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 LC50 and Scophthalmus maximus (juvenile turbot) LC50 toxicity tests; sediment toxicity refers to Corophium volutator LC50 test.

3.13.1.2 Biodegradation

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

CEFAS categories 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 an OSPAR HOCNF accepted ready biodegradation protocol are considered acceptable in terms of biodegradation.

3.13.1.3 Bioaccumulation

The bioaccumulation of chemicals is assessed using the CEFAS bioaccumulation criteria, which align with the categorisation outlined in the Environmental Risk Assessment of Chemicals used in WA Petroleum Activities Guideline (DMP 2013). Bioaccumulation is determined by calculating the partitioning of the substances between water and n-octanol (LogPow) or experimentally in a full bioconcentration test utilising either fish or a bivalve mollusc (OECD 305 and ASTM E1022) to give an Experimental Bioconcentration Factor (BCF).

The following guidance is used by CEFAS:

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

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

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

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

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 2.4.2** 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 purposes of the risk assessment.

For the purposes of this EP, Woodside has identified the EMBA by combining the potential spatial extent of surface and in-water (dissolved and entrained) hydrocarbons, resulting from a worst-case credible spill, or loss of well integrity. The EMBA also includes areas that are predicted to experience shore-line contact with hydrocarbons above threshold concentrations. Hydrocarbon exposure thresholds used to define the EMBA are outlined in **Table 4-1** and shown in **Figure 4-1**. The thresholds for the EMBA may result in ecological impacts from dissolved and entrained hydrocarbons.

It should be noted that the maps presented do not represent the predicted coverage of any one hydrocarbon spill or a depiction of a slick or plume at any particular instant in time. Rather, the contours are a composite of a large number of theoretical slick paths, integrated over the full duration of the simulations under variations metocean conditions.

Woodside recognises that hydrocarbons may be present beyond the EMBA at low concentrations that may be visible, but are not expected to cause ecological impacts. Surface oil may be visible beyond the EMBA to a concentration of approximately 1 g/m^2, and this may also result in socio-cultural impacts. Woodside has therefore used this as a threshold to define an additional boundary within which socio-cultural impacts to the visual amenity of the marine environment may occur. This additional area is referred to as the socio-cultural EMBA in this EP. Socio-cultural values described within this EMBA include the following:

- protected areas
- national and Commonwealth heritage listed places
- tourism and recreation
- fisheries.

Table 4-1: Hydrocarbon Spill Thresholds Used to Define EMBA for Surface and In-water Hydrocarbons

Hydrocarbon Type	**EMBA**[1]	**Socio-cultural EMBA**[1]
Surface	10 g/m^2 This represents the minimum oil thickness (0.01 mm) at which ecological impacts (e.g. to birds and marine mammals) are expected to occur.	1 g/m^2 This represents the area where a visible sheen may be present on the surface but is below concentrations at which ecological impacts are expected to occur.
Dissolved	50 ppb This is a highly conservative threshold given that the lowest ‘no effect concentration’ (NOEC) observed in Woodside’s ecotoxicity testing for Enfield Crude is 340 ppb (refer to **Section 6.7.1**).	
Entrained	100 ppb	

Hydrocarbon Type	EMBA[1]	Socio-cultural EMBA[1]
	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 6-7**). Entrained oil hydrocarbons are less biologically available to organisms through absorption into their tissues than dissolved oil hydrocarbons. Therefore, 100ppb is a highly conservative threshold given that the lowest 'no effect concentration' (NOEC) observed in Woodside's ecotoxicity testing for dissolved Enfield Crude is 340 ppb (refer to **Section 6.7.1**).	
Accumulated Shoreline	100 g/m^2 The threshold of accumulated hydrocarbons that could impact the survival and reproductive capacity of benthic epifaunal invertebrates living in intertidal habitat (refer to **Section 6.7.1**).	

[1] Further details including the source of the thresholds used to define the EMBA in this table are provided in **Section 6.7.1**.

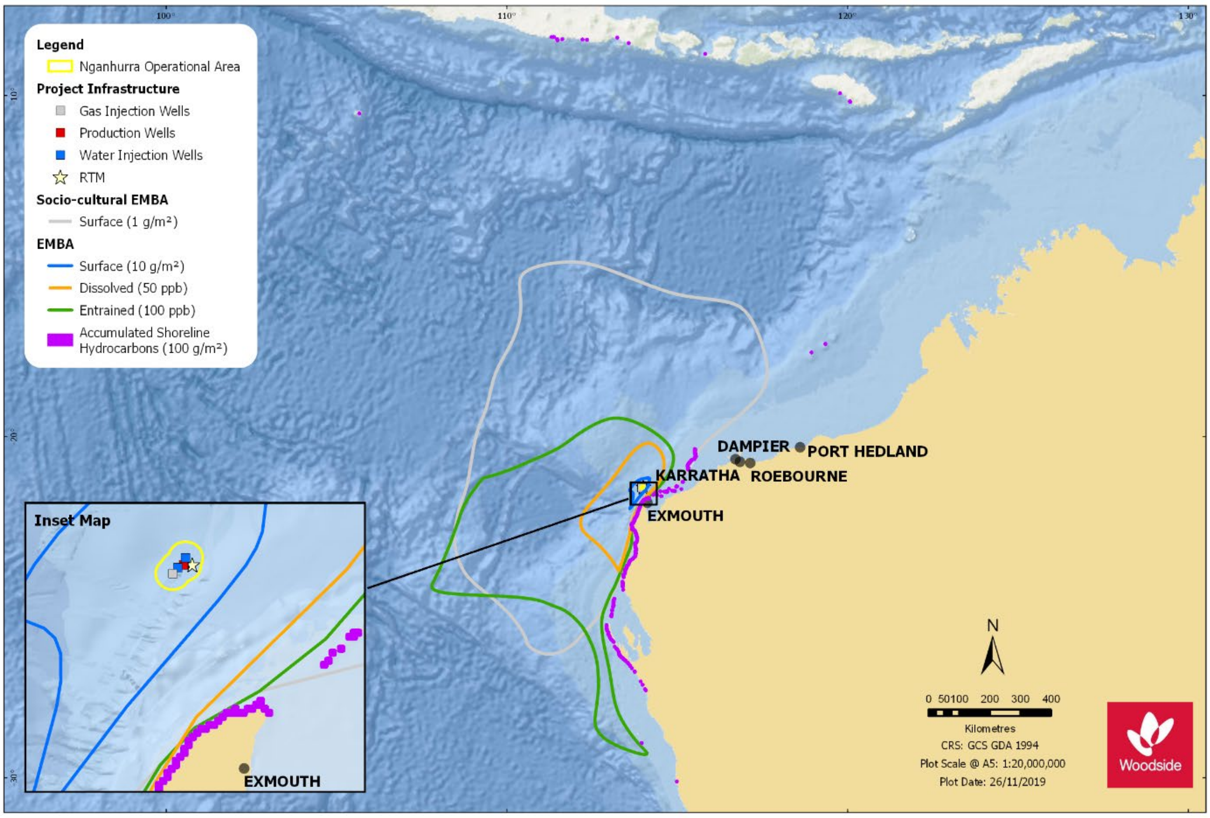


Figure 4-1: Operational Area, EMBA and Socio-cultural EMBA

4.2 Summary of Key Existing Environment Characteristics

A summary of the key existing environment characteristics, in line 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 4-2**. The key existing environment characteristics, in **Table 4-2**, are described in terms of the Operational Area and EMBA (refer to **Section 6.7.1**).

Table 4-2: Summary of key existing environment characteristics

	Sensitive Receptor	EP Section	Description
Physical Environment	***Climate and Meteorology***	4.4.1	***Operational Area and EMBA:*** • tropical monsoon climate with hot summers and mild winters • most rainfall occurs during late summer and autumn • seasonal wind patterns with south-westerly winds characterising summer months and easterly winds characterising winter. Winds during transition period between seasons typically more variable • tropical cyclones regularly occur in the region during summer period.
	Oceanography	4.4.2	***Operational Area:*** • geostrophic flow characterised by the southward flowing Leeuwin Current, which strengthens in winter and weakens in summer • tidal currents influence water movements • locally generated wind surface currents are superimposed on geostrophic and tidal currents • water quality is expected to reflect the offshore oceanic conditions of the Northwest Province and wider region • surface water temperatures are relatively warm, ranging seasonally from approximately 22 to 28 °C; water temperature ranging from 12 to 14 °C at the seabed • offshore waters are expected to be of high quality given the distance from shore and lack of terrigenous inputs. ***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 North West Shelf (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 continental shelf • other areas of localised upwelling in the NWMR include the 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	4.4.3	***Operational Area:*** • located in waters approximately 400–600 m deep along the outer continental shelf • the seabed in the Operational Area contains the Enfield Canyon, which is a part of the Key Ecological Feature (KEF): Canyons linking the Cuvier Abyssal Plain and Cape Range Peninsula • the seabed is relatively flat and featureless, although the subsea infrastructure in the western portion of the Operational Area overlaps the Enfield Escarpment ***EMBA:*** • the NWS has a number of topographic seabed features including submerged banks, shoals and valleys, including Rankin Bank • the bathymetry of the EMBA 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 • numerous Key Ecological Features associated with bathymetric features in the EMBA.
	Marine Sediment	4.4.4	***Operational Area:*** • comprises sand, silt, clays and fines. ***EMBA:*** • sediment character changes with depth and distance from shore, with sediments becoming progressively finer with increasing depth and distance, particularly beyond continental shelf break.
	Air Quality	4.4.5	There are limited air quality data for the Northwest Province. However, ambient air quality in the Operational Area and EMBA is expected to be of high quality.
Habitats	***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 the Operational Area or EMBA.
	Marine Primary Producers	4.5.1	Given the water depth, benthic primary producers will not occur within the Operational Area. *Coral Reefs* ***EMBA:*** • waters of the Ningaloo Coast World Heritage Area (WHA) are the nearest coral reef habitat • other coral reef habitats include the Muiron Islands Marine Management Area, and the Houtman Abrolhos islands Australian Marine Park. *Seagrass Beds/Macroalgae* ***EMBA:***

	Sensitive Receptor	EP Section	Description
			• nearest seagrass/macroalgae habitat is widely distributed in coastal waters that receive sufficient light to support seagrass and macroalgae. _Mangroves_ ***EMBA:*** Broadly distributed in protected coastlines throughout the EMBA.
	Lifecycle Stages 'Critical' Habitats and Migration Corridors	4.5.1	Refer to Biologically Important Areas (BIAs) and species descriptions.
	Other Communities/ Habitats	4.5.1	The Operational Area encompasses continental slope habitat in water depths ranging from approximately 400 to 600 m water depth. Benthic habitats in the Operational Area, which host filter feeding and infauna communities, lie well beyond the photic zone and do not host benthic primary producers. Water temperatures at these depths are relatively cool and stable compared to surface waters. _Plankton_ ***Operational Area:*** • plankton communities in the Operational Area are likely to reflect the broader Northwest Province. ***EMBA:*** • offshore phytoplankton communities in the Northwest Province are characterised by smaller taxa (e.g. bacteria), while shelf waters are dominated by larger taxa (e.g. diatoms) • peak primary productivity along the shelf edge of the Ningaloo Reef occurs in late summer/early autumn. _Pelagic and Demersal Fish Populations_ ***Operational Area:*** • fish communities in the Operational Area comprise small and large pelagic fish species, as well as demersal species, typical of deep water habitat • demersal fish biodiversity correlates with habitat complexity, with more complex habitat supporting greater species richness and abundance compared to bare areas • the Continental Slope Demersal Fish Communities KEF overlaps the Operational Area (refer to **Section 4.7.7**). ***EMBA:*** • key demersal fish biodiversity areas are likely to occur in other complex habitats, e.g. coral reefs • relatively complex habitats (e.g. reefs) support high demersal fish richness and abundance. _Filter Feeders_ ***Operational Area:*** • filter feeders are generally located in areas with strong currents and hard substratum, and may occur in the Operational Area, however, there are no known significant filter feeder communities • biological survey of Enfield canyon identified sparse filter feeder community comprising cnidarians, echinoderms and sponges, consistent with communities in the broader region. ***EMBA:*** • the NWMR has been identified as a sponge diversity hotspot with a high variety of biodiverse areas, particularly in the Ningaloo Marine Park • filter feeder communities are primarily located in the deeper waters of the Ningaloo Reef system as well as the Muiron Islands and nearshore waters of the Pilbara Islands • deeper habitat areas of the NWMR are likely to support filter feeding communities. _Benthic Communities_ Sparse assemblage of deposit feeding (mobile epifauna typical of deep water habitats) fauna recorded in the Operational Area, which included holothurians and crustaceans (e.g. shrimp). The deep water infauna communities in the Operational Area are expected to be low abundance, highly variable and diverse. Infauna communities in the adjacent upper slopes and continental shelf are considered typical of the Northwest Province and widely represented in the EMBA.
Protected Species	***Biologically Important Areas (BIAs)***	4.5.2	***Operational Area:*** • humpback whale migration (annual seasonal migration with their presence during peak periods in the Exmouth region between June–August (northbound migration) and August–October, following closer to the WA coastline (southbound migration)) • pygmy blue whale migration (annual seasonal migration with peak numbers passing Exmouth region towards Indonesia between April–August (northerly migration)) and their southerly return passing North West Cape (late November–December) • foraging area for the wedge-tailed shearwater during its breeding season (August–April). ***EMBA:*** • Large number of BIAs within EMBA, refer to **Section 4.5.2** for additional information.
	Marine Mammals	4.5.2	***Operational Area:***

Sensitive Receptor	EP Section	Description
		• Blue whale – 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 overlaps pygmy blue whale migration corridor BIA (between the 500 and 1000 m depth contours), it is expected that individuals may transit the Operational Area during their northbound and southbound migration. • Humpback whale – humpback whales may transit through the Operational Area during their northbound and southbound migrations (generally in depths <500 m with the greatest density in water depths of 200–300 m), likely between July and September (including northbound and southbound migration). • Antarctic minke whale – migrates up to 20 °S for feed and possible breed. Unlikely to occur within Operational Area, but may occur in EMBA. • Sei whale – there are no known key aggregation areas (resting, breeding or feeding) located within or immediately adjacent to the Operational Area. Migration corridor between Antarctic feeding areas and tropical breeding areas. • Bryde's whale – tropical and temperate waters, with inshore and offshore morphologies/populations. May be seasonally present between December and June. • Fin whale – there are no known key aggregation areas (resting, breeding or feeding) located within or immediately adjacent to the Operational Area. • Southern right whale – unlikely to occur in Operational Area, may occur in southern extent of EMBA. • Killer whale, orca – no recognised key localities, expected to rarely occur. • Sperm whale – unlikely to occur in Operational Area due to preference for oceanic waters. • Spotted bottlenose dolphin (Arafura/Timor Sea populations) – unlikely to occur in the Operational Area due preference for shallow coastal waters. ***EMBA:*** • a range of migratory cetacean species occur, including several dolphin species, the pygmy right whale • resident coastal populations of small cetacean species, the Indo-pacific humpback dolphin • dugong known to occur in tropical coastal environments where seagrasses occur, including Ningaloo Marine Park and Shark Bay • Australian sealions known to occur at Abrolhos Islands.
Marine Turtles	4.5.2	***Operational Area:*** • The Operational Area does not contain any known Habitat Critical to the Survival of a Species or BIAs for any species of marine turtle. • Presence of the five species of Threatened marine turtles (loggerhead, green, leatherback, hawksbill and flatback) within the Operational Area is likely to be infrequent and limited to individuals or small numbers transiting as they seasonally move in and out of key foraging, internesting and nesting locations. ***EMBA:*** • Green, loggerhead, flatback and hawksbill turtles have significant nesting rookeries on beaches along the Ningaloo coast, Montebello/Barrow/Lowendal Islands Group and the Muiron Islands. Leatherback turtles may occur within the EMBA but there are no known nesting beaches in Western Australia. • Marine turtles may forage in shallow waters on the continental shelf.
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. • The short-nosed seasnake was identified by the EPBC Act Protected Matters Search Tool as potentially occurring within the Operational Area. ***EMBA:*** • Seasnakes frequent the waters of the continental shelf and around offshore islands.
Fishes and Elasmobranchs	4.5.2	***Operational Area:*** • The EPBC Act Protected Matters Search Tool identified five species of Threatened and/or Migratory fishes and elasmobranchs (great white shark, narrow sawfish, shortfin mako, longfin mako and giant manta ray) that may occur in the Operational Area. • The Operational Area does not contain any known critical habitat for any species of shark or ray. • The presence of EPBC Act listed sharks and rays is likely to be infrequent and limited to individuals or small numbers transiting through the area. ***EMBA:*** • Whale sharks are known to aggregate annually, from March to July, in areas off Ningaloo and North West Cape. After the aggregation period, the distribution of the whale sharks is largely unknown but surveys suggest that the group disperses widely and up to 1800 km away to areas in Indonesia, Christmas Island and Coral Sea. • Ningaloo Reef is an important area for giant and reef manta rays in autumn and winter, and they are known to occur in tropical waters throughout the EMBA. • Grey nurse sharks are likely to be found in shallow waters of the EMBA. • Great white sharks, shortfin makos and longfin makos are all known to occur within the EMBA. • Dwarf and green sawfish may be found within the EMBA, traversing from coastal mainland waters along the mainland Pilbara. • Porbeagle shark may occur in temperate waters in southern portion of EMBA.

	Sensitive Receptor	EP Section	Description
	Birds	4.5.2	***Operational Area:*** • Thirteen species of Threatened and/or Migratory bird species (red knot, common noddy, curlew sandpiper, lesser frigate bird, common sandpiper, southern giant-petrel, sharp-tailed sandpiper, pectoral sandpiper, eastern curlew, osprey, soft plumaged petrel, fresh-footed shearwater and Australian fairy tern) were identified in the EPBC Act Protective Matters Search as potentially occurring within the Operational Area. No critical habitat associated with these species has been identified for the Operational Area. • A BIA for wedge-tailed shearwater, during their breeding season, overlaps the Operational Area. ***EMBA:*** • There are several biologically important areas (key breeding/nesting, roosting, foraging and resting areas) for seabirds and migratory shorebirds in the EMBA, including areas on the islands of the Ningaloo Coast, Muiron Islands, Montebello/Barrow/Lowendal Islands group, Rowley Shoals, Abrolhos and Pilbara Islands.
Socio-economic	***Cultural Heritage***	4.6.1	***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. ***EMBA:*** • Barrow Island, Montebello Islands, Ningaloo Reef and the adjacent foreshore contain numerous registered Indigenous heritage sites (based on results from Department of Aboriginal Affairs (DAA) searches, **Appendix G**). • The closest historic shipwrecks to the Operational Area are the *Beatrice* and the *Gem*, both approximately 9 km south of the Operational Area. • National Heritage listed and proposed places within the EMBA include the Ningaloo Coast. • Commonwealth Heritage listed places within the EMBA include the Ningaloo Marine Area – Commonwealth Waters. • World Heritage Areas within the EMBA include the Ningaloo Coast World Heritage Area and Shark Bay World Heritage Area.
	Ramsar Wetlands	4.6.2	No Ramsar wetlands in Operational Area or EMBA.
	Fisheries – Commercial	4.6.3	***Operational Area:*** There are a number of Commonwealth and State fisheries designated management areas, however, only the Pilbara Line Fishery and West Australian Mackerel Managed Fishery are expected to be active within the Operational Area: *Commonwealth fisheries:* • North West Slope Trawl Fishery • Southern Bluefin Tuna Fishery • Western Deepwater Trawl Fishery • Western Skipjack Fishery • Western Tuna and Billfish fishery *State fisheries:* • Mackerel Managed Fishery • South West Coast Salmon Managed Fishery • West Coast Deep Sea Crustacean Managed Fishery • Pilbara Crab Managed Fishery • Pilbara Demersal Scalefish Managed Fisheries (Pilbara Trawl, Trap and Line) • West Australian Sea Cucumber Fishery There are no aquaculture activities within or adjacent to the Operational Area. ***EMBA:*** • A number of State and Commonwealth fisheries overlap the EMBA, refer to **Section 4.6.3** for further information.
	Fisheries – Traditional	4.6.4	***Operational Area:*** • There are no traditional, or customary fisheries within or adjacent to the offshore Operational Area. ***EMBA:*** • Traditional fisheries are typically restricted to shallow coastal waters and/or areas with structure such as reef. • Ningaloo Coast, Barrow Island and Montebello Islands and the adjacent foreshores have a known history of fishing, when areas were occupied (as identified from historical records). • Traditional fishing still occurs within some coastal waters of the EMBA.

	Sensitive Receptor	EP Section	Description
	Tourism and Recreation	4.6.5	***Operational Area:*** • Tourism activities in the Operational Area are infrequent due to water depths and distance offshore. ***EMBA:*** • The Ningaloo Marine Park, Montebello Islands and Shark Bay World Heritage area are popular for marine nature-based tourist activities. • Recreational fishing is expected to occur throughout EMBA, primarily in continental shelf waters.
	Shipping	4.6.6	***Operational Area:*** • No AMSA shipping fairways pass through the Operational Area. ***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 and gas industries. • Major shipping routes are associated with entry to the ports of Exmouth, Onslow, Barrow Island and Dampier.
	Oil and Gas Infrastructure	4.6.7	***Operational Area:*** • No existing facilities overlap the Operational Area. ***EMBA:*** • Several platforms and infrastructure lie within the EMBA.
	Defence	4.6.8	***Operational Area:*** • The Operational Area overlaps with the northern tip of one of the Department of Defence's air practice areas. ***EMBA:*** • There are designated defence practice areas in the offshore marine waters off Ningaloo and the North West Cape.
Values and Sensitivities	***Pilbara Coast and Islands***	4.7.1	Sensitive areas in this locality include: • Pilbara Islands (middle group) • Pilbara Islands (south group).
	Ningaloo Coast and Gascoyne	4.7.1	Protected areas in this locality include: • Ningaloo Coast World Heritage Area • Ningaloo AMP • Ningaloo Marine Park and Muiron Islands Marine Management Area • Muiron Islands Nature Reserve • Gascoyne AMP • Carnarvon Canyon AMP.
	Montebello / Barrow / Lowendal Islands		Protected areas in this locality include: • Montebello AMP • Montebello Islands Marine Park, Barrow Island Marine Park, Barrow Island Marine Management Area • Barrow Island Nature Reserve.
	Shark Bay	4.7.4	Protected areas in this locality include: • Shark Bay AMP.
	West Coast and Islands	4.7.5	Protected areas in this locality include: • Abrolhos AMP • Houtman Abrolhos Islands Nature Reserve.
	Rowley Shoals		Protected Areas in this locality include: • Argo-Rowley Terrace Australian Marine Park.
	Key Ecological Features	4.7.7	***Operational Area:*** *KEFS within the Operational Area include:* • canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula

	Sensitive Receptor	EP Section	Description
			• continental slope demersal fish communities. ***EMBA:*** A number of KEFs occur within the EMBA. Refer to **Section 4.7.7** for additional information.

4.3 Regional Context

The Operational Area is located in Commonwealth waters within the Northwest Province, in water depths ranging from 400 to 600 m. The Northwest Province is part of the wider North-west Marine Region (NWMR) (**Figure 4-2**) as defined under the Integrated Marine and Coastal Regionalisation of Australia (National Oceans Office and Geoscience Australia 2005). 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 Northwest Province is characterised by the following biophysical features (Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC) 2012a, DEWHA 2008):

- continental slope, situated between the shallower continental shelf and the abyssal plain
- several topographic features such as the Exmouth Plateau, terraces and canyons (several of which are associated with KEFs; refer to **Section 4.7.7**)
- surface ocean circulation is strongly influenced by the Indonesian Throughflow (ITF) via the Eastern Gyre and the Leeuwin Current. 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
- transitional climatic conditions between dry tropics to the south and humid tropics to the north
- strongly seasonal winds and moderate tropical cyclone activity
- 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 deeper around 120 m depth
- transitional boundary between tropical and temperate marine biological communities
- relatively high endemism of demersal fish species associated with continental slope
- pelagic food webs, potentially enhanced by upwelling associated with seabed features, support larger fauna such as fishes, sharks and dolphins
- soft sediment seabeds dominate benthic habitats, with associated epifauna communities such as filter and deposit feeders
- Presence of 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, pygmy blue whales, marine turtles, whale sharks and seabirds.

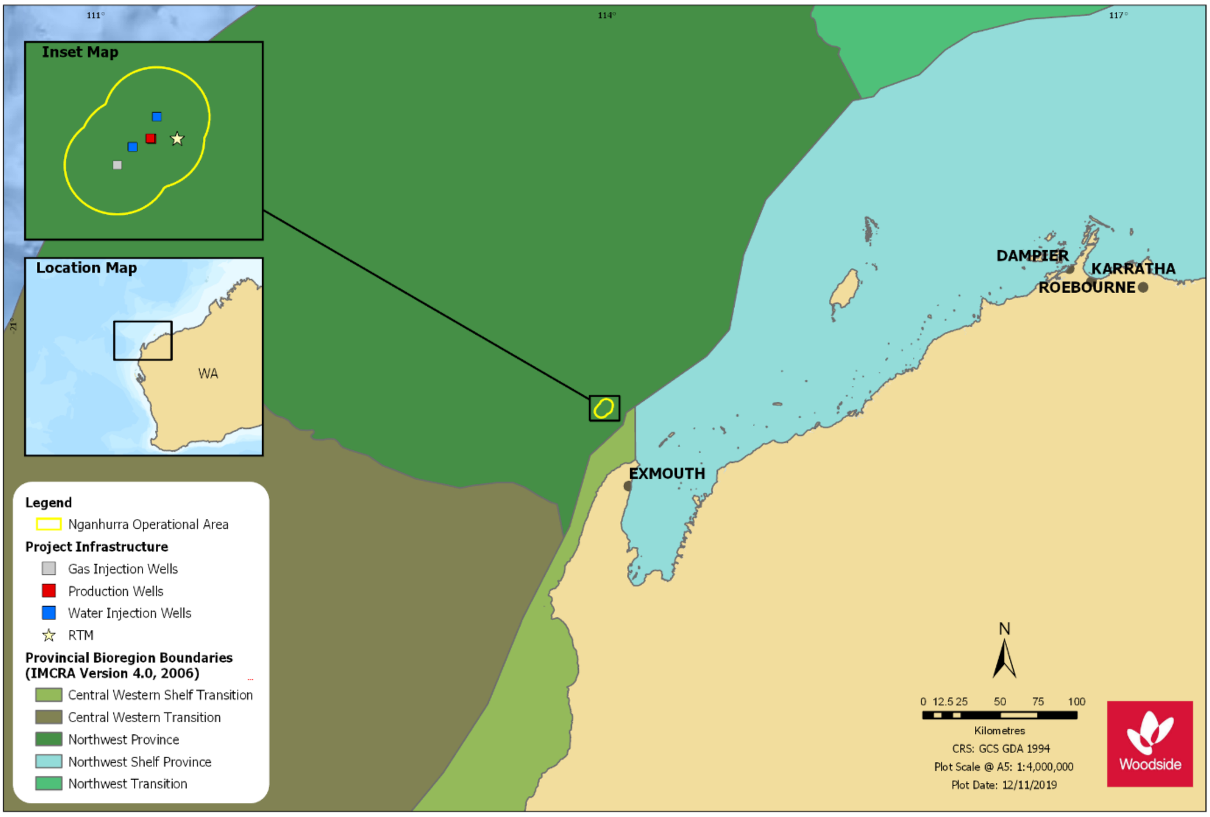


Figure 4-2: North-west Marine Region and the location of the Operational Area (IMCRA Version 4.0, 2006)

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 4-3**) (Bureau of Meteorology n.d.). 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 Learmonth airport meteorological station (approximately 78 km from the Operational Area), indicate maximum average temperatures during summer of 37.5 °C and minimum temperatures of 12.2 °C in winter (Bureau of Meteorology n.d.). The NWMR experiences a tropical monsoon climate, with distinct wet (October to April) and dry (May to September) seasons (Pearce et al., 2003). Rainfall in the NWMR typically occurs during the wet season (summer), with highest falls observed during late summer and autumn (Bureau of Meteorology, n.d.), often associated with the passage of tropical low pressure systems and cyclones (Pearce et al., 2003). Rainfall outside this period is typically low.

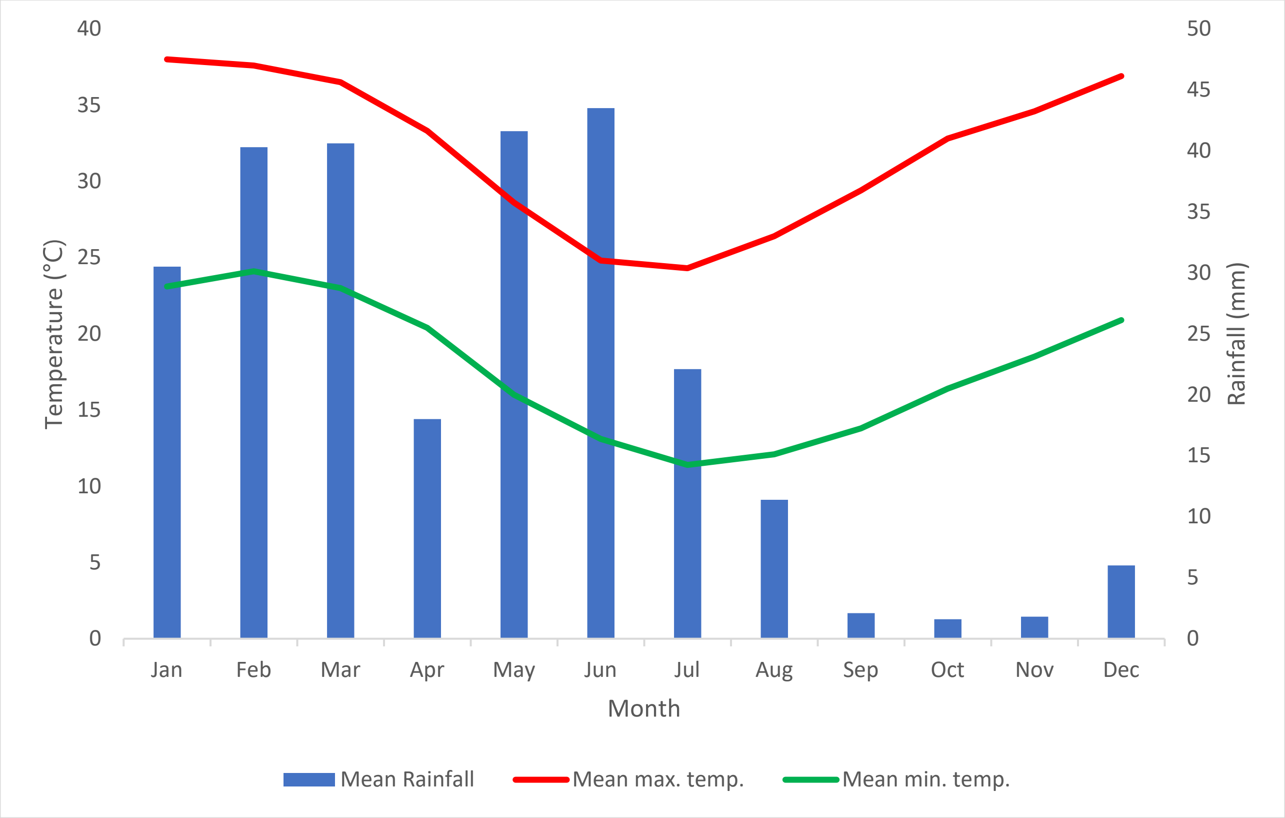


Figure 4-3: Mean monthly average maximum temperature, average minimum temperature and average rainfall from January 1946 to July 2019 from Learmonth Airport meteorological station (data from Bureau of Meteorology, n.d.)

4.4.1.2 Wind

Winds vary seasonally, with a tendency for winds from the south-west quadrant during summer months (October–January) and the north-east quadrant in autumn and winter months (April–August) (**Figure 4-4**). 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 4-4**).

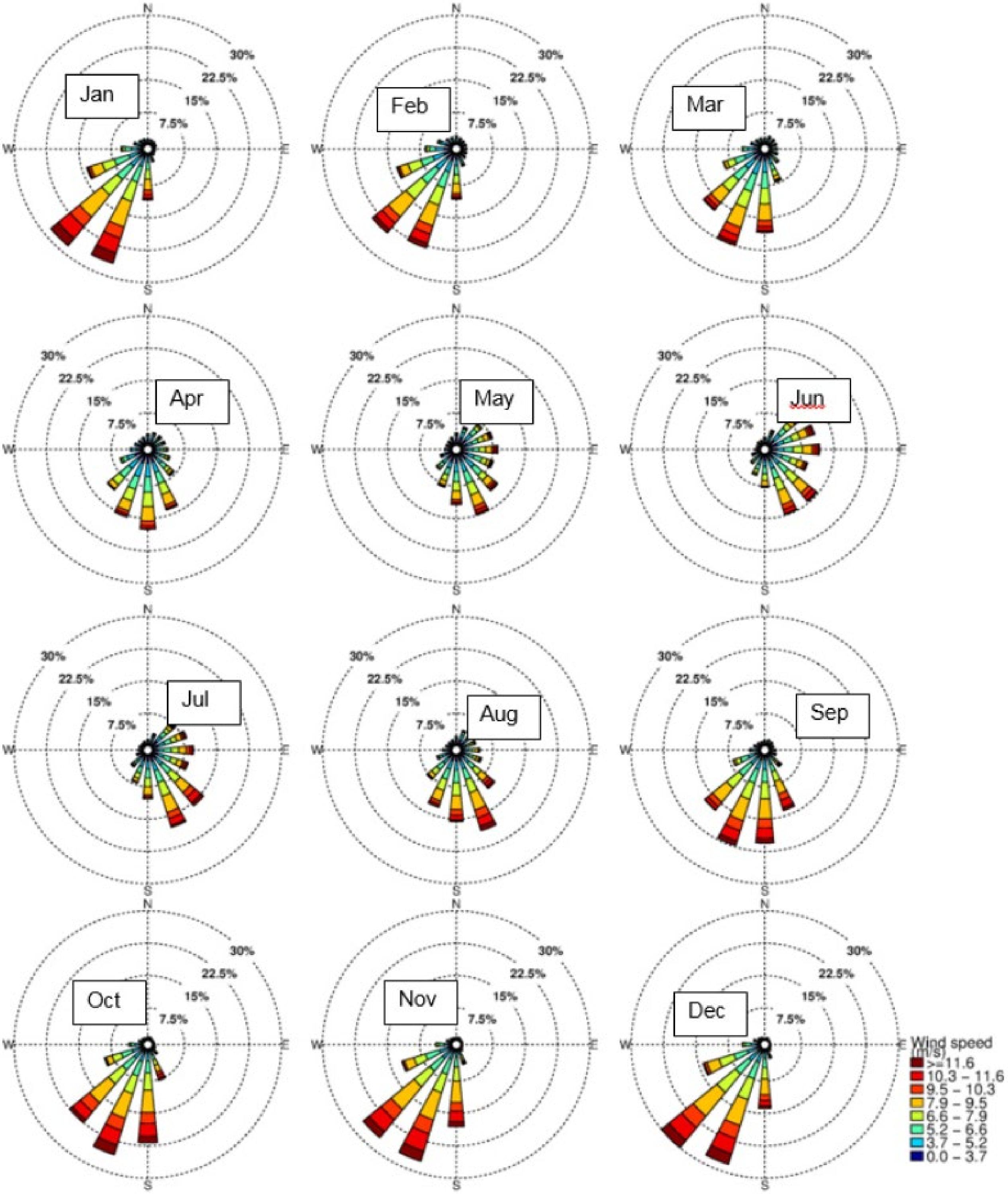
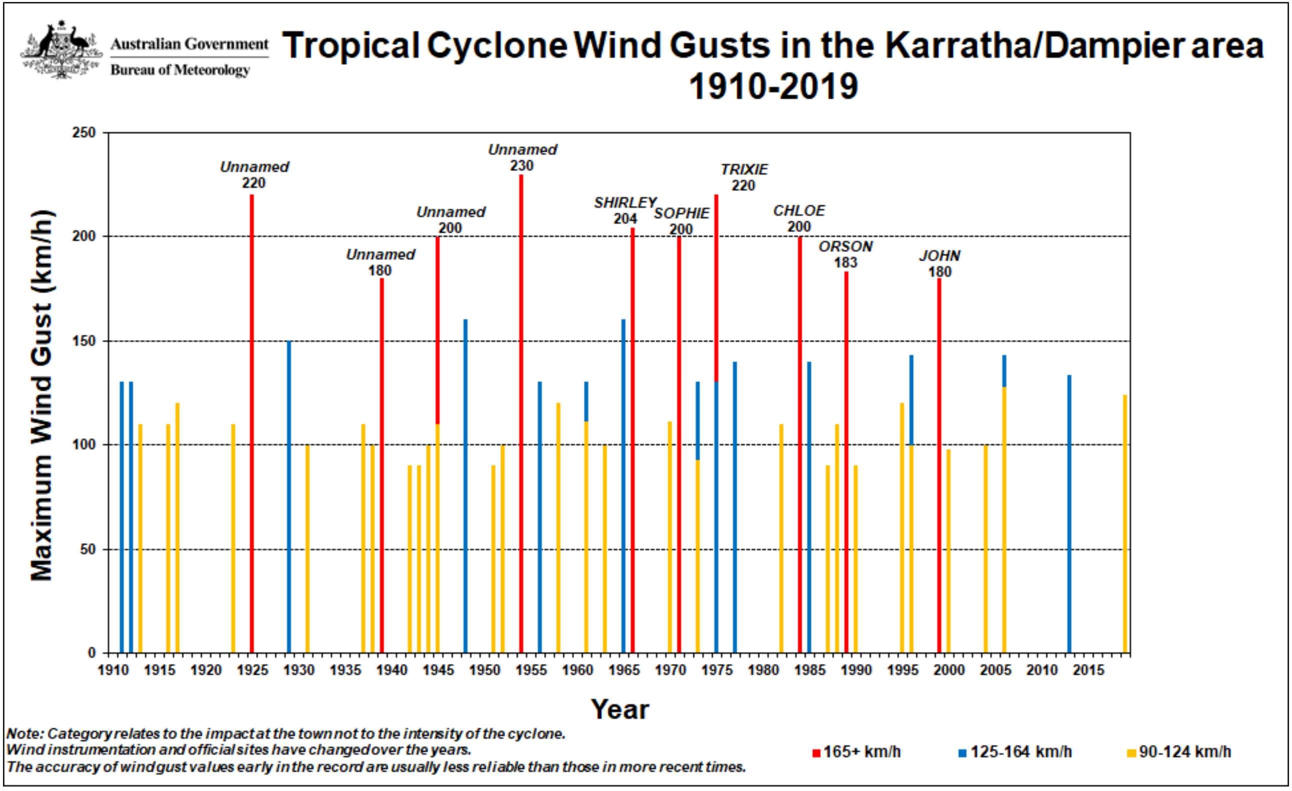


Figure 4-4: Monthly wind roses from WA-28-L (Woodside Energy Limited 2016)

4.4.1.3 Tropical Cyclones

Tropical cyclones are a relatively frequent event in the region, with the Pilbara coast experiencing more cyclonic activity than any other region of the Australian mainland coast (BoM n.d.). Tropical cyclone activity can occur between November and April and is most frequent during January to

March, with an annual average of approximately one storm per month. The cyclone season officially runs from November to April each year although cyclones also occur outside this period (BoM, n.d.). Significant storm surge is associated with the passage of a cyclone, which can result in very high tides and coastal flooding (BoM, n.d.; Pearce et al., 2003).



Note: Category relates to the impact at the town not to the intensity of the cyclone.
Wind instrumentation and official sites have changed over the years.
The accuracy of windgust values early in the record are usually less reliable than those in more recent times.

Figure 4-5: 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

Currents in the region consist of local currents driven by winds and tides, superimposed on synoptic scale geostrophic currents. Local winds generate stress on the water surface, forcing the surface layer in the general direction of wind movement, but with an offset (15–45%) in an anti-clockwise direction (Coriolis effect). In the open ocean, sustained winds result in wind-forced currents of approximately 3% of the wind speed (Holloway and Nye 1985). Thus, a sustained wind of 20 knots may force surface currents of up to 0.6 knots. Wind patterns in the region are described in **Section 4.4.1.1** and shown in **Figure 4-4**.

Currents in the vicinity of the Operational Area (as measured in WA-28-L are between 0.15 and 0.24 m/s on average throughout the year. Surface currents are, on average, faster during winter months, which corresponds with higher Leeuwin Current flow. Currents closer to the seabed are slower on average and less variable seasonally than surface currents (Woodside 2016). Surface currents exhibit seasonal directionality, with flow to the south-west characterising March to June, with currents more variable outside this period (Woodside 2016). This is consistent with stronger Leeuwin Current flow during winter months, with more variable currents driven by local wind stress during periods of weaker Leeuwin Current flow.

The large-scale ocean circulation of the NWMR is primarily influenced by the ITF (Meyers et al., 1995, Potemra et al., 2003), and the Leeuwin Current (Batteen et al., 1992, Godfrey and Ridgway 1985, Holloway and Nye 1985, James et al., 2004, Potemra et al., 2003). Both currents are significant drivers of the NWMR ecosystems. The currents are driven primarily by pressure differences between the equator and the higher density cooler and more saline waters of the Southern Ocean, and are strongly influenced by seasonal change and El Niño and La Niña episodes (DSEWPaC 2012a). In the Northwest Province region, the Leeuwin Current may also incorporate Indian Ocean water from the Eastern Gyral Current (D'Adamo et al., 2007).

The Leeuwin Current flows southward along the edge of the continental shelf and is primarily a surface flow (up to 150 m deep) and is strongest during winter (Cresswell 1991). The Ningaloo Current flows in the opposite direction, running northward along the outside of Ningaloo Reef and across the inner shelf from September to mid-April (**Figure 4-6**). 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 North West Shelf Province (DSEWPaC, 2012a).

In addition to the synoptic-scale current dynamics, tidally driven currents are a significant component of water movement in the NWMR. Tide measurements at the Vincent field indicate that tides in the Operational Area are semi-diurnal, with a tidal range of 2.1 m (Woodside 2016). Tides in the wider NWMR are semi-diurnal and have a pronounced spring-neap cycle, with tidal currents flooding towards the south-east and ebbing towards then north-west (Pearce et al., 2003). The NWMR exhibits a considerable range in tidal height, from microtidal ranges (<2 m) south-west of Barrow Island to macrotidal (>6 m) north of Broome (Brewer et al., 2007, Holloway 1983). Storm surges and cyclonic events can also significantly raise sea levels above predicted tidal heights (Pearce et al., 2003). 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 NWMR (Craig 1988). As these waves pass the shelf break at approximately 125 m depth, the thermocline may rise and fall by up to 100 m in the water column (Holloway 1983, Holloway and Nye 1985). Internal waves of the NWMR are confined to water depths between 70 and 1000 m and the dissipation energy from such waves can enhance mixing in the water column (Holloway et al., 2001).

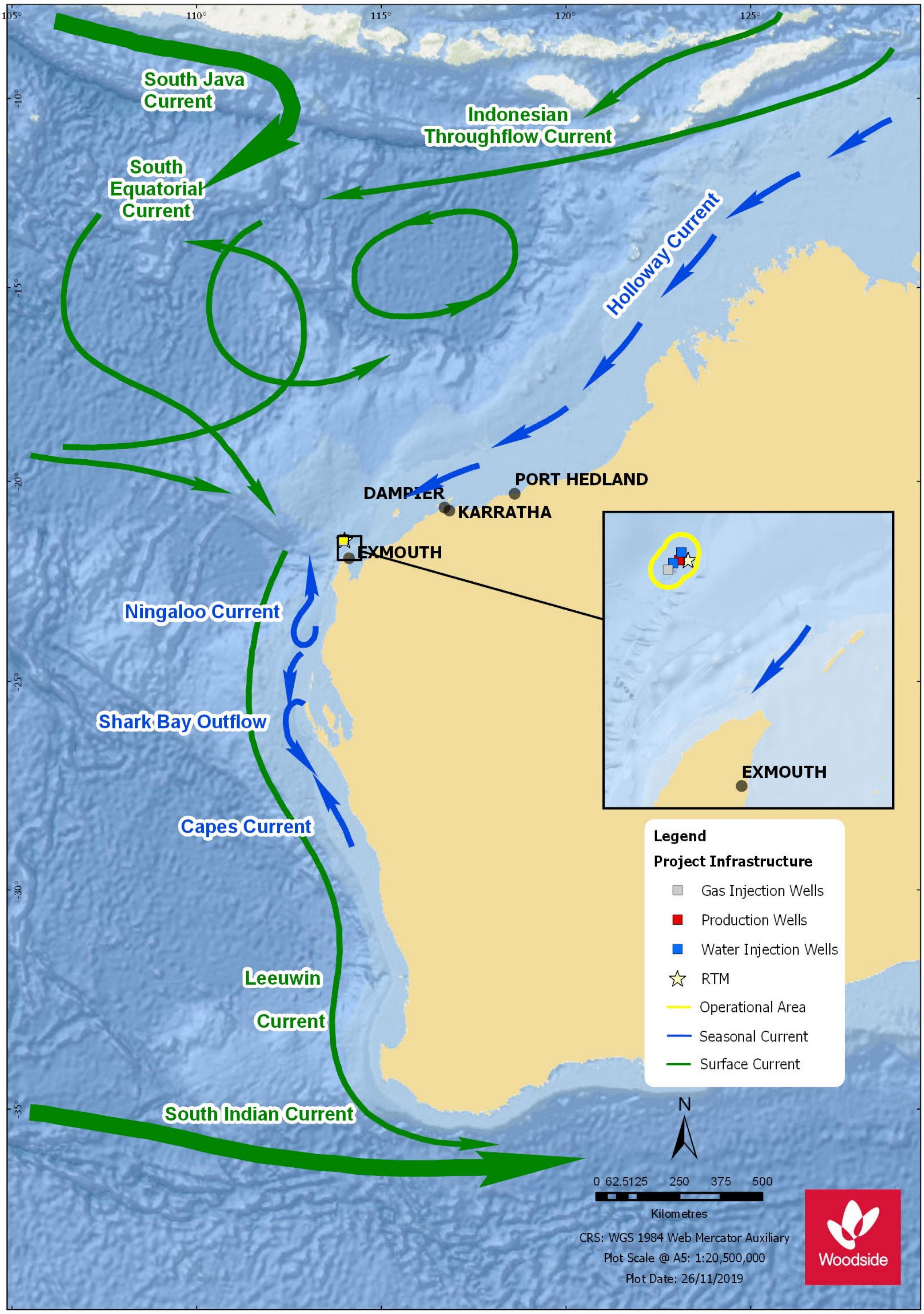


Figure 4-6: Large-scale ocean circulation of the North-west Marine Region including the location of the Indonesian Throughflow and other currents of significance (Department of the Environment, Water, Heritage and the Arts (DEWHA) 2008)

4.4.2.2 Wave Height

Waves at the *Ngujma-Yin* FPSO (approximately 4 km from the Operational Area) are typically bi-modal, comprising locally generated wind waves and oceanic swells generated in the Southern Ocean (Woodside Energy Limited 2016). Non-cyclonic wave heights at the FPSO are on average 2.15 m, although the maximum non-cyclonic wave height recorded was 5.71 m (Woodside Energy Limited, 2016).

Waves within the Northwest Province 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).

4.4.2.3 Seawater Characteristics

The offshore, oceanic seawater characteristics of the Operational Area exhibit seasonal and water depth variation in temperature and salinity being influenced by currents in the region (see Current and Tides above). Surface waters are relatively warm year round due to the tropical water supplied by the ITF and the Leeuwin Current, with temperatures varying between a maximum of 30°C and a minimum of 23°C (Woodside Energy Limited 2016). Temperatures in deeper waters (345 m below sea level) are less variable, ranging between 18 and 12°C year round.

A recent environmental survey of the Enfield canyon commissioned by Woodside indicated the water column has temperature and density gradients consistent with other locations in the region, with a well-mixed surface layer (<100 m water depth) lying above a distinct halocline between 100 and 300 m (BMT Oceanica 2016). Below the halocline, salinity is relatively isohaline, with water temperature decreasing with depth. On the basis of temperature and salinity data, three potential water bodies (tropical surface water, South Indian central water and Antarctic intermediate water) were identified in the vicinity of the Operational Area.

During summer, the water column in the Northwest Province 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 (DSEWPaC 2012a, James et al. 2004).

Variation in surface salinity along the NWS Province (adjacent to the Northwest Province) 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 (James et al., 2004, Pearce et al., 2003). 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).

Turbidity is primarily influenced by sediment transport by oceanic swells and primary productivity (Pearce et al., 2003). Upwelling of nutrient-rich waters may increase phytoplankton productivity in the photic zone, which may increase local turbidity (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). 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 may force the surrounding deeper, cooler, nutrient-rich waters up into the photic zone (DSEWPaC 2012a). Given the upper continental slope location, water quality in the Operational Area is expected to be consistent with the wider Northwest Province region.

4.4.3 Bathymetry

The Operational Area is located in waters approximately 400 to 600 m deep on the upper continental slope. Bathymetry data acquired within the Operational Area indicate the seabed is relatively flat and featureless, although the subsea infrastructure in the western portion of the Operational Area overlaps the Enfield Escarpment (**Figure 4-7**). The Enfield Escarpment is approximately 50 m in height, with a relatively steep slope in comparison to the surrounding seabed. The Enfield canyon lies in the southern portion of the Operational Area and comprises the North and South Enfield Canyons (**Figure 4-7**) (herein referred to as the Enfield Canyon)**.**

The Enfield Canyon is a tributary of the Cape Range Canyon and exhibits relatively low topographic relief (20–30 m), with only isolated boulders (sometimes greater than three metres in height) observed (BMT Oceanica 2016).

More broadly, the NWS encompasses more than 60% of the continental shelf in the NWMR (Baker et al., 2008), and gradually slopes from the coastline to the shelf break at the edge of the region and includes water depths of 0 – 200 m. Approximately half of the NWS is located in water depths of 50 to 100 m (DEWHA 2008). The NWS includes a number of seafloor features including 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). At approximately 120 m depth contour, a broad scale terrace of gradients between 5 and 20 degrees at the start of the outer shelf represents a paleo-shoreline and marks an important divide between shelf carbonate sands and cemented carbonates and the finer, less cemented slope materials offshore. This includes the Ancient Coastline at 125 m depth contour (Ancient Coastline KEF) which is approximately 19 km from the Operational Area at its closest point.

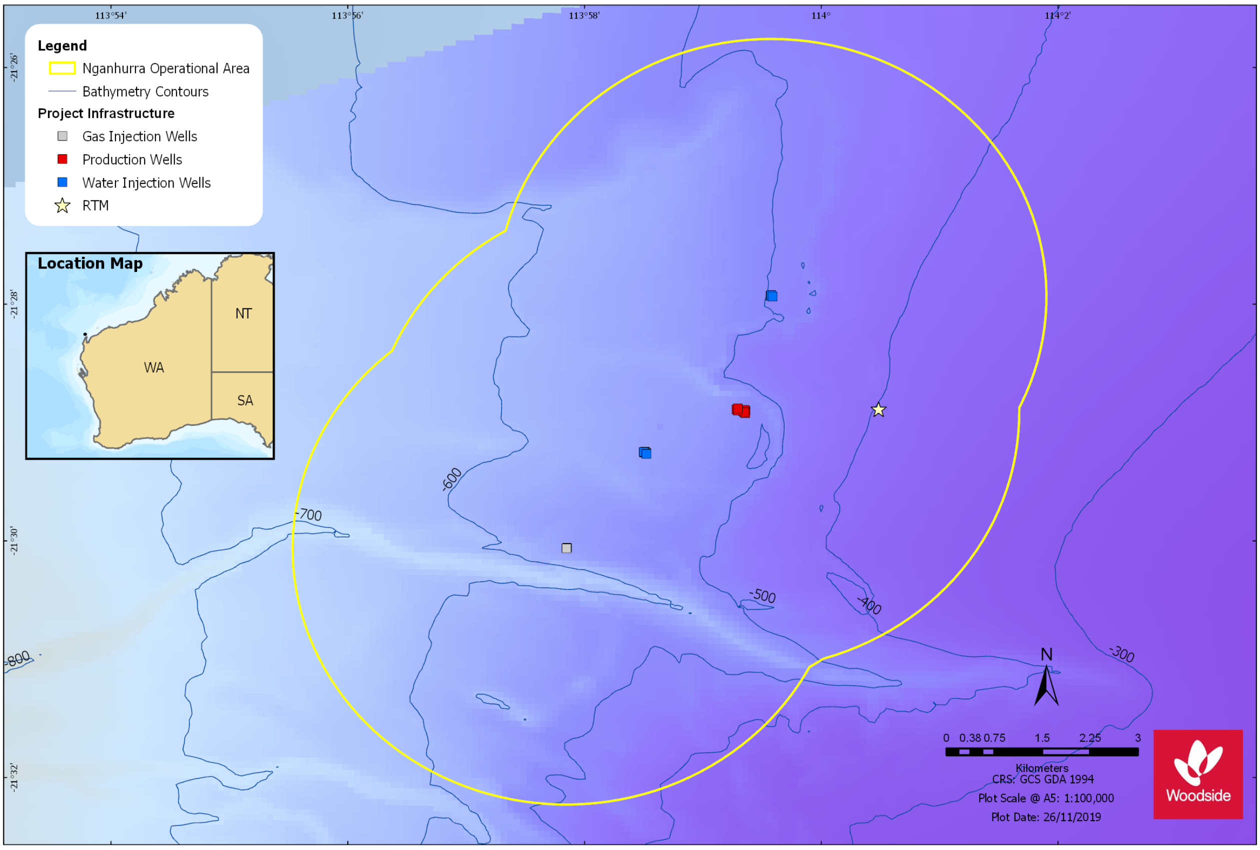


Figure 4-7: Bathymetry and seabed features of the Operational Area

4.4.4 Marine Sediment

Sediment investigations within the Enfield Canyon, based on acoustic data, indicated that the upper slope habitat (in depths of approximately 200 to 500 m) is generally composed of coarser and/or more consolidated sediments as compared to the mid-slope (500 to 1000 m) (BMT Oceanica 2016). Sediments within the Enfield Canyon where they overlap with the Operational Area were found to comprise sand, silt, clays and fines (BMT Oceanica 2016). Isolated areas of hard substrate within the Enfield Canyon were characterised by isolated boulders, and found to be featureless (BMT Oceanica 2016). Sediment quality in the Enfield Canyon was high, with most potential contaminants (metals and hydrocarbons) below recognised guidelines for sediment quality (BMT Oceanica 2016).

Hard substrates in the broader region can host more diverse benthic communities. Hard substrate may be associated with the Ancient Coastline at 125 m depth contour KEF (approximately 19 km away) (**Section 4.7.7**).

Seabed sediments of the continental slope in the Northwest Province are generally dominated by carbonate silts and muds, with sand and gravel fractions increasing closer to the shelf break on the upper slope (Baker et al., 2008). Sediments of the Northwest Province are characterised by fine to medium sediment (silts and sands), with patches of coarser sediments (shells/gravels) (Woodside Energy Limited, 2005). Sediment composition was shown to comprise a gradient of finer sediments with increasing depth, and the area is interspersed with smaller patches of more consolidated, coarser sediment and limited rocky outcrops associated with steeper slope areas (Woodside Energy Limited, 2005).

Sediment quality in the NWS is generally high, except for areas in close proximity to ports (Department of Environment and Conservation, 2006), where elevated concentrations of metals and hydrocarbons may occur.

4.4.5 Air Quality

There is a lack of air quality data for the offshore NWMR 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 undertaken, it is considered the ambient air quality in the Operational Area and wider offshore NWMR will 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 occur within the Operational Area or EMBA, as indicated by the EPBC Act Protected Matters Search Tool (PMST) reports provided in **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 (approximately 400 to 600 m), these benthic primary producer groups will not occur in the Operational Area but are present within the EMBA.

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 the Ningaloo Coast WHA about 15 km to the south. Other coral reef habitats within the EMBA include the Muiron Islands Marine Management Area (31 km south-east) and the Houtman Abrolhos Islands Australian Marine Park (578 km south).

Hard corals in the region typically have a distinct spawning season, with most species spawning during autumn (March-April) (Rosser and Gilmour 2008, Simpson et al., 1993). Further information on locations with coral reef habitats is provided in **Section 4.7**.

Seagrass Beds/Macroalgae

Seagrass beds and benthic macroalgae reefs are a main food source for many marine species, and provide key habitats and nursery grounds (Heck Jr. et al., 2003, Wilson et al., 2010). In the northern half of Western Australia, these habitats are restricted to sheltered and shallow waters due to large tidal movement, high turbidity, large seasonal freshwater runoff and cyclones. They are widely distributed in shallow coastal waters that receive sufficient light to support seagrasses and macroalgae. No seagrass beds or macroalgae occur in the Operational Area, as the seabed depth received insufficient photosynthetically active radiation to support such communities. However, seagrass beds and macroalgae habitats are present in the EMBA including the Ningaloo Coast, Muiron Islands, Shark Bay and Houtman Abrolhos Islands. Further information on locations with seagrass and macroalgae habitats is provided in **Section 4.7**.

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 (Robertson and Duke, 1987). Mangroves also maintain sediment, nutrient and water quality within habitats and minimise coastal erosion. These coastal habitats are not found within or adjacent to the Operational Area, but can be found in the EMBA along the Ningaloo Coast, Exmouth Gulf and Shark Bay. Further information on locations with mangrove habitats is provided in **Section 4.7**.

4.5.1.3 Lifecycle Stages 'Critical' Habitats

Spawning, Nursery, Resting and Feeding Areas

Critical habitats for species conservation include spawning, nursery, resting and feeding areas. These critical habitats will vary for each species. Any critical habitat for protected species within the Operational Area, as identified by the EPBC Act Protected Matters search (**Appendix C** is outlined below in **Section 4.5.2** within the relevant species sections or within **Section 4.7**.

Migration Corridors

Many marine species, including cetaceans, whale sharks, seabirds and shorebirds migrate seasonally between feeding, breeding and nursery habitats using migration corridors. Migration corridors for protected species that pass through the Operational Area and EMBA are outlined below in **Section 4.5.2**.

4.5.1.4 Other Communities/Habitats

Plankton

Plankton within the Operational Area and EMBA is 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).

Within the 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 (Department of Conservation and Land Management (CALM, 2005)), with periodic upwelling throughout the year.

Pelagic and Demersal Fish Populations

Fish species in the NWMR (including the Operational Area and much of the 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.

In the EMBA, fish diversity and abundance is typically correlated with habitat distribution, with complex habitats, such as coral and rocky reefs, hosting more diverse and abundant assemblages. This is a typical pattern globally (Gratwicke and Speight 2005). Notable habitats hosting diverse fish assemblages include Ningaloo Reef (Stevens et al., 2009), Barrow and Montebello Islands (de Lestang and Jankowski 2015), Rowley Shoals (Bryce 2009), Glomar Shoals and Rankin Bank (Australian Institute of Marine Science (AIMS), 2014).

The Continental Slope Demersal Fish Communities KEF overlaps the Operational Area and has been identified as one of the most diverse slope assemblages in Australian waters (see **Section 4.7.7.1**). Diversity of demersal fish assemblages on the continental slope between North West Cape and the Montebello Trough is among the highest in Australia (>500 species of which up to 76 are endemic), with the North West Cape region cited as a transition between tropical and temperate demersal and continental slope fish assemblages (Last et al., 2005). Fish assemblage species richness in the region has been shown to decrease with depth and be positively correlated with habitat complexity (Last et al., 2005).

The Enfield canyon survey investigated three different sections of the canyon, ranging from the head of the canyon at the edge of the continental shelf (365-560 m water depth), an upper portion of the canyon (560-690 m water depth) and a lower portion of the canyon (800-870 m water depth). Abundance and diversity of fishes within each of the canyon sections surveyed was greater than the adjacent non-canyon habitats, although no differences between the three surveyed sections of the canyon were found. As such, the habitat within the surveyed portions canyon appears to host a distinct fish assemblage. Note the surveyed portions of the canyons did not appear to differ significantly physically on a fine scale than the adjacent non-canyon habitat (i.e. relatively flat, unconsolidated sediments characterised by silt and sand-sized fractions) (BMT Oceanica, 2016).

The survey observed 80 species from 41 families, which is consistent with data from the region more broadly (BMT Oceanica, 2016; Last et al., 2005). Ichthyofauna observed during the survey was characterised by macrourid, berycid, morid, liparid, halosaurid and congrid species, which is consistent with other observations of continental slope fish assemblages in the region (BMT Oceanica, 2016; Last et al., 2005). This slightly differed from the assemblages observed in the Greater Enfield area which also observed sternoptychid, oreosomatid and nettastomatid fishes (Heyward et al., 2001a; Heyward and Rees, 2001). Given the high diversity and low abundance that characterised fish assemblages in the upper continental slope, these differences are expected to be the result of relatively low sampling effort rather than actual differences between the assemblages observed, given the similar habitat in surveyed areas. Note the families observed during surveys in the vicinity of the Operational Area are widely distributed in continental slope habitats, both in Australia and other ocean basins (Last et al., 2005), likely due to widespread nature of such continental slope habitats and lack of barriers to dispersal.

Filter Feeders

Filter feeders such as sponges, ascidians, soft corals, and gorgonians are animals that feed by actively filtering suspended matter and food particles from water by passing the water over specialised filtration structures (DEWHA 2008). Sessile filter feeders generally live in areas that have strong currents and hard substratum (CALM, 2005) and are closely associated with substrate type, with areas of hard substrate typically supporting more diverse epibenthic communities (Heyward et al., 2001b).

Several surveys of benthic filter feeder communities in and around the Operational Area have been undertaken (BMT Oceanica, 2016; Heyward et al., 2001a; Heyward and Rees, 2001). Few areas of hard substrate were noted during the most recent survey of the Enfield Canyon and Operational Area, with the seabed at the location of the proposed development infrastructure characterised by low topographic complexity with silty clay/sand sediments. Isolated areas of hard substrate noted during the initial geophysical surveys were subsequently sampled during the recent survey, and found to be characterised by featureless isolated boulders with no different biota observed compared to the other surveyed areas of the canyon (BMT Oceanica 2016).

Benthic filter feeding assemblages observed within the Enfield canyon were consistent with those noted during previous surveys in the region (e.g. Heyward et al., 2001a; Heyward and Rees, 2001). Filter feeders observed during the survey consisted primarily of mobile invertebrates such as cnidarians, echinoderms and sponges, with no obvious differences between assemblages within and beyond the canyon (BMT Oceanica, 2016).

Within the EMBA, the NWMR has been identified as a sponge diversity hotspot with a high variety of areas of potentially high and unique sponge biodiversity, particularly in the Commonwealth waters of Ningaloo Marine Park (CALM, 2005; Rees et al., 2004). Filter feeder communities in the region are primarily located in the deeper waters of the Ningaloo Reef system as well as the Muiron Islands, Rowley Shoals and nearshore waters of the Pilbara Islands.

Other Benthic Communities

Benthic habitats of the continental slope in the Northwest Province bioregion comprise predominantly bare, unconsolidated, muddy substrate types (Baker et al., 2008). Such habitat is broadly represented throughout the Northwest Province, and typically supports sparse assemblages of filter and deposit-feeding epibenthic fauna (Woodside Energy Limited, 2005). Environmental surveys in the area have shown a diverse, but broadly representative infaunal community, dominated by polychaete worms and crustaceans (RPS Environment and Planning, 2012a). Offshore, deeper water epifauna (for example mobile benthic taxa, such as echinoderms or sessile taxa such as sponges) are typically sparse and patchy in distribution. Offshore seabed surveys across the NWS have detected a general reduction in epibenthic coverage as depth increases (Fulton et al., 2006). The Centre for Scientific and Industrial Research Organisation (CSIRO) survey revealed that large epifauna (greater than 25 cm such as sponges) are rare beyond the 100 m isobath (Fulton et al., 2006).

Despite the lack of significant areas of hard substrate within the Operational Area, some deep-water filter feeding communities are still expected to be present in the silty clay/sand sediments, including deposit feeding epifauna (e.g. holothurians) and infauna (e.g. polychaetes). A benthic community assessment has been carried out for WA-28-L, and included ROV surveys near the Operational Area by AIMS. The surveys revealed four main invertebrate groups of deep water benthos including crustaceans, sponges, echinoderms and cnidarians (octocorals) (Heyward and Rees, 2001).

The results of the North West Cape Continental Shelf and Slope survey (Heyward et al., 2001b) indicated that the distribution of biota in the vicinity of the Operational Area was patchy, with epibenthic fauna demonstrating heterogeneity in abundance and diversity both within and between depths. These differences were more marked on the upper slope and continental shelf stations (50–450 m depth) and appeared to be related, with variation in seabed sediments. A more heterogeneous mix of both soft sediment areas and consolidated areas were present between 50–450 m depths, with either a veneer of fine soft sediment or occasionally as outcropping rock.

Similarly, recent observations of epifauna in the Enfield canyon indicated the density of deposit-feeding fauna was low and sparsely distributed throughout the surveyed area (BMT Oceanica, 2016), which is consistent with results from other investigations in the region (Heyward et al., 2001a; Heyward and Rees, 2001). Deposit-feeding fauna (e.g. holothurians and echinoids) were relatively more abundant in the continental slope portion of the canyon than the head of the canyon (on the continental shelf break). The relative increase of deposit feeding fauna in this part of the canyon may be indicative of increased food availability, potentially related to increased deposition through reduced water movement (BMT Oceanica, 2016). This was consistent with casual observation of stronger currents at the canyon head during the Enfield Canyon systems survey (BMT Oceanica, 2016, **Section 4.5.1.5**). Bioturbation was observed within the Enfield Canyon, indicating the presence of burrowing epifauna and infauna (BMT Oceanica, 2016).

4.5.1.5 Enfield Canyon Environmental Survey

A targeted survey of the Enfield Canyon system, as well as the surrounding seabed, was undertaken in 2015 (BMT Oceanica, 2016). The primary objective of the survey was to investigate physical and biological characteristics of the deepwater geomorphological seabed features within the Operational Area, and adjacent representative canyon features.

The following survey activities were undertaken through the deployment of a work class ROV fitted with ancillary survey equipment:

- habitat mapping of key physical and biological characteristics as derived from the physical and biological attributes
- description and high level classification of physical attributes (seabed habitat, sediment composition and physico-chemical characteristics)
- description of the biological attributes (benthic community composition/structure and description of benthic biota; epifauna and infauna)
- description of fish populations
- observations/evidence of environmental pressures such as natural or anthropogenic perturbations (seabed disturbance, fishing gear abandonment etc.).

The areas of interest were chosen to provide comparisons of the canyon environment within the development area (Area A) and non-development areas (Areas B and C) (See **Figure 4-8**).

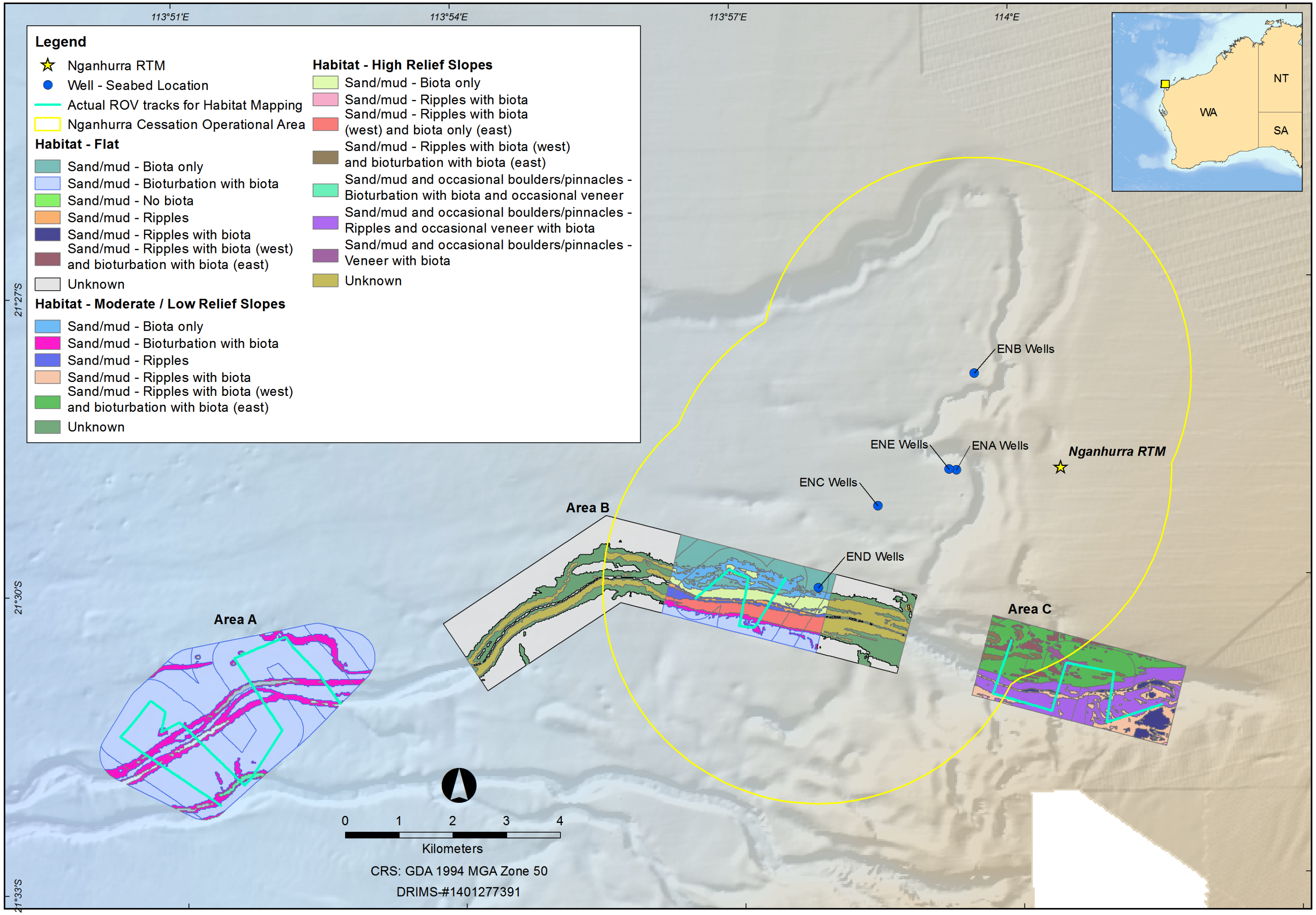


Figure 4-8: Benthic Habitat map of the Enfield Region showing Area B and Area C within the NGA Cessation Operational Area (BMT Oceanica, 2016)

Area A was the deepest survey location and encompassed a portion of the North and South Enfield Canyons. Area B1 was a representative portion of North Enfield Canyon and Area B2 incorporated the head of the North Enfield Canyon. Area C was proposed to be sampled but could not be completed due to weather constraints. A summary of the type and nature of data collected for each of the completed tasks is presented in **Table 4-3** below.

Table 4-3: Type and nature of survey data collected

Area	Tasks	Details
Area A	Transect 1 – Habitat and fish video, CTD	• Depth range: 800-870 m • Transect length: 10.8 km • Time: 13.5 hrs • ROV speed (mean): 0.4-0.5 knots
Area B1	Transect 2 – Habitat and fish video, CTD	• Depth range: 560-690 m • Transect length: 3.5 km • Time: 4 hrs 10 mins • ROV speed (mean): 0.4-0.5 knots
Area B2	Transect 3 – Habitat and fish video, CTD	• Depth range: 365-560 m • Transect length: 6.5 km • Time: 7 hrs 34 mins • ROV speed (mean): 0.4-0.5 knots
Area A	Six sites – sediment collection	• Collected ten push cores from site A1 only • Duration: approx. 3.5 hrs • Two ROV deployments (with five push cores per deployment)

4.5.2 Species

4.5.2.1 Protected Species

The EPBC Act PMST has been used to identify listed species that may occur within and adjacent to the Operational Area and EMBA; this informs the assessment of planned events as well as unplanned events in **Section 6.6** and **Section 6.7**. EPBC Act PMST reports were generated to identify MNES within the Operational Area and the EMBA for the worst-case hydrocarbon spill scenarios considered in this EP, including areas of potential shoreline accumulation. It should be noted that the EPBC Act PMST is a general database that conservatively identifies areas in which protected species have the potential to occur. A number of MNES identified by the EPBC Act PMST reports were not considered to be credibly impacted (e.g. terrestrial species), which have been excluded from further consideration (**Appendix C**).

Information regarding species within the EMBA is included within this section and **Section 4.7**, and was used to inform the assessment of both planned and unplanned events in **Section 6.6** and **Section 6.7**.

A total of 84 EPBC Act listed species considered MNES (41 and 73 listed as threatened or migratory, respectively) were identified as potentially occurring within the EMBA, of which 33 were identified as potentially occurring within the Operational Area (**Table 4-4**). The full list of marine species identified is provided in the EPBC Act PMST Report (**Appendix C**). Two Conservation Dependent species under the EPBC Act were found within the Operational Area and EMBA, but are not currently included in the EPBC Protected Matters search. These species, the southern bluefin tuna, and scalloped hammerhead, are listed on the Species Profile and Threats Database (SPRAT) (DoEE, 2019) and are described in **Section 4.5.2.4**.

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

Species	Common name	Threatened status	Migratory status	Operational Area / EMBA	
				Operational Area	EMBA
Marine Mammals					
Balaenoptera borealis	Sei Whale	Vulnerable	Migratory	Y	Y
Balaenoptera musculus	Blue Whale	Endangered	Migratory	Y	Y
Balaenoptera physalus	Fin Whale	Vulnerable	Migratory	Y	Y
Megaptera novaeangliae	Humpback Whale	Vulnerable	Migratory	Y	Y
Balaenoptera edeni	Bryde's Whale	N/A	Migratory	Y	Y
Orcinus orca	Killer Whale	N/A	Migratory	Y	Y
Physeter macrocephalus	Sperm Whale	N/A	Migratory	Y	Y
Tursiops aduncus (Arafura/Timor Sea populations)	Spotted Bottlenose Dolphin (Arafura/Timor Sea populations)	N/A	Migratory	Y	Y
Eubalaena australis	Southern Right Whale	Endangered	Migratory	Y	Y
Balaenoptera bonaerensis	Antarctic Minke Whale	N/A	Migratory	Y	Y
Sousa chinensis	Indo-Pacific Humpback Dolphin	N/A	Migratory	N/A	Y
Neophoca cinerea	Australian Sea-lion, Australian Sea Lion	Vulnerable	N/A	N/A	Y
Dugong dugon	Dugong	N/A	Migratory	N/A	Y
Marine Reptiles					
Caretta	Loggerhead turtle	Endangered	Migratory	Y	Y
Chelonia mydas	Green turtle	Vulnerable	Migratory	Y	Y
Dermochelys coriacea	Leatherback turtle, leathery turtle, luth	Endangered	Migratory	Y	Y
Eretmochelys imbricata	Hawksbill turtle	Vulnerable	Migratory	Y	Y
Natator depressus	Flatback turtle	Vulnerable	Migratory	Y	Y
Aipysurus apraefrontalis	Short-nosed seasnake	Critically endangered	N/A	N/A	Y

Species	Common name	Threatened status	Migratory status	Operational Area / EMBA	
				Operational Area	EMBA
Fishes and Elasmobranchs					
Carcharodon carcharias	Great White Shark	Vulnerable	Migratory	Y	Y
Anoxypristis cuspidata	Narrow Sawfish	N/A	Migratory	Y	Y
Isurus oxyrinchus	Shortfin Mako	N/A	Migratory	Y	Y
Isurus paucus	Longfin Mako	N/A	Migratory	Y	Y
Manta birostris	Giant Manta Ray	N/A	Migratory	Y	Y
Carcharias taurus	Grey Nurse Shark (west coast population)	Vulnerable	N/A	N/A	Y
Pristis zijsron	Green Sawfish	Vulnerable	Migratory	N/A	Y
Rhincodon typus	Whale Shark[4]	Vulnerable	Migratory	Y	Y
Manta alfredi	Reef Manta Ray	N/A	Migratory	N/A	Y
Pristis clavata	Dwarf Sawfish	Vulnerable	Migratory	N/A	Y
Lamna nasus	Porbeagle, Mackerel Shark	N/A	Migratory	N/A	Y
Thunnus maccoyii	Southern Bluefin Tuna	Conservation Dependent	Migratory	Y	Y
Sphyrna lewini	Scalloped Hammerhead	Conservation Dependent	N/A	Y	Y
Birds					
Calidris canutus	Red Knot, Knot	Endangered	Migratory	Y	Y
Numenius madagascariensis	Eastern Curlew, Far Eastern Curlew	Critically Endangered	Migratory	Y	Y
Anous stolidus	Common Noddy	N/A	Migratory	Y	Y
Fregata ariel	Lesser Frigatebird	N/A	Migratory	Y	Y

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[4] Not identified in the PMST report, however tracking data shows the species within the Operational Area.

Species	Common name	Threatened status	Migratory status	Operational Area / EMBA	
				Operational Area	EMBA
Actitis hypoleucos	Common Sandpiper	N/A	Migratory	Y	Y
Calidris acuminata	Sharp-tailed Sandpiper	N/A	Migratory	Y	Y
Calidris melanotos	Pectoral Sandpiper	N/A	Migratory	Y	Y
Pandion haliaetus	Osprey	N/A	Migratory	Y	Y
Calidris ferruginea	Curlew Sandpiper	Critically Endangered	Migratory	Y	Y
Macronectes giganteus	Southern Giant-Petrel	Endangered	Migratory	Y	Y
Pterodroma mollis	Soft-plumaged Petrel	Vulnerable	N/A	Y	Y
Sternula nereis	Australian Fairy Tern	Vulnerable	N/A	Y	Y
Ardenna carneipes	Flesh-footed Shearwater	N/A	Migratory	Y	Y
Anous tenuirostris melanops	Australian Lesser Noddy	Vulnerable	N/A	N/A	Y
Calonectris leucomelas	Streaked Shearwater	N/A	Migratory	N/A	Y
Fregata minor	Great Frigatebird	N/A	Migratory	N/A	Y
Limosa lapponica baueri	Bar-tailed Godwit	Vulnerable	Migratory	N/A	Y
Limosa lapponica menzbieri	Northern Siberian Bar-tailed Godwit	Critically Endangered	Migratory	N/A	Y
Macronectes halli	Northern Giant Petrel	Vulnerable	Migratory	N/A	Y
Papasula abbotti	Abbott's Booby	Endangered	N/A	N/A	Y
Rostratula australis	Australian Painted-snipe	Endangered	N/A	N/A	Y
Diomedea amsterdamensis	Amsterdam Albatross	Endangered	Migratory	N/A	Y
Diomedea epomophora	Southern Royal Albatross	Vulnerable	Migratory	N/A	Y
Diomedea exulans	Wandering Albatross	Vulnerable	Migratory	N/A	Y
Diomedea sanfordi	Northern Royal Albatross	Endangered	Migratory	N/A	Y
Thalassarche carteri	Indian Yellow-nosed Albatross	Vulnerable	Migratory	N/A	Y
Thalassarche cauta	Shy Albatross, Tasmanian Shy Albatross	Vulnerable	Migratory	N/A	Y

Species	Common name	Threatened status	Migratory status	Operational Area / EMBA	
				Operational Area	EMBA
Thalassarche cauta steadi	White-capped Albatross	Vulnerable	Migratory	N/A	Y
Thalassarche impavida	Campbell Albatross	Vulnerable	Migratory	N/A	Y
Thalassarche melanophris	Black-browed Albatross	Vulnerable	Migratory	N/A	Y
Thalassarche cauta	Tasmanian Shy Albatross	Vulnerable	Migratory	N/A	Y
Apus pacificus	Fork-tailed Swift	N/A	Migratory	N/A	Y
Ardenna pacifica	Wedge-tailed Shearwater	N/A	Migratory	N/A	Y
Hydroprogne caspia	Caspian Tern	N/A	Migratory	N/A	Y
Onychoprion anaethetus	Bridled Tern	N/A	Migratory	N/A	Y
Sterna dougallii	Roseate Tern	N/A	Migratory	N/A	Y
Charadrius veredus	Oriental Plover	N/A	Migratory	N/A	Y
Glareola maldivarum	Oriental Pratincole	N/A	Migratory	N/A	Y
Thalasseus bergii	Crested Tern	N/A	Migratory	N/A	Y
Tringa nebularia	Common Greenshank	N/A	Migratory	N/A	Y
Limosa	Black-tailed Godwit	N/A	Migratory	N/A	Y
Pluvialis squatarola	Grey Plover	N/A	Migratory	N/A	Y
Numenius phaeopus	Whimbrel	N/A	Migratory	N/A	Y
Sternula albifrons	Little Tern	N/A	Migratory	N/A	Y
Phaethon lepturus	White-tailed Tropicbird	N/A	Migratory	N/A	Y
Phaethon rubricauda	Red-tailed Tropicbird	N/A	Migratory	N/A	Y
Arenaria interpres	Ruddy Turnstone	N/A	Migratory	N/A	Y
Calidris alba	Sanderling	N/A	Migratory	N/A	Y
Calidris ruficollis	Red-necked Stint	N/A	Migratory	N/A	Y
Tringa brevipes	Grey-tailed Tattler	N/A	Migratory	N/A	Y

Species	Common name	Threatened status	Migratory status	Operational Area / EMBA	
				Operational Area	EMBA
Tringa glareola	Wood Sandpiper	N/A	Migratory	N/A	Y
Xenus cinereus	Terek Sandpiper	N/A	Migratory	N/A	Y

Listed Threatened Species Recovery Plans

The requirements of the species recovery plans and conservation advice (**Table 4-5**) were considered to identify any requirements that may be applicable 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 undertaken to facilitate the conservation of a listed species or ecological community.

Table 4-5 outlines the recovery plans and conservation advice relevant to those species identified as potentially occurring within or using habitat in the Operational Area and EMBA areas by the EPBC Act Protected Matters search (**Appendix C**) and summarises the key threats to those species, as described in relevant recovery plans and conservation advice.

Table 4-5: Conservation advice for EPBC Act listed species considered during environmental risk assessment

Species	Recovery plan/conservation advice (date issued)	Key threats identified in the recovery plan/ conservation advice	Relevant Conservation Actions	Relevant EP section
All vertebrate fauna				
All vertebrate fauna	Threat abatement plan for the impacts of marine debris on vertebrate marine life (DoEE 2018).	Marine debris	No explicit management actions for non-fisheries-related industries (note that management actions in the plan relate largely to management of fishing waste (e.g. 'ghost' gear), and state and Commonwealth management through regulation.	**6.7.7**
Cetaceans (Whales and Dolphins)				
Sei whale	Conservation Advice for *Balaenoptera borealis* (Sei whale) (Threatened Species Scientific Committee 2015a)	Noise interference	Assess and manage acoustic disturbance	**6.6.6**
		Vessel disturbance	Assess and manage physical disturbance and development activities	**6.7.8**
Blue whale	Conservation management plan for the blue whale: A recovery plan under the EPBC Act 1999 2015-2025 (Commonwealth of Australia 2015a)	Noise interference	Assess and addressing anthropogenic noise	**6.6.6**
		Vessel disturbance	Minimise vessel collisions	**6.7.8**
Fin whale	Approved Conservation Advice for *Balaenoptera physalus* (Fin whale) (Threatened Species Scientific Committee 2015b)	Noise interference	Assess and addressing anthropogenic noise	**6.6.6**
		Vessel disturbance	Minimise vessel collisions	**6.7.8**
Southern right whale	Conservation management plan for the southern right whale: a recovery plan under the EPBC Act 1999 2011-2021 (DSEWPaC 2012b)	Noise interference	Assess and address anthropogenic noise	**6.6.6**
		Vessel disturbance	Address vessel collisions	**6.7.8**
Humpback whale	Approved Conservation Advice for *Megaptera novaeangliae* (humpback whale) (Threatened Species Scientific Committee 2015a)	Noise interference	For actions involving acoustic impacts (example pile driving, explosives) on humpback whale calving, resting, feeding areas, or confined migratory pathways, site-specific acoustic modelling should be undertaken (including cumulative noise impacts).	**6.6.6**
		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	**6.7.8**

Species	Recovery plan/conservation advice (date issued)	Key threats identified in the recovery plan/ conservation advice	Relevant Conservation Actions	Relevant EP section
			appropriate mitigation measures are implemented to reduce the risk of vessel strike.	
Australian sea lion	Issues paper for the Australian sea lion (*Neophoca cinerea*) (DSEWPaC 2013a)	Oil pollution	Improve the understanding of – and where necessary mitigate – the threat posed to Australian sea lion populations by illegal killings, vessel strike, pollution and oil spills.	**6.7.2**
	Recovery plan for the Australian sea lion (*Neophoca cinerea*) (DSEWPaC 2013b)			
Reptiles				
All Marine turtle species (loggerhead, green, leatherback, hawksbill, flatback	Recovery plan for marine turtles in Australia (Commonwealth of Australia 2017)	Light pollution	Minimise light pollution.	**6.6.5**
		Chemical and terrestrial discharge (oil pollution)	Ensure that spill risk strategies and response programs include management for turtles and their habitats.	**6.7.2** **Appendix D**
		Vessel disturbance	No explicit relevant management actions; vessel strikes identified as a threat.	**6.7.8**
		Noise interference	No explicit relevant management actions; vessel strikes identified as a threat.	**6.6.6**
Leatherback Turtle	Approved conservation advice for *Dermochelys coriacea* (Leatherback Turtle) (Threatened Species Scientific Committee 2008a)	Vessel disturbance	No explicit relevant management actions; vessel strikes identified as a threat.	**6.7.8**
Short-nosed seasnake	Approved conservation advice for *Aipysurus apraefrontalis* (short-nosed sea snake) (Department of the Environment 2013a)	No additional threats identified (ex. marine debris)	None applicable	N/A
Sharks and Rays				
White shark	Recovery plan for the white shark (*Carcharodon carcharias*) (DSEWPaC 2013c)	No additional threats identified (ex. marine debris)	None applicable	N/A

Species	Recovery plan/conservation advice (date issued)	Key threats identified in the recovery plan/ conservation advice	Relevant Conservation Actions	Relevant EP section
All sawfish (green, dwarf, narrow)	Sawfish and river shark multispecies recovery plan (Commonwealth of Australia 2015b).	Habitat degradation/ modification	No explicit relevant management actions; habitat loss, disturbance and modification identified as a threat.	**6.7.2** to **6.7.10**
Dwarf sawfish	Approved conservation advice for *Pristis clavata* (dwarf sawfish) (Threatened Species Scientific Committee 2009).	Habitat degradation/ modification	No explicit relevant management actions; habitat loss, disturbance and modification identified as a threat.	**6.7.2** **6.7.3** **6.7.4**
Green sawfish	Approved conservation advice for green sawfish (Threatened Species Scientific Committee 2008b)	Habitat degradation/ modification	No explicit relevant management actions; habitat loss, disturbance and modification identified as a threat.	**6.7.2** **6.7.3** **6.7.4**
Grey nurse shark (west coast population)	Recovery Plan for the Grey Nurse Shark (*Carcharias taurus*) (Department of the Environment 2014)	No additional threats identified (ex. Marine debris)	None applicable	**6.7.2** **6.7.3** **6.7.4**
Whale shark	Approved Conservation advice *Rhincodon typus* (whale shark) (Threatened Species Scientific Committee 2015b)	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 WA coastline along the 200 m isobaths.	**6.7.8**
	Whale shark (*Rhyncodon typus*) recovery plan 2005-2010[5] (Department of the Environment and Heritage 2005a)	Habitat degradation/ modification	No explicit relevant management actions; habitat loss, disturbance and modification identified as a threat.	**6.7.2** **6.7.3** **6.7.4**
Birds				
Migratory shorebird species	Wildlife conservation plan for migratory shorebirds (Commonwealth of Australia 2015c).	Habitat degradation/ modification	Ensure all areas important to migratory shorebirds in Australia continue to be considered in development assessment processes.	**6.7.2** to **6.7.10**

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[5] 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	Recovery plan/conservation advice (date issued)	Key threats identified in the recovery plan/ conservation advice	Relevant Conservation Actions	Relevant EP section
Red knot, knot	Approved Conservation Advice for *Calidris canutus* (red knot) (Threatened Species Scientific Committee, 2016c)	Pollution/contamination	No explicit relevant management actions; pollution identified as a threat.	**6.7.2** to **6.7.10**
Eastern curlew, far eastern curlew	Approved Conservation Advice for *Numenius madagascariensis* (eastern curlew) (Threatened Species Scientific Committee, 2015d)	Pollution/contamination	No explicit relevant management actions; pollution identified as a threat.	**6.7.2** to **6.7.10**
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.	**6.7.2** to **6.7.10**
Abbott's booby	Conservation advice *Papasula abbotti* Abbott's booby (Threatened Species Scientific Committee, 2015f)	Habitat degradation/ modification	No explicit relevant management actions.	**6.7.2** to **6.7.10**
Australian painted snipe	Approved conservation advice on *Rostratula australis* (Australian Painted Snipe) (Threatened Species Scientific Committee 2013)	Habitat degradation/ modification	No explicit relevant management actions; habitat degradation/modification identified as a threat	**6.7.2** to **6.7.10**
Curlew sandpiper	Approved Conservation Advice for Calidris ferruginea (Curlew Sandpiper) (Threatened Species Scientific Committee 2015c)	Acute pollution	Ensure all areas important to migratory shorebirds in Australia continue to be considered in development assessment process.	**6.7.2** to **6.7.10**
All Petrels and Albatrosses (southern giant-petrel, soft-plumaged petrel, 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 2011)	No additional threats identified (ex. marine debris)	No explicit relevant management actions; oil pollution recongnised as a threat	**6.7.2** to **6.7.10**
Australian fairy tern	Conservation advice for *Sterna nereis* (Australian Fairy tern) (Threatened Species Scientific Committee 2011a)	Habitat degradation/ modification	No explicit relevant management actions; habitat degradation/modification identified as a threat.	**6.7.2** **6.7.3**

Species	Recovery plan/conservation advice (date issued)	Key threats identified in the recovery plan/ conservation advice	Relevant Conservation Actions	Relevant EP section
				6.7.4
Bar-tailed godwit (*baueri*)	Conservation advice *Limosa lapponica baueri* bar-tailed godwit (western Alaskan) (Threatened Species Scientific Committee 2016a)	Habitat degradation/ modification Pollution	No explicit relevant management actions; habitat degradation/modification identified as a threat.	**6.7.2** to **6.7.10**
Northern Siberian bar-tailed godwit	Conservation advice *Limosa lapponica menzbieri* bar-tailed godwit (northern Siberian) (Threatened Species Scientific Committee 2016b)	Habitat degradation/ modification Pollution	No explicit relevant management actions.	**6.7.2** to **6.7.10**

Habitat Critical to the Survival of a Species

In accordance with the EPBC Act Significant Impact Guidelines 1.1 – Matters of National Environmental Significance, an action is deemed to have a significant impact if there is a real chance or possibility that it will adversely affect 'habitat critical to the survival of a species'. Habitat critical to the survival of a species for marine turtles has identified nesting and internesting habitat for each genetic stock based on a set criterion outlined in the Recovery Plan for Marine Turtles in Australia 2017-2027 (Commonwealth of Australia, 2017). The Operational Area does not include any habitat critical to the survival of a species though some are located in the EMBA (as described below in **Table 4-6**).

Table 4-6: Nesting and internesting areas identified as habitat critical to the survival of marine turtles for each stock that overlap the EMBA.

Species	Nesting Location	Major nesting area	Internesting buffer	Nesting period	Hatching period
Green turtle	Barrow Island	✓	20 km	Nov-Mar	Jan-May (peak: Feb-Mar)
	Montebello Islands (all with sandy beaches)	✓	20 km	Nov-Mar	Jan-May (peak: Feb-Mar)
	Serrurier Island		20 km	Nov-Mar	Jan-May (peak: Feb-Mar)
	Thevenard Island		20 km	Nov-Mar	Jan-May (peak: Feb-Mar)
	Northwest Cape	✓	20 km	Nov-Mar	Jan-May (peak: Feb-Mar)
	Ningaloo Coast		20 km	Nov-Mar	Jan-May (peak: Feb-Mar)
Loggerhead turtle	Dirk Hartog Island	✓	20 km	Nov-May	Jan-May
	Muiron Islands	✓	20 km	Nov-May	Jan-May
	Gnaraloo Bay	✓	20 km	Nov-May	Jan-May
	Ningaloo Coast		20 km	Nov-May	Jan-May
Flatback turtle	Montebello Islands (all with sandy beaches)		60 km	Oct-Mar	Feb-Mar
	Barrow Island	✓	60 km	Oct-Mar	Feb-Mar
	coastal islands from Cape Preston to Locker Island		60 km	Oct-Mar	Feb-Mar
Hawksbill turtle	Montebello Islands (including Ah Chong Island, South East Island and Trimouille Island)	✓	20 km	Oct-Feb	all year (peak: Dec-Feb)
	Lowendal Islands (including Varanus Island, Beacon Island and Bridled Island)		20 km	Oct-Feb	all year (peak: Dec-Feb)

Biologically Important Areas

A review of the National Conservation Values Atlas identified that the following biologically important areas (BIAs) overlap spatially with the Operational Area:

- Humpback whale migration (annual seasonal migration with their presence during peak periods in the Exmouth region between June–August (northbound migration) and August to October, following closer to the WA coastline (southbound migration)).
- Pygmy blue whale migration (annual seasonal migration with peak numbers passing Exmouth region towards Indonesia between April–August (northerly migration)) and their southerly return passing North West Cape (late November–December)).
- Foraging, breeding area for the wedge-tailed shearwater during its breeding season (August–April).

The Marine bioregional plan for the North-west Marine Region (prepared under the *Environment Protection and Biodiversity Conservation Act 1999*) defines a BIA as a defined area of spatial aggregations of individuals of a species are known in the literature to demonstrate biologically important behavior such as breeding, foraging, resting and migration. A number of BIAs occur within the EMBA, which are provided in **Table 4-7**. Additional information on BIAs is provided in the species-specific summaries throughout **Section 4.5.2**.

Table 4-7: BIAs within the Operational Area and in the EMBA

Species	BIA type	Distance of BIA from Operational Area (km)
Marine Mammals		
Humpback whale	Migration (Exmouth)	Overlaps Operational Area
Pygmy blue whale	Migration (Exmouth, North West Cape)	Overlaps Operational Area
Dugong	Multi-use (breeding/calving/foraging/nursing) (Exmouth Gulf and Ningaloo Reef)	26
Australian Sea lion	Foraging (Shark Bay[1], Abrolhos and adjacent coast)	744
Marine Reptiles		
Flatback turtle	Internesting (Thevenard Island[1], Montebello Islands, Dampier Archipelago)	6
	Nesting (Thevenard Island [1], Barrow Island, Montebello Islands)	66
	Foraging (Montebello Islands[1], Barrow Island)	146
	Mating (Montebello Islands[1], Barrow Island)	146
Green turtle	Internesting (North West Cape[1], Muiron Islands, Montebello Islands, Barrow Island)	12
	Foraging (Montebello Islands)	178
	Mating (Montebello Islands)	178
	Nesting (Montebello Islands)	185
Hawksbill turtle	Internesting (Ningaloo coast and Jurabi coast[1], Thevenard Island, Barrow Island, Lowendal Islands, Montebello Islands, Varanus Island)	10
	Nesting (Ningaloo coast and Jurabi coast[1], Thevenard Island, Barrow Island, Varanus Island, Lowendal Islands)	30

Species	BIA type	Distance of BIA from Operational Area (km)
	Mating (Barrow Island[1], Lowendal Islands)	145
	Foraging (Barrow Island[1], Lowendal Islands)	142
Loggerhead turtle	Internesting (Ningaloo coast and Jurabi coast[1], Muiron Islands, Gnaraloo Bay, Montebello Islands, Lowenthal Island, Dirk Hartog Island)	11
	Nesting (Ningaloo coast and Jurabi coast[1], Muiron Islands, Gnaraloo Bay, Montebello Islands, Lowenthal Island, Dirk Hartog Island)	30
Sharks, Fish and Rays		
Whale Shark	Foraging (northward from Ningaloo along 200 m isobath)	8
	Foraging (Ningaloo Marine Park)	26
Great white shark	Foraging (Abrolhos)	736
Birds		
Wedge-tailed Shearwater	Foraging, breeding (Exmouth, Barrow Island, Dampier Archipelago, Shark Bay, Ningaloo)	Overlaps Operational Area
Australian Fairy Tern	Breeding, foraging (North West Cape[1], Shark Bay, Abrolhos, Montebello Islands, Barrow Island)	29
Lesser Crested Tern	Breeding (Thevenard Island[1], Barrow Island, Shark Bay)	72
Roseate Tern	Breeding (Ningaloo[1], Shark Bay, Dirk Hartog Island, Abrolhos, Thevenard Island, Barrow Island)	84
Bridled Tern	Foraging (south along the WA coast from Shark Bay)	497
Sooty Tern	Foraging (Abrolhos Islands and wider oceanic waters)	497
White-tailed Tropicbird	Breeding (Rowley Shoals)	560
White-faced Storm petrel[2]	Foraging (south from the Abrolhos Islands)	628
Little Shearwater[2]	Foraging (south from the Abrolhos Islands)	636
Little Tern	Resting (Rowley Shoals)	653
Caspian tern	Foraging (south from the Abrolhos Islands)	685
Common noddy	Foraging (Houtman Abrolhos Islands)	728
Pacific Gull[2]	Foraging (Abrolhos)	745
Australian Lesser Noddy	Foraging (Houtman Abrolhos Islands)	750
Australian Lesser Noddy	Foraging (Houtman Abrolhos Islands)	753
Soft-plumaged Petrel	Foraging (south from the Abrolhos Islands)	851

[1] Denotes the closest BIA to the Operational Area where multiple BIAs of the same type overlap the EMBA. Where relevant, distances have been provided for the BIAs closest to the Operational Area only.

[2] Species is not listed as threatened or migratory under EPBC Act (i.e. listed as least concern).

Seasonal Sensitivities of Protected Species

Periods of the year coinciding with key environmental sensitivities for the Operational Area and the EMBA, including EPBC Act listed threatened and/or migratory species, are presented in Table 4-8. These relate to breeding, foraging or migration of the indicated fauna.

Table 4-8: Key environmental sensitivities and timings for migratory fauna identified within the Operational Area and/or EMBA

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]								🟨	🟨	🟨	🟨	
Green turtle – various nesting areas[5]	🟥	🟥	🟨								🟨	🟨
Flatback turtle – various nesting areas[5]	🟥	🟨	🟨							🟨	🟨	🟥
Loggerhead turtle – various nesting areas[5]	🟥	🟨	🟨	🟨	🟨						🟨	🟥
Hawksbill turtles – various nesting areas[6]	🟨	🟨								🟨	🟨	🟨
Manta rays – presence/aggregation/breeding (Ningaloo)[7]			🟨	🟨	🟨	🟨	🟨	🟨				
Whale shark* – foraging/aggregation near Ningaloo[8]			🟨	🟥	🟥	🟨	🟨	🟨	🟨	🟨	🟨	
Caspian tern – breeding (Ningaloo)[9]						🟨	🟨	🟨	🟨	🟨	🟨	
Crested tern – breeding (Ningaloo)[9]			🟨	🟨	🟨	🟨	🟨	🟨				
Australian Fairy tern – breeding (Ningaloo)[9]							🟨	🟨	🟨			
Osprey – breeding (Ningaloo)[9]				🟨	🟨	🟨	🟨	🟨	🟨	🟨		

Species	January	February	March	April	May	June	July	August	September	October	November	December
Roseate tern – breeding (Ningaloo)[9]								🟨	🟨	🟨	🟨	🟨
Wedge-tailed shearwater – various breeding sites[9]	🟨	🟨	🟨	🟨				🟨	🟨	🟨	🟨	🟨

🟨	Species likely to be present in the region
🟥	Peak period. Presence of animals reliable and predictable each year

References for species seasonal sensitivities:

1. *DSEWPaC, 2012a; McCauley and Jenner, 2010; McCauley, 2011*
2. *DSEWPaC, 2012a; McCauley and Jenner, 2010*
3. *CALM, 2005; Environment Australia, 2002; Jenner et al., 2001a; McCauley and Jenner, 2001*
4. *McCauley and Jenner, 2001*
5. *Commonwealth of Australia, 2017; Chevron, 2015; CALM, 2005; DSEWPaC, 2012a*
6. *Commonwealth of Australia, 2017; Chevron, 2015*
7. *Environment Australia, 2002*
8. *CALM, 2005; Environment Australia, 2002*
9. *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.)*

4.5.2.2 Marine Mammals

Cetaceans – Whales

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 up to Port Hedland 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 and the EMBA are unlikely to represent an important habitat for this species. Their presence in the Operational Area is likely to be a remote occurrence and limited to a few individuals infrequently transiting the area. In the EMBA, the antarctic minke whale may be seasonally present during winter months in low numbers.

Blue Whale

There are two recognised subspecies of blue whale in the Southern Hemisphere, both of which are recorded in Australian waters. These are the southern (or 'true') blue whale (*Balaenoptera musculus*) and the ‘pygmy' blue whale (*Balaenoptera musculus brevicauda*) (Commonwealth of Australia 2015a). 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) (Commonwealth of Australia 2015a). On this basis, nearly all blue whales sighted in the NWMR are likely to be pygmy blue whales.

Pygmy blue whales are known to undertake seasonal migration between temperate/sub-Antarctic and tropical waters (Double et al., 2014). In the NWMR, pygmy blue whales migrate along the 500 m to 1000 m depth contour on the edge of the slope. They are likely to carry out opportunistic feeding on ephemeral krill aggregations (DEWHA 2008). Sea noise loggers and satellite tracking at various locations along the Western Australian coast have detected an annual northbound migration past Exmouth and the Montebello Islands between April and August, and south-bound migration from October to the end of January, peaking in late November to early December (Double et al., 2014; McCauley and Duncan, 2011; McCauley and Jenner, 2010).

Satellite tagging (2009-2012) of pygmy blue whales off the Perth Canyon confirmed the general distribution of pygmy blue whales was offshore in water depths over 200 m and commonly over 1000 m (Double et al., 2012b) (**Figure 4-9**). Data showed that whales tagged during March and April migrated northwards post tag deployment. The tagged whales travelled relatively near to the Australian coastline (100.0 ± 1.7 km) until reaching North West Cape after which they travelled offshore (238.0 ± 13.9 km). Whales reached the northern terminus of their migration and potential breeding grounds in Indonesian waters by June (Double et al., 2014).

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 blue whales within WA waters (migratory corridor and foraging areas). The plan also documents that the pygmy blue whale which feed off the Perth Canyon and the Bonney Upwelling (South Australia and Victoria) constitute the same population. The migration BIA off the coast of WA overlaps the Operational Area and EMBA. A foraging BIA lies off the Ningaloo Coast (beyond the Operational Area but within the EMBA), within which pygmy blue whales may feed (Double et al., 2014). The 2015 Conservation Management Plan for the Blue Whale (Commonwealth of Australia, 2015a) describes this BIA as a possible foraging area, where evidence for feeding is based on limited direct observations or indirect evidence, such as prey occurring close to the whale or satellite tracks showing circling tracks. The migration BIA off the coast of WA overlaps the Operational Area and EMBA.

In summary, pygmy blue whales are likely to occur within the Operational Area and EMBA, particularly during their defined annual migrations. When individuals do occur within the Operational Area and EMBA, it is likely there will be only one or a few individuals and their time in the area will be brief.

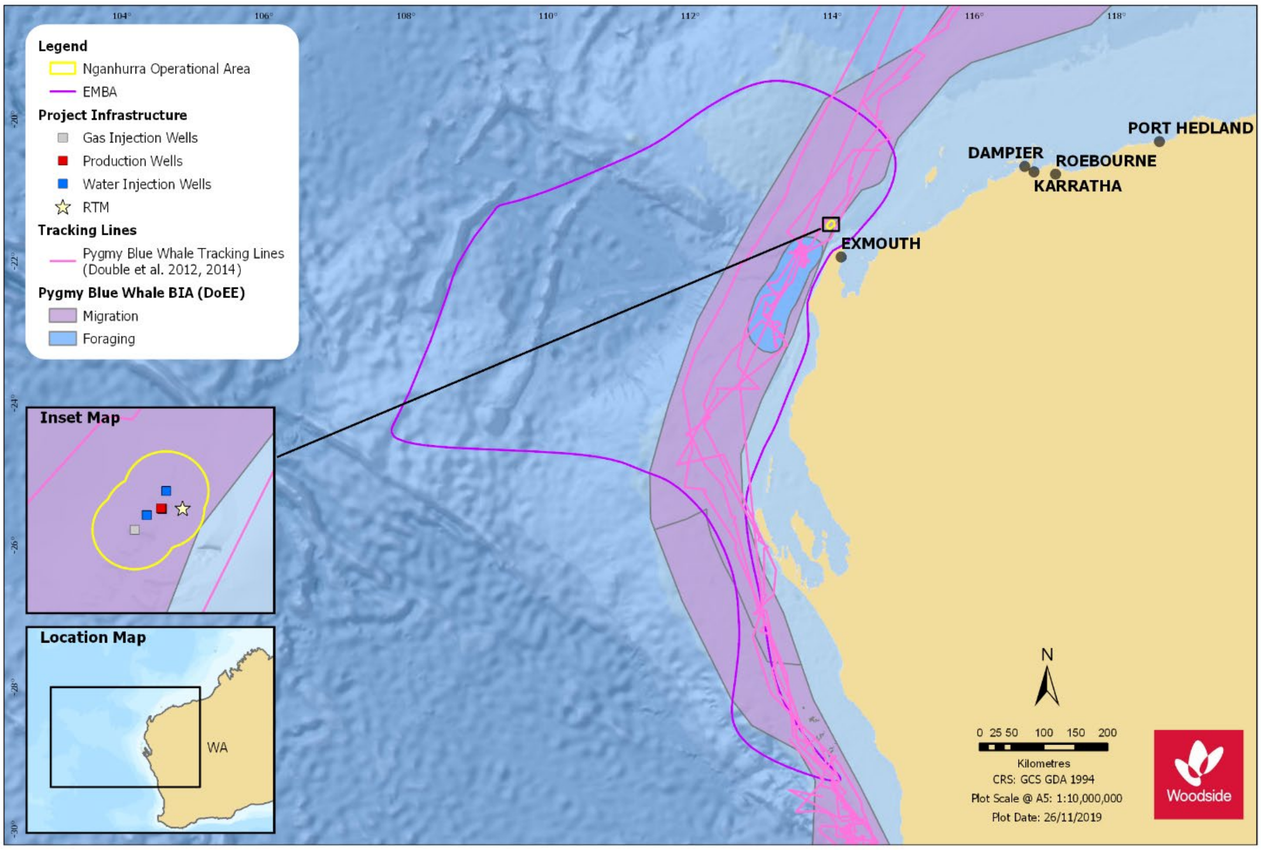

Figure 4-9: Pygmy blue whale satellite tracks and BIAs (Double et al. 2012b, 2014)

Bryde's Whale

The Bryde's whale was identified as potentially occurring within the Operational Area and EMBA. The Bryde's Whale occurs in tropical and temperate waters (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 (largely sedentary) and offshore (may undertake migration). Data suggest offshore whales may migrate seasonally, heading towards warmer tropical waters during the winter, however, information on migration is not well known (McCauley and Duncan, 2011). There is some taxonomic confusion, with Bryde's whales bearing similarity to, and being historically confused with, the sei whale (Bannister et al., 1996), particularly in whaling catch statistics (Slijper et al., 1964).

Bryde's whales may transit seasonally through a broad area of the continental shelf in the NWMR, including the Operational Area and EMBA (McCauley and Duncan, 2011; RPS Environment and Planning, 2012c). This species has been detected within the Northwest Province from mid-December to mid-June, peaking in late February to mid-April (RPS Environment and Planning 2012c). As such, the species may be seasonally encountered within the Operational Area, and is expected to occur in the EMBA, particularly in oceanic and continental slope waters.

Fin Whale

The fin whale is a large baleen whale with a cosmopolitan distribution in all ocean basins between 20 and 75 °S (Department of Environment and Heritage, 2005a). 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 also no known BIAs for fin whales in the NWMR. Fin whales are likely to infrequently occur within the Operational Area. Occurrence within the Operational Area and offshore areas of the EMBA is likely to be mostly restricted to one or a few individuals occasionally transiting the area, mainly during winter months when the species may move away from Antarctic feeding areas.

Humpback Whale

Humpback whales were identified as occurring within the Operational Area and EMBA. The species undertakes regular seasonal migrations between feeding grounds in the Southern Ocean and breeding and calving grounds off northern Western Australia, particularly Camden Sound (Jenner et al., 2001). Calving typically occurs at the northern extent of the migration corridor (beyond the EMBA). The humpback whale population that migrates along the Western Australian coast has been estimated to be as large as 33,300 in 2008, and has recovered significantly since the cessation of commercial whaling (Bejder et al., 2016).

Woodside has conducted marine megafauna aerial surveys that have confirmed that the temporal distribution of migrating humpback whales off the North West Cape has remained consistent since baseline surveys were first conducted in 2000 to 2001 (RPS Environment and Planning 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 to 300 m. Only small numbers of whales were observed to occur in the deeper offshore waters. These survey results are consistent with satellite tagging studies (Double et al., 2012a, 2010) (**Figure 4-10**).

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 (**Figure 4-10**), peaking in late July (Jenner et al., 2001). The southern migratory route follows a relatively narrow track between the Dampier Archipelago and Montebello Islands, north-east of the Operational Area. Exmouth Gulf and Shark Bay are known resting/aggregation areas for southbound humpback whales, and are recognised resting BIAs. In particular, Exmouth Gulf is where cow/calf pairs may stay for up to two weeks during September (Jenner et al., 2001). Both the Exmouth Gulf and Shark Bay resting BIAs are located approximately 36 km and 333 km respectively from the Operational Area.

Noise logger deployment conducted near the Greater Western Flank 2 development detected humpback whales present at the end of September, likely migrating south, and from late June to mid-August in deeper water, nearer to the continental shelf, likely migrating north (RPS Environment and Planning 2012c). The southward migration of cow/calf pairs is slightly later during October (extending into November and December). During the southbound migration, it is likely that most individuals, particularly cow/calf pairs, stay closer to the coast than the northern migratory path. The peak of the northward migration in the vicinity of the Operational Area is during July, whilst the southern migration peak is late August/early September. Humpback whales may occur within the Operational Area and EMBA during these migration periods.

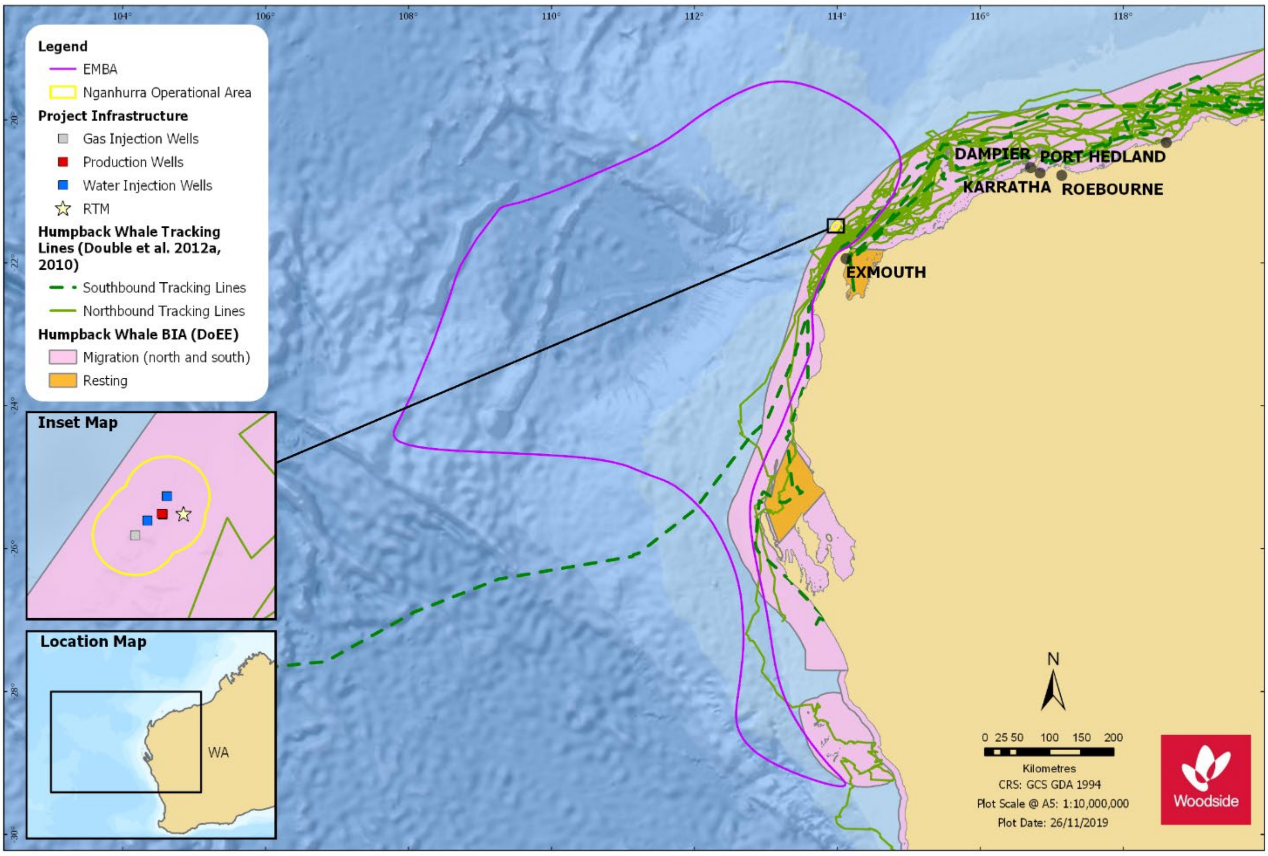

Figure 4-10: Humpback whale satellite tracks and BIA (Double et al. 2012a, 2010)

Sei Whale

Sei whales were identified as potentially occurring within the Operational Area and EMBA. Sei whales have a worldwide oceanic distribution, and are expected to migrate seasonally between low latitude wintering areas and high latitude (Antarctic) summer feeding grounds (Bannister et al., 1996; Prieto et al., 2012). Sei whales have been infrequently recorded in Australian waters (Bannister et al., 1996), which could be due to the similarity in appearance of sei whales and Bryde's whales leading to incorrect recordings.

They have been sighted inshore (in the proximity of the Bonney upwelling, Victoria) as well as in deeper offshore waters and have only been sighted in summer and autumn. There are no known mating or calving areas in Australian waters (Department of the Environment and Energy (DoEE) 2019). While sei whales have been sighted inshore (in the proximity of the Bonney Upwelling, Victoria), they prefer deep waters and typically occur 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., 1996). Neither the Operational Area nor EMBA are considered critical habitat for sei whales. Sei whales are likely to occur within the Operational Area and EMBA.

Southern Right Whale

Southern right whales were identified as potentially occurring within the EMBA. The southern right whale occurs primarily in waters between around 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 (DSEWPaC 2012b). During the calving season, between May and November, female southern right whales that are either pregnant or with calf can be present in shallow protected waters along the entire southern WA coast and west up to 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). Given the species prefers temperate waters and has rarely been recorded north of Exmouth, southern right whales are unlikely to occur within the Operational Area or EMBA.

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., 1996a). Within the EMBA, sperm whales have been recorded in deep water off North West Cape (Jenner et al., 2010, RPS Environment and Planning 2010a) and appear to occasionally venture into shallower waters in other areas (RPS Environment and Planning 2010b). The only key locality recognised in WA waters for sperm whales are foraging BIAs in the Perth Canyon, and on the outer continental shelf from Cape Naturaliste to south of Jurien, outside of the EMBA for the Petroleum Activities Program. A MC3D seismic survey campaign was conducted off the North West Cape, including the Operational Area, over five months from December 2016 to April 2017, which recorded 65 whale sightings (of variable pod sizes), and 23 of those sightings were sperm whales. These sperm whale sightings occurred approximately 50 km offshore and in water depths between 500-1000 m depth (Woodside Energy Limited, 2019). Given the wide distribution of sperm whales and their preference for deeper oceanic waters, the Operational Area and EMBA is unlikely to represent an important habitat for this species. Their presence is likely to be a rare occurrence and limited to individuals infrequently transiting the area.

Cetaceans – Dolphins and Porpoises

Killer Whale

Killer whales are found in all of the world’s oceans, from the Arctic and Antarctic regions to tropical seas (Department of Environment, 2013a; Ford at al., 2005), and have 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, particularly near seal colonies, as well as in shallow coastal areas of WA (Bannister et al., 1996; Thiele & Gill, 1999).

Anecdotal evidence suggests killer whales may feed on dugongs in Shark Bay (outside the EMBA), between June and August (Department of Environmental Protection, 2001), but there are no recognised key localities or important habitats for killer whales within the Operational Area or EMBA. The presence of killer whales is likely to be a rare occurrence and limited to individuals infrequently transiting the EMBA, with a very low likelihood of them transiting the Operational Area.

Spotted Bottlenose Dolphin (Arafura/Timor Sea Populations)

There are four known subpopulations of spotted bottlenose dolphins, of which the Arafura/Timor Sea populations were identified as potentially occurring within the Operational Area and the EMBA. The species occurs in open coastal waters, primarily within the continental shelf, and within the coastal waters of oceanic islands from Shark Bay to the western edge of the Gulf of Carpentaria. The species forages in a wider range of habitats and within deeper waters than most dolphin species, but is generally restricted to water depths of less than 200 m (DSEWPaC, 2012a).

The Arafura/Timor Sea spotted bottlenose dolphin population is considered migratory; however, its movement patterns are considered highly variable, with some individuals displaying year-round residency to a small area and others undertaking long-range movements and migrations (DSEWPaC, 2012a). Given the distribution of spotted bottlenose dolphins and their preference for shallow coastal waters, the Operational Area is unlikely represent an important habitat for this species. Their presence is likely to be a remote and limited to infrequent transiting of the area, although they are expected to occur in the EMBA.

4.5.2.3 Marine Reptiles

Marine Turtles

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

With consideration of the distance offshore, depth range of surrounding offshore waters (400-600 m), and absence of potential nesting or foraging sites (i.e. no emergent islands, reef habitat or shallow shoals) the Operational Area is not considered an important habitat for marine turtles.

Four of the turtle species (green, loggerhead, flatback and hawksbill) have significant nesting rookeries on beaches along the mainland coast and islands in the EMBA including Ningaloo Coast, North West Cape, Lowendal islands, Muiron Islands, Gnaraloo Bay and Dirk Hartog Island (Commonwealth of Australia, 2017; Limpus, 2009, 2008a, 2008b, 2007). **Table 4-9** 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 EMBA).

Table 4-9: Key information on marine turtles in the North-west Marine Region

Turtle Species	Key Seasons within the NWMR	Diet	Key Habitats
Green Turtle	**Breeding**: Approximately September to December **Nesting**: November to March. Peak period from December 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 (Commonwealth of Australia, 2017). **Internesting habitat**: Generally within 10 km of nesting beaches (Waayers et al., 2011). **Nearest BIA**: None overlap the Operational Area. Refer to **Table 4-7** for BIAs/habitat critical to the survival of a species* within the EMBA.
Loggerhead Turtle	**Breeding**: Approximately September to March **Nesting**: November to March. Peak period in 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 Gnaraloo 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 (Commonwealth of Australia, 2017). **Nearest BIA**: None overlap the Operational Area. Refer to **Table 4-7** for BIAs/habitat critical to the survival of a species* within the EMBA.

Turtle Species	Key Seasons within the NWMR	Diet	Key Habitats
Hawksbill Turtle	**Breeding**: All year round **Nesting**: All year round with peak in October to 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 (Limpus 2009). **Internesting habitat**: Limited data on Australian hawksbill turtles, however literature indicates internesting habitat for this species is generally within 20 km of nesting beaches (Commonwealth of Australia, 2017). **Nearest BIA**: None overlap the Operational Area. Refer to **Table 4-7** for BIAs/habitat critical to the survival of a species* within the EMBA.
Flatback Turtle	**Breeding**: September to January **Nesting**: October to March with peak period in November 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; Whittock et al., 2014). Satellite tracking of flatback turtle nesting populations at Barrow Island indicates that this species travels to the east of Barrow Island, towards WA mainland coastal waters, between nesting events. **Nearest BIA**: None overlap the Operational Area. Refer to **Table 4-7** for BIAs/ habitat critical to the survival of a species* within the EMBA.
Leatherback Turtle	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 NWMR but noted that there are no known nesting sites within the NWMR. **Nearest BIA/Critical Habitat:** No known BIAs for leatherback turtles in the Operational Area or EMBA.

** Habitat critical to the survival of a species identified in the Recovery Plan for Marine Turtles in Australia 2017–2027 (Commonwealth of Australia, 2017) see Section 4.5.2.1*

Post-nesting migratory routes for green, hawksbill and flatback turtles recorded for the NWMR (Barrow Island and mainland sites) (Chevron Australia Pty Ltd, 2015) and green turtle tracking for post-nesting individuals from Scott Reef (Guinea, 2009), indicated no overlap with the Operational Area or the EMBA. Green, flatback and hawksbill turtles travelling from nesting sites to foraging grounds generally travelled east or south of Barrow Island and 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 Australia Pty Ltd, 2015).

Tracking data indicate the three marine turtle species recorded for the NWMR travel and forage in coastal waters that are relatively shallow (Chevron Australia Pty Ltd, 2015) as follows:

- Hawksbill turtles – less than 10 m deep
- Green turtles – less than 25 m deep
- Flatback turtles – less than 70 m deep.

Based on the results of tagging studies, along with the absence of suitable foraging habitat in the Operational Area, flatback turtles are considered unlikely to be encountered within the Operational Area. However, the species is expected to occur within the EMBA, particularly in the vicinity of known nesting beaches between October and March.

Seasnakes

Seasnakes occur along the NWS 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 bycatch logs maintained by the Northern Prawn Fishery (DEWHA, 2008).

The short-nosed seasnake, listed as Critically Endangered under the EPBC Act, was identified as potentially occurring within the EMBA (although not within the Operational Area). This species has been recorded on the Sahul Shelf, in particular at Ashmore and Hibernia reefs, as well as Exmouth Gulf, and is strongly associated with shallow (<10 m) reef habitat.

Seasnakes of the families Hydrophidae and Laticaudidae are widespread in the EMBA and are protected under the EPBC Act. The Protected Matters search identified 15 species of seasnake listed as marine under the EPBC Act within the 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 within the Operational Area.

4.5.2.4 Fishes and Elasmobranchs

Seahorses and Pipefish

A total of 46 species of pipefish and seahorse (**Appendix C**) protected under the EPBC Act are identified as potentially occurring within the EMBA, however, bycatch data (Department of Fisheries 2010) indicate 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 in seagrass and sandy habitats around coastal islands and shallow reef areas along the NWS, and is likely to be found in coastal areas including the Ningaloo area. Recent data collected using Baited Remote Underwater Video Stations (BRUVS) at Rankin Bank and Glomar Shoals did not record any seahorses or pipefish (AIMS 2014). Seahorses and pipefish may be encountered in a wide variety of shallow habitats, including seagrass meadows, reefs and sandy substrates within the EMBA.

Sawfish

Narrow Sawfish

The narrow sawfish occurs from the northern Arabian Gulf to Australia and north to Japan. Like other sawfish in the family *Pristidae*, the narrow sawfish prefers shallow coastal, estuarine and riverine habitats, although may occur in waters up to 40 m deep (D'Anastasi et al., 2013). In Australia, the species may have a broad tropical distribution from approximately North West Cape in Western Australia to southern Queensland.

Like other sawfish species, the narrow sawfish has experienced considerable decline in numbers due to human activities, including fishing and habitat loss/damage (Cavanagh et al., 2003). They are not currently listed as threatened but are commonly caught as bycatch (Morgan et al., 2010). Given their depth and habitat preference, narrow sawfish are not expected to occur within the Operational Area and would only be infrequently encountered within the shallower waters of the EMBA.

Sharks

Whale Shark

The whale shark was identified as potentially occurring within the EMBA and Operational Area. Whale sharks aggregate annually to feed in the waters of the Ningaloo Coast (this feeding BIA lies approximately 26 km south of the Operational Area, within the EMBA) 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 population (comprising individuals that visit the reef at some point during their lifetime) has been estimated to range between 300 and 500 individuals and 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 approximately 30–50 m deep (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. Satellite tracking has shown that the sharks may follow three migration routes from Ningaloo (Meekan and Radford 2010, Wilson et al. 2006) (**Figure 4-11**):

- north-west, into the Indian Ocean
- directly north, towards Sumatra and Java
- north-east, passing through the NWS traveling along the shelf break and continental slope.

These studies provided the justification for a foraging BIA for whale sharks which lies to the east and north-east of the Operational Area (approximately 8 km at the closest point), as shown in **Figure 4-11.** Though the BIA has been defined as a foraging area for whale sharks, it is more likely to be a migration pathway with whale sharks undertaking opportunistic foraging. While no BIAs overlap 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 (Department of Conservation and Land Management 2005).

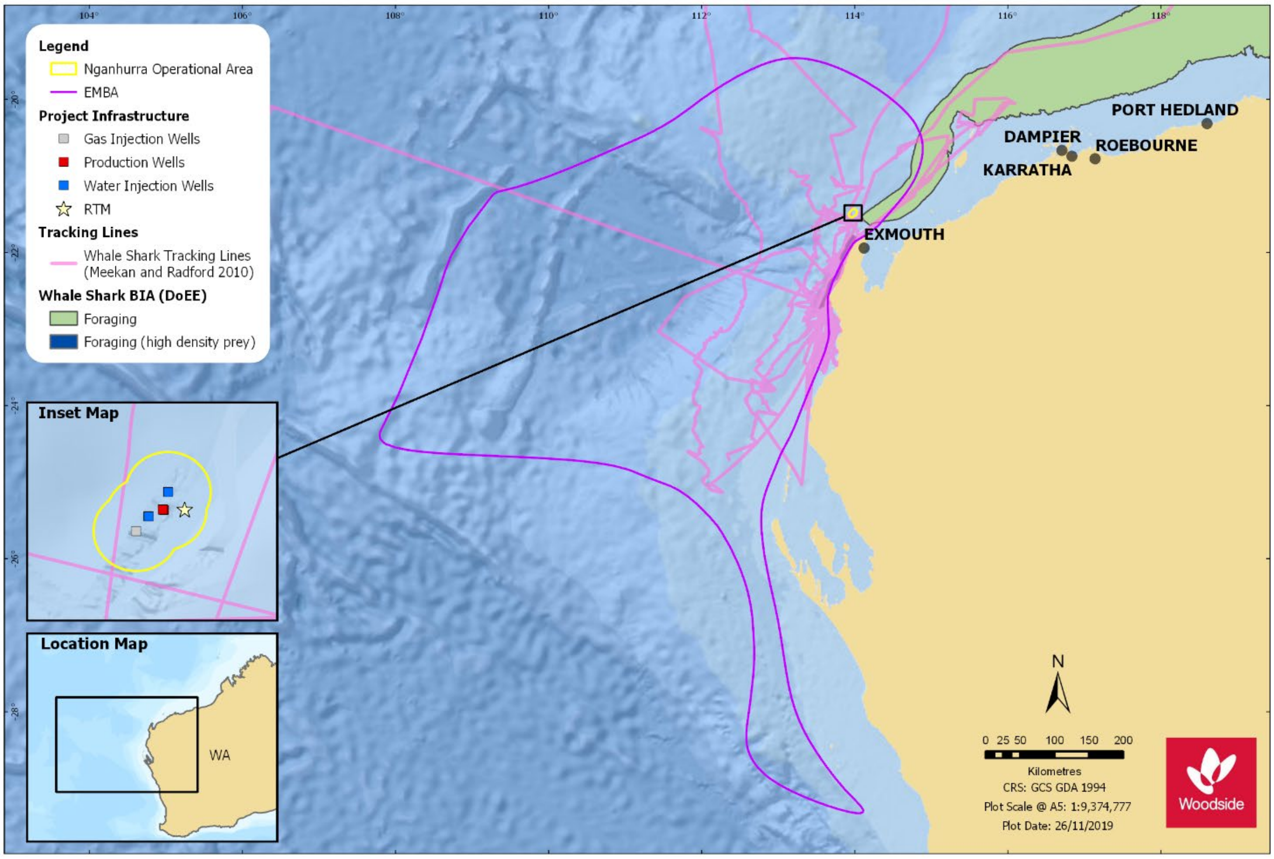

Figure 4-11: Satellite tracks of whale sharks tagged between 2005 and 2008 (after Meekan and Radford 2010)

Great White Shark

The great white shark was identified as potentially occurring within the Operational Area. The species typically occurs in temperate coastal waters between the shore and the 100 m depth contour; however, adults and juveniles have been recorded diving to depths of 1000 m (Bruce 2008, Bruce et al., 2006). They are also known to make open ocean excursions of several hundred kilometres and can cross ocean basins (Weng et al., 2007a, 2007b). Although great white sharks are not known to form and defend territories, they are known to return to on a seasonal/regular basis to regions with high prey density, such as pinniped colonies (Bruce, 2008).

Given the migratory nature of the species, its low abundance, broad distribution in temperate waters across southern Australia and absence of preferred prey (pinnipeds), great white sharks are unlikely to occur within the Operational Area or EMBA. No BIAs for great white sharks overlap the Operational Area or EMBA.

Shortfin Mako

The shortfin mako shark is a pelagic species with a circumglobal, wide-ranging oceanic distribution in tropical and temperate seas (Mollet et al., 2000). It is identified as potentially occurring within the Operational Area. The shortfin mako is commonly found in water with temperatures greater than 16 °C and can grow to almost 4 m. Females mature later (19 to 21 years) than males (seven to nine years) and adults have moderate longevity estimates of 28 to 29 years (Bishop et al., 2006). The shortfin mako shark is an apex and generalist predator that feeds on a variety of prey, such as teleost fish, other sharks, marine mammals and marine turtles (Campana et al., 2005). Tagging studies indicate shortfin makos spent most of their time in water less than 50 m deep but with occasional dives up to 880 m (Abascal et al., 2011; Stevens et al, 2010). Little is known about the population size and distribution of shortfin mako sharks in Western Australia, however it is possible they will transit the Operational Area and EMBA. No BIAs for the shortfin mako overlap the Operational Area or EMBA.

Longfin Mako

The longfin mako is a widely distributed but rarely encountered oceanic shark species. The species can grow to just over 4 m long and is found in northern Australian waters, from Geraldton in Western Australia to at least Port Stephens in New South Wales. It is uncommon in Australian waters relative to the shortfin mako (Bruce, 2013; Department of the Environment, Water, Heritage and the Arts, 2010). There is very little information about these sharks in Australia, with no available population estimates or distribution trends. A study from southern California documented juvenile longfin mako sharks remaining near surface waters, while larger adults were frequently observed at greater maximum depths of about 200 m (Sepulveda et al., 2004). Longfin mako may occur in the Operational Area and broader EMBA but, given their widespread distribution and apparent low density they are likely to be uncommon. No BIAs for the longfin mako overlap the Operational Area or EMBA.

Scalloped Hammerhead

The scalloped hammerhead is not currently included in the EPBC Act Protected Matters Search; however, the species is Conservation Dependent under the EPBC Act. Scalloped hammerheads are large sharks which are widely distributed in tropical and sub-tropical waters, primarily inhabiting shallow coastal shelfs. In Australian waters the species ranges from Geographe Bay in WA, around the northern coast to Wollongong in New South Wales (Harry et al., 2011). On the east coast of Australia pupping occurs year round, peaking during November and December, with juveniles remaining in shallow inshore habitats (Harry et al., 2011). The species is highly mobile but rarely ventures into deep offshore waters. Scalloped hammerheads are likely to occur within the Operational Area and EMBA.

Rays

Giant Manta Ray

The giant manta ray is broadly distributed in tropical waters of Australia. The species 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 the Ningaloo Reef, approximately 15 km south-west of the Operational Area but within the 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. No BIAs for the giant manta ray overlap the Operational Area or EMBA.

Pelagic Fish

Southern Bluefin Tuna

The southern bluefin tuna is not currently included in the EPBC Act Protected Matters Search; however, the species is Conservation Dependent under the EPBC Act. Southern bluefin tuna are highly migratory, occurring throughout waters 30° S to 50° S but mainly in the eastern Indian Ocean and south-western Pacific Ocean. In Australian waters, the species ranges from northern WA, around the southern coast to northern New South Wales. Juveniles are known to inhabit inshore waters (Honda et al., 2010) and the species is thought to congregate at reefs, lumps and seamounts

(Fujioka et al., 2010). Spawning occurs in warm waters south of Java from August–April with a peak during October–February (Honda et al., 2010). Following the spawning period juveniles migrate down the south coast of WA, with juveniles commonly found in the coastal waters of southern Australia during summer and in deeper, temperate oceanic waters during winter (Bestley et al., 2008; Willis et al., 2009). Southern bluefin tuna are likely to occur within the Operational Area and EMBA, particularly during summer when juveniles migrate southwards.

4.5.2.5 Birds

Oceanic Seabirds and/or Migratory Shorebirds

Based on the results of two survey cruises and other unpublished records, (Dunlop et al., 1988) recorded the occurrence of 18 species of seabirds over the NWS. 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 (Bamford et al., 2008; Commonwealth of Australia, 2015d).

The Operational Area may be occasionally visited by migratory and oceanic birds but does not contain any emergent land that could be utilised as roosting or nesting habitat and contains no known critical habitats (including feeding) for any species. Thirteen species of listed birds were identified by the EPBC Act Protected Matters search (**Appendix C**) for the Operational Area (Table 4-4).

One BIA (for the migratory wedge-tailed shearwater) overlaps the Operational Area, which relates to breeding between mid-August and April in the Pilbara; note the PMST report did not identify wedge-tailed shearwaters within the Operational Area.

Within the EMBA, there are numerous important habitats for seabirds and migratory shorebirds including key breeding/nesting areas, roosting areas and surrounding waters, important foraging and resting areas within the NWMR. These include (approximate distances from the Operational Area shown in brackets):

- Muiron Islands (37 km to Marine Management Area)
- Pilbara Islands (North, Middle and South groups – 180, 146, 67 km to closest State Nature Reserves, respectively)
- Shark Bay (442 km)
- Houtman Abrolhos Islands (795 km).

These habitats are discussed further as key environmental sensitivities in **Section 4.7**.

Australian Fairy Tern

The Australian fairy tern was identified as potentially occurring within the Operational Area. The species is a widely distributed shorebird and occurs along the coasts of New South Wales, Victoria, Tasmania, South Australia and Western Australia (Threatened Species Scientific Committee 2011a). In Western Australia, the species occurs along the coast as far north as the Dampier Archipelago and offshore islands Barrow/Montebello/Lowendal Islands Group (Threatened Species Scientific Committee 2011b, 2011a). No BIAs for the Australian fairy tern overlap the Operational Area, however, a breeding BIA on the Ningaloo Coast (approximately 27 km south of the Operational Area), and foraging BIA on the Houtman Abrolhos Islands (approximately 717 km south of the Operational Area) were identified within the EMBA.

Usage of this BIAs is seasonal, with the species typically found in the region during July, August and September (CALM 2005, Environment Australia 2002). Australian fairy terns nest above the high water mark in sandy substrates where vegetation is low (Threatened Species Scientific Committee 2011a). Australian fairy terns feed primarily on small schooling fish, and are rarely encountered beyond sight of land (BirdLife International 2014). Given the species' preference for coastal waters, the Australian fairy tern is unlikely to be encountered within the Operational Area, but may occur within the EMBA in littoral environments.

Common Noddy

The common noddy is the largest species of noddy found in Australian waters. 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 (Burbidge and Fuller, 1989). 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 may occur within the Operational Area and the EMBA, particularly around offshore and coastal islands.

Common Sandpiper

The common sandpiper is a small bird 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). In Australia, 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 presence of the common sandpiper within the Operational Area and EMBA is likely to be restricted to when they transit through during seasonal migration periods.

Curlew Sandpiper

The curlew sandpiper breeds in northern Siberia but has a non-breeding range that extends from western Africa to Australia, with small numbers reaching New Zealand (Bamford et al., 2008). In Australia, curlew sandpipers occur around the coasts and are also quite widespread inland, though in smaller numbers. Records occur in all states during the non-breeding period and also during the breeding season when many non-breeding one-year old birds remain in Australia rather than migrating north. Their presence in the Operational Area and EMBA is likely to be restricted to when they transit through the area during their seasonal migration periods.

Pectoral Sandpiper

Similar to other species of sandpiper, the pectoral sandpiper breeds in the northern hemisphere during the boreal summer, before migrating long distances to feeding grounds in the southern hemisphere (DEWHA 2006). The species occurs throughout mainland Australia between spring and autumn. 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 EMBA.

Sharp-tailed Sandpiper

Like other species of sandpiper, the sharp-tailed sandpiper is a migratory, wading shorebird and undertakes long distance seasonal migrations 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 and only infrequently in the EMBA as they transit through, particularly near offshore islands.

Eastern Curlew

The eastern curlew was identified as potentially occurring within the Operational Area. The species is Australia's largest shorebird and a long-haul flyer (Department of Environment and Energy 2016). The eastern curlew takes an annual migratory flight to Russia and north-eastern China to breed, arriving back in Australia in August to feed in intertidal mudflats (Bamford et al., 2008). No BIAs or critical habitats for the eastern curlew have been identified in the Operational Area or EMBA.

Flesh-footed Shearwater

The flesh-footed shearwater was identified as potentially occurring within the Operational Area, and the species mainly occurs in the subtropics, over continental shelves and slopes and occasionally inshore waters, with individual birds passing over deeper waters during migrations (Department of the Environment and Energy, 2016). They are a common visitor to the waters off southern Australia, from south-western Western Australia to south-eastern Queensland. The fleshy-footed shearwater is a trans-equatorial migrant, breeding from late September to May off south-western Australia, and migrating north by early May, across the southern Indian and possibly Indonesia to the northern Pacific Ocean (Department of the Environment and Energy, 2016). No BIAs for the flesh-footed shearwater were identified within the Operational Area or EMBA.

Lesser Frigatebird

The lesser frigatebird was identified as potentially occurring within the Operational Area. It is usually seen in tropical or warmer waters around the coast of north Western Australia, the Northern Territory, Queensland and northern New South Wales (DSEWPaC 2012d). Within the North-west Marine Region the lesser frigatebird is known to breed on Adele, Bedout and West Lacapede islands, Ashmore Reef and Cartier Islands (DSEWPaC 2012d). The lesser frigatebird feeds mostly on fish and sometimes cephalopods and all food is taken while the bird is in flight. Lesser frigatebirds generally forage close to breeding colonies. No BIAs for the lesser frigatebird were identified within the Operational Area or EMBA.

Osprey

The osprey was identified as potentially occurring within the Operational Area. The osprey is a medium-sized raptor (length 50–65 cm; wingspan 145–170 cm) that is widely distributed around Australia in coastal and wetland habitats (Department of the Environment, 2016b). The species also occurs throughout south-eastern Asia (Indonesia, Philippines, Palau Islands, New Guinea, Solomon Islands and New Caledonia) (Department of the Environment, 2016b). Ospreys feed almost exclusively on fish, typically capturing prey observed while flying by plunging feet first into the water (Clancy, 2005). Whilst listed as migratory, adults are generally restricted to a foraging area surrounding their nests (Department of the Environment, 2016b). Egg laying in Australia is protracted between April and February (Olsen and Marples, 1993), which may be due to the extended geographic range of the species within Australia and discrete genetic populations that may constitute subspecies (Olsen and Marples, 1993; Wink et al., 2004). Given the species' preference for coastal and wetland environments, it is unlikely to occur within the Operational Area, but may occur within the EMBA in coastal waters. No BIAs for the osprey were identified within the Operational Area or EMBA.

Red Knot

The red knot migrates long distances 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). The species is likely to occur in coastal wetland, intertidal sand or mudflats throughout the EMBA but is unlikely to occur in the Operational Area due to the lack of suitable habitat.

Soft-plumaged Petrel

The soft-plumaged petrel was identified as potentially occurring within the Operational Area. As a mainly sub-Antarctic species they are usually seen in cooler seas but have been recorded off south-eastern Australia in waters between 10-21°C (Department of the Environment 2013b). The petrel is a marine oceanic species but occasionally occurs inland and may transit the Operational Area and EMBA. No BIAs for the soft-plumage petrel were identified within the Operational Area or EMBA.

Southern Giant Petrel

The southern giant petrel was identified as potentially occurring within the Operational Area. The species is widespread throughout the Southern Ocean and breeds on six subantarctic and Antarctic islands within Australia (Patterson et al., 2008). The species is found mainly over Antarctic waters and migrates into subtropical waters during winter months. No critical habitat associated with the southern giant petrel has been identified for the Operational Area or EMBA, and therefore the presence of this species within the Operational Area is likely to be infrequent as individuals traverse the area. This is supported by the National Recovery Plan for Threatened Albatrosses and Giant Petrels 2011-2016, which identifies critical habitat for foraging in waters south of 25 degrees (DSEWPaC 2011). No BIAs for the southern giant petrel were identified in the Operational Area or EMBA.

4.6 Socio-economic and Cultural

4.6.1 Cultural Heritage

4.6.1.1 European and/or Indigenous Sites of Significance

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

Within the EMBA, Ningaloo Reef, Exmouth and the adjacent coastline have a long history of occupancy by Aboriginal communities. Indigenous heritage places are protected under the *Aboriginal Heritage Act 1972* (WA) or EPBC Act. A search of the Department of Planning, Lands and Heritage (DPLH) Aboriginal Heritage Inquiry System was undertaken for the shoreline within the socio-cultural EMBA (**Appendix G**). The search indicated there are numerous registered sites recorded, including middens, burial, ceremonial, artefacts, rock shelters, mythological and engraving sites recorded on the Montebello Islands (**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 hydrocarbon release, would involve prioritising further consultation with key contacts within DPLH and local Aboriginal communities (refer to **Section 6.7**).

4.6.1.2 Underwater Cultural Heritage

In 2018 the Australian Parliament passed the *Underwater Cultural Heritage Act 2018* (Underwater Heritage Act). The Act came into effect on 1 July 2019, replacing the *Historic Shipwrecks Act 1976*. This new Underwater Heritage Act continues the protection of Australia's shipwrecks, but has also broadened to include protection to sunken aircraft and other types of underwater cultural heritage.

A search of the Australian National Shipwreck Database (Department of the Environment and Energy n.d.), which records all known Maritime Cultural Heritage (shipwrecks, aircraft, relics and other underwater cultural heritage) in Australian waters, indicated that there are no known

Underwater Cultural Heritage sites within the Operational Area. However, a number of sites were identified within the EMBA; 28 of these (shipwrecks) were identified within 100 km of the Operational Area (**Table 4-10**).

Table 4-10: Recorded historical shipwrecks in the vicinity of the Operational Area (Department of the Environment and Energy n.d.)

Vessel name	Year wrecked	Wreck location*	Latitude (D.DD °S)	Longitude (D.DD °E)	Distance from Operational Area (km)
Beatrice	1899	Off North-West Cape	21.62	113.98	9
Gem	1893	North West Cape	21.62	113.98	9
Lady Ann	1982	North of North West Cape	21.40	114.20	19
Agnes	1893	Exmouth Gulf	21.75**	114.08**	26
Bell	1893	Exmouth	21.75**	114.08**	26
Elizabeth	1893	Exmouth Gulf	21.75**	114.08**	26
Ellen	1893	Exmouth Gulf	21.75**	114.08**	26
Florence	1893	Exmouth Gulf	21.75**	114.08**	26
Kapala	1964	Exmouth Gulf	21.75**	114.08**	26
Lamareaux	1893	Exmouth Gulf	21.75**	114.08**	26
Leave	1893	Exmouth Gulf	21.75**	114.08**	26
Lily Of The Lake	1875	Exmouth Gulf	21.75**	114.08**	26
Mabel	1893	Exmouth Gulf	21.75**	114.08**	26
Nellie	1893	Exmouth Gulf	21.75**	114.08†	26
Olive	1893	Exmouth Gulf	21.75**	114.08**	26
Pearl	1896	Exmouth Gulf, Meda Creek	21.75**	114.08**	26
Ruby	1893	Exmouth Gulf	21.75**	114.08**	26
Sea Queen	1893	Exmouth Gulf	21.75**	114.08**	26
Smuggler	1893	Exmouth Gulf	21.75**	114.08**	26
Unidentified Lugger	1893	Exmouth Gulf	21.75**	114.08**	26
Wild Wave	1875	Exmouth Gulf	21.75†**	114.08**	26
Emlyn Castle	1960	-	21.78	114.17	34
Mildura	1907	North-West Cape	21.78	114.17	34
Fairy Queen	1875	Exmouth N W Cape	21.82	114.19	38
Veronica	1928	Sunday Island, Exmouth Gulf	21.68	114.38	42
Rose	1908	Exmouth Guld	21.58	114.83	84
Cossack	1889	Exmouth Gulf	21.67	114.87	89
Old Onslow	-	Onslow	21.71	114.95	98

** Wreck location as recorded in Australian National Shipwreck Database (Department of the Environment and Energy n.d.)*

*** Considered an unreliable generic location – refer to stated wreck location*

4.6.1.3 World, National and Commonwealth Heritage Listed Places[6]

There are no heritage listed sites within the Operational Area; listed National and Commonwealth Heritage Places within the EMBA consist of:

- World Heritage Sites:
  - Ningaloo Coast World Heritage Area (approximately 15 km south of the Operational Area)
- National Heritage places:
  - The Ningaloo Coast National Heritage Place (approximately 15 km south of the Operational Area)
- Commonwealth Heritage places:
  - Ningaloo Marine Area (Commonwealth Waters) Commonwealth Heritage Place (approximately 15 km south of the Operational Area).

Two additional National Heritage listed places occur within the socio-cultural EMBA, including the Barrow Island and the Montebello-Barrow Islands Marine Conservation Reserves Nominated Heritage Place (about 142 km north-east of the Operational Area), and HMAS Sydney II and HMK Kormoran Shipwreck Sites National Heritage Place (approximately 590 km south the Operational Area).

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

4.6.2 Ramsar Wetlands

No Ramsar wetlands overlap the Operational Area or the EMBA.

4.6.3 Fisheries – Commercial

4.6.3.1 Commonwealth and State Fisheries

A number of Commonwealth and State fisheries are located within the Operational Area and EMBA. Fishcube data were requested to analyse the potential for interaction of fisheries with the Operational Area, which was used to determine consultation with State Fisheries who may be impacted by proposed petroleum activities (DPIRD, 2019a). **Table 4-11** provides further detail on the fisheries that have been identified through desk-based assessment and consultation (**Section 5**). **Figure 4-12**, **Figure 4-13** and **Figure 4-14** provides the designated fisheries management areas in relation to the Operational Area.

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[6] World Heritage designations are addressed in **Section 4.7**.[7] Qualitative measure

Table 4-11: Commonwealth and State fisheries within the Operational Area and Environment that May Be Affected (EMBA) (including the Socio-cultural EMBA).

Fishery	Operational Area	Within EMBA (incl. the Socio-cultural EMBA)	Potential for interaction within Operational Area	Description
Commonwealth Managed Fisheries				
North-West Slope Trawl Fishery	✓	✓	×	**Description**: The North West Slope Trawl Fishery licence area extends, from 114 °E to 125 °E, between the 200 m isobath and the outer boundary of the Australian Fishing Zone (AFZ) and Australian Exclusive Economic Zone (EEZ). The fishery traditionally targets scampi, deep water prawns and mixed snappers. 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 focussed in waters to the north-east of the Operational Area and EMBA, from offshore Barrow Island north to the south of Ashmore Reef (Mazloumi et al., 2019a). Activity in the fishery commenced in 1985, peaking at 21 active vessels in 1986-87. Activity has since decreased to stabilise at one or two active vessels each year since 2008-09, operating from Point Samson and Darwin (Mazloumi et al., 2019a). Fishing effort (number of trawl-hours) in the fishery is closely related to vessel activity, which increased during 2017-18 season. (Mazloumi et al., 2019a). **Licences/vessels**: four vessels active in 2017-18 season (Mazloumi et al., 2019a).
Southern Bluefin Tuna Fishery	✓	✓	×	**Description**: The Southern Bluefin Tuna Fishery licence area overlaps the Operational Area and EMBA, however current fishing effort is confined to southern and south-eastern Australia; within the Great Australian Bight (GAB), Tasmania and along the east coast of NSW (Patterson, et al., 2019). Southern bluefin tuna (*Thunnus maccoyii*) are known to spawn in the north-eastern Indian Ocean (Davis et al., 1990, Matsuura et al., 1997). The species has been heavily exploited by commercial fisheries worldwide. The fishery employs both longlining and purse seine net fishing methods, with the majority of fishing in Australia by purse-seine in the GAB (Patterson, et al., 2019). **Licences/vessels**: seven purse seine vessels, 31 longline vessels active in 2017-18 season (Patterson, et al., 2019)
Western Deepwater Trawl Fishery	✓	✓	×	**Description**: The Western Deepwater Trawl Fishery is located in deep water off Western Australia, between longitude115°08'E and the western boundary of the North West Slope Trawl Fishery (NWSTF) in the north (114°E), to the outer boundary of the AFZ. Recent changes to the boundary have occurred to align with the 200 m isobath (Mazloumi et al., 2019b). This fishery targets a number of deep water, demersal finfish and crustacean species. The nominated fishing grounds are extensive, however, the fishing effort is to the south, offshore of the North West Cape, with areas of fishing activity located to along Ningaloo Reef, west of Shark Bay, and offshore Perth Metropolitan area, in water greater than the

Fishery	Operational Area	Within EMBA (incl. the Socio-cultural EMBA)	Potential for interaction within Operational Area	Description
				200 m isobath. Fishing effort increased during the 2017-18 season compared to low effort in recent years after the early 2000's peak (Mazloumi et al., 2019b). **Licences/vessels**: three vessels active in 2017-18 season (Mazloumi et al., 2019b).
Skipjack Tuna Fishery	✓	✓	×	**Description**: The combined Western and Eastern Skipjack Tuna (*Katsuwonus pelamis*) Fishery encompasses the entire Australian EEZ, including the Operational Area and EMBA. The target species has historically been used for canning, and with the closure of canneries at Eden and Port Lincoln, effort in the fishery declined and there have been no active vessels operating since 2009 (Patterson and Mobsby, 2019). Should the fishery commence efforts in the future, fishing effort in the Operational Area and EMBA is considered to be unlikely, given the historical fishery was concentrated off southern Australia. **Licences/vessels**: Fishery inactive. No vessels active in 2017-18 season.
Western Tuna and Billfish Fishery	✓	✓	×	**Description**: The Western Tuna and Billfish Fishery zoning extends to the Australian EEZ boundary in the Indian Ocean, overlapping the Operational Area and EMBA. Key species the fishery targets are four highly mobile pelagic species; swordfish (*Xiphias gladius*), bigeye tuna (*Thunnus obesus*), yellowfin tuna (*T. albacares*), striped marlin (*Kajikia audax*), some albacore tuna (*T. alalunga*) is also taken (Williams et al., 2019). Recent fishing effort is concentrated from offshore Point Cloates (Exmouth) south along the WA coast to Augusta in the southwest of WA (Williams et al., 2019). **Licences/vessels**: 94 statutory fishing rights, four vessels in 2017-2018 season, (SFRs; (Williams et al., 2019).
State Managed Fisheries				
Pilbara Demersal Scalefish Fisheries (Pilbara Trawl, Trap and Line)	✓	✓	✓	**Description**: The Pilbara Demersal Scalefish Fishery (PDSF) lies approximately 14 km from the Operational Area, targeting a range of low and high value finfish species. The fishery includes the Pilbara Fish Trawl (Interim) Managed Fishery (PFTIMF), the Pilbara Trap Managed Fishery (PTMF) and the Pilbara Line Fishery (PLF; Newman et al., 2017). The PDSF collectively use a combination of vessels, effort allocations (time), gear limits, plus spatial zones (including extensive trawl closures) as management measures (Newman et al., 2017). The PFTIMF contributes more than 50 species of Scalefish, the PTMF and PLF fisheries contribute 40-50 species, with the line fishery providing additional offshore species such as ruby snapper (*Etelis carbunculus*) and eightbar grouper (*Hyporthodus octofasciatus*) (Newman et al., 2017).

Fishery	Operational Area	Within EMBA (incl. the Socio-cultural EMBA)	Potential for interaction within Operational Area	Description
				The PFTIMF is divided into two zones, waters inside of the 50 m isobath are permanently closed to fish trawling, Zone 1 is closed to fish trawling, Zone 2 comprises six management areas and Area 3 is permanently closed to trawling, Area 6 has had no fish trawl effort allocation since 1998 (Newman et al., 2017). The PFTIMF lands the largest component of the catch and operates in waters between 50 and 200 m water depth (Newman et al., 2015b; 2017). The PTMF covers the area from Exmouth northwards and eastwards to the 120° line of longitude, and offshore as far as the 200 m isobath. Like the trawl fishery, the trap fishery is also managed by the use of input controls in the form of individual transferable effort allocations monitored with a satellite-based vessel monitoring system (VMS). Waters inside of the 50 m isobath are permanently closed to trap fishing and Area 3 has also been closed to trapping since 1998 (Newman et al., 2015b). 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 (Newman et al., 2019). There have been at least three active PTMF vessels that operate within a 60 nm block that cover part of the Operational Area and have operated there for the past five years. The fishing activity occurs in the 60 nm grid, however there is no fishing interaction data for the 10 nm grid, therefore this fishing activity is not expected to overlap the Operational Area (DPIRD, 2019a). The PLF encompasses all of the 'Pilbara waters', extending from a line commencing at the intersection of 21°56'S latitude and the boundary of the Australian Fishing Zone and north to longitude 120°E (Newman et al., 2014). The PLF targets tropical demersal scalefish and is the smallest scale fishery in terms of monetary value, attaining a commercial catch of 40 tonnes (Newman et al., 2015b). There are no stated depth limits and the western extent of the fishery is the boundary of the AFZ (Newman et al., 2015b). The PLF is managed under the Prohibition on Fishing by Line from Fishing Boats (Pilbara Waters) Order 2006 with the exemption of nine fishing vessels for any nominated five-month block period within the year. Fishing in Area 3 has also been a closed to line fishing since 1998 (Newman et al., 2015b). There have been up to five active PLF vessels that operate within a 60 nm block that cover part of the Operational Area and have operated there for the past five years (DPIRD, 2019a). **Licences/vessels**: 11 permits in the PFTIMF, six licences in PTMF, 2017-18 season (DPIRD, 2019b). 10 vessels active in 2017-18 season (2 PFTIMF, 3 PTMF and 5 PLF; Newman et al., 2017)
Mackerel Managed Fishery	✓	✓	×	**Description**: The Mackerel Managed Fishery targets Spanish mackerel (*Scomberomorus commerson*) using near-surface trawling gear from small vessels in coastal areas around reefs, shoals and headlands. Jig fishing is also used to capture grey mackerel (*S. semifasciatus*), along with other species from the genera Scomberomorus (Lewis and Jones, 2017).

Fishery	Operational Area	Within EMBA (incl. the Socio-cultural EMBA)	Potential for interaction within Operational Area	Description
				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). Managed Fishing Areas 2 and 3 overlap the Operational Area. The catch is generally taken from the Pilbara and Kimberley coasts reflecting the tropical distribution of mackerel species (Molony et al., 2015). The fishing activity occurs around the coastal reefs of the Dampier Archipelago and Port Hedland area, with the seasonal appearance of mackerel in shallower coastal waters most likely associated with feeding and gonad development prior to spawning (Mackie et al., 2003). The catch effort in 2018-2019 was 214 t (DPIRD, 2019b). Spanish mackerel spawn between August and November when inhabiting coastal reef areas of the Exmouth/Gascoyne region, 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. However, there is anecdotal evidence to suggest populations move into deeper offshore waters (Mackie et al., 2003). There was limited fishing activity in the 60 nm grid (DPIRD, 2019a), however given fishing occurs in coastal areas around reefs, shoals and headlands it will not occur within the Operational Area. **Licences/vessels**: 52 licences in 2017-18 season (DPIRD, 2019b). 14 vessels in 2014 (Molony et al., 2015). Not stated from 2015 to 2018 (Lewis et al, 2018).
South West Coast Salmon Managed Fishery	✓	✓	×	**Description**: The South West Coast Salmon Managed Fishery operates on various beaches south of the metropolitan area 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. The fishery has not been active in the Operational Area within the last five years (DPIRD, 2019a). **Licences/vessels**: not applicable (shore-based).
West Coast Deep Sea Crustacean Managed Fishery	✓	✓	×	**Description**: The West Coast Deep Sea Crustacean Managed Fishery extends north from Cape Leeuwin to the Western Australia/Northern Territory border in water depths great than 150 m within the AFZ, including the Operational Area. The fishery targets deep water crustaceans, including crystal (snow) crabs, giant (king) crabs and champagne (spiny) crabs, with the vast majority (>99%) of the catch landed in 2017 comprising crystal crabs (How and Orme, 2018). Two vessels operated in the fishery in 2015, using baited pots operated in a longline formation in the shelf edge waters greater than 150 m water depths (How and Orme, 2018). The catch effort in 2019-18 was 152.8 t (DPIRD, 2019b) and was concentrated between Fremantle and Carnarvon.

Fishery	Operational Area	Within EMBA (incl. the Socio-cultural EMBA)	Potential for interaction within Operational Area	Description
				The fishery has not been active in the Operational Area within the last five years (DPIRD, 2019a). **Licences/vessels**: Seven licences in 2017-18 season (DPIRD, 2019b). Six vessels active in 2017-18 season (How and Orme, 2018).
Pilbara Crab Managed Fishery	✓	✓	×	**Description:** Blue Swimmer Crabs (*Portunus armatus*) are targeted by the Pilbara Crab Managed Fishery, which came into force in 2018. As there are no recent status reports, the Pilbara crab resource had been commercially accessed through the Pilbara Developing Crab Fishery (Developing Fishery) since it commenced in 2001 (DPIRD, 2018). The fishing effort occurs in Nickol Bay, near Dampier. Crab stocks in the Pilbara region are highly variable due to environmental fluctuations. Total commercial catch of blue swimmer crabs was 51 t and mud crabs was 9 t in the North Coast Bioregion for 2017-18 (Johnston et al., 2017). The fishery has not been active in the Operational Area within the last five years (DPIRD, 2019a). **Licences/vessels**: not available.
West Australian Sea Cucumber 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 collection methods of this fishery is 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 indicate 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 $400k in 2017-18 (Hart et al., 2018b) with a total catch of 135 t. There are specific areas closed to this fishery including the Dampier Archipelago and Rowley Shoals (DoF, 2012a). The catch effort in 2018 for the Pilbara region was 33 t (DPIRD, 2018). Fishing is usually concentrated in the northern half of the State from Exmouth Gulf to the Kimberley region (Hart et al., 2018b). There was previously vessels operating within a 60 nm block that partially enters the Operational Area, however these have not operated in the block since at least 2014. (DPIRD, 2019a,b). **Vessels:** Not applicable (hand collection - shallow water-based).
Marine Aquarium Managed Fishery	×	✓	×	**Description**: The Marine Aquarium Managed Fishery operates within Western Australian waters. The managed fishery boundary lies within the EMBA, approximately 12 km from the Operational Area. The fishery is primarily a dive-based fishery that uses hand-held nets to capture the desired target species and is restricted to safe diving depths (typically <30 m). The fishery is typically active from Esperance to Broome, with popular areas including the coastal waters of the Cape Leeuwin/Cape Naturaliste region, Dampier and Exmouth.

Fishery	Operational Area	Within EMBA (incl. the Socio-cultural EMBA)	Potential for interaction within Operational Area	Description
				The landed catch was predominantly ornamental fish but also included hermit crabs, seahorses, invertebrates, corals and live rock (Newman et al., 2014). The fishery has not been active in the Operational Area within the last five years (DPIRD, 2019a). **Licences/vessels**: 11 licences in 2017-18 (DPIRD, 2019; Newman et al., 2018).
Specimen Shell Managed Fishery	×	✓	×	**Description**: The Specimen Shell Managed Fishery (SSF) can be conducted anywhere within Western Australia waters and targets the collection of specimen shells for display, collection, cataloguing and sale. The SSF encompasses the entire WA coastline but effort is concentrated approximately 12 km from the Operational Area, in areas adjacent to the largest population centres such as: Broome, Karratha, Shark Bay, Mandurah, Exmouth, Capes area, Albany and Perth (Hart and Crowe 2015). Collection is predominately by hand when diving or wading in shallow coastal waters, though a deeper water collection aspect to the fishery has been initiated with the employment of ROVs operating at depths up to 300 m (Hart and Crowe 2015). The fishery has not been active in the Operational Area within the last five years (DPIRD, 2019a). **Licences/vessels**: 31 licences in 2017-18, with 23 of these being active in 2017 (Hart et al., 2018c).
Western Australian Abalone Managed Fishery	×	✓	×	**Description**: The Western Australian Abalone Managed 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 and therefore the fishery operates outside of the Operational Area but within the southern extent of the EMBA, approximately 12 km from the Operational Area. Abalone are harvested by divers, 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*). No commercial fishing for abalone north of Moore River (zone 8 of the managed fishery) took place in 2015 (Hart et al., 2015a). The commercial fishery reported a total commercial catch of 61 t in 2018-19 (DPIRD, 2019b). The fishery has not been active in the Operational Area within the last five years (DPIRD, 2019a). **Licences/vessels**: 23 vessels active in Roe's abalone fishery in 2017 (Strain et al., 2018c).
Pearl Oyster Managed Fishery	×	✓	×	**Description**: The Western Australian Pearl Oyster Fishery lies approximately 14 km from the Operational Area and is the only remaining significant wild-stock fishery for pearl oysters in the world (Fletcher et al., 2006). The species targeted is the Indo-Pacific silver-lipped pearl oyster (*Pinctada maxima*), which are collected in shallow coastal waters along the north-west-shelf through the use of divers (restricted to safe diving depths), and are mainly for use in the culture of pearls (Hart et al., 2017).

Fishery	Operational Area	Within EMBA (incl. the Socio-cultural EMBA)	Potential for interaction within Operational Area	Description
				The fishery is separated into four zones. The Pearl Oyster Zone 1 lies within the vicinity of the Operational Area, extending from North West Cape (including Exmouth Gulf) (119° 30´ E) to Cape Thouin (118° 20´ E). There are five licences in Zone 1, with fishing recently recommencing after a hiatus of several years (Hart et al., 2015b). The catch effort in 2018-19 was 614,002 oysters (DPIRD, 2018). The fishery has not been active in the Operational Area within the last five years (DPIRD, 2019b). **Licences/vessels**: five vessels and 12,845 diver hours in 2017-18 (DPIRD, 2018).
West Coast Rock Lobster Fishery	×	✓	×	**Description**: The West Coast Rock Lobster Fishery targets the western rock lobster (*Panulirus cygnus*) from Shark Bay south to Cape Leeuwin using baited traps (pots), approximately 22 km from the Operational Area. 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 fishing effort is off the central and southern west coast (de Lestang et al., 2018).The catch effort in 2018 was 6400 t (DPIRD, 2018). The fishery has not been active in the Operational Area within the last five years (DPIRD, 2019a). **Licences/vessels**: 653 licences in 2017-18 (DPIRD, 2019b). 234 vessels in 2017 (de Lestang et al., 2018).
Gascoyne Demersal Scalefish Managed Fishery	×	✓	×	**Description**: The Gascoyne Demersal Scalefish Fishery (GDSF) comprises commercial and recreational fishing for demersal scalefish in the continental waters of the Gascoyne Coast Bioregion, approximately 175 km from the Operational Area. The GDSF is located between the southern Ningaloo Coast to south of Shark Bay with a closure area from Point Maud to Tantabiddi. Commercial vessels have historically targeted the oceanic stocks of pink snapper (*Pagrus auratus*) during the winter months, with the main component caught within Shark Bay, accounting for 80% of the total commercial catch. The GDSF continues operating throughout the year targeting additional demersal species including the goldband snapper (*Pristipomoides spp*.), red emperor (*Lutjanus sebae*), emperors and cod (family Serranidae) (Jackson et al., 2015). The catch effort in 2019 was 45.1 t of snapper, and 164 t of other demersals (DPIRD, 2019b). The fishery has not been active in the Operational Area within the last five years (DPIRD, 2019a).

Fishery	Operational Area	Within EMBA (incl. the Socio-cultural EMBA)	Potential for interaction within Operational Area	Description
				Licences/vessels: 58 licences in 2017-18 (DPIRD, 2019b). 16 vessels (Jackson et al., 2018; Gaughan and Santoro, 2018).
Shark Bay Prawn and Scallop Managed Fisheries	×	✓	×	**Description**: The Shark Bay Prawn Managed Fishery lies approximately 228 km from the Operational Area and 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 2018, The Shark Bay Prawn Managed Fishery reported a catch effort of 1608 t (DPIRD, 2018). The Shark Bay Scallop Managed Fishery targets the saucer scallop (*Amusium balloti*) and was usually Western Australia's most productive scallop fishery until it was closed due to the results from the pre-season survey of stock abundance (Sporer et al., 2015). The stock is currently recovering after sustained recruitment (Kangas et al., 2017b). In 2018, the Shark Bay Scallop Managed Fishery reported a catch effort of 1632 t (DPIRD, 2018). The fishery has not been active in the Operational Area within the last five years (DPIRD, 2019a). **Licences/vessels**: 18 vessels in 2017 (Kangas et al., 2018). 18 (Prawn) and 29 (Scallop) licences in 2019 (DPIRD, 2019b).
West Coast Demersal Scalefish Fishery	×	✓	×	**Description**: The West Coast Demersal Scalefish Fishery lies approximately 507 km from Operational Area and comprises inshore and offshore suites of demersal scalefish species that are exploited by different commercial fisheries, recreational and charter fishers operating in the West Coast Bioregion. The West Coast Inshore Demersal suite occurs in waters <250 m deep and comprises approximately 100 different species, the most important of which are West Australian dhufish (*Glaucosoma hebraicum*) and pink snapper (*Pagrus auratus*). Less important species include redthroat emperor (Lethrinus miniatus), bight redfish (*Centroberyx gerrardi*) and baldchin groper (*Choerodon rubescens*). The West Coast Offshore Demersal suite occurs in waters <250 m deep and includes eightbar groper (*Hyporthodus octofasciatus*), hapuka (*Polyprion oxygeneios*), blue-eye trevalla (*Hyperoglyphe antactica*) and ruby snapper (*Etelis carbunculus*). In 2016, the West Coast Demersal Scalefish (interim) Managed Fishery reported a total catch of 353 t (Smith and Grounds, 2018) The fishery has not been active in the Operational Area within the last five years (DPIRD, 2019a). **Licences/vessels:** commercial not available; 53 charter vessels (Fairclough et al., 2017).

Fishery	Operational Area	Within EMBA (incl. the Socio-cultural EMBA)	Potential for interaction within Operational Area	Description
Onslow Prawn Managed Fishery	×	✓	×	**Description**: The Onslow Prawn Managed Fishery encompasses a portion of the continental shelf off the Pilbara; approximately 66 km from the Operational Area. The fishery targets a range of penaeids (primarily king prawns) which typically inhabit soft sediments <45 m water depth. Fishing is carried out using trawl gear over unconsolidated sediments (sand and mud). The catch was negligible in the 2017-18 season, at <1 t, Only five days of fishing effort was undertaken (by one vessel) in 2017 (Kangas et al., 2017). There was limited fishing activity in the 60 nm grid (DPIRD, 2019a), however given fishing occurs in <45 m water depth, it will not occur within the Operational Area. **Licences/vessels:** 30 licences in 2017-18 (DPIRD, 2019b). One vessel (Kangas et al., 2018a).
Nickol Bay Prawn Managed Fishery	×	✓	×	**Description:** The Nickol Bay Prawn Managed Fishery is approximately 285 km of the Operational Area, and targets penaeid prawns (primarily banana prawns) using trawl gear. The target species typically inhabits sandy and muddy substrate in <45 m water depth. The catch effort in 2018-19 was 81 t (DPIRD, 2018). The fishery has not been active in the Operational Area within the last five years (DPIRD, 2019a). **Licences/vessels:** 14 licences in 2017-18 (DPIRD, 2019b). The number of vessels is unreported.
Exmouth Gulf Prawn Managed Fishery	×	✓	×	**Description**: The Exmouth Gulf Managed Fishery targets penaeid prawns (primarily banana prawns) using trawl gear within Exmouth Gulf, approximately 37 km from Operational Area. The target species typically inhabits sandy and muddy substrate in <45 m water depth. The catch effort in 2018-19 was 880 t (DPIRD, 2019b). There was limited fishing activity in the 60 nm grid (DPIRD, 2019b), however given fishing occurs in <45 m water depth, it will not occur within the Operational Area. **Licences/vessels:** 15 licences in 2017-18 (DPIRD, 2019a); Six vessels in 2015 (Sporer et al., 2015a), not provided in 2017-18 report.

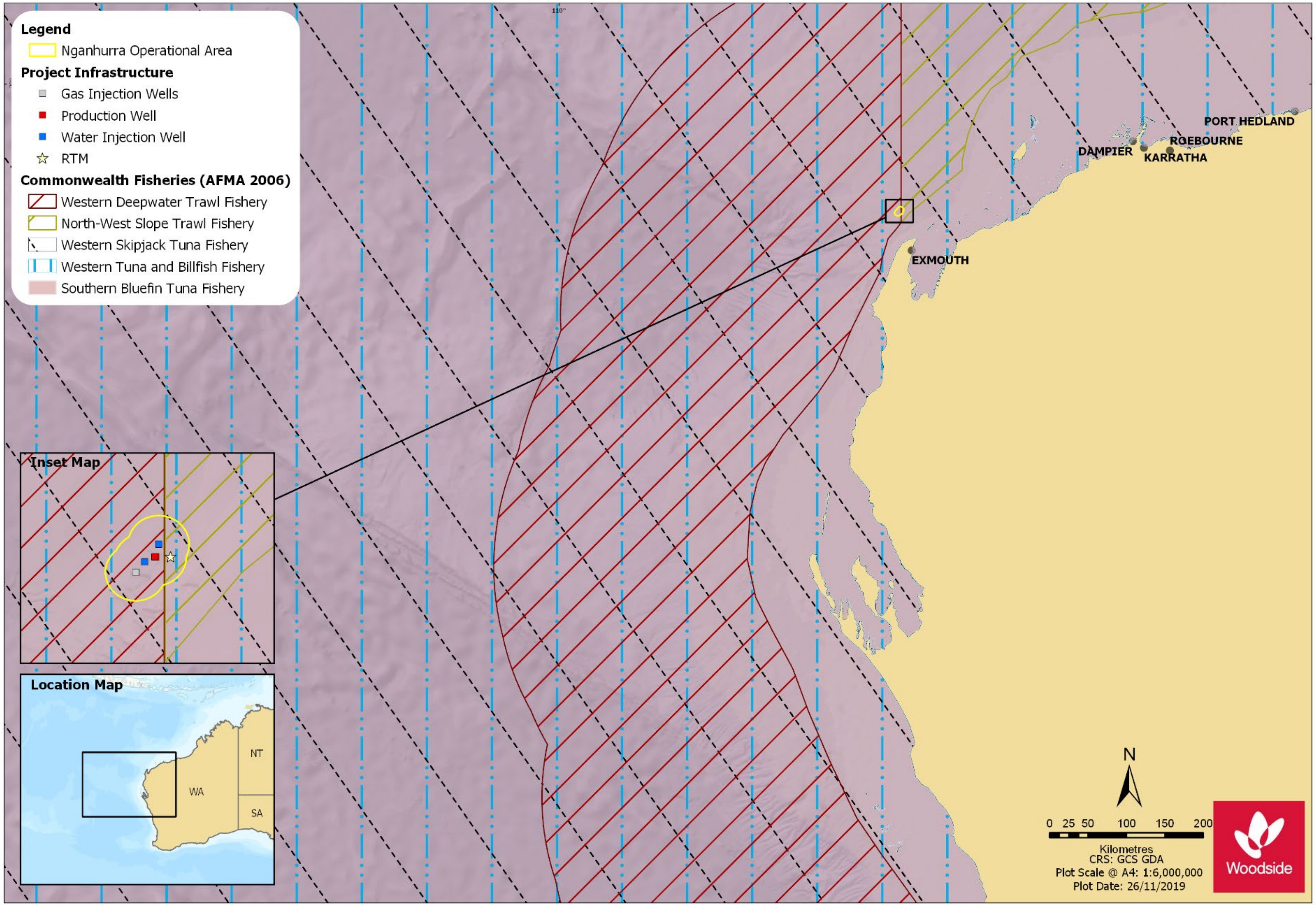

Figure 4-12: Location of Commonwealth fisheries in relation to the Operational Area

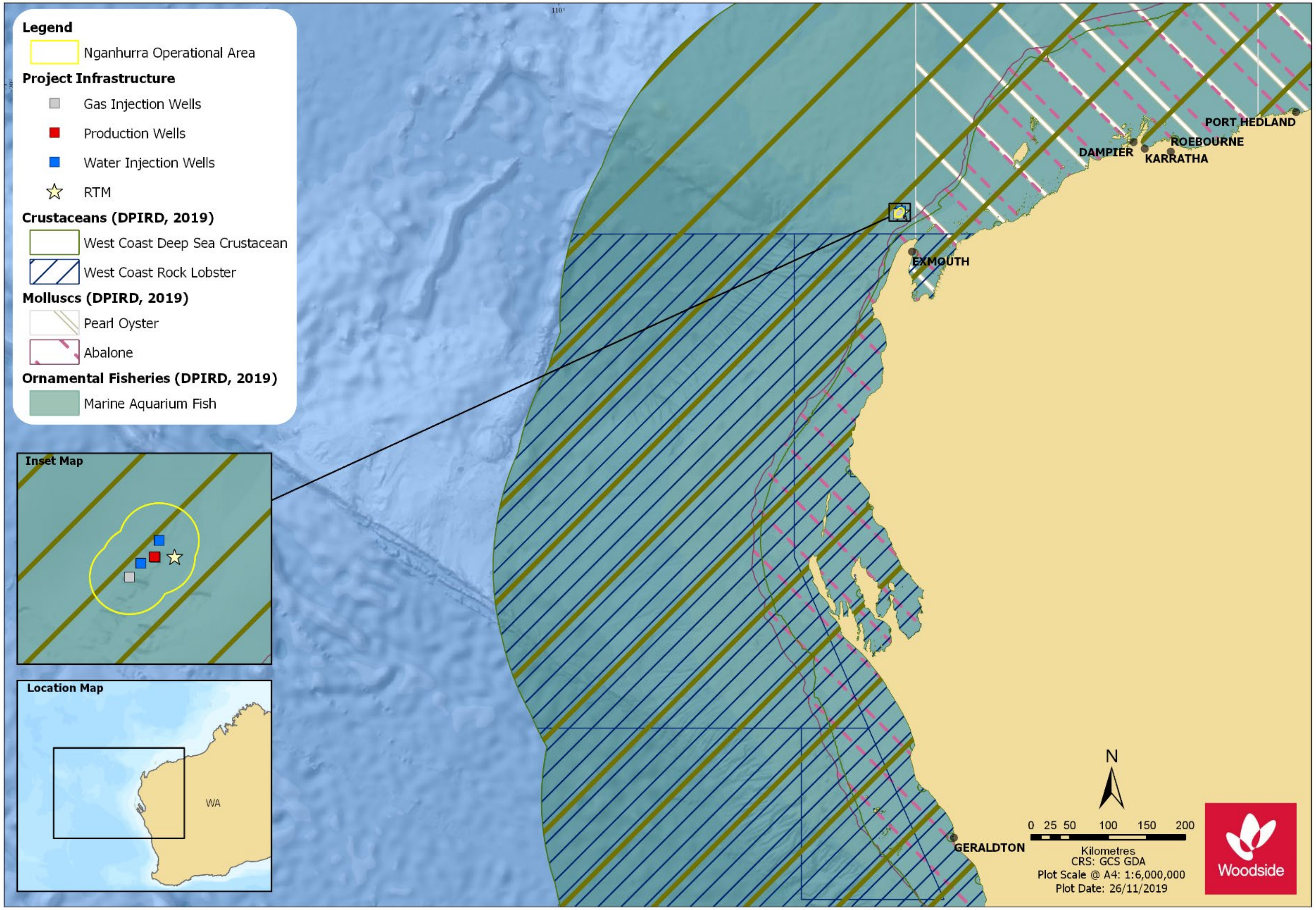

Figure 4-13: Location of State fisheries in relation to the Operational Area

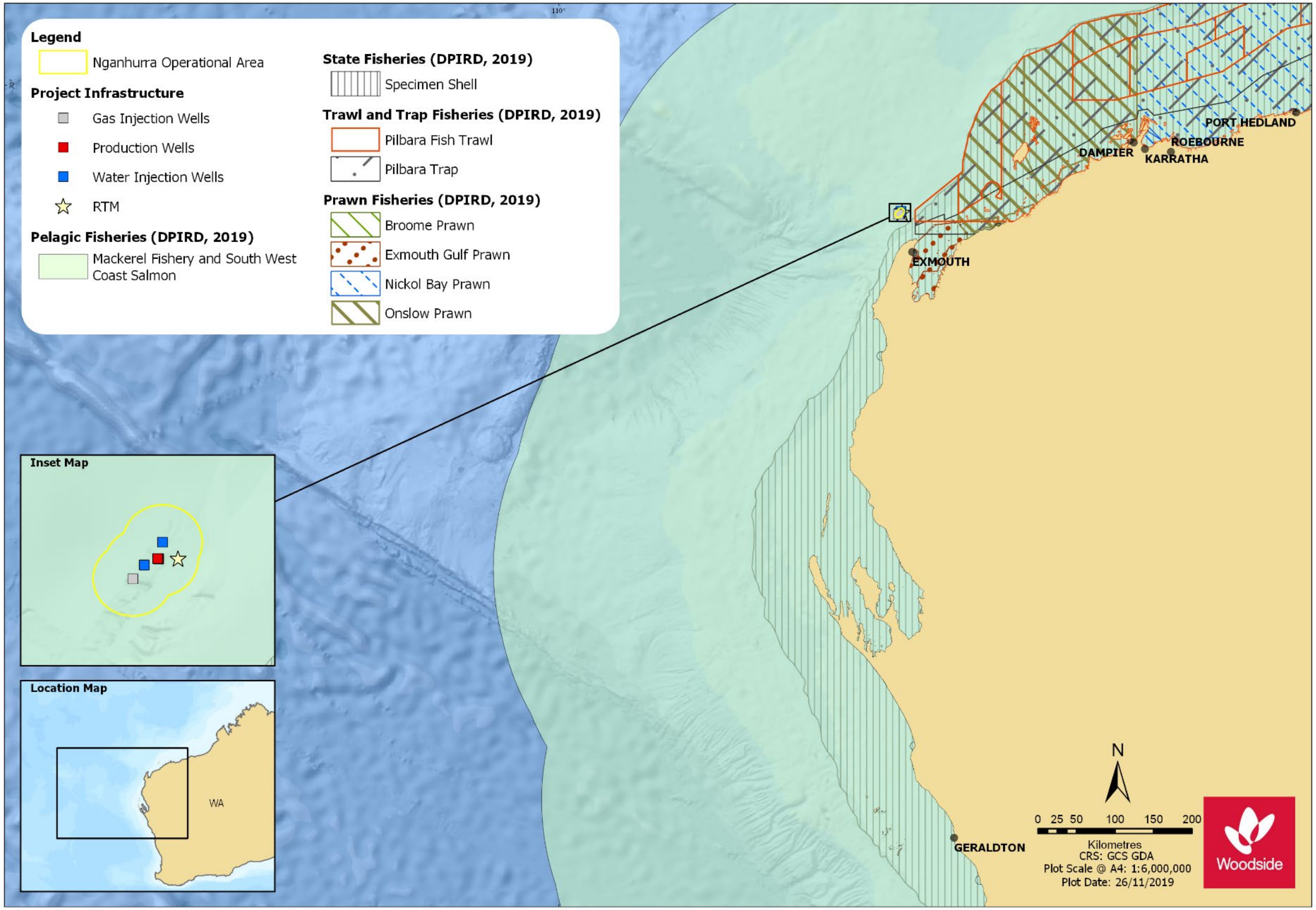

Figure 4-14: Location of State fisheries in relation to the Operational Area

4.6.3.2 Aquaculture

There are no aquaculture activities within the Operational Area as these operations are typically restricted to shallow coastal waters. Aquaculture in the region consists primarily of culturing hatchery-reared and wild caught oysters (*Pinctada maxima*) for producing pearls, which is primarily centred around Broome and the Dampier Peninsula (outside the EMBA). Leases typically occur in shallow coastal waters at depths of less than 20 m (Fletcher et al., 2006). There are existing pearl aquaculture leases at the Montebello Islands, within the Flying Foam Passage in the Dampier Archipelago and within Exmouth Gulf (Fletcher et al., 2017), all outside the EMBA. Other types of aquaculture leases are also found near the Montebello Islands, Dampier Archipelago, the Exmouth Gulf and near Onslow, all outside the EMBA.

Primary spawning of the pearl oyster occurs from mid-October to December. A smaller secondary spawning occurs in February and March (Fletcher et al., 2006).

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 structure such as reef. However, it is recognised that Barrow Island, Montebello Islands and Ningaloo Reef, all within the EMBA, have a known history of fishing when areas were occupied (as from historical records) (CALM, 2005, Department of Environment and Conservation 2007).

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 and 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).

Due to the Operational Area's water depths (approximately 400-600 m) and distance offshore, recreational fishing is unlikely to occur in the Operational Area. Recreational fishing in the EMBA is mainly concentrated around the coastal waters and islands (including Ningaloo Marine Park, North West Cape area, the Montebello Islands, and other islands and reefs in the region) (DoF, 2011).

Current FishCube data indicate negligible Charter Operator vessels have been active in the waters within or adjacent to the Operational Area in the past five years. However, there have been up to five licences and a recorded catch count of up to 382. These recordings have been irregular and catch effort is therefore considered negligible (DPIRD, 2019a,b; **Table 4-11**). The Exmouth Gulf is the next closest location for tourism, therefore charter operator boats may be likely to transit in the vicinity of the Operational Area.

Within the EMBA, tourism is one of the largest revenue earners of all the major industries of the Gascoyne and Pilbara regions 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 World Heritage Area (approximately 15 km from the Operational Area) and North West Cape area, including recreational fishing, snorkelling and scuba diving, whale shark encounters (April to August) and manta rays (September to November), whale watching and encounters (July to October) and turtle watching (all year round) (Schianetz et al., 2009). Within the socio-cultural EMBA, the northern Pilbara beaches provide fishing, swimming and boating opportunities as well as Thevenard Island.

4.6.6 Shipping

The NWMR supports significant commercial shipping activity, the majority of which is associated with the mining and oil and gas industries (**Figure 4-15**).

The Australian Maritime Safety Authority (AMSA) has introduced a network of marine fairways across the NWMR off 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. It is noted that none of these fairways intersect with the Operational Area; the nearest fairway is approximately 40 km north-west of the Operational Area (**Figure 4-15**). Vessel tracking data suggest shipping is concentrated to the north-east of the Operational Area, which is likely associated with ports.

Ports in the region are nodes of increased vessel activities; active ports in the vicinity of the Operational Area include:

- Exmouth (approximately 47 km south of the Operational Area, beyond EMBA)
- Onslow (approximately 114 km east of the Operational Area, beyond EMBA)
- Barrow Island (approximately 150 km north-east of the Operational Area, beyond the EMBA).

Additional shipping routes are located within the region and it is expected that local vessel traffic will pass through the area. Shipping activities in the region include:

- international bulk freighters/tankers 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
- commercial and recreational fishing vessels.

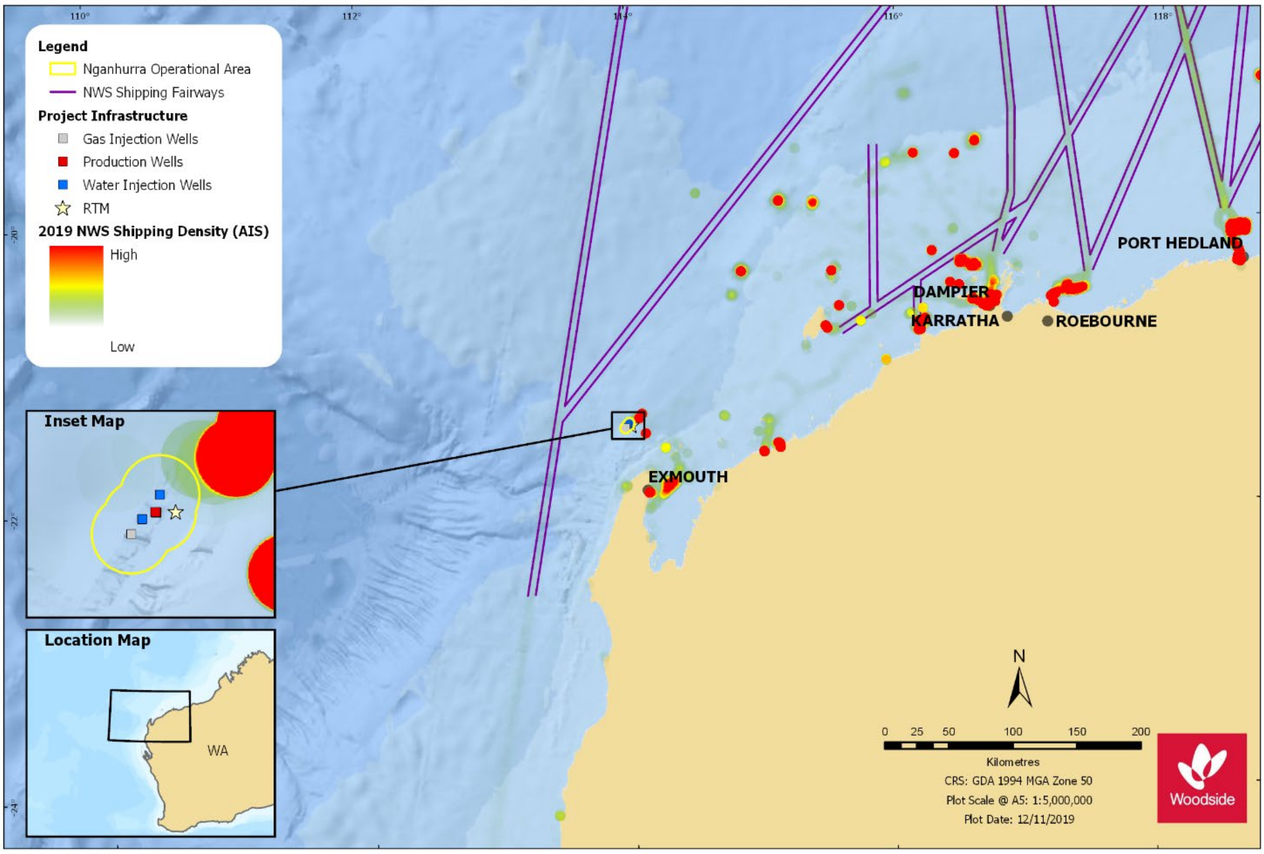

Figure 4-15: Vessel density map for the Operational Area from 2016, derived from AMSA satellite tracking system data (vessels include Cargo, LNG Tanker, Passenger Vessels, support vessels and others/unnamed vessels).

4.6.7 Oil and Gas Infrastructure

The Operational Area is located within an area of established oil and gas operations in the broader NWMR. **Table 4-12** details other facilities located in proximity to the Operational Area. Several facilities (platforms and floating production, storage and offloading vessels (FPSOs) and platforms) are currently operating in the vicinity of the Operational Area (**Figure 4-16** and **Table 4-12**). While the Stybarrow Venture FPSO is no longer on station, the subsea infrastructure associated with the development remains in situ. The closest field tied back to the *Stybarrow Venture* is the Skiddaw field, approximately 11 km west of the Operational Area at the closest point.

Table 4-12: Other oil and gas facilities in the vicinity of the Operational Area

Facility name and operator	Approximate distance from Operational Area (km)	Direction
Ngujima Yin FPSO (Woodside)	4	North-east
Ningaloo Vision FPSO (Santos)	8	North-east
Pyrenees FPSO (BHP Billiton)	11	South-east

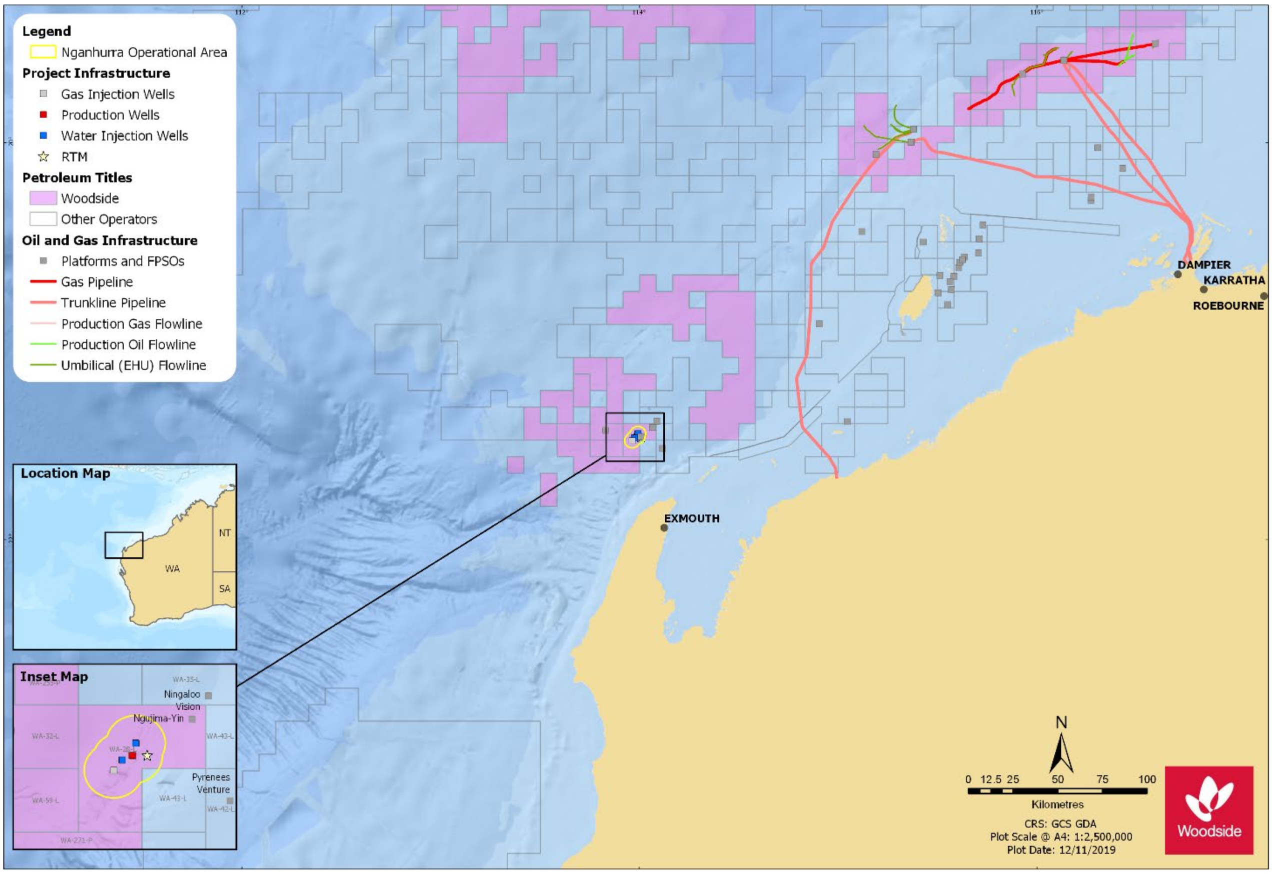

Figure 4-16: Oil and gas Infrastructure with reference to the location of the Operational Area

4.6.8 Defence

There are designated defence practice areas in the offshore marine waters off Ningaloo and the North West Cape, of which a military flying training area overlaps the Operational Area (**Figure 4-17**).

A Royal Australian Air Force base is located at Learmonth on North West Cape, approximately 78 km south of the Operational Area.

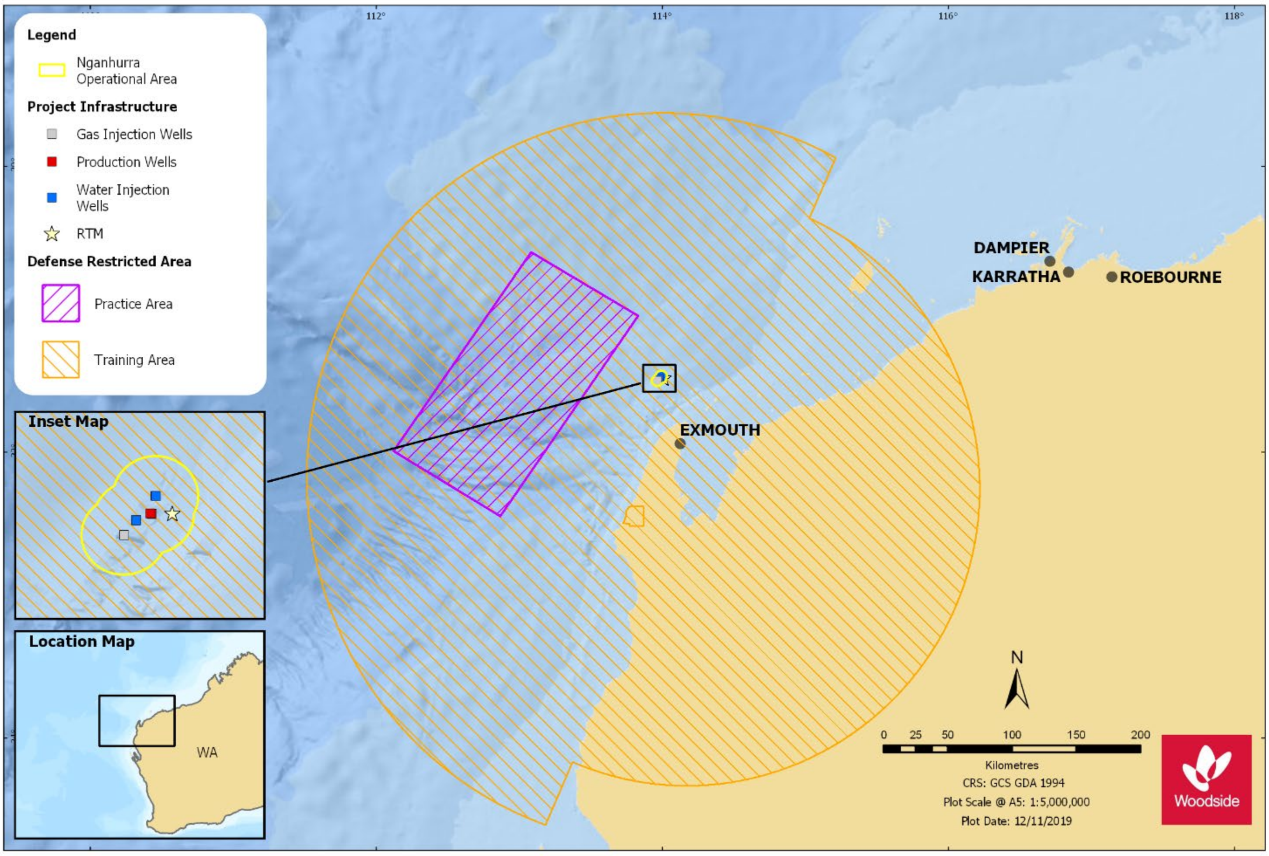

Figure 4-17: Department of Defence Demarcated Marine Offshore Areas for military and defence practice with reference to the location of the Operational Area

4.7 Values and Sensitivities

The values and sensitivities of the Operational Area and EMBA are presented in this subsection of the existing environment description. The offshore environment of the NWMR contains environmental assets (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 Ningaloo World Heritage Area, and the associated resident, temporary or migratory marine life including species such as marine mammals, turtles and birds (**Section 4.5.2**).

Many sensitive receptor locations are protected as part of Commonwealth and State managed areas and have been allocated conservation objectives (International Union for Conservation of Nature (IUCN) Protected Area Category) based on the Australian IUCN reserve management principles in Schedule 8 of the EPBC Regulations 2000. These principles determine what activities are acceptable within a protected area under the EPBC Act. As all planned petroleum activities will take place within the Operational Area, and no protected areas overlap this, the planned activities associated with the Petroleum Activities Program will be conducted in a manner consistent with the Australian IUCN reserve management principles for the IUCN categories which have been identified in **Table 4-13**.

The North-west Marine Parks Network Management Plan (Director of National Parks, 2018a) provides the protection and conservation of biodiversity and values of marine parks in the North-west Region that extends from the WA-NT border to Kalbarri, south of Shark Bay. The North-west Marine Parks Network covers 335,341 km^2 and includes 13 marine parks (Director of National Parks, 2018a).

The North-west Network includes two World Heritage sites, these being the Ningaloo Coast World Heritage Property and the Shark Bay, WA World Heritage Property. The plan also supports a range of uses such as shipping, ports, commercial fishing, pearling and aquaculture, as well as offshore mining operations.

The South-west Marine Parks Network Management Plan (Director of National Parks, 2018b) provides the protection and conservation of biodiversity and values of marine parks in the North-west Region that extends from the eastern end of Kangaroo Island in South Australia to the waters off Shark Bay in WA. The South-west Marine Parks Network covers 508,371 km^2 and includes 14 marine parks (Director of National Parks, 2018b).

The South-west Network includes a World Heritage sites, these being the Shark Bay, WA World Heritage Property. The plan also supports a range of uses such as shipping, ports, commercial and recreational fishing, tourism, as well as offshore mining operations.

A number of high value or sensitive environments located within the EMBA are part of the North-west Marine Parks Network and the South-west Marine Parks Network, and management of these is governed by the North-west Marine Parks Network Management Plan and the South-west Marine Parks Network Management Plan (Director of Parks, 2018).

The following section outlines the values and sensitivities of the established and proposed Marine Protected Areas (MPAs) and other sensitive areas in the EMBA (listed in **Table 4-13**, shown in **Figure 4-18**). In addition these areas are also considered in the environmental risk evaluation of planned and unplanned activities associated with the Petroleum Activities Program.

Table 4-13: Summary of established and proposed Marine Protected Areas (MPAs) and other sensitive locations within the EMBA and Socio-cultural EMBA

	Distance from Operational Area to Values/Sensitivity boundaries (km)	IUCN Protected Area Category[1]
Australian Marine Parks (AMP)		
Ningaloo	15	II, IV
Gascoyne	15	II, IV, VI
Montebello[2]	150	VI
Shark Bay	320	VI
Carnarvon Canyon	329	IV
Abrolhos	477	II, IV, VI
Argo-Rowley Terrace[2]	478	II, VI
State Marine Parks and Nature Reserves		
Marine Parks		
Ningaloo	27	IA, II, IV
Barrow Island[2]	151	IA

	Distance from Operational Area to Values/Sensitivity boundaries (km)	IUCN Protected Area Category[1]
Montebello Islands[2]	179	IA
Marine Management Areas		
Muiron Islands	31	IA, VI
Barrow Island[2]	141	IA
Fish Habitat Protection Areas		
None identified within the Operational Area of EMBA		
Nature Reserves		
Pilbara Islands – South and Middle Island Groups	67	IA
Barrow Island[2]	147	IA
Murion Islands[2]	39	IA
Boodie, Double, and Middle Islands[2]	145	IA
Heritage		
World Heritage Areas		
Ningaloo	15	Not applicable
National Heritage Areas		
The Ningaloo Coast	15	Not applicable
Commonwealth Heritage Areas		
Ningaloo Marine Area – Commonwealth Waters	15	Not applicable
Key Ecological Features		
Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula	Overlaps Operational Area	Not applicable
Continental Slope Demersal Fish Communities	Overlaps Operational Area	Not applicable
Commonwealth waters adjacent to Ningaloo Reef	15	Not applicable
Ancient coastline at 125 m depth contour	19	Not applicable
Exmouth Plateau	70	Not applicable
Glomar Shoals[2]	329	Not applicable
Western Demersal Slope and Associated Fish Communities	475	Not applicable
Wallaby Saddle	491	Not applicable
Mermaid Reef and Commonwealth waters surrounding Rowley Shoals[2]	648	Not applicable
Ancient Coastline at 90-120 m Depth	683	Not applicable
Western Rock Lobster	683	Not applicable
Commonwealth marine environment within and adjacent to the west coast inshore lagoons[2]	724	Not applicable
Commonwealth marine environment surrounding the Houtman Abrolhos Islands	727	Not applicable
Perth Canyon and adjacent shelf break, and other west coast canyons	741	Not applicable

[1] *Conservation objectives for IUCN categories in **Table 4-13** include:*

IA: Strict nature reserve – protected from all but light human use
II: National park – protect ecosystems and natural values, but facilitate human visitation
IV: Habitat/species management area – conservation of a particular species, taxonomic group or habitat
VI: Protected area with sustainable use of natural resources – allow human use but prohibits large scale development

[2] *MPAs only found in the Socio-cultural EMBA.*

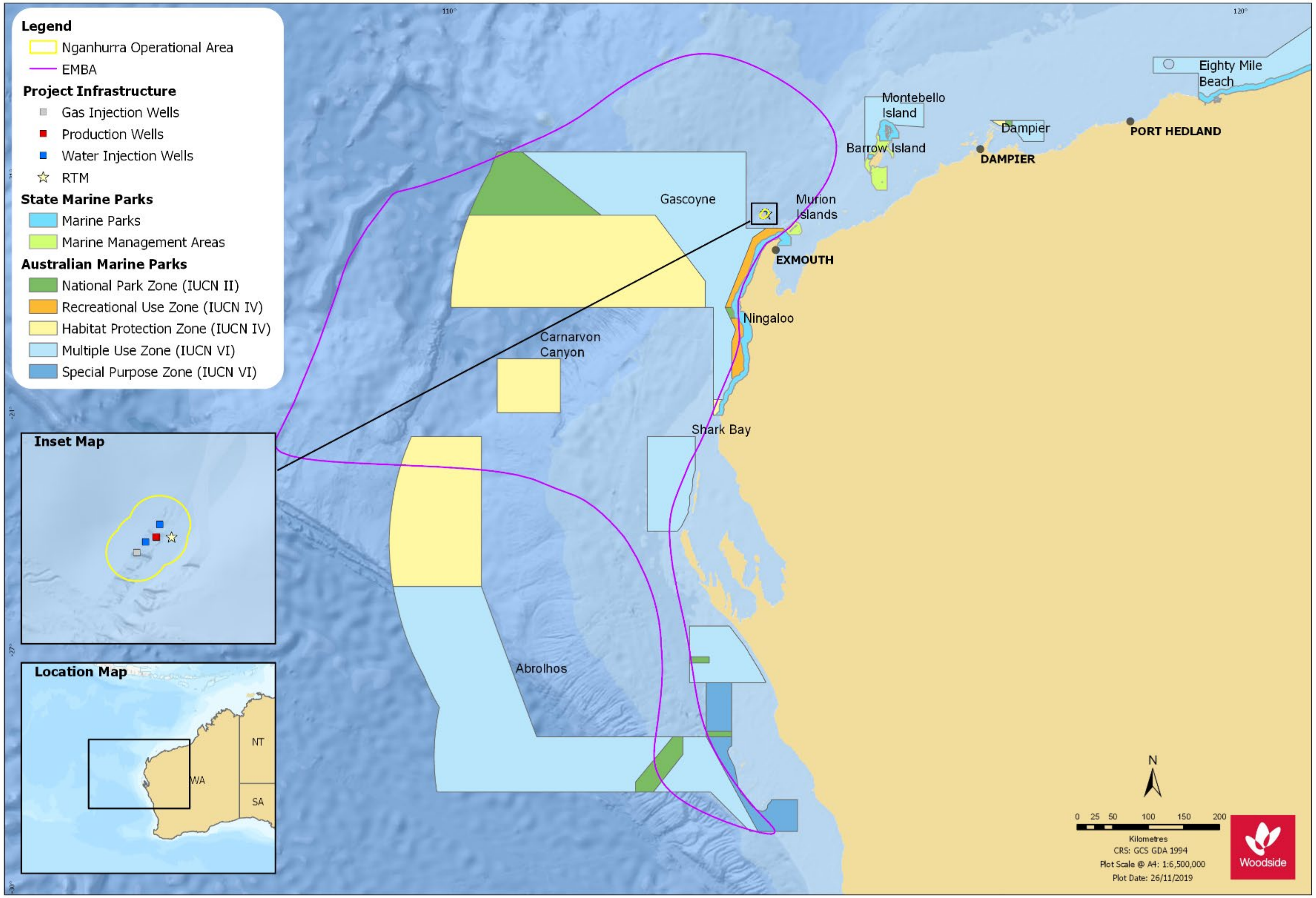

Figure 4-18: Established and proposed Commonwealth and State Marine Protected Areas in relation to the Operational Area

4.7.1 Pilbara Coast and Islands

4.7.1.1 Pilbara Islands (Northern, Middle and Southern Island Groups)

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 includes more than 30 islands that range from east of Cape Preston south to the mouth of the Robe River, 10–35 km offshore, including the Great Sandy Islands Nature Reserve and the Passage Islands. The Northern Island Group is located approximately 180 km east of the Operational Area.

The Middle Island Group, which is located approximately 146 km east of the Operational Area, includes the Mary Anne Reefs and neighbouring small islands. The Southern Island Group includes Serrurier, Bessieres and Thevenard Islands Nature Reserves and is located approximately 67 km east of the Operational Area. 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 Australia Pty Ltd 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 (Chevron Australia Pty Ltd 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. Wedge-tailed shearwaters also have breeding populations on islands from the Northern Island Group. Hawksbill turtle feeding grounds occur in the Mary Anne and Great Sandy Island groups. Mary Anne Island also includes a breeding population of roseate terns. 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 is 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 reef
- 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.

4.7.2 Ningaloo Coast and Gascoyne

4.7.2.1 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 statement of Outstanding Universal Value for the Ningaloo coast was based on the natural criteria and recognised the following:

- Criterion (vii): The landscapes and seascapes are mostly intact and comprise large-scale marine, coastal and terrestrial environments. The lush and colourful underwater scenery provides a stark and spectacular contrast with the arid and rugged land. Large aggregations of whale sharks and important aggregations of other fish species and marine mammals occur in the Ningaloo Coast WHA. Mass coral spawning and seasonal nutrient upwelling cause a peak in productivity that leads to groups of approximately 300–500 whale sharks, making this the largest documented aggregation in the world.
- Criterion (x): The Ningaloo Reef harbours a high marine diversity of more than 300 documented coral species, over 700 reef fish species, roughly 650 mollusc species, as well as around 600 crustacean species and more than 1000 species of marine algae. The high numbers of 155 sponge species and 25 new species of echinoderms add to the significance of the area. In the transition zone between tropical and temperate waters, the Ningaloo Coast hosts an unusual diversity of marine turtle species with an estimated 10,000 nests along the coast annually.

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 (DoEE n.d.). The region has a high diversity of marine habitats including coastal mangroves, lagoons, coral reef, open ocean, continental slope and the continental shelf (CALM, 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 (CALM, 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 approximately 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 2007). The Muiron Islands are minor nesting sites for flatback and hawksbill turtles (DEC 2007).

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).

4.7.2.2 Ningaloo AMP

The Ningaloo AMP covers 2326 km^2 and is approximately 1200 km north of Perth. It is contiguous with the Western Australian Ningaloo Marine Park. The Ningaloo reef, which lies in State waters within the State-managed Marine Park, is further protected by the Ningaloo AMP. Water depths range from shallow water of 30 m depth to oceanic waters at 1000 m deep. Major natural values of the reserve include (DoEE n.d., Director of National Parks):

- three KEFs (Section 4.7.7):
  - canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula
  - Commonwealth Waters adjacent to Ningaloo Reef

  - continental slope demersal fish communities.
- 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 park 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 the supply of nutrients to reef communities from deeper waters further offshore, to the Ningaloo Reef ecosystem.

The Ningaloo AMP (Commonwealth Waters) Management Plan outlines objectives for retaining the values of this protected area and any potential or confirmed threats which could impact these values. Values which could be impacted from the Petroleum Activities Program and the associated management objectives (goals and strategies) in the Management Plan are outlined in **Table 4-14**. Note each management objective in the plan relates only to a source of risk, rather than the value potentially impacted, and is therefore generic for all Petroleum Activities.

Table 4-14: Relevant key threats and management objectives from the Ningaloo AMP (Commonwealth Waters) Management Plan

Value potentially impacted by Petroleum Activities Program	Relevant existing and potential threats identified in Management Plan	Associated management objectives (strategies/goals)	Relevant EP section
Physical values			
High water quality	Pollution: • contaminants and marine debris arising from petroleum or mineral exploration and production • oil/chemical spill from shipping accident.	Management goal – to prevent adverse impacts on the physical, ecological, social and cultural values of the Commonwealth Waters from petroleum or mining activities in the vicinity of Ningaloo AMP. Management strategies – maintain the exclusion of petroleum and mineral exploration and production from Commonwealth Waters.	Credible risks and impacts to these receptors are considered in **Section 6.7**
Ecological values			
High water quality	• Petroleum or mineral exploration and production activities including seismic operations • Pollution (see above).	Management goal – to prevent adverse impacts on the physical, ecological, social and cultural values of the Commonwealth Waters from petroleum or mining activities in the vicinity of Ningaloo AMP. Management strategies – maintain the exclusion of petroleum and mineral exploration and production from Commonwealth Waters.	Credible risks and impacts to these receptors are considered in **Section 6.7**
Marine mammals and fish (e.g. whales; dugong; whale sharks)	Oil/chemical spill		

Value potentially impacted by Petroleum Activities Program	Relevant existing and potential threats identified in Management Plan	Associated management objectives (strategies/goals)	Relevant EP section
Marine reptiles (e.g. turtles)	Oil/chemical spill		
Sea birds	Oil/chemical spill		
Social values			
• Major destination for recreational fishers • Recreational boating and yachting • Destination for nature based tourism (e.g. diving/fishing, whale shark/marine life viewing/interaction tours).	Reduced amenity resulting from major oil/chemical spill.	Management goal – to prevent adverse impacts on the physical, ecological, social and cultural values of the Commonwealth Waters from petroleum or mining activities in the vicinity of Ningaloo AMP. Management strategies – maintain the exclusion of petroleum and mineral exploration and production from Commonwealth Waters.	Credible risks and impacts to these receptors are considered in **Section 6.7**

4.7.2.3 Ningaloo Marine Park and Muiron Islands Marine Management Plan

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 Muiron Islands Marine Management Area is managed under the same management plan as for the Ningaloo State Marine Park (CALM, 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 (CALM, 2005). The ecological and conservation values include:

- unique geomorphology, which has resulted in a high habitat and species diversity
- high sediment and water quality
- subtidal and intertidal coral reef communities providing food, settlement substrate and shelter for marine flora and fauna
- filter feeding communities (sponge gardens) in the northern part of the North West Cape and the Muiron and Sunday islands
- shoreline intertidal reef communities providing feeding habitat for larger fish and other marine animals during high tide
- soft sediment communities found in deeper waters, characterised by a surface film of microorganisms that provide a rich source of food for invertebrates
- macroalgae and seagrass communities, which are an important primary producer providing habitat for vertebrate and invertebrate fauna

- mangrove communities which occur only in the northern part of the Ningaloo Marine Park and are important for reef fish communities (Cassata and Collins 2008) and support a high diversity of infauna, particularly, molluscs (600 mollusc species)
- diverse fish fauna (approximately 460 species)
- foreshores and nearshore reefs of the Ningaloo coast and Muiron/Sunday islands which provide internesting, nesting and hatchling habitat for several species of marine turtles including the loggerhead, green, flatback and hawksbill turtles
- whale sharks which aggregate annually to feed in the waters around Ningaloo reef, from March to July, with the largest numbers being 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
- seasonal shark aggregations and manta rays which 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, whilst 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 n.d.)
- annual mass coral spawning 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 (Rosser and Gilmour, 2008; Taylor and Pearce, 1999)
- large coral slicks which 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 that frequent or reside in nearshore waters. Dugong numbers in Ningaloo Marine Park are considered to be in the order of around 1000 individuals, with a similar number in Exmouth gulf (CALM, 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 for seabirds and shorebirds. Approximately 33 species of seabirds are recorded in the Ningaloo Marine Park (13 resident and 20 migratory), with five known rookeries as well 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 (**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 4-18**) and The Ningaloo Coast was listed as a National Heritage Place, 6 January 2010 due to its extraordinary natural qualities and Indigenous Significance (DoEE 2019).

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 including shallow outer reef slope (spur and groove habitat), reef crest (emergent at low tide), reef flat (coralline algae and high cover tabular *Acropora* spp. coral communities), back reef lagoon (coral, soft sediment and macroalgal communities), sublittoral limestone platform (turf algae/molluscs/echinoderm community), and intertidal mangrove, mud flat and salt marsh communities (Cassata and 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 spurs 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* spp. 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 and Collins, 2008) as follows:

- outer reef flat (very shallow, < 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 (approximately 1 m depth): tabular *Acropora* spp. community
- Back reef lagoon (> 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* spp., *Acropora* spp.) With scattered patches of macroalgae (*Sargassum* spp., *Halimeda* spp., *Caulerpa* spp.) or seagrass (*Halophila* spp.)
- 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* spp. 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
- mangroves: 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. 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*. *A. 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 water salt marshes: the salt marsh habitat is seaward of the mangroves and is represented by salt tolerant vegetation and sandy patches.

In addition to the ecological and conservation values, the Ningaloo Marine Park has a number of social values including cultural 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 AMP (Commonwealth Waters).

The Management Plan for the Ningaloo Marine Park and Muiron Islands Marine Management Area outlines objectives for retaining the values of this protected area and any potential or existing threats which could impact these values. Values which could be impacted from the Petroleum Activities Program and the associated management objectives outlined in the Management Plan are detailed in **Table 4-15**.

Table 4-15: Relevant key threats and management objectives from the Management Plan for the Ningaloo Marine Park and Muiron Islands Marine Management Area

Value potentially impacted by Petroleum Activities Program	Relevant existing and potential threats identified in Management Plan	Associated management objectives	Relevant EP section
Ecological values			
Water quality	No explicit threats from hydrocarbon spill, i.e.: toxicant inputs from the accidental spillage of fuel and oils hydrocarbon spills from passing ships	To ensure that the water quality of the reserves is maintained at a level which supports and maintains the area's ecological and social values.	Credible risks and impacts to these receptors are considered in **Section 6.7**.
Coral reef communities	Pollution events (shipping, oil/gas industry)	To ensure the diversity and abundance of coral reef communities in the reserves are not significantly impacted by human activities within the reserves.	
Shoreline and intertidal communities	Pollution events (shipping, oil/gas industry)	To ensure the diversity and abundance of shoreline intertidal reef communities in the reserves are not significantly impacted by trampling and recreational collecting within the reserves.	
Macroalgal and seagrass communities	Pollution events (shipping, oil/gas industry)	To ensure seagrass and macroalgal communities are not disturbed as a result of human activities in the reserves.	
Mangrove communities	Pollution events (shipping, oil/gas industry)	To ensure the species diversity and abundance of mangrove communities within the Park are not significantly impacted by trampling.	
Seabirds, shorebirds and migratory waders	Pollution events (shipping, oil/gas industry)	To ensure the species diversity and abundance of seabird, shorebird and migratory bird species in the reserves	

Value potentially impacted by Petroleum Activities Program	Relevant existing and potential threats identified in Management Plan	Associated management objectives	Relevant EP section
		are not significantly impacted by human activity.	
Social values			
• Major destination for recreational fishers • Recreational boating and yachting • Destination for nature based tourism (e.g. diving, fishing, whale shark/ marine life viewing/ interaction tours)	Reduced amenity resulting from major oil/chemical spill	Management goal – to prevent adverse impacts on the physical, ecological, social and cultural values of the Commonwealth Waters from petroleum or mining activities in the vicinity of Ningaloo AMP. Management strategies – maintain the exclusion of petroleum and mineral exploration and production from Commonwealth Waters.	Credible risks and impacts to these receptors are considered in **Section 6.7**.

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 and Collins, 2008, Kobryn et al., 2013).

4.7.2.4 Gascoyne AMP

The Gascoyne AMP covers approximately 81,766 km^2 and includes waters from less than 15 m depth to 6000 m depth. Natural values identified within the reserve include (DoEE n.d., Director of National Parks 2018a):

- 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 Northwest Province provincial bioregions as well as the Ningaloo mesoscale bioregion.

The park contains three key natural values for the region:

- 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)

- Exmouth Plateau (unique seafloor feature associated with internal wave generation)
- 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 park boundary is adjacent to the existing Commonwealth portion of the Ningaloo marine protected area.

4.7.2.5 Carnarvon Canyon AMP

The Carnarvon Canyon AMP lies about 328 km from the Operational Area, partially within the EMBA. The AMP covers 6177 km² and includes water depths in the range of 1500–6000 m (Director of National Parks, 2018a). The reserve contains a number of natural values, including (Director of National Parks, 2018a):

- 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.

4.7.3 Montebello/Barrow/Lowendal Islands

The marine and coastal environments of the Montebello/Barrow/Lowendal Islands group 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 2007).

4.7.3.1 Montebello AMP

The Montebello AMP is adjacent to the Montebello Islands Marine Park/Barrow Island Marine Park/Barrow Island Marine Management Area, providing a contiguous marine park covering both State and Commonwealth Waters. Major conservation values within the Montebello AMP include (DoEE n.d., Director of National Parks 2018):

- habitats, species and ecological communities associated with the NWS Province
- BIAs for a range of MNES, include breeding habitat for seabirds and foraging habitat for whale sharks (**Section 4.5.2**)
- two historic shipwrecks, the Trial and the Tanami (both over 100 km from the Operational Area)
- diverse social values including tourism, fishing, mining and recreation
- foraging areas adjacent to important nesting sites for marine turtles
- part of the migratory pathway of the protected humpback whale
- shallow shelf environments with depths ranging from 15 to 150 m, providing protection for shelf and slope habitats, as well as pinnacle and terrace seafloor features
- examples of the seafloor habitats and communities of the NWS Province bioregion as well as the Pilbara (offshore) mesoscale bioregion (Heap et al., 2005)
- one KEF for the region, the Ancient Coastline at 125 m Depth Contour (**Section 4.7.7**).

The entire Montebello AMP, an area of 341,300 ha, is designated a multiple use zone (IUCN Category IV), allowing for long-term protection and maintenance of the AMP in conjunction with sustainable use, including oil and gas exploration activities. The Montebello AMP is 150 km to the Operational Area.

The Montebello AMP contains two known shipwrecks which have been in Australian waters for at least 75 years, and are therefore protected under the *Underwater Cultural Heritage Act 2018*:

- the Trial, which was wrecked in 1622, is the earliest known shipwreck in Australian waters
- the Tanami, which was wrecked in a cyclone in 1935.

Tourism, commercial fishing, mining and recreation are important activities in the Marine Park (Director of National Parks, 2018).

4.7.3.2 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 km^2, located approximately 141 km from the Operational Area at the closest point. A sanctuary zone covers the entire 4100 ha Barrow Island Marine Park. 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 (Department of Environment and Conservation 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 mangroves, 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
- historical culture of the pearl oyster (*Pinctada maxima*), which produced some of the highest quality pearls in the world.

These islands support significant colonies of wedge-tailed shearwaters and bridled terns. The Montebello Islands support the biggest breeding population of roseate terns in WA. 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 NWMR, 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 2012c).

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 group are influenced by the passage of tropical cyclones that shape sandy beaches (RPS Bowman Bishaw Gorham, 2007). 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 Bowman Bishaw Gorham, 2007).

4.7.3.3 Barrow Island Nature Reserve

The Barrow Island Nature Reserve is a Class A Nature Reserve covering approximately 235 km^2 and extends to the low water mark adjacent to the Montebello Islands/Barrow Island Marine Parks. 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. Key conservation values within the reserves include (DPaW, 2015):

- the second largest island off the WA coast
- important biological refuge site because of isolation from certain threatening processes on the mainland
- contains flora that are restricted in distribution and at or near the limit of their range
- high number of fauna species with high conservation value
- extensive hydrogeological karst system that supports a subterranean community of high conservation significance
- regionally and nationally significant rookeries for green and flatback turtles
- important habitat for migratory shorebirds and also used by these species as a staging and destination terminus
- significant habitat values, such as intertidal mudflats, rock platforms, mangroves, rock piles and cliffs, clay pans and caves
- a significant fossil record that indicates local historical biodiversity and evolution
- a history of aboriginal and other Australian use including 13 registered aboriginal cultural heritage sites.

4.7.4 Shark Bay

4.7.4.1 Shark Bay World Heritage Area

The Shark Bay WHA includes Bernier Island, Dorre Island and Dirk Hartog's landing site. Shark Bay was inscribed under all four natural criteria (criterion vii, viii, ix, and x) by the World Heritage Committee onto the World Heritage Register 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, which represent the oldest form of life on earth and are comparable to living fossils
- one of the few marine areas in the world dominated by carbonates not associated with reef building corals
- one of the largest seagrass meadows in the world, covering 103,000 ha, with the most seagrass species recorded in one area
- marine fauna such as dugong, dolphins, sharks, rays, turtles, fish, and migratory seabirds which occur 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, they utilise seagrass habitats for foraging and nursing year round and breed during the summer months
- breeding habitat for 14 species of seabirds, and more than 50 other seabirds passing through the area
- major loggerhead turtle nesting site on Dirk Hartog Island
- minor nesting area on islands for green turtles
- habitat for whale sharks and manta rays
- important staging and socialising locations for humpback whales during their annual migration
- large population of resident Indo-Pacific bottlenose dolphins estimated to number between 2000 and 3000 individuals (Preen et al., 1997)
- the Shark Bay WHA lies outside but just in the vicinity of the EMBA, 340 km south of the Operational Area.

4.7.4.2 Shark Bay AMP

The Shark Bay AMP covers approximately 7443 km^2, and includes waters in the depth range of approximately 15–220 m (DoEE n.d.). The marine park encompasses offshore waters that buffer the state waters of Shark Bay and the barrier islands of Dirk Hartog, Dorre and Bernier. The park contains a number of natural values (as listed below) and social values relating to marine nature-based tourism and recreation (water-sports and fishing) (**Section 4.6.5**), including (Director of National Parks, 2018a):

- 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)
- provides protection to shelf and slope habitats as well as terrace features
- connectivity between the inshore waters of the Shark Bay WHA and deeper Commonwealth waters
- examples of shallower ecosystems of the Central Western Shelf and Central Western Transition provincial bioregions including the Zuytdorp meso-scale bioregion
- provides connectivity between inshore waters of the Shark Bay WHA and deeper waters offshore.

4.7.5 West Coast and Islands

4.7.5.1 Abrolhos AMP

The Abrolhos Australian Marine Park lies approximately 475 km from the Operational Area and partially within the EMBA (Habitat Protection Zone), and within the socio-cultural EMBA (Marine National Park Zone, Multiple Use Zone and Special Purpose Zone). The AMP 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, 2018a). The reserve contains a number of natural values, including (Director of National Parks, 2018a):

- 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.

4.7.5.2 Houtman Abrolhos Island Nature Reserve

The Houtman Abrolhos Islands is a series of islands and reefs located at the edge of the continental shelf between 28° 15’ S and 29° 00’ S, approximately 740 km offshore from the Operational Area, comprising three major island groups:

- North Island-Wallabi Group
- Easter Group
- Pelsaert (or Southern) Group.

The islands support a diverse and unique range of marine and terrestrial flora and fauna (DoF 2012). A number of important historical shipwrecks are located within the island area, with historic sites located on the islands themselves. The key natural values (DoF 2012) comprise:

- high water quality which is important for maintaining marine ecosystem health and function
- waters comprising a diverse range of marine habitats, home to tropical and temperate species, including Australian sea lions, western rock lobsters and a number of other species currently listed under State and Commonwealth legislation
- a variety of terrestrial plant species and communities, which are utilised by a diverse range of fauna, including birds, some of them unique to the Abrolhos. Many of these species are listed under State and Commonwealth legislation and international agreements
- a wide array of fish and invertebrate species including dhufish, coral trout, pink snapper, baldchin groper, red throat emperor, western rock lobster and saucer scallops, making it a priority target area for commercial, recreational and charter fishing in the Midwest region
- numerous aquaculture licences have been granted for the production of various pearl oyster species, finfish, western rock oysters, corals and sponges at the Abrolhos. There is increasing interest at the Abrolhos for aquaculture of these and other marine species
- unique history including the *Batavia* (National Heritage Listed site) and subsequent shipwrecks, evidence of guano mining and commercial fishing all contribute to the heritage values
- important socio-economically for the region due to tourism and recreation with a high number of visitors. Activities include boating, fishing, diving, wildlife and heritage photography and appreciation
- features including canyons, demersal slope fish communities and meso-scale eddies.

4.7.6 Rowley Shoals

4.7.6.1 Argo-Rowley Terrace AMP

The Argo-Rowley Terrace AMP covers 146,099 km^2 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 AMP encompasses water depths from approximately 220–6000 m.

The ecological and conservation values include (DoEE n.d., Director of National Parks 2018):

- 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

- two KEFs (Section **4.7.7**)
  - canyons linking the Argo Abyssal Plain with the Scott Plateau
  - Mermaid Reef and Commonwealth Waters surrounding Rowley Shoals
- connectivity between the reefs of the Rowley Shoals
- linkage of the Argo Abyssal Plain with the Scott Plateau through canyons.

4.7.7 Key Ecological Features

Key Ecological Features (KEFs) are the parts of the marine ecosystem that are considered to be of importance for a marine region's biodiversity or ecosystem function and integrity. KEFs have been identified by the Australian Government on the basis of advice from scientists about the ecological processes and characteristics of the area.

KEFs meet one or more of the following criteria:

- a species, group of species, or a community with a regionally important ecological role (e.g. a predator, prey that affects a large biomass or number of other marine species)
- a species, group of species, or a community that is nationally or regionally important for biodiversity
- an area or habitat that is nationally or regionally important for:
  - enhanced or high productivity (such as predictable upwellings - an upwelling occurs when cold nutrient-rich waters from the bottom of the ocean rise to the surface)
  - aggregations of marine life (such as feeding, resting, breeding or nursery areas)
  - biodiversity and endemism (species which only occur in a specific area), or a unique seafloor feature, with known or presumed ecological properties of regional significance.

Two KEFs overlap the Operational Area, with an additional nine KEFs within or intersecting the EMBA (**Table 4-13** and **Figure 4-19**).

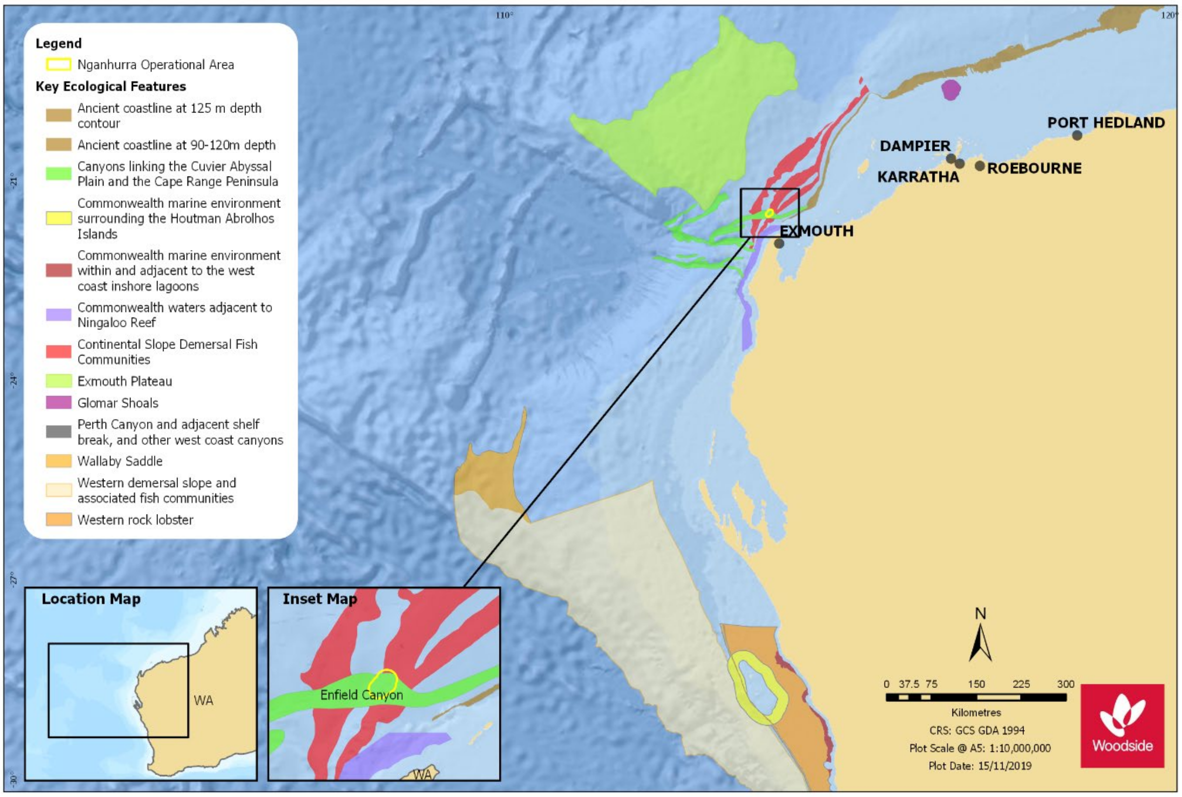

Figure 4-19: KEFs in relation to the Operational Area

4.7.7.1 Key Ecological Features Within the Operational Area

Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula

The canyons linking the Cuvier Abyssal Plain with the Cape Range Peninsula KEF (the Canyons KEF) lie off the north-west coast of Australia, overlapping the Operational Area.

The canyons associated with the Canyons KEF are believed to support the productivity and species richness of Ningaloo Reef (DSEWPaC 2012a). 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, sea snakes, sharks, predatory fish and seabirds are known to occur in the area due to the enhanced productivity (Sleeman et al., 2007). Note that such upwelling may not result from the presence of the canyons, but from other factors such as local wind stress (e.g. upwelling off the Capes region in south-western Australia) and internal waves (Taylor and Pearce, 1999; Woo et al., 2006).

The Canyons KEF are considered to be ‘blind’ canyons (i.e. confined to the continental slope with heads that terminate below the continental shelf). Such canyons are thought to have formed during slumping of deposited sediments downwards along the continental slope, rather than as the result of drowned river valleys during Holocene sea level changes (BMT Oceanica, 2016).

Woodside commissioned a literature review of the Cape Range canyon, supported by an environmental survey of the Enfield canyon, which is a tributary of the Cape Range canyon (**Figure 4-7**). The Cape Range canyon is one of the northernmost of a series of canyons on the North and South sections of the Enfield Canyon, on the continental slope of the Ningaloo coast. This survey examined several sections of the canyons and sampled a range of physical and biological parameters, including water, sediments, epifauna and mobile invertebrates, infauna and fish assemblages. Benthic habitats within and surrounding the canyons surveyed were similar in nature to those observed elsewhere in the deep-water NWMR and were characterised by flat unconsolidated sediments composed of sand- and mud-sized particles (BMT Oceanica, 2016; Falkner et al., 2009). Epifauna and mobile invertebrate communities associated with these habitats were considered to be similar to those observed elsewhere in the region, as well as other continental slopes in the Indo-Pacific region (BMT Oceanica, 2016; Heyward and Rees, 2001). The fish assemblages associated with the canyon observed during the survey were considered to be relatively species rich and abundant compared to adjacent non-canyon habitat, and consistent with data recorded during other investigations (Last et al., 2005; Williams et al., 2001). The fish assemblage at the foot of the canyon (the deepest area surveyed) was more diverse than those observed in higher sections of the canyon, with Anguilliform (eels) and Scorpaeniform (*Paraliparis* sp.) species present that were not observed in the body of the canyon.

In reviewing KEFs in the NWMR, (Falkner et al., 2009) concluded that the canyons examined in the region exhibited habitat heterogeneity (although noted that such habitat was not restricted to canyon features) and were representative of the region. These conclusions were based on a review of existing physical and biological data from a range of sources. The observations made during the survey of the Canyons KEF were not consistent with these conclusions, finding that the habitat at different locations within the canyon comprised flat unconsolidated sediments composed of sand- and mud-sized particles (BMT Oceanica 2016). This is consistent with the seabed in the Operational Area and continental slope in the region more broadly (**Section 4.4.4**).

It was identified (Falkner et al., 2009) that canyons functioning as a conduit between the continental shelf and deep ocean were considered to be important. Such conduits provide a pathway for shelf production to be transported to the deep sea, as observed in river canyons. However, given the Enfield canyon is a ‘blind’ canyon (i.e. formed by slumping of shelf and slope sediments rather than river canyon), it may not provide this conduit function. It was noted (Falkner et al., 2009) that canyons may facilitate upwelling of nutrient-rich water, which is consistent with the observed upwelling associated with the Ningaloo Current, however, alternative explanations supported by metocean observation and modelling studies have been put forward (e.g. local wind stress (Woo et al., 2006) and internal wave action (Taylor and Pearce, 1999)). Additionally, given the depth of the head of the Enfield canyon (>200 m), there is little potential for benthic primary production on the continental shelf to be advected to the deep sea, which has been identified as an ecological function of river canyons with shallow heads (Falkner et al., 2009; Vetter and Dayton, 1999).

Given KEFs are identified based on their regional importance or ecosystem function/integrity, the Enfield canyon does not appear significantly different than the surrounding seabed although a diverse deep-water fish assemblage species richness was documented (BMT Oceanica, 2016). A pressure analysis of threats to the Canyons KEF did not identify any threats of concern, but identified ocean acidification as being of potential concern (Department of the Environment and Energy n.d.).

Continental Slope Demersal Fish Communities

The continental slope demersal fish communities in the region have been identified as a KEF of the NWS (DSEWPaC, 2012a), and overlaps 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 2008). Additional features relating to the fish populations of this area are as follows:

- Continental slope demersal fish communities have been identified as a key ecological feature of the NWMR due to the notable diversity of the demersal fish assemblages and high levels of endemism (DSEWPAC 2012a).
- The North West Cape 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 region, like the ichthyofauna of many regions, exhibit 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 and 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 (CALM, 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.

4.7.7.2 Key Ecological Features Within the EMBA

Commonwealth Waters Adjacent to Ningaloo Reef

The Commonwealth waters adjacent to Ningaloo Reef KEF lies adjacent to the three nautical mile state waters limit along Ningaloo Reef and includes the Ningaloo AMP, and is approximately 15 km from the Operational Area. See **Section 4.7.1** for further information for the values and sensitivities associated with this KEF.

Ancient Coastline at 125 m Depth Contour

Several steps and terraces as a result of Holocene 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, which forms the Ancient Coastline at 125 m depth contour KEF (the ancient coastline). The ancient coastline lies approximately 19 km south and east of the Operational Area, extending along a line approximated by the 125 m isobath (**Figure 4-19**). The ancient coastline is not continuous throughout the NWS, and coincides with a well-documented eustatic stillstand at approximately 130 m worldwide (Falkner et al., 2009).

Where the ancient coastline provides areas of hard substrate, it may contribute to higher diversity and enhanced species richness relative to soft sediment habitat (DSEWPaC 2012a). 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. Although the ancient coastline adds additional habitat types to a representative system, the habitat types are not unique to the coastline as they are widespread on the upper shelf (Falkner et al., 2009).

Exmouth Plateau

The Exmouth Plateau is a large, mid-slope, continental margin plateau that lies off the north-west coast of Australia, approximately 70 km south-west of the Operational Area. It ranges in depth from approximately 800 to 3500 m and is a major structural element of the Carnarvon Basin (Miyazaki and Stagg, 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 Exmouth Plateau is overlaid by an interface between the ITF and the Indian Ocean Central Water. This interface constitutes a potential shear zone (with associated mixing) and may display substantial temporal variability both seasonally and in response to longer-term changes, such as ITF variability (Brewer et al., 2007). Internal tides are strongest during January–March (Brewer et al., 2007). Satellite observations suggest that productivity is enhanced along the northern and southern boundaries of the plateau and along the shelf edge which in turn suggests that the plateau is a significant contributor to the productivity of the region (Brewer et al., 2007). The seascape of the Exmouth Plateau is not considered to be unique by Falkner et al., (2009) in their review of KEFs in the North-west Marine Region, however, the geological origin (Exon and Willcox, 1980) and potential enhanced upwelling due to the Exmouth Plateau (Brewer et al., 2007) may constitute unique environmental values (DSEWPaC 2012a).

Fauna in the pelagic waters above the plateau are likely to include small pelagic species and nekton (Brewer et al., 2007). Protected and migratory species are also known to pass through the region including whale sharks and cetaceans.

Most actions in or adjacent to the NWMR are considered unlikely to adversely impact upon the integrity or ecosystem function of the Exmouth Plateau; ocean acidification resulting from climate change is the only potential pressure identified in the relevant bioregional plan (DSEWPaC 2012a).

Glomar Shoals

The Glomar Shoals is situated approximately 329 km north-east of the Operational Area. These submerged shoals are large (215 km^2), complex bathymetrical features on the outer continental shelf off the Pilbara. Glomar Shoals rises gently on the south-west side of the reef from 80 m depth to a single plateau at 40 m depth. The north-eastern side of the reef rises steeply from 70 m to 40 m depth. The shoals are relatively shallow, with water depths reaching 22 to 28 m at the 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 region (AIMS, 2014a; Wahab et al., 2018).

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

Benthic habitats of Glomar Shoals vary with depth and are characterised by coarse unconsolidated sediment at depths greater than 60 m to hard substrate supporting benthic communities comprising spare hard and soft corals sponges and macroalgae at depths < 40 m. Total cover of benthic taxa (hard coral, soft coral, sponges and other benthic biota) is highest at depths < 40 m and decreases with depth (Wahub et al., 2018). At depths of 60-80 m benthic cover is low at approximately 2% and at depths greater than 80 m benthic cover is barely present with baseline survey data indicating 0.1% cover of benthic biota. The results of a baseline survey and habitat modelling undertaken by AIMS in 2013 indicate that the portion of the Glomar Shoals overlapping the Operational Area is composed of soft sediment seabed and not areas of higher, phototrophic benthic biota (AIMS, 2014b). Structurally complex biodiverse benthic habitats are mainly found within the north-eastern portion of Glomar Shoals (AIMS, 2014b; Wahab et al., 2018).

Overall, the benthic habitats of Glomar Shoals are considered pristine and hosts regionally distinct ecological communities. 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 reefs and the submerged shoals and banks in the region, although less diverse and abundant than fish assemblages at Rankin Bank (Wahab et al., 2018).

Western Demersal Slope and Associated Fish Communities

The Western Demersal Slope is located approximately 475 km from the Operational Area and provides important habitat for demersal fish communities. In particular, the continental slope of the Central Western provincial bioregion supports demersal fish communities, characterised by high diversity compared with other, more intensively sampled oceanic regions of the world. Its diversity is attributed to the overlap of ancient and extensive Indo-West Pacific and temperate Australasian fauna (Williams et al., 2001). Scientists have described 480 species of demersal fish that inhabit the slope of this bioregion; 31 of these are considered endemic to the bioregion.

Wallaby Saddle

The Wallaby Saddle is located approximately 491 km south-west of the Operational Area in water depths ranging from 4000 to 4700 m. The Wallaby Saddle is an abyssal geomorphic feature linking the north-west margin of the Wallaby Plateau with the upper continental slope margin of the Carnarvon Basin.

Mermaid Reef and Commonwealth Waters Surrounding Rowley Shoals

The Mermaid Reef and Commonwealth waters surrounding the Rowley Shoals KEF is located approximately 648 km from the Operational Area, lies adjacent to the three nautical mile State waters limit surrounding Clerke and Imperieuse reefs, and includes the Mermaid Reef National Nature Park.

Ancient Coastline at 90-120 m Depth

The Ancient Coastline KEF lies approximately 683 km from the Operational Area, and consists of a ridge comprising a submerged shoreline from a glacial period when sea levels were lower. The ancient coastline between 90 and 120 m may host relatively high benthic biodiversity and be associated with increased productivity (DSEWPaC 2012c).

Western Rock Lobster

The Western Rock Lobster KEF covers a considerable portion (around 40,000 km^2) of continental shelf waters on the lower west coast of Western Australia (approximately 683 km from the Operational Area). It was established in recognition of the presumed ecological role played by the western rock lobster (*Panulirus cygnus*) in shelf waters (DSEWPaC, 2012c; MacArthur et al., 2007).

Commonwealth Marine Environment within and Adjacent to the West Coast Inshore Lagoons

The west coast inshore lagoons KEF covers around 1761 km^2 and includes areas that are important for benthic productivity, and breeding and nursery aggregations for many temperate and tropical marine species (McClatchie et al., 2006). The lagoons are dominated by seagrass and epiphytic algae, which provide habitat and food for many marine species (directly and indirectly). Seagrass meadows occur in more sheltered areas and in the inter-reef lagoons along exposed sections of the coast, while emergent reefs and small islands create a diverse topography. This mix of sheltered and exposed environments forms a complex mosaic of habitats.

The lagoons are also important areas for recruiting commercially and recreationally important fishery species, including western rock lobster. Extensive schools of migratory fish visit the area annually, including herring, garfish, tailor and Australian salmon (McClatchie et al., 2006).

Commonwealth Marine Environment Surrounding the Houtman Abrolhos Islands

The Houtman Abrolhos Islands host a unique mix of temperate and tropical species, facilitated by the transport of relatively warm water and tropical larvae southwards by the Leeuwin Current (DSEWPaC 2012d). The islands host significant aggregations of breeding seabirds, supporting over one million breeding pairs, and include a range of benthic habitats and associated fisheries resources (Department of Fisheries, 2012; DSEWPaC, 2012d).

Perth Canyon and Adjacent Shelf Break, and Other West Coast Canyons

The Perth Canyon is the largest canyon on the Australian margin and, together with numerous smaller submarine canyons that incise the continental slope of southern Western Australia, is expected to have high biodiversity values. Canyons can be characterised by higher productivity and species diversity than surrounding slope areas of similar depth or distance offshore (Richardson et al., 2005). They are pathways for transporting sediments, nutrients and biota off the continental shelf and slope and onto the abyssal plain, either acting as a sink for this relatively organic-rich material or directing it into deeper water (Richardson et al., 2005). Canyons are also conduits for upwelling and downwelling, processes that influence environmental variables such as nutrient availability and water temperature. Upwelling of water from the deep ocean supplies nutrients to the continental shelf and slope, which is important for phytoplankton blooms and production in local fisheries (Richardson et al., 2005).

The west coast canyons are believed to be associated with small periodic upwellings that locally increase productivity and attract aggregations of marine life. In the Perth Canyon, interactions between the canyon topography and the Leeuwin Current induce clockwise-rotating eddies, that transport nutrients upwards in the water column from greater depths. Due to the canyon's depth and the Leeuwin Current's barrier effect, this remains a subsurface upwelling (depths greater than 400 m), which confers ecological complexity that is typically absent from canyon systems in other areas (Pattiaratchi, 2007). The Perth Canyon also marks the southern boundary for numerous tropical species groups on the shelf, including sponges, corals, decapods and xanthid crabs. The Perth Canyon is approximately 741 km from the Operational Area but within the EMBA.

The 'Perth Canyon and adjacent shelf break, and other west coast canyons' KEF covers 9244 km^2 of the continental slope of southern Western Australia, and includes the Perth Canyon and numerous smaller submarine canyons. The Perth Canyon is the largest canyon on the Australian margin and is thought to have small periodic upwellings that locally increase productivity and attract aggregations of marine life (Richardson et al., 2005). The Perth Canyon also marks the southern boundary for numerous tropical species groups on the shelf, including sponges and corals. It is defined as a KEF because it is an area of higher productivity that attracts feeding aggregations of deep-diving mammals and large predatory fish.

4.7.7.3 Other Sensitive Areas

Rankin Bank

Rankin Bank is on the continental shelf, approximately 225 km from the Operational Area. 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 approximately 18–30.5 m (AIMS, 2014).

Rankin Bank, along with the Glomar Shoals, was surveyed by the 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 (around 55% cover), followed by hard corals (around 5% cover), unconsolidated sand/silt habitat (around 16% cover), and benthic communities composed of macroalgae, soft corals, sponges and other invertebrates (around 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 NW Australia (Heyward et al., 2012).

Rankin Bank has been shown to support a diverse fish assemblage (AIMS, 2014). This is consistent with studies showing a strong correlation between habitat diversity and fish assemblage species richness (Gratwicke and Speight, 2005; Last et al., 2005).

Indonesia

The Indonesian islands of Bali, Lombok, Sumba, Sumbawa, Flores, Savu and Pulau Roti are located within Indonesia’s Lesser Sunda ecoregion and contain significant marine and socio-economic environmental values. Such values include:

- Subtidal benthic habitats – These islands host extensive subtidal benthic habitats including fringing coral reefs, seagrass meadows and algal beds. Whilst such habitats are generally under considerable pressure due to over exploitation of resources (e.g. over-fishing), pollution and climate change induced impacts (Hutomo and Moosa 2005), they still represent a significant environmental value within the region, supporting local subsistence fishing, tourist and aquaculture activities.
- Intertidal habitats – Mangroves are commonly distributed within estuaries and around deltas within this region of Indonesia. Such habitats form important benthic primary producing habitats, acting as nurseries for fish and shrimps, as well as maintaining an important role in coastal defence (e.g. mitigating coastal erosion) and nutrient recycling. In addition, such mangrove communities play a significant role in Indonesia’s national and global climate change mitigation strategies, given their carbon storage properties (Murdiyarso et al., 2015; Donato et al., 2011).
- Whales – As a result of seasonal upwellings, the Lesser Sunda Ecoregion hosts several species of migratory whales (up to 19 species noted), which traverse through the area, in particular the waters in between Sumba and Timor, within the Savu Sea Marine Protected Area) (Mustika et al., 2006).
- Aquaculture – Aquaculture within the region is undertaken within estuarine and marine waters focusing on a variety of species and methods, including prawns, fish and seaweed. These activities often contribute significantly to local employment and food production within the region (FAO 2017a).
- Fisheries – As the world’s largest archipelagic state with approximately 17,500 islands, fisheries form a significant socio-economic sector. The vast majority of fishery production (up to 95 percent) comes from artisanal fishing practices (FAO 2017b). The fisheries management area 573 (South of Java – East Nusa Tenggara), encompasses the Lesser Sunda Ecoregion and is a particular productive area with a variety of target demersal

and pelagic fisheries, including, lobster, tuna, sardines and shark fisheries. Many of these fisheries are under pressure from over-exploitation, unsustainable fishing practices, under-regulation and poor management/monitoring, nevertheless they significantly contribute to the economy and social fabric within coastal communities in the region (FAO 2017b).

- Tourism – Tourism is a major industry within the Lesser Sunda Ecoregion, with particular tourist centres in Bali, Flores, Lombok, Komodo and the Gili Islands. The marine environment within these centres is a major attraction, with beach and coastal activities a primary attraction.

The following National Parks within the Lesser Sunda Ecoregion are largely marine:

- Laut Sawu Marine National Park – The Marine National Park is a known migration route for several cetacean species, including the blue whale and sperm whale. Other cetacean species such as pygmy killer whales, melon-head whale, short-finned pilot whales and numerous dolphin species (including Risso's dolphin, Fraser's dolphin, common dolphin, bottlenose dolphin and spinner dolphin) are known to frequent the Marine National Park. Several species of marine turtle, including the green turtle, hawksbill turtle and leatherback turtle have also been recorded in the Marine National Park. The Marine National Park covers a range of habitats and species diversity, including
  - 532 corals species which include 11 endemic and sub endemic species
  - 350 reef fish species
  - fifteen mangrove species are recorded that represent nine families of mangrove
  - ten seagrass species
  - deep-water habitats such as seamounts, deep-water canyons, straits (migratory corridors)
  - main migratory corridors and habitats for 14 whales species, seven dolphin species, and dugong
  - Habitats for five sea turtle species (green, leatherback, olive ridley, loggerhead, and flat back) as well as for large marine fauna such as sharks, napoleon, parrotfish and groupers
- Manupeu Tanadaru National Park and Laiwangi Wanggameti National Park, both located on Sumba, are important for endemic bird species and protected plant species.
- Komodo National Park is located between the islands of Sumbawa and Flores and is composed of three major islands (Rinca, Komodo, and Padar) and numerous smaller ones of volcanic origin. This national park lies within the Wallacea Biogeographical Region and has been identified as a global conservation priority area (UNESCO World Heritage Listing 609). The environment within the park is noted for its terrestrial and marine ecosystems and covers a total area of 219,322 ha. The coral reefs fringing the Komodo islands host a significant diversity of marine species, including sea turtles, whales, dolphins and dugongs.

The southern coast of Java, within the Southern Java ecoregion, maintains many of the same environmental and socio-economic values as the Lesser Sundra ecoregion, albeit with increased population pressure as the most populated island in Indonesia.

5 STAKEHOLDER CONSULTATION

5.1 Summary

Woodside is committed to consulting relevant stakeholders to ensure stakeholder feedback informs its decision making and planning for proposed petroleum activities and builds upon Woodside's extensive and ongoing stakeholder consultation for its offshore petroleum activities in the region.

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 carried out under the Environment Plan, or the revision of the Plan, may be relevant.
- Each Department or agency of a State or the Northern Territory Government to which the activities to be carried out under the Environment Plan, or the revision of the Plan, may be relevant.
- The Department of the responsible State Minister, or the responsible Northern Territory Minister.
- A person or organisation whose functions, interests or activities may be affected by the activities to be carried out under the Environment Plan, or the revision of the Plan.
- 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 communications material to stakeholders that is relevant to their interests and information needs.
- Incorporate stakeholder feedback into the management of the proposed activity where practicable.
- Provide feedback to stakeholders on Woodside's assessment of their feedback and keep a record of 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*

Commonwealth 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*

Commonwealth Department of Agriculture and Water Resources:

- *Fisheries and the Environment – Offshore Petroleum and Greenhouse Gas Act 2006*
- *Offshore Installations Biosecurity Guide*

WA 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 prior to or during the proposed activity. These stakeholders will be contacted, provided with information relevant 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
Commonwealth Government department or agency		
Australian Customs Service - Border Protection Command (ACS)	Yes	Responsible for coordinating maritime security.
Australian Fisheries Management Authority	No	Responsible for the management of Commonwealth fisheries. No potential for interaction with Commonwealth fisheries in the Operational Area.
Australian Hydrographic Office (AHO)	Yes	Response for maritime safety and Notices to Mariners.
Australian Maritime Safety Authority (AMSA)	Yes	Statutory agency for vessel safety and navigation and legislated responsibility for oil pollution response in Commonwealth waters. Proposed activity has a hydrocarbon spill risk, which may require AMSA assistance for pollution response.
Department of Agriculture and Water Resources (DAWR)	Yes	Responsible for implementing Commonwealth policies and programmes to support the agriculture, fisheries, food and forestry industries. The proposed activity has the potential impact to DAWR's interests in the prevention of introduced marine species. No impacts are expected on commercial fishing operators licensed to fish in Commonwealth Fisheries that would impact the functions, interests or activities of DAWR.
Department of Defence (DoD)	Yes	Responsible for defending Australia and its national interests. The proposed Operational Area overlaps the Defence training area.
Department of the Environment and Energy (DoEE)	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 (DIIS)	Yes	Department of relevant Commonwealth Minister and is required to be consulted under the Regulations.
Director of National Parks (DNP)	No	Responsible for the management of Commonwealth parks and conservation zones. Whilst 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 park.
WA Government department or agency		
Department of Biodiversity, Conservation and Attractions (DBCA)	No	Responsible for the management of Western Australia's parks, forests and reserves. Planned activities do not impact DBCA's functions, interests or activities.

Stakeholder	Relevant to activity	Reasoning
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 (DPIRD)	Yes	Responsible for the management of State fisheries. Potential for interaction during proposed activities with State fisheries in the Operational Area.
Department of Transport (DoT)	Yes	Legislated responsibility for oil pollution response in State waters. Proposed activity has a hydrocarbon spill risk, which may require DoT response in State waters.
Commonwealth fisheries*		
North-West Slope Trawl Fishery	No	Whilst the fishery overlaps the Operational Area, the fishery has not been active in the Operational Area within the last five years.
Southern Bluefin Tuna Fishery	No	Whilst the fishery overlaps the Operational Area, the fishery has not been active in the Operational Area within the last five years.
Western Tuna and Billfish Fishery	No	Whilst the fishery overlaps the Operational Area, the fishery has not been active in the Operational Area within the last five years.
Western Deepwater Trawl Fishery	No	Whilst the fishery overlaps the Operational Area, the fishery has not been active in the Operational Area within the last five years.
State fisheries*		
Mackerel Managed Fishery – Pilbara (Area 2)	No	Whilst the fishery overlaps the Operational Area, the fishery has not been active in the Operational Area within the last five years.
South West Coast Salmon Managed Fishery	No	Whilst the fishery overlaps the Operational Area, the fishery has not been active in the Operational Area within the last five years.
West Coast Deep Sea Crustacean Managed Fishery	No	Whilst the fishery overlaps the Operational Area, the fishery has not been active in the Operational Area within the last five years.
Pilbara Crab Managed Fishery	No	Whilst the fishery overlaps the Operational Area, the fishery has not been active in the Operational Area within the last five years.
Pilbara Demersal Scalefish Fishery • Pilbara Trawl Fishery	No	The Operational Area is outside of the Pilbara Trawl Fishery.
• Pilbara Trap Fishery	No	The Operational Area is outside of the Pilbara Trap Fishery.

Stakeholder	Relevant to activity	Reasoning
- Pilbara Line Fishery	Yes	The fishery overlaps the Operational Area and DPIRD data indicate active fishing within the Operational Area.
Industry		
BHP	Yes	Adjacent Titleholder
Santos	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.
Commonwealth Fisheries Association (CFA)	No	Represents the interests of commercial fishers with licences in Commonwealth waters. No potential for interaction with Commonwealth fisheries in the Operational Area.
Pearl Producers Association (PPA)	Yes	Although interactions with licence holders in the Pearl Oyster Managed Fishery are unlikely, PPA has requested to be informed of Woodside's planned activities.
Recfishwest	Yes	Represents the interests of recreational fishers in Western Australia. Activities have the potential to impact recreational fishers.
Western Australian Fishing Industry Council (WAFIC)	Yes	Represents the interests of commercial fishers with licences in State Waters. There is potential for interaction with commercial fishers in the Pilbara Line Fishery.
Other Stakeholders		
Exmouth-based charter boat, tourism and dive operators	Yes	There has been no recent fishing effort in the Operational Area by charter boat operators, however Woodside has chosen to consult charter operators.
Cape Conservation Group	Yes	Volunteer not-for-profit organisation that is involved in protecting the terrestrial and marine environment of the North West Cape.
Exmouth Community Reference Group	Yes	Group established in 2002 to provide a forum for local community, industry and government stakeholders and the oil and gas industry to discuss operations and community issues.
Exmouth Game Fishing Club	Yes	Exmouth based game fishing club, which hosts a number of fishing tournaments in the region.

** 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 4-11*** *provides a detailed assessment of Commonwealth and State fisheries within or adjacent to the Operational Area.*

5.5 Stakeholder Consultation

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

The Consultation Information Sheet (**Appendix F**, reference 1.2) is published on the Woodside website and includes a toll-free 1800 phone number.

Table 5-2: Stakeholder consultation plan activities

Stakeholder	Information provided	Stakeholder response	Woodside response
Australian Government department or agency			
ACS	On 10 October 2019 Woodside emailed ACS advising of the proposed activity (**Appendix F**, reference 1.1) and provided a consultation Information Sheet.	No feedback received.	Woodside has addressed maritime security-related issues in **Section 6** of this EP based on previous offshore activities. Woodside considers the level of consultation to be adequate.
AHO	On 10 October 2019 Woodside emailed AHO advising of the proposed activity (**Appendix F**, reference1.15) and provided a shipping fairways map (**Appendix F**, reference 1.16) and a consultation Information Sheet.	No feedback received.	Woodside will notify the AHO no less than four working weeks before operations commence. Woodside considers the level of consultation to be adequate.
AMSA (marine safety)	On 10 October 2019 Woodside emailed AHO advising of the proposed activity (**Appendix F**, reference1.15) and provided a shipping fairways map (**Appendix F**, reference 1.16) and a consultation Information Sheet.	On 10 October 2019 AMSA emailed Woodside requesting the Master to email AMSA's Joint Rescue Coordination Centre at least 24-48 hours before operations commence and provided details of information required by the Centre in that communication. AMSA requested that the Australian Hydrographic Service (AHS) be contacted through datacentre@hydro.gov.au no less than four working weeks before operations commence for the promulgation of related notices to mariners.	Woodside will notify AMSA's Joint Rescue Coordination Centre at least 24-48 hours before operations commence for each survey. Woodside will notify the AHO no less than four working weeks before operations commence. Woodside notes AMSA's advice on vessel traffic information.

Stakeholder	Information provided	Stakeholder response	Woodside response
		AMSA provided advice on obtaining vessel traffic plots, including digital datasets and maps.	
AMSA (marine pollution)	On 10 October 2019 Woodside emailed AMSA advising on its consultation approach for the Oil Pollution First Strike Plan (**Appendix F**, reference 1.17) consultation Information Sheet.	No feedback received.	No response required.
	On 1 November 2019 Woodside emailed AMSA a copy of the Oil Pollution First Strike Plan (**Appendix F**, reference 1.19).	No feedback received.	Woodside has addressed oil pollution planning and response in **Appendix D**. Woodside considers the level of consultation to be adequate.
DAWR	On 10 October 2019 Woodside emailed DAWR advising of the proposed activity and provided information on invasive marine species (**Appendix F**, reference 1.9) and a consultation Information Sheet.	On 11 October 2019 DAWR emailed Woodside acknowledging receipt of its consultation information and that a response will be provided within 10 business days.	Woodside notes DAWR's advice.
		No feedback received.	Woodside has addressed maritime biosecurity and Commonwealth fishing related issues in **Section 6** of this EP based on previous offshore activities. Woodside considers the level of consultation to be adequate.
DoD	On 10 October 2019 Woodside emailed DoD advising of the proposed activity (**Appendix F**, reference1.5) and provided a defence map (**Appendix** F, reference 1.6) and a consultation Information Sheet.	No feedback received.	Consultation Information Sheet, and defence map provided. Woodside considers the level of consultation to be adequate.
DIIS	On 10 October 2019 Woodside emailed DIIS advising of the proposed activity (**Appendix F**, reference 1.1) and provided a consultation Information Sheet.	No feedback received.	Email and Consultation Information Sheet provided. Woodside considers the level of consultation to be adequate.

Stakeholder	Information provided	Stakeholder response	Woodside response
DNP	On 22 November 2019 Woodside emailed DNP advising of the proposed activity (**Appendix F**, reference 1.22), considering potential risks for Australian Marine Parks, and provided a consultation Information Sheet.	On 12 December 2019 DNP responded noting planned activity does not overlap any Australian Marine parks, noting the EP guidance NOTE, North-west Marine Parks network management Plan 2018, and that it does not require further notification of progress in relation to the activity. Also DNP should be made aware of any incidence within a marine park.	On 13 December 2019, Woodside thanked DNP for its response and the information provided including emergency response details.
Western Australian Government department or agency or advisory body			
DMIRS	On 10 October 2019 Woodside emailed DMIRS advising of the proposed activity. (**Appendix F**, reference 1.1) and provided a consultation Information Sheet.	On 28 October 2019 DMIRS emailed Woodside acknowledging receipt of the consultation information. DMIRS noted that disposal of the riser turret mooring would not be covered in the EP, but sought clarification on disposal options.	Woodside noted it is considering a range of options for disposal of the RTM. A 500 m exclusion zone remains in place around the RTM which is located about 38 km from the North West Cape. Offered to meet DMIRS.
		On 15 November 2019 DMIRS thanked Woodside for its response and state no further information is required at this stage, and requested to be kept informed of activities.	Woodside to keep DMIRS information of activities.
DPIRD	On 10 October 2019 Woodside emailed DPIRD advising of the proposed activity (**Appendix F**, reference 1.3) and provided a State Fisheries map relevant to the proposed activity (**Appendix F**, reference 1.4) and a consultation Information Sheet.	No feedback received.	Woodside to re-consult DPIRD to seek and consider feedback for this Environment Plan.
	On 1 November 2019 Woodside sent a follow-up email seeking stakeholder feedback. Woodside also offered to meet with DPIRD.	No feedback received.	Woodside to call DPIRD as part of consultation

Stakeholder	Information provided	Stakeholder response	Woodside response
	On 12 November 2019 Woodside called DPIRD and left voicemail to discuss the activity.	No response or call back.	Woodside to re-consult DPIRD to seek and consider feedback for this Environment Plan.
	On 25 November 2019 Woodside called DPIRD and sought feedback on a number of EP consultation activities, including this EP, Woodside noted it had consulted WAFIC and relelvant licence holders.	DPIRD thanked Woodside for the information provided.	Woodside agreed to provide an extension to the feedback deadline and re-emailed consultation materials.
	On 25 November 2019 Woodside emailed DPIRD providing information on EPs currently under consultation.	On 25 November 2019 DPIRD thanked Woodside by way of an email response.	Woodside has attempted on a number of occasions to contact and consult DPIRD via email and phone calls and considers the level of consultation appropriate.
DoT	On 10 October 2019 Woodside emailed DoT advising on its consultation approach for the Oil Pollution First Strike Plan (**Appendix F**, reference 1.17) consultation Information Sheet	On 10 October 2019 Woodside received an auto response from DoT in response to its consultation information.	No further action.
	On 30 October 2019 Woodside emailed DoT a copy of the Oil Pollution First Strike Plan (**Appendix F**, reference 1.18)	On 5 December 2019 DoT emailed Woodside seeking clarification on the following items. • Areas of duplication • Crude oil type • Condensate • Response options • Potential receptors • Shoreline impact timing DoT also requested Tactical Response Plans detailed in the First Strike Plan.	Woodside emailed DoT on 6 December 2019 providing responses to the DoT's questions, noting that the First Strike Plan would be updated to reflect the responses prior to submission to NOSEMA. Woodside committed to sending DoT a final version of the Plan followng acceptance by NOPSEMA.

Stakeholder	Information provided	Stakeholder response	Woodside response
State Fisheries			
Pilbara Line Fishery	On 25 October 2019 Woodside emailed licence holders in the Pilbara Line Fishery advising of the proposed activity and potential implications and mitigation and management measures for fishers (**Appendix F**, reference 1.3) and provided a State fisheries map relevant to proposed activity (**Appendix F**, reference 1.4) and a consultation Information Sheet.	No response received.	Woodside has consulted WAFIC who have provided a response on behalf of commercial fishers. Woodside considers the level of consultation and information provided as appropriate to make an informed decision on how activities could impact fishers.
Industry			
BHP	On 10 October 2019 Woodside emailed BHP advising of the proposed activity (**Appendix F**, reference 1.7) and provided a titles map relevant to the proposed activity (**Appendix F**, reference 1.8) and a consultation Information Sheet.	No feedback received.	Email, titles map and consultation Information Sheet provided. Woodside considers the level of consultation to be adequate.
Santos	On 10 October 2019 Woodside emailed Santos advising of the proposed activity (**Appendix F**, reference 1.7 and provided a titles map relevant to the proposed activity (**Appendix F**, reference 1.8) and a consultation Information Sheet.	No feedback received.	Email, titles map and consultation Information Sheet provided. Woodside considers the level of consultation to be adequate.
Industry representative organisations			
APPEA	On 10 October 2019 Woodside emailed APPEA advising of the proposed activity (**Appendix F**, reference 1.1) and provided a consultation Information Sheet.	No feedback received.	Email and consultation Information Sheet provided. Woodside considers the level of consultation to be adequate.
PPA	On 10 October 2019 Woodside emailed PPA advising of the proposed activity and potential implications and mitigation and management measures for fishers (**Appendix F**, reference 1.1) and provided a	No feedback received.	Email, State Fisheries map and consultation Information Sheet provided. Woodside considers the level of consultation to be adequate.

Stakeholder	Information provided	Stakeholder response	Woodside response
	State Fisheries map relevant to the proposed activity and a consultation Information Sheet.		
Recfishwest	On 4 November 2019 Woodside emailed Recfishwest advising of the proposed activity (**Appendix F**, reference 1.20) and a consultation Information Sheet.	No feedback received.	Woodside to re-consult Recfishwest to seek and consider feedback for this Environment Plan.
	On 4 December 2019 Woodside resent consultation email to to Recfishwest (**Appendix F**, reference 1.21).	No feedback received.	Woodside will continue to engage Recfishwest throughout the EP activity.
WAFIC	On 10 October 2019 Woodside emailed WAFIC advising of the proposed activity and potential implications and mitigation and management measures for fishers (**Appendix F**, reference 1.1), and provided a State Fisheries map relevant to the proposed activity (**Appendix F**, reference 1.4) and a consultation Information Sheet.	On 11 October 2019 WAFIC emailed Woodside advising its relevant officer was on leave and would review Woodside information upon return.	On 15 October 2019 Woodside emailed WAFIC advising it would circulate consultation information to Pilbara Line Fishery Licence holders.
	On 21 October 2019 Woodside emailed WAFIC advising it would extend WAFIC's review of consultation information until 24 October 2019, with information to be sent to licence holders on 25 October.	On 21 October 2019 WAFIC emailed Woodside advising its relevant officer would not be returning from leave until 30 October 2019.	On 24 October 2019 Woodside advised it would send information to licence holders by 25 October 2019 to allow sufficient time for review and provision of feedback, prior to Woodside submitting the Environment Plan to NOPSEMA.
	On 12 November 2019 Woodside left a voicemail to discuss the activity.	On 14 November 2019 WAFIC left Woodside a voicemail following up.	Woodside to call back WAFIC.
	On 15 November Woodside called WAFIC to discuss the activity.	WAFIC advised Woodside should consult Pilbara Line Fishers.	Woodside has emailed Pilbara Line Fishers advising of the proposed activity, and provided the consultation Information Sheet and fisheries map.
		On 20 November 2019 WAFIC emailed Woodside advising the water depth is in the range fished by Pilbara Line fishers.	On 2 December 2019 Woodside confirmed by email that it had consulted Pilbara Line fishers.

Stakeholder	Information provided	Stakeholder response	Woodside response
		It is keen to understand the fishing potential of the area, asking if a site map or footage is available. Requested Pilbara Line fishers be advised once the 500 m radius exclusion zone is removed. Requested clarity - the operational areas are not exclusion zones.	Woodside advised that fish aggregations may disperse as infrastructure is removed from the area and that Pilbara Lines fishers currently had access to fish in the area. Woodside will advise Pilbara Line fishers once exclusion zones for activities have been removed. Woodside will also issue a notification to mariners and request the AHO update navigation charts for both the removal of the RTM 500m exclusion zone, and for the temporary MODU / Intervention Vessel 500 m exclusion zone. Woodside provided advice to WAFIC on definitions for Operational Areas.
Other stakeholders			
Cape Conservation Group	On 10 October 2019 Woodside email the Exmouth Community Reference Group advising of the proposed activity (**Appendix F**, reference 1.11) and provided a consultation Information Sheet.	On 9 October 2019 the Cape Conservation Group as member of the Exmouth Community Reference Group emailed Woodside seeking clarification on: Whether consultation was just about the riser turret mooring removal and temporary plug installations. Whether the permanent abandonment of the wells and infrastructure still in the field will have future consultation and a separate EP. The difference between what is in place now for the wells, the temporary plug installation and the permanent plug installation. Whether the 10-20 days well intervention activities were for installation of temporary plugs or for permanent abandonment.	On 15 October 2019 Woodside emailed the Cape Conservation Group with the following responses: Woodside confirmed it was seeking stakeholder feedback on the removal of the riser turret mooring, and well intervention in preparation for permanent plugging of the existing 18 wells. Woodside confirmed that Environment Plan(s) and consultation will be conducted as part of the permanent abandonment of the wells and infrastructure and that these activities will likely require more than one Environment Plan. Woodside advised that the wells were shut-in, with the valves on the Xmas tree closed and leak tested. 'Temporary' plugs, which

Stakeholder	Information provided	Stakeholder response	Woodside response
		Whether there is increased difficulty of retrieval with items laid on the sea floor. Where the riser turret mooring will be moved to. The 18 wells plus riser turret removal could be up to 390 days or would activities occur concurrently. Associated use of Exmouth Gulf for this work, including an estimate of vessel numbers, type and frequency.	have a design life of 5-10 years, had been installed inside the well bore to enable the Xmas tree to be removed. The Xmas trees are required to be removed to enable permanent plugging activities to occur. Permanent plugging activities will involve re-establishing a rock to rock bond to enable the well to be abandoned. These plugs were typically cement. Woodside confirmed that 10/20 days was required for installing temporary mechanical plugs into the well bore. Woodside confirmed that laying items on the seafloor did not increase the difficulty of future removal and was a common industry practice. Woodside advised that the future location of the riser turret mooring was still being determined and would be subject to a separate approval process and consultation with stakeholders. Woodside confirmed that 390 days could be the maximum duration, with the expected total duration of the 18 wells around 180 days (estimated only). Up to 360 have been allowed for project scheduling requirements, metocean conditions, vessel/MODU availability, unforeseen circumstances and weather. Woodside also advised that well activities may not be undertaken in a single campaign. The wells and riser turret mooring removal may be undertaken concurrently, depending on the variables above. Woodside advised that there may be some use of the Exmouth Gulf to mobilise and demobilise vessels for the activities. The frequency of use of Exmouth Gulf is to be

Stakeholder	Information provided	Stakeholder response	Woodside response
			determined in the months prior to the activities being undertaken. Any use will comply with Woodside's Exmouth Gulf Vessel Management Plan. Woodside advised it would provide further information once available.
Exmouth Community Reference Group	On 9 October 2019 Woodside emailed the Exmouth Community Reference Group advising of the proposed activity (**Appendix F**, reference 1.11) and provided a consultation Information Sheet	On 10 October 2019 the Cape Conservation Group emailed Woodside if the information provided was the same as that it had received previously and whether Woodside had received its emailed response and questions. Feedback received from Cape Conservation Group outlined above in this table.	On 15 October 2019 Woodside emailed the Cape Conservation Group apologising for sending the material twice – as member of the Exmouth Community Reference Group and as an individual stakeholder. Woodside confirmed it would respond to questions from the Cape Conservation Group.
	The proposed activity was an agenda item at a Community Reference Group meeting on 7 November 2019. A presentation slide and advising of proposed activity (**Appendix F**, reference 1.12) and a consultation Information Sheet were provided.	No feedback was provided.	Woodside presentation including information on the activity was sent to the Reference Group on 19 November 2019. Woodside considers the level of consultation to be adequate.
Exmouth Game Fishing Club	On 10 October 2019 Woodside emailed the Exmouth Game Fishing Club advising of the proposed activity (**Appendix F**, reference 1.13) and a consultation Information Sheet was provided.	No feedback received.	Woodside to re-consult the Game Fishing Club.
	On 1 November 2019 Woodside sent a follow-up email seeking stakeholder feedback.	No feedback received.	Woodside has also consulted Recfishwest and Charter Operators and considers the level of consultation to be adequate.
Exmouth-based charter boat, tourism and dive operators	On 10 October 2019 Woodside emailed stakeholders advising of the proposed activity (**Appendix F**, reference 1.14) and provided a consultation Information Sheet	No feedback received.	Email and Consultation Information Sheet provided. Woodside considers the level of consultation to be adequate.

Stakeholder	Information provided	Stakeholder response	Woodside response
Exmouth community and visitors	On 17 October 2019 the consultation Information sheet placed on community oil and gas noticeboard (**Appendix F**, reference 1.2)	No feedback received.	Woodside has consulted the Exmouth Community Reference Group and considers this level of consultation as appropriate.

5.6 Ongoing Stakeholder Consultation

Woodside is committed to the engagements listed in **Table 5-3**, based on stakeholder feedback.

Table 5-3: Assessment ongoing stakeholder consultation

Stakeholder	***Activity***
AMSA	Woodside will notify AMSA's Joint Rescue Coordination Centre at least 24-48 hours before operations commence.
	Woodside will notify the AHO no less than four working weeks before operations commence.

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

6.1 Overview

This section presents the risk analysis, risk 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 Risk Analysis and Evaluation

As required by Regulation 13(5) and 13(6) of the Environment Regulations, the analysis and evaluation demonstrates that the identified risks and impacts associated with the Petroleum Activity Program are reduced to ALARP, are of an acceptable level and consider all operations of the activity, including potential emergency conditions.

The risks identified during the ENVID workshop (including decision type, current risk level, acceptability of risk and tools used in the demonstration of acceptability and ALARP) have been divided into two broad categories: planned (routine and non-routine); and unplanned events (accidents, incidents or emergency situations). Within these categories, impact assessment groupings are based on stressor type, e.g. emissions, physical presence. In all cases, the worst-case risk was assumed.

The ENVID (undertaken in accordance with the methodology described in **Section 2.3**) identified 25 sources of environmental risk, comprising 15 planned, which are all assessed as having a low current risk rating, and nine unplanned sources of risk, which are assessed as having a low to high current risk rating following the implementation of identified preventative and mitigation control measures. Planned activities and unplanned events are summarised in **Table 6-1** and **Table 6-2**.

The risk analysis and evaluation for the Petroleum Activities Program indicate that all of the current environmental risks and impacts 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

Given the presence of operating FPSOs in the vicinity of the NGA facility (**Section 4.6.7**), the cessation of operations of the NGA facility may have reduced cumulative impacts that could arise from the operation of facilities in the region, such as routine, non-routine and accidental discharges from FPSOs, offtake tankers and support vessels.

Woodside may undertake opportunistic well interventions during the Petroleum Activities Program. However, these are short-term activities with minimal discharges.

Table 6-1: Environmental impact analysis summary of planned activities

Aspect	EP Section	Source of Impact	Key Potential Environmental Impacts (Refer to relevant EP section for details)	Controlled Impact Classification	Residual Impact Level (ALARP controls in place)	Acceptability of Impact
Planned Activities (Routine and Non-routine)						
Physical presence: interference with or displacement of other users or seabed	6.6.1	Presence of project vessels causing interference with or displacement to third-party vessels (commercial shipping and commercial/recreational fishing)	Isolated social impact potentially resulting from interference with other sea users (e.g. commercial and recreational fishing, and shipping)	E	Social & Cultural – Slight, short-term impact (<1 year) to a community or areas/items of cultural significance	Broadly acceptable
		Retention of RTM in situ prior to removal causing interference with or displacement to third-party vessels (commercial shipping and commercial/recreational fishing)	Isolated social impact potentially resulting from interference with other sea users (e.g. commercial and recreational fishing, and shipping)	E	Social & Cultural – Slight, short-term impact (<1 year) to a community or areas/items of cultural significance	Broadly acceptable
		Presence of subsea infrastructure causing interference with or displacement to commercial fishing	Isolated social impact potentially resulting from interference with other sea users (e.g. commercial fishing)	F	Social & Cultural – No lasting effect (<1 month). Localised impact not significant to area/item of cultural significance	Broadly acceptable
		Proximity of helicopters causing interference with other aerial operations	Isolated social impact potentially resulting from interference with other area users (e.g. defence and commercial)	F	Social & Cultural – No lasting effect (<1 month). Localised impact not significant to area/item of cultural significance	Broadly acceptable
	6.6.2	Disturbance to benthic habitat from laydown of infrastructure (RTM mooring lines)	Localised disturbance to seabed within laydown footprint	E	Environment – Slight, short-term impact (<1 year) on species, habitat (but not affecting ecosystem function), physical or biological attributes	Broadly acceptable
		Disturbance to the seabed from the deployment of subsea equipment (MODU anchors and ROV activities)	Localised disturbance to seabed from anchoring and ROV activities within Operational Area footprint	E	Environment – Slight, short-term impact (<1 year) on species, habitat (but not affecting ecosystem function), physical or biological attributes	Broadly acceptable
Routine and non-routine discharges: project vessel discharges, hydrocarbons, chemicals and well intervention fluids	6.6.3 and 6.6.4	Routine discharge of sewage, grey water and putrescible wastes to marine environment from project vessels	Localised and temporary effects to water quality and marine biota in offshore waters	F	Environment – No lasting effect (<1 month); localised impact not significant to environmental receptors	Broadly acceptable
		Routine discharge of deck and bilge water to marine environment from project vessels	Localised and temporary effects to water quality and marine biota in offshore waters	F	Environment – No lasting effect (<1 month); localised impact not significant to environmental receptors	Broadly acceptable
		Routine discharge of cooling water or brine to the marine environment from project vessels	Localised and temporary effects to water quality and marine biota in offshore waters	F	Environment – No lasting effect (<1 month); localised impact not significant to environmental receptors	Broadly acceptable
		Routine and non-routine discharges to the marine environment during IMMR activities.	Localised and temporary effects to water quality and marine biota in offshore waters	F	Environment – No lasting effect (<1 month); localised impact not significant to environmental receptors	Broadly acceptable
		Routine discharge of cement and wellbore fluids to the seabed and the marine environment during well intervention activities.	Localised and temporary effects to water quality and marine biota in offshore waters	F	Environment – No lasting effect (<1 month); localised impact not significant to environmental receptors	Broadly acceptable
Routine light emissions	6.6.5	External light emissions on-board project vessels	Localised and temporary behavioural disturbance to marine fauna	F	Environment – No lasting effect (<1 month); localised impact not significant to environmental receptors	Broadly acceptable
Routine acoustic emissions	6.6.6	Generation of noise from project vessels during normal operations	Localised and temporary behavioural disturbance to marine fauna	F	Environment – No lasting effect (<1 month); localised impact not significant to environmental receptors	Broadly acceptable
		Generation of noise from helicopter transfers	Localised and temporary behavioural disturbance to marine fauna	F	Environment – No lasting effect (<1 month); localised impact not significant to environmental receptors	Broadly acceptable
Routine and non-routine atmospheric emissions	6.6.7	Exhaust emissions from internal combustion engines and incinerators on project vessels and helicopters	Localised and temporary reduction in air quality	F	Environment – No lasting effect (<1 month); localised impact not significant to environmental receptors	Broadly acceptable
		Bleed-off of hydrocarbon gas during well intervention				

Table 6-2: Environmental risk analysis summary of unplanned events

Aspect	EP Section	Source of Risk	Key Potential Environmental Impacts (Refer to relevant EP section for details)	Current Risk Rating				Acceptability of Risk
				Consequence Classification	Potential Consequence level of impact	Likelihood	Risk Rating	
Unplanned Events (Accidents/Incidents)								
Accidental hydrocarbon release	6.7.2	Loss of hydrocarbons to marine environment due to loss of well containment during well intervention	Short- to medium-term impacts to the offshore marine environment Long-term impacts to sensitive nearshore areas of coastal shorelines (e.g. Ningaloo Coast) Disruption to marine fauna, including protected species Potential medium-term interference with or displacement of other sea users (e.g. fishing and shipping)	B	Environment – Major, long-term impact on highly values ecosystems, species, habitats or physical or biological attributes Reputation and Brand – National concern and/or international interest. Medium to long-term impact to reputation and brand. Venture and/or asset operations restricted Social and Cultural – Major, long-term impact to a community, social infrastructure or highly valued areas/ items of national cultural significance	2	H	Acceptable if ALARP
	6.7.3	Loss of hydrocarbons to marine environment due to loss of well containment due to accidental damage to, or removal of, Xmas tree	Minor and temporary disruption to marine fauna, including protected species Minor and/or temporary impacts to water quality Potential short-term interference with or displacement of other sea users (e.g. fishing and shipping)	D	Environment – Minor, short-term impact (1–2 years) on species, habitat (but not affecting ecosystems function), physical or biological attributes Social and Cultural – Minor, short-term impact (1–2 years) to a community or highly valued areas/items of cultural significance	0	L	Broadly acceptable
	6.7.4	Loss of hydrocarbons to marine environment due to a vessel collision (e.g. project vessels or other marine users)	Minor and temporary disruption to marine fauna, including protected species Minor and/or temporary impacts to water quality Potential short-term interference with or displacement of other sea users (e.g. fishing and shipping)	D	Environment – Minor, short-term impact (1–2 years) on species, habitat (but not affecting ecosystems function), physical or biological attributes Social and Cultural – Minor, short-term impact (1–2 years) to a community or highly valued areas/items of cultural significance	1	M	Broadly acceptable
	6.7.5	Loss of hydrocarbons to marine environment from bunkering	Minor and temporary disruption to marine fauna, including protected species Minor and/or temporary impacts to water quality	E	Environment – Slight, short-term impact (<1 year) on species, habitat (but not affecting ecosystems function), physical or biological attributes	3	M	Broadly acceptable
Unplanned Discharges	6.7.6	Accidental discharge of other hydrocarbons/chemicals from project vessel deck activities and equipment (e.g. cranes) to the marine environment, including helicopter refuelling and subsea ROV hydraulic leaks	Minor and temporary disruption to marine fauna, including protected species Minor and/or temporary impacts to water quality	E	Environment – Slight, short-term impact (<1 year) on species, habitat (but not affecting ecosystems function), physical or biological attributes	2	M	Broadly acceptable
	6.7.7	Accidental loss of hazardous or non-hazardous wastes to the marine environment (excludes sewage, grey water, putrescible waste and bilge water)	Minor and temporary disruption to marine fauna, including protected species Minor and/or temporary impacts to water quality	F	Environment – No lasting effect (<1 month); localised impact not significant to environmental receptors	2	L	Broadly acceptable
Physical Presence	6.7.8	Accidental collision between project vessels and threatened and migratory marine fauna	Minor and temporary disruption to marine fauna, including protected species	E	Environment – Slight, short-term impact (<1 year) on species, habitat (but not affecting ecosystems function), physical or biological attributes	1	L	Broadly acceptable
	6.7.9	Dropped subsea infrastructure during laydown or removal activities /dragged subsea equipment	Localised short-term damage of benthic subsea habitats in the immediate location of the dropped object	E	Environment – Slight, short-term impact (<1 year) on species, habitat (but not affecting ecosystems function), physical or biological attributes	1	L	Broadly acceptable
		Accidental sinking of the RTM	Localised short-term damage of benthic subsea habitats in the immediate location of the dropped object	E	Environment – Slight, short-term impact (<1 year) on species, habitat (but not affecting ecosystems function), physical or biological attributes	1	L	Broadly acceptable
	6.7.10	Introduction of invasive marine species	Introduction of invasive marine species possibly resulting in an alteration of the localised environment	E	Environment – Slight, short-term impact (<1 year) on species, habitat (but not affecting ecosystems function), physical or biological attributes	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 risks of the activity to ALARP and Acceptable levels.

Environmental performance outcomes, standards and measurement criteria for the Petroleum Activity 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 2.6**, 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 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 table denotes the purpose of each part of the table with reference to the relevant sections of the Regulations and/or this EP.

<table>
<tr><th colspan="15">Context <Description of the context for the impact/risk. Regulation 13(1, 13(2) and 13(3)></th></tr>
<tr><td><i>Description of the Activity – Regulation 13(1)</i></td><td colspan="7"><i>Description of the Environment – Regulations 13(2)(3)</i></td><td colspan="7"><i>Consultation – Regulation 11A</i></td></tr>
<tr><td colspan="15">Impacts and Risks Evaluation Summary - Summary of ENVID outcomes</td></tr>
<tr><td rowspan="2">Source of Risk
<i>Regulation 13(1)</i></td><td colspan="7">Environmental Value Potentially Impacted
<i>Regulations 13(2)(3)</i></td><td colspan="7">Evaluation
<i>Section 2.3</i></td></tr>
<tr><td><i>Soil and Groundwater</i></td><td><i>Marine Sediment</i></td><td><i>Water Quality</i></td><td><i>Air Quality (incl Odour)</i></td><td><i>Ecosystems/Habitat</i></td><td><i>Species</i></td><td><i>Socio-economic</i></td><td><i>Decision Type</i></td><td><i>Consequence</i></td><td><i>Likelihood</i></td><td><i>Current Risk Rating</i></td><td><i>ALARP Tools</i></td><td><i>Acceptability</i></td><td><i>Outcome</i></td></tr>
<tr><td>Summary of source of impact/risk</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="15">Description of Source of Risk</td></tr>
<tr><td colspan="15"><i>Description of the identified risk including sources or threats that may lead to the risk or identified event. Regulation 13(1).</i></td></tr>
<tr><td colspan="15">Impact Assessment</td></tr>
<tr><td colspan="15"><i>Environmental Value/s Potentially Impacted</i></td></tr>
<tr><td colspan="15"><i>Discussion and assessment of the potential impacts to the identified environment value/s. Regulation 13(5) (6).</i>
<i>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).</i></td></tr>
</table>

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS)***[7]	***Benefit in Impact/Risk Reduction***[8]	***Proportionality***	***Control Adopted***
ALARP Tool Used – Section 2.7				
Summary of control considered to ensure that 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 & 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 2.7 and Figure 2-4) and a proportionality assessment. Regulation 10A (b).*				

Demonstration of Acceptability
Acceptability Statement *Made on the basis of the application of the process described in Section 2.7 and Figure 2-4, taking into account internal & external expectations, risk to environmental thresholds and use of environment decision principles. Regulation 10A(c)*

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[7] Qualitative measure

[8] Measured in terms of reduction of likelihood (L), consequence (C) and current risk rating (CRR)

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 that 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 Environment 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, and therefore, which 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 approximately 400-600 m and at a distance approximately 33 km from nearest landfall (North West Cape). Consequently, risks associated with shallow/near-shore activities such as anchoring and vessel grounding were assessed as not credible.

6.6 Planned Activities (Routine and Non-routine)

6.6.1 Physical Presence: Interference with or Displacement of Other Users

Context		
RTM – **Section 3.7** Well Intervention – **Section 3.9** Project Vessels – **Section 3.10** Helicopter – **Section 3.12**	Socio-economic and Cultural – **Section 4.6**	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***	***ALARP Tools***	***Acceptability***	***Outcome***
Presence of project vessels causing interference with or displacement to third-party vessels (commercial shipping and commercial/ recreational fishing)							X	A	E	LCS GP PJ	Broadly acceptable	EPO 1, 2 & 3
Retention of RTM in situ prior to removal causing interference with or displacement to third party vessels (commercial shipping and commercial/ recreational fishing)							X	A	E	LCS GP PJ		
Presence of subsea infrastructure causing interference with or displacement to commercial fishing							X	A	F	LCS GP PJ		
Proximity of helicopters causing interference with other aerial operations							X	A	F	LCS GP PJ		N/A

Description of Source of Risk

Presence of project vessels

In order to undertake well intervention, a MODU or intervention vessel will be on station above the wells within the Operational Area. The number and type of well activities undertaken will be dependent on the availability of vessels and MODUs over the five years of the EP. General well intervention activities are expected to require 10-20 days per well to complete.

Project vessels will support the Petroleum Activities Program throughout and will remain on standby to communicate with third-party vessels and assist in maintaining the safety exclusion zone. Indicative project vessels, numbers, and timeframes for the Petroleum Activities Program are provided in **Table 6-3**. Refer to **Table 3-3** and **Table 3-11** for indicative timing of project vessels. There is also a short period of time that the RTM will be under tow as it is removed from the Operational Area. During this time, the vessel and the towed RTM may present a minor navigational hazard. However, this is a very short period of time and will be of no lasting effect.

Table 6-3: Indicative durations of vessel-based activities during the Petroleum Activities Program

Activity	Vessels	Duration (days)
Well intervention	MODU Intervention vessel Anchor handling vessel Support vessels	Up to 360 (18 wells)
Inspection and maintenance	Support vessel	To be determined by risk-based inspection schedule
RTM removal (including potential IMMR activities)	PIV Anchor handling Vessel	30 days (with potential for a cumulative 90 days)

Helicopters

During petroleum activities, crew changes will be undertaken using helicopters as required.

Retention of RTM in situ prior to removal

The RTM is a floating, partially submerged structure that is maintained in position by mooring lines. The presence of the RTM within the Operational Area may present a navigational hazard to shipping and commercial fishing activities, resulting in displacement of third party vessels.

The RTM is located within an established 500 m Petroleum Safety Zone and is clearly marked on current nautical charts.

While the FPSO was connected to the RTM during production operations, it was not uncommon for FPSO facilities to disconnect from RTM systems (e.g. to avoid cyclones, drydock for major repairs). As such, the need for other users to avoid the RTM when the FPSO is absent is not considered unusual.

The RTM is approximately 6 m above the sea surface and is coated in high visibility paint, as per good maritime practice for fixed hazards; warning lights are also fitted to the RTM. The outer casing of the RTM is constructed of steel and is reflective, resulting in a clear signal return for anti-collision radars fitted on-board commercial vessels. Additionally, a passive radar reflector is installed on the RTM to enhance the detectability of the RTM by shipboard radar.

Presence of subsea infrastructure

Subsea infrastructure will be retained in situ in a preserved state (i.e. wells isolated, production system flushed of hydrocarbons, filled with preservation fluid at hydrostatic pressure). During removal of the RTM, the mooring lines will be disconnected from the RTM and lowered to the seabed in a controlled manner. These will remain in situ for future field decommissioning.

Impact Assessment

Potential Impacts to Socio-economic Environment

Interference with commercial shipping

The presence of project vessels and the RTM could potentially cause temporary disruption to commercial shipping. Consultation with AMSA confirms that vessel traffic may be encountered within the Operational Area. However, it is noted that no shipping fairways intersect the Operational Area. The nearest shipping fairway designated by AMSA lies approximately 40 km north-west of the Operational Area. Additionally, in the vicinity of the Operational Area, vessel tracking data provided by AMSA indicate that the majority of traffic will be vessels associated with existing oil and gas infrastructure (**Section 4.6.7**).

There may be commercial vessels infrequently in the Operational Area. The use of the shipping fairways is strongly recommended by AMSA, but is not mandatory, and shipping vessels still have to adhere to the International Regulations for Preventing Collisions at Sea 1972, as implemented under Australian laws and regulations. The potential impacts could include short-term displacement of vessels as they make slight course alterations to avoid project vessels.

Displacement of commercial and recreational fishing activity

A number of Commonwealth and State managed fishery boundaries overlap the Operational Area (**Section 4.6.3**):

<u>Commonwealth</u>

- North West Slope Trawl Fishery
- Southern Bluefin Tuna Fishery
- Western Deepwater Trawl Fishery
- Western Skipjack Fishery
- Western Tuna and Billfish Fishery.

<u>State</u>

- Mackerel Managed Fishery

- South West Coast Salmon Managed Fishery
- West Coast Deep Sea Crustacean Managed Fishery
- Pilbara Crab Managed Fishery
- Pilbara Demersal Scalefish Fisheries
- West Australian Sea Cucumber Fishery.

This overlap of the Operational Area with commercial fishing activity may exclude fishers from the area. Additionally, the presence of subsea infrastructure such as well heads, manifolds, flowlines and risers may present a snagging hazard to benthic trawls.

Of the fisheries managed areas that overlap the Operational Area, there is potential for interaction with the PDSF, in particular the PLF, with DPIRD (Fishcube 2019) records showing activity within the 60 nm that covers the Operational Area. Consultation in relation to the Petroleum Activities Program indicated no claims or objections were raised by participants in fisheries that overlap the Operational Area.

Additionally, the NGA Facility commenced operations in 2006, and the RTM remains marked on standard nautical charts. Given the period in which the facility had been in operation and the location being marked on nautical charts, commercial fishers are expected to be aware of the infrastructure.

Potential impacts to commercial fishing activities within the Operational Area are considered to be localised displacement/avoidance by commercial trawling and line fishery vessels within the immediate vicinity of the Operational Area. As such, the potential impact is considered to be slight and of no lasting effect.

Recreational fishing and nature-based tourism in the region is concentrated in shallow coastal waters, particularly those in proximity to access nodes such as boat ramps. Recreational fishing effort in the Operational Area is expected to be minimal to nil, given the water depth (400-600 m), lack of reef habitat hosting sought-after demersal species, and distance offshore (47 km from Exmouth). Additionally, consultation in relation to the Petroleum Activities Program indicated no claims or objections were raised by recreational fishers. No tourism operators have been documented in the Operational Area since commencement of NGA operation in 2006. As such, no impacts to recreational fishing and tourism are expected during the Petroleum Activities Program.

Therefore, the potential impact to commercial and recreational fisheries is considered to be slight.

Interference with other aerial operations

The Operational Area is located within the northern tip of one of the designated defence practice areas of the Royal Australian Air Force base located at Learmonth (**Section 4.6.8**). While it is unlikely that helicopter activities from the petroleum activity program could interfere with defence activities, the use of helicopters to transfer crew has the potential to interact with defence activities, and therefore defence stakeholders were consulted (**Section 5**). No concerns were raised during the consultation process, and as such the potential impact is considered to be of no lasting effect.

Summary of Potential Impacts to environmental values(s)

Given the adopted controls, it is considered that the physical presence of project vessels, helicopters and RTM will not result in a potential impact greater than isolated and short-term impact to shipping, commercial/recreational fishing, oil and gas interests or other aerial operations with a consequence of slight or lower.

Vessel-based activities for the Petroleum Activities Program will lead to a small increase in the overall vessel traffic in the Operational Area. However, vessels associated with other oil and gas activities are not expected in the Operational Area, and no cumulative impacts from the interference with or displacement of third party vessels are expected.

Demonstration of ALARP

Control Considered	Control Feasibility (F) and Cost/Sacrifice (CS)[9]	Benefit in Impact/Risk Reduction	Proportionality	Control Adopted
Legislation, Codes and Standards				
Passive radar reflectors and navigation lights maintained on RTM.	F: Yes. CS: Minimal cost, standard practice.	Communicating the Petroleum Activities Program to other marine users ensures they are informed and aware, thereby	Benefits outweigh cost/sacrifice.	Yes C 1.1

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[9] Qualitative measure

Demonstration of ALARP				
Control Considered	**Control Feasibility (F) and Cost/Sacrifice (CS)[9]**	**Benefit in Impact/Risk Reduction**	**Proportionality**	**Control Adopted**
		reducing the likelihood of interfering with other marine users.		
500 m safety exclusion zone established around MODU / intervention vessel and RTM.	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.	Controls based on legislative requirements – must be adopted.	Yes 2.1
Good Practice				
Activity support vessel(s) on standby during well intervention activities to communicate with third-party vessels and assist in maintaining the safety exclusion zone.	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.	Controls based on legislative requirements – must be adopted.	Yes 2.2
Activity support vessel(s) assigned to surveillance will undertake the following actions: • Maintain a 24-hour radio watch on designated radio channel(s) • Undertake continuous surveillance and warn the MODU/ intervention vessel/ PIV (as required) of any approaching vessels reaching 500 m safety exclusion zone. Surveillance shall be conducted by a combination of the following: - Visual lookout - Radar watch - Other electronic systems available including automatic identification system (AIS) - Monitoring any additional/agreed radio communications channels	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.	Controls based on legislative requirements – must be adopted.	Yes 2.3

Demonstration of ALARP				
Control Considered	**Control Feasibility (F) and Cost/Sacrifice (CS)[9]**	**Benefit in Impact/Risk Reduction**	**Proportionality**	**Control Adopted**
- All other means available. • Monitor and advise if: - MODU/ intervention vessel / PIV navigation signals are defective - Visibility becomes restricted.				
AHO notified of activity no less than four working weeks prior to undertaking activities within the Petroleum Activity Program.	F: Yes CS: Minimal cost. Standard practice.	Notification to AHO will enable them to generate navigation warnings (Maritime Safety Information Notifications (MSIN) and Notices to Mariners (NTM) (including AUSCOAST warnings where relevant)).	Control is Standard Practice.	Yes 3.1
DPIRD notified of activities within three months of undertaking activities within the Petroleum Activity Program.	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 3.2
AMSA notified JRCC of activities 24-48 hours of undertaking activities within the Petroleum Activity Program.	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 3.3
Consultation undertaken with relevant stakeholders for activities within the Petroleum Activities Program that commence more than a year after EP acceptance.	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 3.4
Professional Judgement – Eliminate				
Do not undertake well intervention.	F: Yes, not undertaking well intervention is considered feasible. CS: Potentially significant. Woodside has	While it is feasible to eliminate well intervention from the Petroleum Activities Program, to do so would defer intervention to a later	Disproportionate. The cost/sacrifice grossly outweighs the environmental benefit gained.	No

Demonstration of ALARP				
Control Considered	**Control Feasibility (F) and Cost/Sacrifice (CS)**[9]	**Benefit in Impact/Risk Reduction**	**Proportionality**	**Control Adopted**
	identified the potential to engage a MODU or intervention vessel of opportunity (i.e. undertaking other activities in the area) to undertake well intervention during the Petroleum Activities Program. Engaging a MODU or intervention vessel of opportunity represents a considerable cost saving to Woodside when compared to contracting a MODU or intervention vessel specifically at a later time.	date (i.e. defer rather than eliminate the risk).		
Sink RTM to seabed to remove hazard to other users.	F: Yes. Sinking the RTM to the seabed would result in reduced hazard at surface. However, it may not be technically feasible to recover once on the seabed. CS: Sinking followed by recovery of the RTM for disposal would impose significant cost upon the Petroleum Activities Program. A vessel capable of securing and lifting the RTM from the seabed would need to be procured to recover the RTM.	While it is feasible to sink the RTM to reduce the surface hazard to other users, it will move the impact to the sea floor, and may not be technically feasible to recover.	Disproportionate. The cost/sacrifice involved with removal of the RTM from the sea floor (if even possible) grossly outweighs the environmental benefit gained.	No
Removal of all subsea infrastructure and flowlines.	F: Yes. However, Woodside has not yet finalised the full decommissioning scope for the Enfield development beyond the activities considered in this EP. In order to remove the	While it is feasible to remove all subsea infrastructure and flowlines, leaving this infrastructure in situ in a preserved state does not present a significant environmental risk and eliminates personnel exposure.	Disproportionate. The cost/sacrifice grossly outweighs the environmental benefit gained.	No

Demonstration of ALARP				
Control Considered	**Control Feasibility (F) and Cost/Sacrifice (CS)[9]**	**Benefit in Impact/Risk Reduction**	**Proportionality**	**Control Adopted**
	subsea infrastructure (in particular flowline recovery) a heavy lift vessel will be required to support logistics to remove infrastructure. In addition, any recovery tooling will also need to be modified to suit the specific subsea infrastructure. Full decommissioning scope and feasibility will be assessed at a later stage. CS: Removal of all subsea infrastructure during the Petroleum Activities Program would pose a significant technical, safety and financial risk at this stage of decommissioning. Leaving the infrastructure in situ in a preserved state, does not present a significant environmental risk and eliminates personnel exposure.			
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, Woodside considers the adopted controls appropriate to manage the impacts and risks of the presence of the RTM, project vessels, helicopters and subsea infrastructure 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, the presence of the project vessels, helicopters and subsea infrastructure on other users represents a consequence to commercial fishing, recreational fishing, defence, and shipping activities within the Operational Area limited to slight. 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 stakeholders (including AMSA and AHO) determined during consultation. Therefore, Woodside considers the adopted controls appropriate to manage the impacts and risks of presence of the project vessels and subsea infrastructure on other users to a level that is broadly acceptable.

Regarding interference with other aerial operations, the impact assessment has determined that, in its current state, helicopter operations present no lasting effect that is localised and not significant. The potential impacts 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 helicopter operations to a level that is broadly acceptable.

Environmental Performance Outcomes, Standards and Measurement Criteria			
Outcomes	***Controls***	***Standards***	***Measurement Criteria***
EPO 1 No unplanned interactions between RTM and marine users.	**C 1.1** Passive radar reflectors and navigation lights maintained on RTM.	**PS 1.1** Passive radar reflectors and navigation lights to be maintained in functional order.	**MC 1.1.1** Records confirm that navigation warning lights are functioning and RTM is clearly detectable by radar.
EPO 2 Prevent adverse interactions between vessels/RTM and other marine users during the Petroleum Activities Program.	**C 2.1** 500 m safety exclusion zone established around MODU/ intervention vessel and RTM.	**PS 2.1** No adverse interactions between vessels/RTM.	**MC 2.1.1** Records of adverse interactions in 500 m PSZ with other marine users are recorded.
	C 2.2 Activity support vessel(s) on standby during well intervention activities to communicate with third-party vessels and assist in maintaining the safety exclusion zone.	**PS 2.2** Activity support vessel(s) on continuous standby during well intervention activities to assist in third party vessel interactions (including warning to vessels approaching the 500 m safety exclusion zone) to prevent unplanned interaction and assist in emergencies as required.	**MC 2.2.1** Records demonstrate activity support vessel(s) present at all times during well intervention activities.
	C 2.3 Activity support vessel(s) assigned to surveillance will undertake the following actions: • Maintain a 24-hour radio watch on designated radio channel(s) • Undertake continuous surveillance and warn the MODU/ intervention vessel/ PIV (as required) of any approaching vessels reaching 500 m safety exclusion zone. Surveillance shall be conducted by a combination of the following - Visual lookout - Radar watch - Other electronic systems available including automatic	**PS 2.3** Marine Charterers Instructions implemented which define the role of activity support vessels in maintaining safety exclusion zones, preventing unplanned third party vessel interactions, monitoring the effectiveness of navigation controls (e.g. signals), and warning third party vessels of navigation hazards.	**MC 2.3.1** Records of non-conformance against Marine Charters Instructions maintained.

Environmental Performance Outcomes, Standards and Measurement Criteria			
Outcomes	***Controls***	***Standards***	***Measurement Criteria***
	identification system (AIS) - Monitoring any additional/agreed radio communications channels - All other means available • Monitor and advise if - MODU / intervention vessel / PIV navigation signals are defective - Visibility becomes restricted.		
EPO 3 Marine users aware of the Petroleum Activities Program.	**C 3.1** AHO notified of activity no less than four working weeks prior to undertaking activities within the Petroleum Activity Program.	**PS 3.1** Notification to AHO 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 3.1.1** Consultation records demonstrate that AHO has been notified before undertaking activities within required timeframes.
	C 3.2 DPIRD notified of activities within three months of undertaking activities within the Petroleum Activity Program.	**PS 3.2** Notification to DPIRD to inform other marine users of the activities to reduce activities interfering with other marine users for longer than necessary.	**MC 3.2.1** Consultation records demonstrate that DPIRD has been notified prior to undertaking activities within required timeframes.
	C 3.3 AMSA notified JRCC of activities 24-48 hours of undertaking activities within the Petroleum Activity Program.	**PS 3.3** 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 3.3.1** Consultation records demonstrate that AMSA JRCC has been notified prior to undertaking activities within required timeframes.
	C 3.4 Consultation undertaken with relevant stakeholders for activities within the Petroleum Activities Program that commence more than a year after EP acceptance.	**PS 3.4** In order to prevent activities interfering with other marine users, relevant stakeholders consulted no less than four working weeks prior to scheduled activity commencement date.	**MC 3.4.1** Consultation records demonstrate relevant stakeholders have been consulted with prior to undertaking activities within required timeframes.

6.6.2 Physical Presence: Disturbance to Seabed from Infrastructure Laydown and Subsea Equipment including MODU Anchors

Context	
RTM removal – **Section 3.6** ROVs – **Section 3.8** Mooring installation and anchor hold testing – **Section 3.11.2**	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***	***ALARP Tools***	***Acceptability***	***Outcome***
Disturbance to benthic habitat from laydown of infrastructure (RTM mooring lines)		X	X		X			A	E	LCS GP PJ	Broadly acceptable	EPO 4
Disturbance to the seabed from the deployment of subsea equipment (MODU anchors and ROV activities)		X	X		X			A	E	LCS GP PJ		

Description of Source of Risk

Laydown of infrastructure

During the Petroleum Activities Program, the mooring lines attached to the RTM will be laid upon the seabed, until final decommissioning, in the Operational Area. Laydown of mooring lines on the seabed will result in localised and temporary disturbance to the seabed. The mooring lines will be placed alongside existing infrastructure to limit the amount of disturbance to the seabed. Laydown of mooring lines is expected to result in seabed disturbance, with a total disturbance footprint of approximately 4.23 ha. A radius of 1.5 km from existing infrastructure has been selected to provide the project vessels the ability to laydown the mooring lines within a previously disturbed area, thereby limiting further seabed disturbance.

Deployment of subsea equipment

Equipment deployed to the seabed during the Petroleum Activities Program includes:

- mooring installation for MODU anchors
- ROVs.

Seabed disturbance will result from anchor hold testing for the MODU mooring system, including placement of anchors on the seabed, potential dragging during tensioning and recovery of anchors. Mooring of the MODU and anchor hold testing activities will result in localised seabed disturbance in comparison to the spatial extent of benthic habitats within the Operational Area.

The use of the ROVs during Petroleum Activities Program may result in temporary seabed disturbance and suspension of sediment as a result of working close to, or occasionally on, the seabed. ROV use close to or on the seabed is limited to that required for effective and safe subsea activities. The footprint of a typical work class ROV is approximately 2.5 m by 7 m, hence disturbance to the seabed will be localised.

Impact Assessment

Potential Impacts to Marine Sediment, Water Quality and Ecosystems / Habitats

Ecosystems / Habitats

The laydown of mooring lines on the seabed will affect a relatively small footprint on the seabed within the Operational Area below the RTM, along with the additional subsea infrastructure that was layed on the seafloor during cessation operations. The deployment, use and retrieval of the mooring system for a MODU and anchor hold testing is likely to result in a localised short term physical modification to a small area of the seabed and disturbance to soft sediment. Benthic habitats within the footprint of the infrastructure laydown consist of soft, unconsolidated sediments which host sparse assemblages of filter- and deposit-feeding epifauna and infauna, as well as demersal fishes. These soft sediment habitats, and associated biological communities, are widely represented throughout the Northwest Province and are not considered to be of particular conservation significance. The laydown of infrastructure will not overlap canyon habitat and will be restricted to the area surrounded by the existing FPSO mooring anchors.

The potential discharge of minor quantities of produced sand and scale at or near the seabed may lead to localised smothering and increased sedimentation, as well as localised contamination of the seabed surface sediments. Produced sands and scale within the riser may contain minor quantities of naturally occurring radioactive material (NORM). However, given the routine use of scale inhibitor and flushing of subsea infrastructure, the potential for scale to develop within the risers is considered to be very low.

Marine Sediments

The mooring lines were designed for long-term use in the marine environment and are constructed to resist corrosion / decomposition. Additionally, subsea infrastructure was flushed and filled with preservation fluid and capped to further inhibit corrosion and degradation through biological activity. As such, no significant decomposition is expected to occur during the period of this EP. Note that the fate of subsea infrastructure has not been finalised and will be the subject to a future environmental approval.

Water quality

The laydown of infrastructure, deployment of anchors and use of ROVs near the seabed is expected to lead to localised, minor resuspension of sediments. Sediments in the Operational Area are characterised by silts and muds, which may remain suspended in the water column and advected beyond the Operational Area. Given the discrete, one-off nature of laydown and MODU anchoring activities, sediment resuspension events will be of short duration and involve relatively small quantities of sediment. Impacts are expected to consist of a short duration increase in total suspended sediment load in the vicinity of the Operational Area. Sedimentation is a naturally occurring process, and benthic organisms are adapted to survive sedimentation. As such, no significant impacts to benthic fauna are expected.

Canyons KEF

The ecological values of the Canyons KEF (and the Enfield Canyon in particular) are discussed in **Section 4.7.7.** These include the potential of enhanced productivity due to upwelling and increased connectivity between the continental shelf and the deep ocean. Woodside's environmental survey of the Enfield Canyon indicated that the canyon habitat hosts more diverse and abundant fish assemblages relative to surrounding non-canyon habitat. While the Operational Area overlaps a small portion of the Canyons KEF, the ecological functions of the Canyons KEF (enhanced upwelling, conduit between continental shelf and deep sea, diverse biological assemblages) are not predicted to be impacted by the Petroleum Activities Program.

Summary of Potential Impacts to environmental values(s)

Given the adopted controls, seabed disturbance will result in slight localised impact to benthic habitat, water quality and marine sediment within the Operational Area.

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS)***[10]	***Benefit in Impact/Risk Reduction***	***Proportionality***	***Control Adopted***
Legislation, Codes and Standards				
No additional controls identified.				
Good Practice				
Project-specific Mooring Design Analysis.	F: Yes CS: Standard activity, no significant additional cost associated with activity.	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 4.1
Woodside Well Location and Site Appraisal Data Sheet (WLSADS) includes environmental sensitivities and seabed topography to inform the selection of the MODU mooring locations.	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 4.2
Laydown of RTM mooring lines in pre-defined area to limit the extent of disturbance to the seabed.	F: Yes CS: Standard activity, no significant additional cost associated with activity.	The mooring design analysis Reduces the likelihood of laydown of mooring lines in areas of high sensitivity.	Benefits outweigh cost/sacrifice	Yes C 4.3

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[10] Qualitative measure

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS)***[10]	***Benefit in Impact/Risk Reduction***	***Proportionality***	***Control Adopted***
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
Professional Judgement - Eliminate				
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 activities. 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 considered – control not feasible	Not considered – control not feasible	Not considered – control not feasible	No
Professional Judgement – Substitute				
Only use DP MODU (no anchoring required)	F: Yes, however a DP MODU cannot be	Slight reduction in the footprint on the sea floor. However, given the predicted limited	Disproportionate. The cost/sacrifice outweighs the	No

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS)***[10]	***Benefit in Impact/Risk Reduction***	***Proportionality***	***Control Adopted***
	guaranteed for intervention activities. CS: Restricting MODU selection to only DP capable rigs could introduce unacceptable additional costs and operational delays. Woodside has a demonstrated capacity to manage the environmental risks and impacts from mooring to a level that is ALARP and acceptable.	footprint which will occur within an area of existing disturbance, the environmental benefit is negligible.	environmental benefit gained.	
Professional Judgement – Engineered Solution				
Recovery of mooring lines at the time of RTM disconnection (i.e. no laydown on seabed).	F: Yes. It is possible to recover the mooring lines at the time of disconnection. However, the fate of these components has not yet been determined and is the subject of future investigation by Woodside. Recovery of mooring lines would require additional vessels in the field (heavy lift vessel and additional anchor handling vessel). CS: Significant. Recovery of the mooring lines at the time of disconnection from the RTM would require significant additional vessel resources capable of recovering the mooring lines. Given the fate of the mooring lines is yet to be determined, the operational sequence of the Petroleum Activities Program does not allow for the recovery of mooring lines at the time of disconnection from the RTM.	Slight reduction in the footprint on the sea floor. However, given the predicted limited footprint which will occur within an area of existing disturbance, the environmental benefit is negligible.	Disproportionate. The cost/sacrifice outweighs the environmental 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, Woodside considers the adopted controls appropriate to manage the impacts of disturbance to the seabed from				

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS)[10]***	***Benefit in Impact/Risk Reduction***	***Proportionality***	***Control Adopted***
infrastructure laydown and equipment deployment. As no reasonable additional/alternative controls were identified that would further reduce the impacts without 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 the seabed from infrastructure laydown and subsea equipment represents a consequence to benthic community/habitat structure limited to slight. 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. 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 4 No impacts to benthic habitats greater than a consequence level of F.	**C 4.1** Project-specific Mooring Design Analysis.	**PS 4.1** Seabed disturbance from MODU mooring limited to that required to ensure adequate MODU station holding capacity.	**MC 4.1.1** Records demonstrate Mooring Design Analysis completed and implemented during anchor deployment.
	C 4.2 Woodside WLSADS includes environmental sensitivity and seabed topography to inform the selection of the MODU mooring locations.	**PS 4.2** Well site locations as planned within WLSADS.	**MC 4.2.1** Data verifies well location as planned within WLSADS.
	C 4.1 Laydown of RTM mooring lines in pre-defined area to limit the extent of disturbance to the seabed.	**PS 4.1** All infrastructure laydown limited to within 1.5 km radius of existing subsea infrastructure[11] to limit the extent of disturbance to the seabed	**MC4.1.1** An 'as left survey' will be undertaken to verify that infrastructure laydown and subsea equipment deployment is within pre-defined corridors

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[11] The Operational Area is defined as the combined delineated distances from the following: 1500 m area from the RTM, 4000 m area around all wells and 500 m area around flowlines

6.6.3 Routine Discharges: Project Vessels

Context	
Project Vessels – **Section 3.10**	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***	***ALARP Tools***	***Acceptability***	***Outcome***
Routine discharge of sewage, grey water and putrescible wastes to marine environment from project vessels			X					A	F	LCS GP PJ	Broadly Acceptable	EPO 5
Routine discharge of deck and bilge water to marine environment from project vessels			X					A	F	LCS GP PJ		
Routine discharge of cooling water or brine to the marine environment from project vessels			X					A	F	LCS GP PJ		

Description of Source of Risk

The project vessels are expected to routinely generate/discharge the following:

- Small volumes (typically 15 m^3 per project vessel per day) of treated sewage, grey water and putrescible wastes to the marine environment.
- Routine/periodic discharge of relatively small volumes of bilge water. Bilge tanks on project vessels receive fluids from many parts of the vessel. Bilge water can contain water, oil, detergents, solvents, chemicals, particles and other liquids, solids or chemicals.
- Variable water discharge from project vessel decks directly overboard or via deck drainage systems. Water sources could include rainfall events and/or from deck activities such as cleaning/wash-down of equipment/decks.
- Cooling water from machinery engines and brine water produced during the desalination process of reverse osmosis to produce potable water on board project vessels.

Environmental risk relating to the disposal/discharges above regulated levels or incorrect disposal/discharge of waste would be unplanned (non-routine/accidental) and are addressed in **Sections 6.7.6**.

Impact Assessment

Potential Impacts to Water Quality

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 m^3 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 receptors, such as fish, reptiles, birds and cetaceans, in significant numbers within 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. as they traverse the Operational Area during their seasonal migrations (**Section 4**). 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(s)

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.

Demonstration of ALARP

Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS)[12]***	***Benefit in Impact/Risk Reduction[13]***	***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

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[12] Qualitative measure

[13] Measured in terms of reduction of likelihood (L), consequence (C) and current risk rating (CRR)

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS)***[12]	***Benefit in Impact/Risk Reduction***[13]	***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 will 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

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS)***[12]	***Benefit in Impact/Risk Reduction***[13]	***Proportionality***	***Control Adopted***
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 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.	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
Good Practice				
No additional controls identified.				
Professional Judgement - Eliminate				
No additional controls identified.				
Professional Judgement – Substitute				

<table>
<tr><th colspan="5">Demonstration of ALARP</th></tr>
<tr><th><i>Control Considered</i></th><th><i>Control Feasibility (F) and Cost/Sacrifice (CS)</i>[12]</th><th><i>Benefit in Impact/Risk Reduction</i>[13]</th><th><i>Proportionality</i></th><th><i>Control Adopted</i></th></tr>
<tr><td>Storage, transport & treatment / disposal onshore of sewage, greywater, putrescible & bilge wastes.</td><td>F: Not feasible. Would present additional safety & hygiene hazards resulting from the storage, loading & transport of the waste material
CS: Not considered – control not feasible</td><td>Not considered – control not feasible.</td><td>Not considered – control not feasible.</td><td>No</td></tr>
<tr><td colspan="5"><i>Professional Judgement – Engineered Solution</i></td></tr>
<tr><td colspan="5">No additional controls identified.</td></tr>
<tr><td colspan="5"><i>ALARP Statement</i>
On the basis of the environmental risk assessment outcomes and use of the relevant tools appropriate to the decision type, Woodside considers the adopted controls appropriate to manage the impact of planned (routine and non-routine) discharges from project vessels. 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>

<table>
<tr><th>Demonstration of Acceptability</th></tr>
<tr><td><i>Acceptability Statement</i>
The impact assessment has determined that, given the adopted controls, planned discharges (routine and non-routine) from project vessels is unlikely to result in a potential impact greater than temporary contamination above background levels and/or national/international quality standards and/or known biological effect concentrations outside a localised mixing zone with 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 95 and 96. Therefore, Woodside considers the adopted controls appropriate to manage the impacts of these discharges to a level that is broadly acceptable.</td></tr>
</table>

<table>
<tr><th colspan="4">Environmental Performance Outcomes, Standards and Measurement Criteria</th></tr>
<tr><th><i>Outcomes</i></th><th><i>Controls</i></th><th><i>Standards</i></th><th><i>Measurement Criteria</i></th></tr>
<tr><td rowspan="2">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.</td><td>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.</td><td>PS 5.1
Project vessels compliant with Marine Orders 95 – pollution prevention – Garbage.</td><td>MC 5.1.1
Records demonstrate activity ssupport vessels and MODU are compliant with Marine Orders 95 – pollution prevention (as appropriate to vessel class).</td></tr>
<tr><td>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</td><td>PS 5.2
Project vessels compliant with Marine Orders 96 - pollution prevention – sewage (as appropriate to vessel class).</td><td>MC 5.2.1
Records demonstrate project vessels are compliant with Marine Orders 96 - pollution prevention – sewage (as appropriate to vessel class).</td></tr>
</table>

Environmental Performance Outcomes, Standards and Measurement Criteria			
Outcomes	***Controls***	***Standards***	***Measurement Criteria***
	• 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.		
	C 5.3 Where there is potential for loss of primary containment of oil and chemicals on the MODU, deck drainage will 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 bilge/oily water management systems that is compliant Engineering Standard for Rig Equipment.
	C 5.4 Marine Order 91 – oil (as relevant to vessel class) requirements, which includes mandatory measures for	**PS 5.4** Discharge of machinery space bilge/oily water will meet oil content standard of <15 ppm without dilution.	**MC 5.4.1** Records demonstrate discharge specification met for MODU and project vessels.

Environmental Performance Outcomes, Standards and Measurement Criteria			
Outcomes	***Controls***	***Standards***	***Measurement Criteria***
	pprocessing 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.	**PS 5.4** Deck drainage and bilge water will be discharged to meet the oil content standard of <15ppm without dilution.	**MC 5.4.2** Records demonstrate maintained and up-to-date oil discharge records for the project vessels.

6.6.4 Routine and Non-routine Discharges: Hydrocarbons, Chemicals and Well Intervention Fluids

Context	
Subsea IMMR Chemicals – **Section 3.8.4** Well Intervention – **Section 3.9** Assessment of Project Chemicals – **Section 3.13**	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***	***ALARP Tools***	***Acceptability***	***Outcome***
Routine and non-routine discharges to the marine environment during IMMR activities.			X			X		A	F	LCS GP PJ	Broadly acceptable	EPO 6
Routine discharge of cement and wellbore fluids to the seabed and the marine environment during well intervention activities.		X			X			A	F	LCS GP PJ		

Description of Source of Risk

During the Petroleum Activities Program, small volumes of hydrocarbons, chemicals and well intervention fluids may be discharged intermittently and for short durations as a result of planned breaking of containment of the preserved subsea system, and non-routine operations and inspection and maintenance activities. This includes discharges of treated seawater during the disconnection of subsea infrastructure, release of control fluid from valves (including the BOP) and minor discharge of the contents of umbilicals.

Expected worst-case releases are detailed below:

- Small quantities (10-20 L) of biocide, corrosion inhibitor, oxygen scavenger and residual hydrocarbons present in treated seawater when breaking containment of subsea system (e.g. well intervention activities). Note that the subsea infrastructure has been flushed until the residual hydrocarbon concentration was considered to be ALARP (undertaken under NGA Facility Operations EP).
- Small quantities of BOP control fluid may be released during testing of the BOP during well intervention activities;
- Small quantities of corrosion inhibitor and residual hydrocarbons contaminating the kill weight brine may be discharged from the MODU.
- Small quantities of cement discharged to the marine environment during well intervention, with potential discharge of small quantities of excess cement following completion of well intervention.

Kill weight brine (including corrosion inhibitors) will be used to maintain control of wells during intervention activities. Residual hydrocarbons within wells may contaminate the brine. Brine may be re-injected, recovered and disposed of onshore, or treated and discharged at sea. Brine will be treated prior to discharge to ≤1% hydrocarbon by volume.

Cementing fluids are not routinely discharged to the marine environment; however, volumes of up to approximately 2 m^3 per well when surplus fluids require disposal after cementing operations. Cement spacers can be used as part of the cementing process within the well casing to assist with cleaning of 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) or cement which does not meet technical requirements will either be used for subsequent wells, provided to the next operator at the end of the well intervention program or if these options aren't practicable discharged to the marine environment as a slurry.

Marine growth removal from subsea infrastructure may also be required. Marine growth removal may involve the following activities:

- water jetting using high pressure water to remove marine growth
- use of brushes attached to ROV
- use of acid (typically sulphamic acid) to dissolve calcium deposits
- use of sand/abrasive blasting using staurolite products (naturally occurring mineral).

Minor discharges of chemicals (e.g. sulphamic acid) or sand are likely from marine growth removal activities.

All chemicals that may be released or discharged to the marine environment during the Petroleum Activities Program are assessed as per Woodside Chemical Selection and Assessment Guideline. This guideline is used to demonstrate that the potential impacts of the chemicals that may be released are acceptable and ALARP (refer to **Section 3.13**).

Impact Assessment

Potential Impacts to Marine Sediment, Water Quality and Species

The release of minor hydrocarbon and chemical discharges may reduce local water quality through contamination of the water column, resulting in potential adverse effects to marine biota as a result of hydrocarbon and chemical toxicity. The discharges present a risk to the marine environment due to the contaminants within them.

Potential impacts to sensitive receptors may be attributable to dissolved hydrocarbons and suspended oil droplets and nutrients, as well as low residual concentrations of a small number of chemicals such as corrosion and scale inhibitors and biocides. Hydrocarbons however are considered the constituent of most concern to marine fauna, particularly polycyclic aromatic hydrocarbons (PAHs).

Minor Hydrocarbon Discharges

Hydrocarbon exposure may lead to mortality to marine organisms within the immediate vicinity of the discharge plume, as well as sub-lethal chronic (long exposure) effects such as decreased genetic diversity in communities, decreased growth and fecundity, lower reproductive success, respiratory problems, behavioural and physiological problems, decreased developmental success and endocrine disruption (Neff et al. 2011).

Further details on potential biological and ecological impacts associated with hydrocarbon spills are presented in **Section 6.7.2**. A minor loss of hydrocarbon will be much reduced in terms of spatial and temporal scales, and given the minor quantities expected to be released, impacts to limited transient megafauna, plankton and fish populations (water column biota) are considered to be highly unlikely. No impacts to commercial fisheries, sensitive environmental receptors or KEFs are expected.

Cement

Cement discharges are not expected to widely disperse and are expected to settle on the seabed in the immediate vicinity of the well head. The impact of cement discharge at the seabed will therefore, be limited to affecting sediment quality and any surrounding benthic and/or infauna communities, in a small localised area immediately around the well. The seabed which may be impacted around the well heads are expected to have residual cuttings, and has been previously disturbed. The seabed in the Operational Area comprises soft, unconsolidated sediments hosting sparse infauna and epifauna assemblages. This habitat is widely represented in the region. As such, the seabed subject to potential cement discharges is considered to be of low sensitivity. No impacts to the ecosystem functions of the Canyons KEF are expected.

Chemical Discharges

The release of treated seawater containing preservation chemicals, marine growth removal chemicals and the minor discharge of control fluid from subsea valves (e.g. BOP) and umbilicals may decrease the water quality in the immediate area of the release; however, the impacts are expected to be of no lasting effect due to rapid dilution in the open ocean environment.

Marine fauna may be affected if they come in direct contact with a release (i.e. by traversing the immediate discharge area). There are no EPBC Act listed critical habitats within the Operational Area. Given the small volumes that represent the worst credible releases, and the dilution of any such discharge, the likelihood of ecological impacts to these marine fauna is considered to be highly unlikely.

The release of treated seawater containing small quantities of biocide and corrosion inhibitor in the treated seawater during breaking of containment of the subsea system may result in a localised, temporary minor decrease in water quality. The chemicals were added to the subsea system as components of the preservation fluid (note the system is depressurised). Given the dosage concentration of biocide sticks and oxygen scavenger and the subsea system has been depressurised to ambient hydrostatic pressure, potential impacts from any such releases are expected to be of no lasting effect. All chemicals added to the treated seawater are subject to the chemical assessment process described in **Section 3.13**.

No impacts to commercial or recreational fisheries or KEFs are expected.

Summary of Potential Impacts to environmental values(s)
Given the adopted controls, it is considered that routine and non-routine discharges of hydrocarbons, chemicals and well intervention fluids described will result in no lasting effect expected due to the temporary contamination of water above background levels.

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS)***[14]	***Benefit in Impact/Risk Reduction***	***Proportionality***	***Control Adopted***
Legislation, Codes and Standards				
No additional controls identified.				
Good Practice				
Well Intervention 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
Displacement, brine, workover or intervention fluids contaminated with hydrocarbons will be treated prior to discharge or contained. If discharge specification is 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 6.2
Bulk operational discharges conducted under Permit to Work (PTW) system (to operate discharge valves/pumps).	F: Yes CS: Minimal cost. Standard practice.	The PTW system 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 6.3

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[14] Qualitative measure

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS)[14]***	***Benefit in Impact/Risk Reduction***	***Proportionality***	***Control Adopted***
Return residual cement onshore for treatment/disposal	F: Yes. However, cement slurry may harden during transport, introducing difficulty in handling and transportation. CS: Given the non-toxic nature of cement and the relatively small volumes of cement generated, the cost sacrifice involved in transporting cement to 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
Professional Judgement - Eliminate				
Do not use preservation chemicals	F: No. Preservation fluids are required to maintain the structural integrity of the subsea infrastructure during the preservation period. The volume is determined by technical requirements. CS: Not considered – control not feasible	Not considered – control not feasible	Not considered – control not feasible	No
Professional Judgement – Substitute				
Use of excess bulk cement 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. Can degrade if not reused within short time therefore, no longer meeting the technical performance requirements. CS: Inability to conduct the activities if degraded	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 may outweighs the benefit gained.	Yes, where practicable C 6.4
Professional Judgement – Engineered Solution				
Intervention fluids or suspension brine which may have come into contact with NWBM or reservoir hydrocarbons should be processed through a water	F: Yes CS: Minimal cost	Treatment of returned may slightly reduce the consequence of impacts resulting from discharges to the marine environment	Benefits outweigh cost/sacrifice.	Yes C 6.5

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS)***[14]	***Benefit in Impact/Risk Reduction***	***Proportionality***	***Control Adopted***
treatment package prior to discharge.				
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, Woodside considers the adopted controls appropriate to manage the impacts and risks of routine and non-routine discharges of minor quantities of hydrocarbons, chemicals and well intervention fluids. 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, routine and non-routine discharges of minor quantities of hydrocarbons, chemicals and well intervention fluids represent no lasting effect with only temporary contamination above background levels and/or national/international quality standards and/or known biological effect concentrations. Further opportunities to reduce the impacts and risks have been investigated above. The adopted controls are considered good oil-field practice/industry best practice. 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 6 No impact to water quality or marine biota greater than a consequence level of E from discharging fluids during the Petroleum Activities Program.	**C 6.1** Well Intervention 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 Displacement, brine, workover or intervention fluids contaminated with hydrocarbons will be treated prior to discharge or contained. If discharge specification is not met, the fluid will be returned to shore.	**PS 6.2** Achieves oil concentration <1% by volume prior to discharge.	**MC 6.2.1** Records demonstrate that discharge criteria was met prior to discharge or contained.
	C 6.3 Bulk operational discharges conducted under PTW system (to operate discharge valves/pumps).	**PS 6.3** Ensures an increased level of assurance and verification on bulk operational discharges.	**MC 6.3.1** Records demonstrate that bulk discharges are conducted under the MODU PTW system.
	C 6.4 Excess bulk cement will be used on subsequent wells or passed onto subsequent operator, where feasible – cost effective and technically viable	**PS 6.4** An assessment will be undertaken to determine feasibility of cement use on subsequent wells or by subsequent operator	**MC 6.4.1** Decision note documenting assessment of cost effectiveness and technically feasibility of cement re-use.

Environmental Performance Outcomes, Standards and Measurement Criteria			
Outcomes	***Controls***	***Standards***	***Measurement Criteria***
	C 6.5 Intervention fluids or suspension brine which may have come into contact with NWBM or reservoir hydrocarbons should be processed through a water treatment package prior to discharge.	**PS 6.5** All intervention fluids or suspension brine which may have come into contact with reservoir hydrocarbons will be discharged with a hydrocarbon content of 1% or less.	**MC 6.5.1** Environmental discharge report records demonstrate water treatment package has been used to process intervention/workover fluids where NWBM or reservoir hydrocarbon contamination may be present

6.6.5 Routine Light Emissions

Context	
Project vessels – **Section 3.10**	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***	***ALARP Tools***	***Acceptability***	***Outcome***
External light emissions on-board project vessels						X		A	F	LCS GP PJ	LCS GP PJ	N/A

Description of Source of Risk

Project vessels will routinely use external lighting to facilitate navigation and safe operations at night throughout the Petroleum Activities Program. External light emissions from project vessels are typically managed to maintain good night vision for crew members. Lighting on vessels will also be used to communicate the MODU's presence and activities to other marine users (i.e. navigation / warning lights). Lighting is required for the safe operation of project vessels, and cannot reasonably be eliminated. Note that flaring, which is a relatively bright light source, will not occur during the activity.

External lighting is located over the entire MODU, as well as external decks of vessels, with most external lighting directed towards working areas such as the main decks, pipe rack etc. These areas are typically lower than 20 m above sea level for the project vessels whilst in the Operational Area. The highest point of all potential artificial light sources during the activity is the top of the derrick of the MODU, which is typically approximately 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 below:

$$\text{Horizon distance} = 3.57 \times \sqrt{\text{height}}$$

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, the approximate distances at which the highest lit component of any project vessel will be visible at sea level is approximately 25 km from MODU (derrick top around 50 m above sea level).

Impact Assessment

Potential Impacts 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.

The fauna within the Operational Area are predominantly pelagic fish and zooplankton, with a low abundance of transient species such as marine turtles, whale sharks and whales within the Operational Area. Additionally, there is no known critical habitat within the Operational Area for EPBC Act listed species. Given the fauna expected to occur within the Operational Area, impacts from light emissions are considered to be localised and of no lasting effect.

Marine Turtles - Hatchlings

Light emissions reaching turtle nesting beaches is widely considered detrimental owing to interference with important nocturnal activities including the choice of nesting sites and orientation/navigation to the sea by post-nesting females and hatchlings (Lorne and Salmon 2007, Salmon 2003, Tuxbury and Salmon 2005). Hatchling turtles use light as a visual cue to orientate themselves towards the sea during the post-hatching dash after emerging from the nest, orientating themselves towards the relatively bright horizon above the sea and away from the relatively dark dunes (Salmon et al. 1995b, Salmon and Witherington 1995). Artificial light from coastal developments has been identified as potentially disorientating hatchling turtles during the post-hatching movements, with hatchling turtles orientated towards artificial light sources away from the sea (Lorne and Salmon 2007, Salmon 2003, Tuxbury and Salmon 2005). Turtles disorientated by artificial lighting may take longer, or fail, to reach the sea, potentially resulting in increased mortality through dehydration, predation or exhaustion (Salmon and Witherington 1995).

Once hatchling turtles reach the sea, the primary cue for hatchling turtle orientation is water movement, with hatchlings swimming directly towards oncoming waves (Lohmann et al. 1990, Lohmann and Lohmann 1992). Hatchling and adult turtles may also use the Earth's magnetic field for larger scale navigation (Lohmann and Lohmann 1996). As such, hatchling turtles are only likely to be disorientated by artificial light between leaving the nest and reaching the sea.

The nearest potential nesting site in relation to the Operational Area is North West Cape Island (approximately 33 km from the Operational Area). The North West Cape area is a known turtle nesting area. Several other islands in the vicinity of the Operational Area are known to host turtle nesting beaches, including:

- South and North Muiron Island (approximately 37 km and 39 km from the Operational Area respectively)
- Sunday Island (approximately 47 km from the Operational Area)
- Peak Island (approximately 51 km from the Operational Area).

Given the nature of the light emitted from project vessels and the distance to the nearest landfall (and nearest significant rookeries), artificial light is not expected to be directly visible to hatchling turtles. Disorientation of hatchling turtles in response to artificial lighting from project vessels is not expected. In the event that hatchling turtles were attracted to light from project vessels during the post-hatching movement from the nest to the sea, such hatchlings would be encouraged to reach the water rather than be misdirected, as the Operational Area is offshore from potential turtle nesting locations. Therefore, potential impacts such as failure to reach the sea or increased exposure to terrestrial predators would not occur.

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. 1995b, 1995a, Salmon and Witherington 1995). Such lighting is typically from residential and industrial development overlapping the coastline, rather than offshore from nesting beaches. The Operational Area does not contain any known critical habitat for any species of marine turtle (nearest landfall (North West Cape) is located approximately 37 km from Operational Area), nor do any BIAs for turtles overlap the Operational Area. It is acknowledged that marine turtles may be present transiting the Operational Area in low densities; given the water depth (approximately 400-600 m) turtles are unlikely to be foraging within the Operational Area. Given the distance between the Operational Area and the North West Cape (approximately 37 km), light from the MODU is not expected to be visible from the nearest known turtle rookery.

Other Marine Fauna

The risk associated with collision from seabirds attracted to the light is considered to be low given there is no critical habitat for these species within the Operational Area and slow moving speeds associated with activity support vessels. Seabird may be attracted to project vessels operating at night, including foraging wedge-tailed shearwaters (for which a foraging BIA overlaps the Operational Area); however, this is not expected to result in impacts to seabird beyond a temporary change in behaviour.

Summary of Potential Impacts to environmental values(s)

Light emissions from project vessels will not result in an impact greater than a localised disturbance to fauna in the vicinity of the Operational Area with no lasting effect.

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS)***[15]	***Benefit in Impact/Risk Reduction***	***Proportionality***	***Control Adopted***
Legislation, Codes and Standards				
No additional controls identified.				
Good Practice				
Variation of the timing of the Petroleum Activities Program	F: Yes. Avoidance of turtle nesting periods is technically	Negligible or no reduction	Grossly disproportionate.	No

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[15] Qualitative measure

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS)[15]***	***Benefit in Impact/Risk Reduction***	***Proportionality***	***Control Adopted***
to avoid peak turtle nesting periods (December to March).	feasible, although is not considered to be practicable. CS: Not considered – control not feasible.	consequence given the distance of the nesting areas to the operational area.	Implementation of the control requires considerable cost sacrifice for minimal environmental benefit.	
Professional Judgement - Eliminate				
Restrict the Petroleum Activities Program to daylight hours, eliminating the need for external work lights	F: No. Components of the Petroleum Activities Program cannot safely be completed within a 12 hr day shift. As such, the need for external lighting cannot safety be eliminated. CS: Not considered – control not feasible	Not considered – control not feasible	Not considered – control not feasible	No
Professional Judgement - Substitute				
Substitute external lighting with "turtle friendly" light sources (reduced emissions in turtle visible spectrum)	F: Yes. Replacement of 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 project vessels would result in considerable cost and time expenditure. Considerable logistical effort to source sufficient inventory of the range of light types.	Negligible or no reduction in likelihood (which is already remote), no reduction in consequence.	Grossly disproportionate. Implementation of the control requires considerable cost sacrifice for minimal environmental benefit.	No
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, Woodside considers the potential impacts from routine light emissions from project vessels to be ALARP. This includes consideration of the intermittent nature of light emissions for the duration of the Petroleum Activities Program, the requirements for external lighting for safe operations, and the considerable distance from known sensitivities such as turtle nesting beaches. As no reasonable additional/alternative controls were identified that would further reduce the impacts and risks without grossly disproportionate sacrifice, the impacts are considered ALARP.

Demonstration of Acceptability

Acceptability Statement

The impact assessment has determined that routine light emissions from project vessels represent a low consequence that is unlikely to result in a potential impact greater than temporary behavioural disturbance to fauna within the Operational Area with no lasting effect. Further opportunities to reduce the impacts have been investigated above. Therefore, Woodside considers standard operations appropriate to manage the impacts and risks of routine light emissions to a level that is broadly acceptable.

6.6.6 Routine Acoustic Emissions

Context	
Project Vessels – **Section 3.10** Helicopters – **Section 3.12**	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***	***ALARP Tools***	***Acceptability***	***Outcome***
Generation of noise from project vessels during normal operations.						X		A	F	LCS GP PJ	Broadly acceptable	N/A
Generation of noise from helicopter transfers						X		A	F	LCS GP PJ		N/A

Description of Source of Risk

Project vessels will generate noise both in the air and underwater, due to the operation of thruster engines, propeller cavitation, well intervention operations, on-board machinery etc. These noises will contribute to and have the potential to exceed ambient noise levels which range from around 90 dB re 1 µPa (root square mean sound pressure level (rms SPL)) under very calm, low wind conditions, to 120 dB re 1µPa (rms SPL) under windy conditions (McCauley 2005).

MODU Noise

Noise associated with a moored MODU will be restricted to well intervention activities. For a DP MODU, noise will also be generated by thrusters used for station keeping. For a DP MODU the main source of underwater noise emissions relate to the use of DP, rather than intervention activities. A DP MODU will typically produce low intensity but continuous sound. A range of broadband values (59 to 185 dB re 1 µPa (rms SPL)) have been quoted for various MODUs (Oceans of noise 2004), where noise is likely to be between 100 to 190 dB re 1 µPa (rms SPL) during drilling and between 85 to 135 dB re 1 µPa (rms SPL) when not actively drilling. McCauley (1998) recorded received noise levels approximately 117 dB re 1 µPa (rms SPL) at 125 m from a moored MODU whilst actively drilling (with support vessel on anchor). Given that no drilling will be undertaken during the Petroleum Activities Program, noise emitted by the MODU (if utilised) is expected to be at the lower end of this range. The MODU may to be on location for up to 360 days (based on the estimated maximum time for intervention all eighteen wells under this EP).

Project Vessel Noise

The intervention vessel, PIV and activity support vessels may maintain DP for varying duration during the Petroleum Activities Program, depending on the activity the vessel is undertaking. The project vessels and support vessels will utilise DP to hold station during the Petroleum Activities Program. Additionally, the routine operations of a MODU during well interventions will produce low intensity noise (e.g. machinery noise).

McCauley (1998) measured underwater broadband noise equivalent to approximately 182 dB re 1 µPa at 1 m (rms SPL) from an activity support vessel holding station in the Timor Sea (in 110 m water depth); it is expected that similar noise levels will be generated by the intervention vessel, PIV and activity support vessels used for this Petroleum Activities Program.

Note that all project vessels are required to comply with EPBC Act Regulation 2000 – Part 8 Interacting with Cetaceans to reduce the likelihood of collisions with cetaceans (refer to **Section 6.7.6**). 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.

Helicopter Noise

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 helideck. During these critical stages of helicopter operations, safety takes precedence. 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.

Helicopter noise is emitted to the atmosphere during routine helicopter flights. 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).

Impact Assessment

Potential Impacts to Species

Underwater Noise

The Operational Area of the Petroleum Activities Program is located in continental slope waters approximately 400-600 m deep. The fauna associated with this area will be predominantly pelagic species of fish, with migratory species such as cetaceans present in the area seasonally.

Elevated underwater noise can affect marine fauna, including cetaceans, fish, sharks and rays in three main ways (*Oceans of noise* 2004, Richardson et al. 1995):

(1) by causing direct physical effects on hearing or other organs (injury)

(2) by masking or interfering with other biologically important sounds (including vocal communication, echolocation, signals and sounds produced by predators or prey)

(3) through disturbance leading to behavioural changes or displacement from important areas.

The thresholds of recommended root mean square sound pressure level (SPL (rms)) that could result in behavioural response for cetaceans is expected to be:

- 120 dB SPL (rms) for continuous noise sources
- 160 dB SPL (rms) for impulsive noise sources.

These thresholds are consistent with the levels presented by Southall *et al.* (2007). More permanent injury would be expected to occur at 230 dB re 1 µPa (peak) (Southall *et al*. 2007).

Project Vessel Noise Impacts

The project vessels (MODU or PIV), support vessels, helicopters and positioning transponders will generate noise both in the air and underwater, due to the operation of thrusters, engines, propeller movement, well intervention 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).

Noise associated with a moored MODU will be restricted to intervention activities. 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 well activities and between 85 to 135 dB re 1 µPa at 1 m SPL (rms) when not actively operating. 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 main source of noise from a DP vessel or MODU relates to using DP thrusters. 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%. Support vessels and the PIV 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.

Noise generated by the project vessels and activity support vessels likely to be used for this Petroleum Activities Program does not exceed that level so permanent injury to protected species is not anticipated.

Listed threatened and listed migratory species that could be potentially impacted by noise and vibration may be present within the Operational Area and primarily include cetaceans. The Operational Area overlaps BIAs for the following species (**Section 4.5.2**; refer to **Table 4-8:** for seasonality):

- Humpback whales (migration BIA): seasonally present June to September
- Pygmy blue whales (migration BIA: seasonally present April to May (northbound) and November to December (southbound).

The likelihood of these species being present within the Operational Area is increased during the seasonal periods described above. However, even with an increased likelihood of interaction, the potential impacts are considered to be minor given the noise levels associated with routine operations of project vessels. Woodside has undertaken long-term monitoring of humpback whale abundance off North West Cape, which has indicated the majority of seasonally present migrating humpback whales occur east of the Operational Area (RPS Environment and Planning 2010a). Interactions between blue / humpback whales and vessels typically results in avoidance behaviour, with whales generally moving away from vessels (Bauer 1986, Stamation et al 2010). 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, cetaceans may deviate from their migration corridor, 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 Operational Area. Therefore, any avoidance or attraction behaviours displayed are expected to be localised and temporary.

Predicted noise levels from project vessels are not considered to be ecologically significant at a population level.

The fauna associated with the Operational Area will be predominantly pelagic species of fish with migratory species such as marine turtles, whale sharks and cetaceans transiting through 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 low.

Helicopter Noise Impacts

Helicopter noise is emitted to the atmosphere during routine helicopter flights. 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 approximately 90 dB at 150 m would be reduced to approximate 76 dB directly below a helicopter travelling at an altitude of 500 m.

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 to marine fauna is considered non 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. Approach, landing and take-off are relatively short phases of the flight, resulting in little opportunity for underwater noise to be generated. 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.).

Helicopter surveys of humpback whales in Antarctic waters noted behavioural responses attributed to the presence of the helicopter on three occasions out of a total of 221 animal sightings, all of which occurred with a separation of <500 m between the helicopter and the animal (Scheidat et al. 2011). Given the standard flight profile of a helicopter transfer 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.

Summary of Potential Impacts to environmental values(s)

It is considered that noise generated by project vessels and helicopters will not result in a potential impact greater than temporary disruption to a small proportion of the populations of marine fauna associated with the Operational Area with no lasting effect.

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS)***[16]	***Benefit in Impact/Risk Reduction***	***Proportionality***	***Control Adopted***
Legislation, Codes and Standards				
No additional controls identified.				

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[16] Qualitative measure

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS)[16]***	***Benefit in Impact/Risk Reduction***	***Proportionality***	***Control Adopted***
Good Practice				
The use of dedicated Marine Fauna Observers (MFOs) on project 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 Act Regulations.	F: Yes. However, activity support vessel bridge crews already maintain a constant watch during operations in compliance with the Woodside Marine – Charterers Instructions, on the requirements of vessel and whale interactions. In the event of a cetacean (or other sensitive fauna) in close proximity to project vessels, it is unlikely that DP (the most significant source of underwater noise expected during the Petroleum Activities Program) will be deactivated given it is a safety critical requirement for project vessels to hold station. As such, an MFO implementing management / shut down zones is considered to be ineffective. 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
Avoid peak migration periods for migratory cetaceans.	F: Yes. Migration periods for cetaceans that may occur in the Operational Area (pygmy blue and humpback whales) are well defined. CS: Potentially significant. The timing of the activities to be conducted during the Petroleum Activities Program. Woodside has not finalised the schedule for the Petroleum Activities Program, and some activities may be undertaken on an opportunistic basis and in succession to one another while a vessel is available. Precluding operations during cetacean migration periods may impose a considerable cost and operational burden, while resulting in little environmental benefit.	Avoiding migration periods would reduce the likelihood of impacts to cetaceans. However, given that the Predicted noise levels are not considered to be ecologically significant at a population level, the overall benefit is minimal.	Disproportionate. The cost/sacrifice outweighs the benefit gained.	No
Professional Judgement - Eliminate				
Remove activity 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 exclusion zone around the MODU / intervention vessel and PIV. 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)[16]**	**Benefit in Impact/Risk Reduction**	**Proportionality**	**Control Adopted**
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, Woodside considers the potential impacts from noise generated from project vessels and helicopters to be ALARP. As no reasonable additional/alternative controls were identified that would further reduce the impacts without grossly disproportionate sacrifice, the impacts are considered ALARP.				

Demonstration of Acceptability
Acceptability Statement The impact assessment has determined that noise from project vessels and helicopters is unlikely to result in a potential impact greater than temporary disruption with no lasting effect to a small proportion of the fauna populations and no impact on critical habitat or activity. Further opportunities to reduce the impacts have been investigated above. Therefore, Woodside considers standard operations appropriate to manage the impacts of noise from project vessels and helicopters to a level that is broadly acceptable.

6.6.7 Routine and Non-routine Atmospheric Emissions

Context	
Well Intervention– **Section 3.9** RTM Removal – **Section 3.6** Project Vessels – **Section 3.10**	Physical Environment – **Section 4.4**

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***	***ALARP Tools***	***Acceptability***	***Outcome***
Exhaust emissions from internal combustion engines and incinerators on project vessels and helicopters				X				A	F	LCS GP PJ	Broadly acceptable	EPO 7 & 8
Bleed off of hydrocarbon gas during well intervention				X				A	F	LCS GP PJ		

Description of Source of Risk

Internal combustion engines and incinerators

Atmospheric emissions will be generated by the project vessels from internal combustion engines (including all equipment and generators) during the Petroleum Activities Program. Emissions will include SO_2, NO_x, ozone depleting substances, CO_2, particulates and volatile organic compounds (VOCs).

Bleed off of hydrocarbon gas during well intervention

During well intervention activities, hydrocarbon gas may be released from the well. In the event that gas is released from the well, the gas may bubble to the sea surface (if released at the seabed) or be vented from the MODU (if well intervention undertaken by a MODU). Gas vented via the MODU will not be flared.

Impact Assessment

Potential Impacts to Air Quality (incl. Odour)

Fuel combustion has the potential to result in 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 project vessels (which will lead to the rapid dispersion of the low volumes of atmospheric emissions), the potential impacts are expected to be localised and of no lasting effect.

Venting of hydrocarbon gases may result in a short-lived localised gas plume and a minor 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 residential receptor is the town of Exmouth, approximately 47 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 localised and of no lasting effect.

Summary of Potential Impacts to environmental values(s)

Given the adopted controls, it is considered that the release of a small volume of greenhouse gases will not result in a potential impact greater than a temporary impact to local air quality with no lasting effect.

Demonstration of ALARP				
Control Considered	**Control Feasibility (F) and Cost/Sacrifice (CS)**[17]	**Benefit in Impact/Risk Reduction**	**Proportionality**	**Control Adopted**
Legislation, Codes and Standards				
Marine Order 97 (Marine Pollution Prevention – Air Pollution).	F: Yes CS: Minimal cost	Legislative requirements to be followed may slightly reduce the likelihood of air pollution.	Control based on legislative requirements – must be adopted	Yes C 7.1
Offshore Petroleum and Greenhouse Gas Storage (Resource Management and Administration) Regulations 2011: Accepted Well Operations Management Plan (WOMP).	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.	Control based on legislative requirements – must be adopted	Yes C 8.1
Good Practice				
Woodside Engineering Standards Well Barriers specifies the process to be undertaken to maintain an overbalance on the reservoir during well intervention .	F: Yes CS: Minimal cost. Standard practice for Woodside activities	Implementing equipment and procedures will reduce the volume of gas vented in the event of a well kick.	Benefits outweigh cost/sacrifice.	Yes C 8.2
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, Woodside considers the adopted controls appropriate to manage the potential impacts of release of atmospheric emissions. As no reasonable additional/alternative controls were identified that would further reduce the impacts without grossly disproportionate sacrifice, the impacts are considered ALARP.				

Demonstration of Acceptability
Acceptability Statement The impact assessment has determined that, given the adopted controls, atmospheric emissions during the Petroleum Activities Program will not result in a potential impact greater than a temporary decrease in local air quality with low impact to the environment or human health and no lasting effects. Further opportunities to reduce the impacts and risks have been investigated above. The adopted controls are considered good oil-field practice/industry best practice. Therefore, Woodside considers the adopted controls appropriate to manage the impacts of the described emissions to a level that is broadly acceptable.

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[17] Qualitative measure

Environmental Performance Outcomes, Standards and Measurement Criteria

Outcomes	***Controls***	***Standards***	***Measurement Criteria***
EPO 7 Fuel combustion emissions and incineration during the Petroleum Activities Program will be in compliance with marine order requirements to restrict emissions to those necessary to perform the activity.	**C 7.1** Marine Order 97 (Marine Pollution Prevention – Air Pollution).	**PS 7.1** 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 7.1.1** Marine Assurance inspection records demonstrate compliance with Marine Order 97.
EPO 8 No unplanned emissions to air as a result of venting from well.	**C 8.1** Offshore Petroleum and Greenhouse Gas Storage (Resource Management and Administration) Regulations 2011: Accepted Well Operations Management Plan (WOMP).	**PS 8.1** Wells managed in compliance with the accepted WOMP, including implementation of barriers to prevent a loss of well integrity.	**MC 8.1.1** Acceptance letter from NOPSEMA demonstrates the WOMP was accepted by NOPSEMA prior to the well intervention commencing.
			MC 8.1.2 Records demonstrate WOMP has been implemented
	C 8.2 Woodside Engineering Standards Well Barriers specifies the process to be undertaken to maintain an overbalance on the reservoir during well intervention.	**PS 8.3** Well intervention compliant with internal Woodside Standards and international requirements (API Standard 53 4th Edition) as agreed by Woodside and MODU Contractor.	**MC 8.3.1** Records demonstrate that control system specifications were in accordance with minimum standards for the expected conditions and maintain well control.

6.7 Unplanned Activities (Accidents, Incidents, Emergency Situations)

6.7.1 Quantitative Spill Risk Assessment Methodology

6.7.1.1 Stochastic Modelling

Quantitative hydrocarbon spill modelling was undertaken by RPS APASA, on behalf of Woodside, using a three-dimensional hydrocarbon spill trajectory and weathering model, SIMAP (Spill Impact Mapping and Analysis Program), which is designed to simulate the transport, spreading and weathering of specific hydrocarbon types under the influence of changing meteorological and oceanographic forces.

A stochastic modelling scheme was followed in this study, whereby SIMAP was applied to repeatedly simulate the defined credible spill scenarios using different samples of current and wind data. These data samples 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 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.

During each simulation, the SIMAP model records the location (by latitude, longitude and depth) of each of the particles (representing a given mass of hydrocarbons) on or in the water column, at regular time steps. For any particles that contact a shoreline, the model records the accumulation of hydrocarbon mass that arrives on each section of shoreline over time, less any mass that is lost to evaporation and/or subsequent removal by current and wind forces.

The collective records from all simulations are then analysed by dividing the study region into a 3-dimensional grid. For surface hydrocarbons (floating oil), the sum of the mass in all hydrocarbon particles located within a grid cell, divided by the area of the cell provides hydrocarbon concentration estimates in that grid cell, at each model output time interval. For entrained and dissolved aromatic hydrocarbon particles, concentrations are calculated at each time step by summing the mass of particles within a grid cell and dividing by the volume of the grid cell. The process is also subject to the application of spreading filters that represent the expected mass distribution of each distinct particle. The concentrations of hydrocarbons calculated for each grid cell, at each time step, are then analysed to determine whether concentration estimates exceed defined threshold concentrations.

All hydrocarbons spill modelling assessments undertaken by APASA 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. This assessment is done by post-processing the sensitivity test results and analysing time-series of median and maximum concentrations in the water and on the surface.

6.7.1.2 Deterministic Modelling

A hydrocarbon release from a loss of well containment is an inherently uncertain event, due to the variable nature of the metocean conditions of the receiving environment. The uncertainty in the physical processes that affect the movement and weathering of spilled hydrocarbons in the environment is compounded by the temporal and spatial variability (e.g. seasonally constrained behaviours such as nest and spawning, migratory movements, discrete life history phases of sensitive biota) of environmental receptors within the EMBA.

The stochastic modelling approach described in the section above is intended to account for the potential variability in a hydrocarbon release by providing a stochastic data set to inform impact assessment. This approach results in a probabilistic distribution of hydrocarbon phases (surface, entrained, dissolved and accumulated) in relation to environmental receptors. However, as a result of applying this inherently conservative approach to the assessment of environmental risks and impacts, the potential impacts to specific receptors from a discrete spill event may be over-estimated. In assessing the impacts of a discrete spill event to particular receptors, a deterministic modelling approach may provide a basis for a more realistic assessment of risks and impacts. Woodside applies this approach (i.e. the use of deterministic spill model runs) to inform oil spill response planning.

To assist in an assessment of potential population-scale impacts to sensitive receptors in the event of a worst-case hydrocarbon spill, additional consideration of sensitive fauna based on a single deterministic spill model run (i.e. one of the modelling runs from which the stochastic modelling results are comprised) was undertaken. Woodside selected the model run with the greatest potential/extent (i.e. largest area) of shoreline accumulation as the basis for this consideration. This deterministic run was considered to be suitable to inform the assessment of population-scale effects, as a number of particularly sensitive protected fauna occur on, or in close proximity to, shorelines (e.g. nesting turtles, migratory birds, pinnipeds etc.). While acknowledging that each deterministic model run may indicate different contact pathways with environmental receptors (e.g. the model run with greatest shoreline accumulation may not be a worst-case scenario for receptors in the offshore environment), Woodside considers this approach is reasonable given the concentration of sensitive receptors on the nearshore environment.

6.7.1.3 Hydrocarbon Characteristics

Woodside has undertaken physical and ecotoxicology testing on Enfield crude, which is the hydrocarbon that can credibly be released from a loss of well containment event. The physical characteristics of Enfield crude, as used in the hydrocarbon spill modelling studies, are provided in **Table 6-4**.

Table 6-4: Enfield crude oil characteristics

Hydrocarbon Type	Initial Density (g/cm^3)	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	
Enfield crude	0.921	46.022	% of total	2.6	15.6	43.4	38.4	13.5

6.7.1.4 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 EMBA, which is driven by the worst-case credible hydrocarbon spill scenario, which in this instance is the loss of well integrity.

As the weathering of different fates of hydrocarbons (surface, entrained and dissolved) differs due to the influence of the metocean mechanism of transportation, the EMBA combines the potential spatial extent of the different fates. The EMBA also includes areas that are predicted to experience shoreline contact with hydrocarbons above threshold concentrations.

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 (100 simulations in total). The EMBA therefore represents the extent of where hydrocarbon thresholds could be exceeded from all modelling runs. Given the EMBA comprises the results of many individual simulations, the total area covered at the thresholds has been smoothed to create a continuous boundary for the purpose of describing the environment within it.

Surface and accumulated shoreline hydrocarbon concentrations are expressed as grams per square metre (g/m^2), 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 the table below (**Table 6-5**) and described in the following subsections.

Woodside recognises that hydrocarbons may be present beyond the ecological impact EMBA at low concentrations that may be visible, but are not expected to cause ecological impacts. The threshold for visible surface oil (1 g/m^2) has therefore been used to define an additional boundary within which socio-cultural impacts to the visual amenity of the marine environment may occur. This area is referred to as the socio-cultural EMBA. Any ecological impacts from dissolved and entrained hydrocarbons above prescribed thresholds, as in **Table 6-5**, may also result in socio-cultural impacts. Potential impacts to socio-cultural values assessed within these EMBAs include the following:

- protected areas
- national and Commonwealth Heritage Listed places
- tourism and recreation
- fisheries.

Table 6-5: Summary of thresholds applied to the quantitative hydrocarbon spill risk modelling results

	EMBA				Socio-economic EMBA
	Surface Hydrocarbon (g/m^2)	Entrained hydrocarbon (ppb)	Dissolved aromatic hydrocarbon (ppb)	Accumulated hydrocarbons (g/m^2)	Surface Hydrocarbon (g/m^2)
Crude	10	100	50	100	1
Diesel	10	500	500	100	-

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/m^2 for both condensate and diesel. This is equivalent to dull metallic colours based on the relationship between film thickness and appearance (Bonn Agreement, 2015) (**Table 6-6**).

This threshold concentration expressed in terms of g/m^2 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 approximately 10–25 g/m^2 (French et al. 1999, Koops et al. 2004, National Oceanic and Atmospheric Administration 1996). Potential impacts of surface slick concentrations in this range for floating hydrocarbons may include harm to seabirds through ingestion from preening of contaminated feathers or the loss of the thermal protection of their feathers. The 10 g/m^2 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. The 10 g/m² threshold is considered appropriate for both Enfield Crude and diesel delineating potential chronic and acute effects to ecosystems.

A lower concentration of 1 g/m^2, which represents a rainbow sheen on the surface (**Table 6-6**), has also been used to define a wider area within which socio-cultural impacts to the visual amenity of the marine environment may occur. This area is referred to as the 'socio-cultural EMBA'.

Table 6-6: The Bonn Agreement oil appearance code

Appearance (following Bonn visibility descriptors)	Mass per area (g/m^2)	Thickness (µm)	Volume per area (L/Km^2)
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

Dissolved Aromatic Hydrocarbon Threshold Concentrations

Enfield Crude

The hydrocarbon threshold concentration value for dissolved aromatic hydrocarbons (i.e. 50 ppb) is considered conservative and has been set with reference to the dissolved exposure values detailed in NOPSEMA Bulletin #1 Oil Spill Modelling (2019), and in context of ecotoxicity tests results from Enfield Crude.

The purpose of the threshold is to inform the assessment of the potential for toxicity impacts to sensitive marine biota. The ecotoxicity tests were undertaken 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 ecotox testing of the Enfield crude (**Table 6-4)** focuses on the TPH concentration of the water accommodated fractions (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).

The laboratory-based ecotoxicology tests used a range of 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. **Table 6-7** presents the results of no observed effect aromatic concentrations (NOECs) for Enfield crude WAFs tested. The range of NOECs for the organisms tested ranged from 340 ppb to 3512 ppb. Tests with a NOEC below the set threshold were the sea urchin fertilisation and microalgal growth tests. These tests indicated acute and chronic effects at dissolved aromatic concentrations less than 500 ppb (NOEC: >340 ppb), toxicity test results on all other test organisms found no observed effects at concentrations above 500 ppb.

Table 6-7 shows the range of the no observable effect (NOEC) total petroleum hydrocarbons (TPH) concentrations for Enfield crude water accomodated fractions (WAFs) tested. The 50 ppb threshold is significantly below the NOEC for all six sensitive organisms tested and is considered to be conservative

Table 6-7: Summary of total TPH NOECs for key life-histories of different biota based on toxicity tests for WAF of Enfield crude oil

Biota and Life Stage	Exposure duration	NOEC – TRH concentration of Enfield crude showing no direct biological effect (ppb)
Sea urchin fertilisation	1 hour	340
Sea urchin larval development	72 hours	838
Milky oyster larval development	48 hours	1550
Micro-algal growth test	72 hours	350
Amphipod acute toxicity test	72 hours	828
Tropical copepod acute toxicity test	96 hours	640
Larval fish imbalance test	96 hours	3512

Source: Ecotox Services Australia, 2009

Diesel

The dissolved aromatic threshold of 500 ppb for diesel has been selected as a conservative threshold to be consistent with the NERA Environment Plan Reference Case: Consequence analysis of an accidental release of diesel (2018:1003; NERA 2018). A threshold of 500 ppb is recommended in the reference case in accordance with a review by IRC (2011) of Group II (MGO) hydrocarbon toxicity to the marine environment (NERA 2018). A contact threshold of 500 ppb was found to be conservative for a range of species including crustaceans, molluscs, echinoderms and fish. Five out of six indicator species in ecotoxicology testing showed no observed effect from hydrocarbons below this concentration.

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).

Condensate

The condensate threshold concentration value for entrained hydrocarbons (i.e. 100 ppb) is considered conservative and has been set with reference to the entrained exposure values detailed in NOPSEMA Bulletin #1 Oil Spill Modelling (2019), and in context of ecotoxicity tests results from the Enfield Crude.

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 6-7**). However, it is likely these 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 oil hydrocarbons. It is therefore expected that the entrained threshold concentration of 100 ppb will represent a potential impact substantially lower than the NOEC concentrations presented in **Table 6-7** and is therefore considered to be conservative.

Diesel

The entrained threshold for diesel has been selected to be consistent with the NERA Environment Plan Reference Case: Consequence analysis of an accidental release of diesel (2018:1003; NERA 2018). As described above, entrained droplets may contain soluble compounds and hence have the potential for generating elevated concentrations of dissolved hydrocarbons. However, the potential for physical and chemical effects from direct contact with entrained oil droplets, which are less biologically available, is more applicable. An entrained threshold of 500 ppb, consistent with the threshold for toxicity from dissolved components, is therefore considered to be conservative.

Accumulated Hydrocarbon Threshold Concentrations

Owens and Sergy (1994) define accumulated hydrocarbon <100 g/m^2 to have an appearance of a stain on shorelines. French-McCay (2009) defines accumulated hydrocarbons ≥100 g/m^2 to be the threshold that could impact the survival and reproductive capacity of benthic epifaunal invertebrates living in intertidal habitat. A threshold of ≥100 g/m^2 has therefore been adopted to define the EMBA for both a condensate and diesel spill. Further, any ecological impacts at the accumulated thresholds concentration EMBA may also result in socio-cultural impacts.

6.7.1.5 Scientific Monitoring

A planning area for scientific monitoring is also described in Section 5.7 of the Oil Spill Preparedness and Response Mitigation Assessment (**Appendix D**). This planning area has been set with reference to the low exposure entrained value of 10 ppb detailed in NOPSEMA Bulletin #1 Oil Spill Modelling (2019).

A scientific monitoring program 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 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.

6.7.2 Unplanned Hydrocarbon Release: Loss of Well Containment during Intervention Activities

Context		
Well Intervention – **Section 3.9** Disturbance to Seabed from Dropped Objects – **Section 6.7.9**	Physical Environment – **Section 4.4** Biological Environment – **Section 4.5** Socio-economic – **Section 4.6** Values and Sensitivities – **Section 4.7**	Stakeholder Consultation – **Section 5**

Impacts and Risks Evaluation Summary

	Environmental Value Potentially Impacted							***Evaluation***						
Source of Risk	***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 containment during well intervention	X	X	X	X	X	X	X	C	B	2	H	LCS GP PJ RBA CV SV	Acceptable if ALARP	EPO 8 & 9

Description of Source of Risk

Background

Woodside has identified a well blowout as the scenario with the worst-case credible environmental outcome as a result of loss of well containment. A loss of well containment is an uncontrolled release of reservoir hydrocarbon or other well fluids to the environment. 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 has 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
- probability of a blow-out from a well intervention is 1 x 10^{-4} (0.0001, or 0.01%), considerably lower than drilling activities (International Association of Oil and Gas Producers 2010).

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 containment events that have resulted in significant releases or significant environmental impacts.

Therefore, in accordance with the Woodside Risk Matrix, a loss of well containment and resulting blowout event corresponds to an 'unlikely' event as it has occurred many times in the industry, but not in the Company.

Credible Scenario – Loss of Well Containment during Intervention

Multiple wells may be intervened during the Petroleum Activities Program if a suitable opportunity (e.g. MODU of convenience) arises during the Petroleum Activities Program. The well intervention involves re-establishing barriers via a MODU or intervention vessel. The credible scenario to be considered during well intervention is uncontrolled release to environment during well intervention

- Note that other credible loss of well containment scenarios not associated with well intervention are considered in **Section 6.7.3**.
- Note that the loss of well containment scenario is considerably smaller in volume (<29% of the total volume over 77 days) than was presented in the NGA Facility Operations EP. This is due to reservoir depletion resulting in an increased water cut and decreased reservoir pressure. Consequently, the nature and scale of the spill scenarios and associated EMBAs are considerably different.

Quantitative Hydrocarbon Spill Modelling – Loss of Well Containment

Spill modelling was undertaken by RPS APASA, on behalf of Woodside, to determine the fate of hydrocarbon released from the loss of well containment scenario, based on the assumptions in **Table 6-8**. Modelling considered metocean conditions throughout the year; this was done to inform the determination of consequence of loss of well control during intervention at any time of the year.

Table 6-8: Summary of modelled credible scenario – loss of well containment during intervention

Parameter	Loss of well containment
Total discharge[18] at surface	5 days 1177 m^3
Total discharge at Seabed	72 days 13,279 m^3
Water Depth	522.3 m
Fluid	Enfield Crude

Hydrocarbon Characteristics

The characteristics of the Enfield Crude oil are presented in **Table 6-4**.

Enfield crude oil will have a tendency to persist on the sea surface, with negligible levels of entrainment and only around 15% of the spilled volume expected to evaporate with the first 24 hours under light winds. Biological and photochemical degradation is predicted to contribute to the decay of the floating slicks at an approximate rate of 2% per day, for an accumulated total of about 15% after seven days. Adding to this the loss through evaporation (2—25%) and entrained/dissolved losses (around 5%) indicates that the proportion of oil remaining afloat will be around 55-60% after seven days under both light and moderate winds.

The bulk of the spilled mass of Enfield Crude that does not evaporate with the first 48 hours will be expected to remain floating on the water surface. Some components of the remaining oil will evaporate and/or degrade over time scales of several weeks to a few months.

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[18] The discharge volumes in this table are predicted using reservoir modelling software packages that take into account a number of factors (well design, reservoir properties and environmental conditions (e.g. water depth, temperature and pressure) to provide a production profile over the oil spill modelling period.

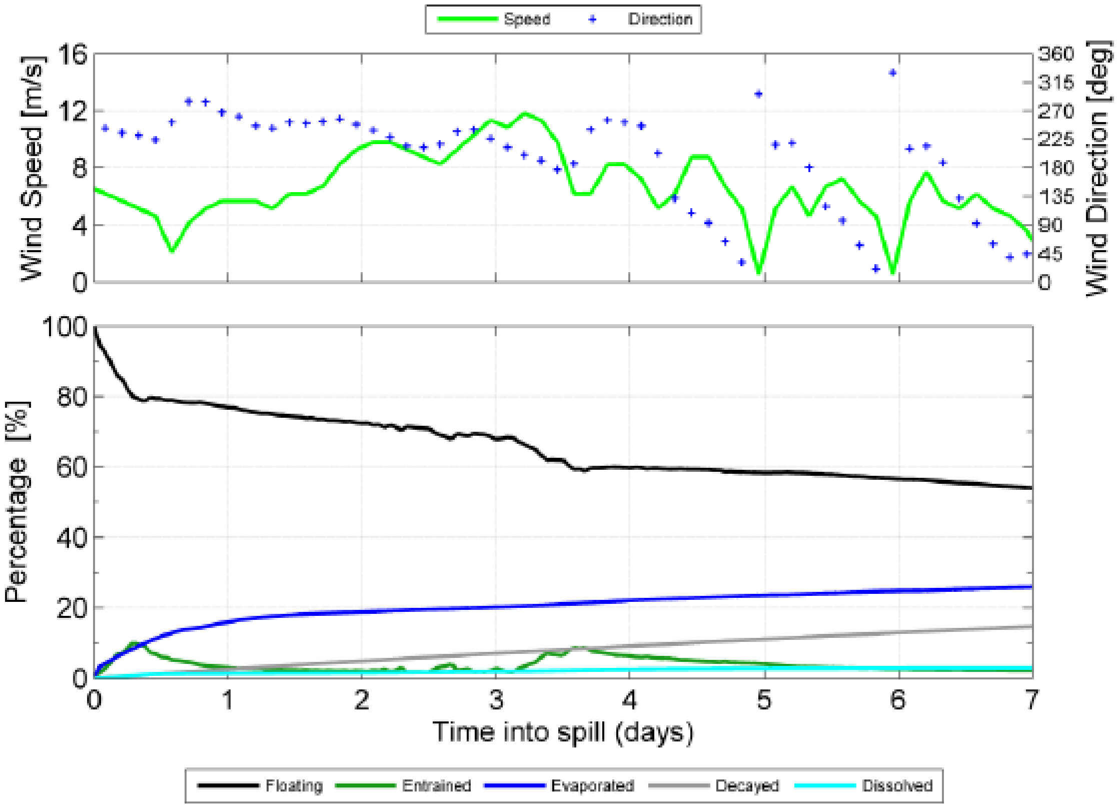

Figure 6-1: Proportional mass balance plot representing the weathering of Enfield Crude spilled onto the water surface as a one-off release (50 m^3 over one hour) and subject to variable wind at 27 °C water temperature and 25 °C air temperature

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-Deep model. **Table 6-9** shows a summary of the results of the OILMAP Deep modelling for the well blowout.

Table 6-9: Near-field blowout model parameters for loss of well containment

OILMAP	Parameter	Value
Inputs	Release Depth (m BMSL)	522.3
	Oil Density (g/cm^3) (at 15 °C)	0.921
	Oil Viscosity (cP (at 20 °C)	46.022
	Oil Temperature (°C)	68.0
	Gas:Oil Ratio (scf/bbl)	2,101
	Oil Flow Rate (bbl/d) [m^3/d]	1160 [184.4]
	Diameter of Hole (m) [in]	0.157 [6.184]
Outputs	Plume Diameter (m)	25.3
	Plume Height (m ASB)	114.8
	Plume Initial Rise Velocity (m/s)	0.8
	Plume Terminal Rise Velocity (m/s)	0.0
Predicted Oil Droplet Size Distribution -	9.7% droplets size (µm)	1,666.7
	17.6% droplets size (µm)	3,333.3
	20.2% droplets size (µm)	5,000.0

	19.9% droplets size (µm)	6,666.7
	17.8% droplets size (µm)	8,333.3
	14.8% droplets size (µm)	10,000.0

The results of the OILMAP simulation predicted that the discharge would generate a cone of rising gas that would entrain the oil droplets and ambient seawater up to a “trapping depth” (where the gas plume becomes neutrally buoyant and its vertical velocity drops to zero) approximately 115 m above the seabed and 407 m below the surface. The mixed plume is initially forecast to accelerate towards the water surface with a vertical velocity of 0.8 m/s, gradually slowing and increasing in plume diameter as more ambient water is entrained. The diameter of the central cone at the neutral buoyancy point is predicted to be approximately 25 m.

The discharge velocity and turbulence generated by the expanding gas plume is predicted to produce large oil droplets, of diameter ranging from 11,667-10,000 µm, which will rise to the surface at rates determined by their buoyancy relative to the surrounding water density and the viscous resistance imposed by the water. 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. With theoretical rise velocities ranging from 4.1-11.6 cm/s, the surfacing times with range from approximately 1-3 hours in the absence of turbulence or strong stratification of the water column. Floating slicks are likely to be formed under calm wind conditions.

The results suggest that beyond the immediate vicinity of the blowout the majority of the released hydrocarbons will be present on the ocean surface, with the oil’s high in viscosity meaning it will tend to resist entrainment under typical local wind conditions.

Impact Assessment

Potential Impacts to Marine Sediment, Water Quality, Air Quality, Ecosystems / Habitats, Species and Socio-economic Environment

EMBA

Quantitative hydrocarbon spill modelling results are shown in **Figure 4-1** and have been used to define the EMBA (**Section 4.1** and **Section 6.7.1**).

Surface Hydrocarbons

Quantitative hydrocarbon spill modelling results for surface hydrocarbons are shown in **Figure 4-1**. In the event of the loss of well containment scenario occurring, surface hydrocarbons at or above 1 g/m^2 are forecast to potentially occur up to 750 km from the release site. The oil slick is forecast to drift in all directions, reflecting the competing influence of both surface currents and winds across the wide area in which a large and persistent slick could travel over the long duration of the release, with higher-probability trajectories reaching the Ningaloo Coast (**Table 6-10**). At the surface threshold of 10 g/m^2, floating oil is forecast to potentially occur up to 100 km from the release site.

Entrained Hydrocarbons

Quantitative hydrocarbon spill modelling results for entrained hydrocarbons are shown in **Figure 4-1**. The most likely direction of drift is south-westerly around the Ningaloo Coast and then southwards, reflecting the prevailing current patterns. Results also indicate that entrained oil may also be likely to drift towards the northeast and in the offshore directions at lower probabilities. The probability of contact by entrained oil at concentrations above 100 ppb is predicted to be 20% at both Ningaloo Coast North WHA and Ningaloo Coast Middle WHA, and 3% at Ningaloo Coast South WHA, and 1% at Shark Bay, Montebello Islands AMP, Abrolhos Islands AMP and the Gascoyne AMP (**Table 6-10**).

The cross-sectional transects of maximum entrained oil concentrations in the vicinity of the release site indicate a zone of low concentrations (<500 ppb) in the upper 200 m of the water column, representing the oil droplets rising from the trapping depth. Concentrations above 1000 ppb are only found in the upper 20 m within around 30 km of the release site, the result of wind- and wave-induced mixing entraining portions of the floating slicks. This process will also occur at greater distances, but with thinner floating slicks and lower concentrations.

Dissolved Hydrocarbons

Quantitative hydrocarbon spill modelling results for dissolved hydrocarbons are shown in **Figure 4-1**. Contact above the 50 ppb threshold was restricted to receptors associated with Ningaloo Reef (>10% probability) and the Gascoyne AMP (29% probability). The worst-case dissolved aromatic hydrocarbon concentrations reaching receptors are forecast at Gascoyne AMP (807 ppb), followed by Ningaloo Coast North WHA (191 ppb) (**Table 6-10**).

The cross-sectional transects of maximum dissolved aromatic hydrocarbon concentrations in the vicinity of the release site show how concentrations, in general, are forecast to be below 200 ppb, and insignificant below a depth of around 75 m. This reflects dissolution of aromatic compounds in the wave-mixed surface layer during infrequent entrainment events.

Accumulated Hydrocarbons

Quantitative hydrocarbon spill modelling results for maximum local accumulated hydrocarbon concentrations indicated that the following sensitive receptors have potential to experience shoreline accumulation above threshold concentrations (100 g/m^2); Ningaloo Coast, Muiron Islands, Montebello/Barrow/Lowendal Islands Group, Pilbara

Southern Island Group, Rankin Bank, Rowley Shoals (Clerke and Imperieuse Reef), Abrolhos Islands and Shark Bay (including the WHA), and areas along the Indonesian coastline (**Table 6-10**). The largest potential volume of oil accumulating on any shoreline is expected to be 692 m^3 at Ningaloo Coast North. Large potential volumes are also forecast at Barrow and Lowendal Island (413 m^3).
Summary of Potential Impacts to environmental values(s)
Table 6-10 presents the full extent of the EMBA, i.e. the sensitive receptors and their locations that may be exposed to hydrocarbons (surface, entrained and dissolved) at or above the set threshold concentrations in the unlikely event of a major hydrocarbon release from a loss of well containment 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 containment during the Petroleum Activities Program are presented in the following sections.

Table 6-10: Environment that may be Affected (EMBA) – Key Receptor Locations and Sensitivities with the Summary Hydrocarbon Spill Contact for a 77 day subsea blowout of Enfield Crude

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 (1-10 g/m²)	Surface hydrocarbon (≥10 g/m²)	Entrained hydrocarbon (≥100 ppb)	Dissolved aromatic hydrocarbon (≥50 ppb)	Accumulated hydrocarbons (>100 g/m²)
Offshore	Argo-Rowley Terrace AMP	✓						✓							✓	✓			✓			✓	✓	✓		✓			✓		2	–	–	–	–
	Montebello AMP	✓	✓	✓			✓	✓							✓	✓			✓	✓	✓	✓	✓	✓	✓	✓		✓	✓		7	–	1	–	–
	Carnarvon Canyon AMP	✓	✓					✓		✓														✓	✓	✓			✓		2	–	–	–	–
	Ningaloo AMP	✓						✓		✓					✓	✓			✓		✓	✓	✓	✓	✓	✓		✓	✓		63	3	20	8	–
	Gascoyne AMP	✓	✓												✓	✓			✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	100	5	67	29	–
	Shark Bay AMP/WHA	✓	✓					✓							✓	✓	✓		✓	✓		✓	✓	✓	✓	✓		✓	✓		–	–	1	–	5
	Abrolhos AMP	✓	✓	✓			✓	✓		✓						✓		✓	✓	✓		✓	✓	✓	✓			✓	✓		1	–	1	–	–
Submerged shoals	Rankin Bank	✓	✓	✓			✓	✓		✓						✓				✓		✓		✓	✓	✓		✓			2	–	–	–	–
Islands	Montebello Islands (including State Marine Park)	✓	✓	✓	✓	✓	✓	✓				✓		✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	2	–	–	–	3
	Lowendal Islands (including State Nature Reserve)	✓	✓	✓	✓	✓	✓	✓				✓		✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	2	–	–	–	4
	Barrow Island (including State Nature Reserves, State Marine Park and Marine Management Area)	✓	✓	✓	✓	✓	✓	✓				✓		✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	2	–	–	–	3

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	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 (1-10 g/m²)	Surface hydrocarbon (≥10 g/m²)	Entrained hydrocarbon (≥100 ppb)	Dissolved aromatic hydrocarbon (≥50 ppb)	Accumulated hydrocarbons (>100 g/m²)
	Muiron Islands (WHA, State Marine Park)	✓	✓	✓	✓		✓	✓		✓		✓		✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓			✓	✓		15	–	–	–	16
	Pilbara Islands – South, Middle and Northern Island Groups	✓	✓		✓		✓		✓			✓		✓		✓	✓		✓	✓		✓	✓	✓	✓	✓		✓	✓		5	–	–	–	9
	Rowley Shoals – Clerke Reef and Imperieuse Reef State Marine Parks	✓	✓	✓			✓	✓		✓						✓			✓	✓		✓	✓	✓	✓			✓	✓		–	–	–	–	3
	Abrolhos Islands	✓	✓	✓	✓	✓	✓	✓				✓		✓	✓	✓		✓	✓	✓		✓	✓	✓	✓	✓		✓	✓		–	–	–	–	1
Mainland (nearshore waters)	Ningaloo Coast (North/North West Cape, Middle and South) (WHA, and State Marine Park)	✓	✓	✓	✓	✓	✓	✓		✓		✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓		✓	✓		63	3	20	8	25
	WA coastline	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓		✓	✓		20	1	–	–	25
	Indonesia	✓	✓	✓	✓	✓	✓				✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓		✓	✓	✓		–	–	–	–	1

Summary of Potential Impacts to environmental values(s)	
Summary of Potential Impacts to protected species	
Setting	***Receptor Group***
Offshore (including Oceanic Reefs and Offshore Islands)	**Cetaceans** Marine mammals are highly mobile and a number of field and experimental observations indicate whales and dolphins may be able to detect and avoid surface slicks. However, instances have been observed where animals have swum directly into oiled areas without seeming to detect the slicks or because the slicks could not be avoided. Cetaceans may exhibit avoidance behaviour and move away from the spill-affected area. Marine mammals that have direct physical contact with surface slicks and entrained hydrocarbons may suffer surface fouling or ingestion of hydrocarbons and inhalation of toxic vapours. 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 or neurological damage (Helm et al. 2015). For example, fouling of baleen whales (e.g. humpback and pygmy blue whales) may disrupt feeding by decreasing the ability to intake prey. If prey (fish and plankton) is also hydrocarbon contaminated, this can result in the absorption of toxic components of the hydrocarbons (PAHs). Feeding appears to be rare during humpback whale migration so the potential for impacts associated with ingestion of hydrocarbons may be low for this particular species during migration. Toothed whales including dolphins, are ‘gulp-feeders’ targeting specific prey at depth in the water column away from any potential surface slick and are likely to be less susceptible to the ingestion of hydrocarbons. Furthermore, given cetaceans are smooth skinned and hydrocarbons would not tend to adhere to body surfaces, the likely biological consequences of physical contact with surface hydrocarbons is likely to be in the form of irritation and sub-lethal stress. In the event of a well blowout, there is potential that surface and entrained hydrocarbons exceeding threshold concentrations will be transported across the north and southbound migratory route (BIA) of EPBC Act listed humpback and pygmy blue whales (**Section 4.5.2**). If the well blowout occurred in July to September, it would coincide with humpback whale migration through the waters off the North West Cape (Ningaloo), Shark Bay (open ocean) and the Pilbara. If the well blowout occurred in April to August or October to January, it would coincide with pygmy blue whale migration. While opportunistic feeding may occur during migration, it is considered rare, therefore, a well blowout could result in a disruption to a portion of the population but it is not predicted to impact on the overall population viability. A loss of well containment resulting in a well blowout could result in a disruption to a 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) 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.

Summary of Potential Impacts to environmental values(s)	
	Marine Turtles Adult sea turtles exhibit no avoidance behaviour when they encounter hydrocarbon slicks (National Oceanic and Atmospheric Administration 2010). Contact with surface slicks, or entrained hydrocarbon, can therefore, result in hydrocarbon adherence to body surfaces (Gagnon and Rawson 2010) causing irritation of mucous membranes in the nose, throat and eyes leading to inflammation and infection (National Oceanic and Atmospheric Administration 2010). Oiling can also irritate and injure skin which is most evident on pliable areas such as the neck and flippers (Lutcavage et al. 1995). 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). 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 (National Oceanic and Atmospheric Administration 2010). Contact with entrained hydrocarbons can result in hydrocarbon adherence to body surfaces (Gagnon and Rawson 2010) causing irritation of mucous membranes in the nose, throat and eyes leading to inflammation and infection (Gagnon and Rawson 2010). Due to the absence of potential nesting habitat and location offshore, the Operational Area is unlikely to represent important habitat for marine turtles (approximately 30 km from the Muiron Islands and 38 km from the north Ningaloo Coast and water depths of approximately 400 to 600 m deep). It is however acknowledged that EMBA overlaps BIAs for several species of marine turtle (**Section 4.5.2**) in particular the interesting BIA for flatback turtles which extends around 80 km from known nesting locations. In the event of a well blowout, 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 2011). They may also be impacted when they return to the surface to breathe and inhale the toxic vapours associated with the hydrocarbons, resulting in damage to 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) and while individuals may be present in the EMBA (**Section 4.5.2**), 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 when migrating to and from Ningaloo Reef, where they aggregate for feeding from March to July. While not overlapping the Operational Area, whale shark foraging BIAs lie within the EMBA in close proximity to the north and south of the Operational Area (**Section 4.5.2**). Therefore, individual whale sharks that have direct contact with hydrocarbons within the spill affected area may be impacted but the consequences to migratory whale shark populations are likely to be minor. Impacts to sharks and 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). 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 only a temporary disruption.

Summary of Potential Impacts to environmental values(s)	
	Seabirds and/or Migratory Shorebirds Offshore waters are potential foraging grounds for seabirds associated with the coastal roosting and nesting habitat (Ningaloo and the Barrow/Montebello/Lowendal Island Group). There are confirmed foraging grounds off Ningaloo and the Barrow/Montebello/Lowendal Island Group and BIAs for the wedge-tailed shearwater (breeding season August-April) and the Australian fairy tern (peak use July–October) and roseate tern (mid-March to July) occur within the Operational Area and EMBA respectively (**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 (Australian Maritime Safety Authority 2013, International Petroleum Industry Environmental Conservation Association 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 chick (Australian Maritime Safety Authority 2013). The extent of the EMBA for a surface slick may result in impacts on feeding habitat and a disruption to a portion of the habitat however this is not expected to result in a threat to the overall population viability of seabirds or shorebirds.
Mainland and Islands (nearshore waters	**Cetaceans and Dugongs** In addition to a number of dolphin species that may occur in nearshore waters (such as spotted bottlenose dolphins, Indo-Pacific humpback dolphins and snubfin dolphins), coastal populations of small cetaceans and dugongs are known to reside or frequent nearshore waters, including the Ningaloo Coast and Shark Bay, which may be potentially impacted by surface, entrained and dissolved hydrocarbons exceeding threshold concentrations in the event of a loss of well containment. The BIA for the dugong lies within the EMBA (**Section 4.5.2**). The predicted EMBA for surface hydrocarbons is located in offshore and coastal waters off the Ningaloo Coast and North West Cape, while the predicted EMBA for entrained extends from offshore and coastal waters from approximately Geraldton. 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, avoidance behaviour may have greater impacts to population functioning. Nearshore dolphin species (e.g. spotted bottlenose dolphins) may exhibit higher site fidelity than oceanic species although Geraci (1988) observed relatively little impacts beyond behavioural disturbance. Additional potential environment impacts may also include the potential for dugongs to ingest hydrocarbons when feeding on oiled seagrass stands or 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 result in a disruption to a 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 in the Houtman Abrolhos Islands Nature Reserve, which may be affected by accumulated hydrocarbons above impact thresholds (**Table 6-10**). Given the considerable distance from the Operational Area to these receptors, and that no surface or entrained hydrocarbons above impact thresholds were identified as potentially reaching the Abrolhos Islands, accumulated hydrocarbons at this receptor are likely to be heavily weathered and are expected to have minor or no impacts on sea lions.

Summary of Potential Impacts to environmental values(s)	
	Marine Turtles Several marine turtle species utilise 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. There are distinct breeding seasons as detailed in **Section 4.5.2**. The nearshore waters of these turtle habitat areas may be exposed to surface, entrained and dissolved 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 on 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. Female turtles attempting to nest may avoid oiled beaches, of become oiled externally after contacting stranded hydrocarbons (Milton et al. 2010). Note that turtles typically nest well above the high tide level, beyond the high tide level where stranded hydrocarbons typically accumulate. Oiled nesting female turtles may be subject to acute and chronic toxic effects, including reduced reproductive success and mortality (Milton et al. 2010). Hatchling turtles may encounter stranded oil when exiting the nest, and surface and entrained oil upon reaching the sea. Hatchling turtles are expected to be more vulnerable to oil exposure than adult turtles, due to the relatively smaller size and greater portion of time spend at the sea surface (i.e. more likely to encounter floating oil) (Milton et al. 2010). In the event that accumulated hydrocarbons (Ningaloo Coast only) or entrained hydrocarbons reach the shoreline or internesting coastal waters (as predicted for the Ningaloo Coast), there is the potential for impacts to turtles utilising the affected area. During the breeding season, turtle aggregations near nesting beaches in the NWMR, within the EMBA, are most vulnerable due to greater turtle densities and potential impacts may occur at the population level but it is not expected to impact on overall population viability. Several important nesting areas were identified as potentially being subject to shoreline accumulation of hydrocarbons >100 g/m^2, including Ningaloo Coast, Montebello Islands, Barrow Island and Lowendal Island (**Table** 6-10). While these are regionally significant nesting areas, all marine turtle species have significant nesting areas beyond the EMBA.
	Seasnakes As discussed previously (see ‘Offshore – seasnakes’) impacts to seasnakes for the mainland and island nearshore waters (including the Ningaloo Coast, and Shark Bay) from direct contact with hydrocarbons may occur but there is expected to be no threat to overall population viability.

Summary of Potential Impacts to environmental values(s)	
	Sharks (including whale sharks) and Rays Whale sharks and manta rays, known to frequent the Ningaloo Reef system (and form feeding aggregations in late summer/autumn) and transit along the Pilbara coast are vulnerable to entrained and dissolved aromatic hydrocarbon spill impacts, with both taxa having similar modes of feeding. Two BIAs in the vicinity of the Operational Area are associated with foraging during these annual aggregations. 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 with the mouth partially open (Taylor 2007). These feeding methods would result in potential for individuals that are present in worse affected spill areas to ingest potentially toxic amounts of entrained/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 cause displacement of 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 entrained/dissolved aromatic hydrocarbons through the contamination of their prey. 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. Several threatened species of sawfish (*Pristis* spp.) may occur in coastal areas, particularly tidal creeks and estuaries. The EMBA overlaps distribution of the *Pristis* spp., including the preferred habitats of all except the Freshwater Sawfish, therefore these species may be expected to be impacted. There is the potential for other resident shark and ray populations 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. Stochastic spill model outputs indicate potential impacts from entrained and/or dissolved aromatic hydrocarbons to the benthic communities of nearshore, subtidal communities of the Ningaloo Coast and Shark Bay it is considered that there is the potential for habitat loss to occur. Shark populations displaced or no longer supported due to habitat loss would be expected to redistribute to other locations. However, widespread habitat loss is unlikely and the consequences to resident shark and ray population (if present) are expected to be minor.

Summary of Potential Impacts to environmental values(s)	
	Seabirds and/or Migratory Shorebirds In the unlikely event of a major spill, there is 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 ingestion of 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. Whether the toxicity of ingested hydrocarbons is lethal or sub-lethal will depend on the weathering stage and its inherent toxicity. 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. Migratory shorebirds may be exposed to stranded hydrocarbon when foraging or resting in intertidal habitats, however, direct oiling is typically restricted to relatively small portion of birds, and such oiling is typically restricted to the birds' feet. Unlike seabirds, shorebird mortality due to hypothermia from matted feathers is relatively uncommon (Henkel et al. 2012). Indirect impacts, such as reduced prey availability, may occur (Henkel et at. 2012). Seabirds typically nest above the high water mark and as such, are not likely to encounter stranded hydrocarbons. As detailed in the preceding offshore setting summary, seabirds may be exposed to floating hydrocarbons, resulting in lethal and sub-lethal impacts. Important areas for foraging seabirds and migratory shorebirds are identified in **Section 4.5.2**. Refer to **Table 6-10** 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): • Ningaloo Coast • North West Cape • Shark Bay • Abrolhos Islands. A hydrocarbon spill may result in sub-lethal or lethal impacts to seabirds in the event that entrained hydrocarbons overlap foraging areas and result in the contamination of prey species. Migratory birds/shorebirds may also be affected, with entrained hydrocarbons potentially affecting birds through impacts to prey species.

Protected Species Populations (all settings)

Based on the deterministic modelling approach outlined in **Section 6.7.1**, the environmental sensitivities listed in **Table 6-11** were identified as potentially being affected by the deterministic model run with the greatest area of shoreline accumulation. Potential population-scale impacts for the fauna groups in **Table 6-11** are considered below.

Table 6-11: Key receptor locations and sensitivities for a 77 day loss of well containment of Enfield crude, as determined by the deterministic run with greatest area of shoreline accumulation above impact thresholds

Location	*Cetaceans – migratory whales*	*Cetaceans – dolphins and porpoises*	*Dugongs*	*Pinnipeds*	*Turtles*	*Seasnakes*	*Whale sharks*	*Sharks and rays*	*Birds*
Muiron Islands	✓	✓	✓		✓	✓	✓	✓	✓
Ningaloo Coast (north, middle and south)	✓	✓	✓		✓	✓	✓	✓	✓
Shark Bay	✓	✓	✓		✓	✓		✓	✓
Abrolhos Islands	✓	✓		✓	✓	✓		✓	✓

Cetaceans – Migratory Whales

Humpback and blue whales migrate seasonally through the EMBA, and may be impacted by exposure to spilled hydrocarbons from a worst-case loss of well containment as described in the preceding section (Offshore (including Oceanic Reefs and Offshore Islands)). Such exposure may result in a range of sub-lethal and lethal impacts, depending on the nature of hydrocarbon exposure. Baleen whales are considered relatively resistant to spilled oil compared to other marine mammals (e.g. pinnipeds, sea otters etc.) (Geraci and Aubin, 1988).

The humpback whale population off Western Australia has exhibited considerable recovery following the significant decline due to commercial whaling, with the rate of increase in the order of 10% per annum (Salgado-Kent et al. 2012). The migration of humpback whales along the Western Australian coastline is protracted, and the entire population will not credibly be within the area affected by spilled hydrocarbons from a worst-case loss of well containment. Migration patterns of blue whales are similar (although further offshore), in that the distribution of migrating animals is protracted (Double et al. 2014), and the entire population will not occur within the area affected by a worst-case hydrocarbon spill.

The portion of the humpback and blue whale populations exposed to spilled hydrocarbons from a worst-case loss of well containment would not experience total mortality; impacts to animals exposed to hydrocarbons above impact thresholds are expected to largely be sub-lethal. Population scale impacts to humpback and blue whales in the event of a worst-case loss of well containment are not expected to occur based on:

- a portion of each population can credibly be exposed to spilled hydrocarbons
- potential impacts to the exposed portion of the population are expected to largely be sub-lethal
- blue whale and humpback whale populations have shown considerable recovery potential.

Cetaceans – Dolphins and Porpoises

Populations of coastal dolphins and porpoises may be affected by a worst-case loss of well containment, although oceanic species (e.g. spinner dolphins) will not experience population-scale impacts due to their widespread distribution. Coastal dolphin species with resident populations include bottlenose dolphins and Indo-Pacific humpback dolphins within the areas identified by the worst-case deterministic model run.

Indo-Pacific humpback dolphins may have localised populations with relatively little exchange between populations (Brown et al. 2014, 2016, Parra and Cagnazzi 2016). The distribution of this species lies largely to the north of EMBA, although there is a resident population in coastal waters around North West Cape (Brown et al. 2014). Given the nature of impacts to dolphins exposed to hydrocarbons are expected to be largely sub-lethal, the potential for population scale impacts to the resident Indo-Pacific humpback dolphins at North West Cape is considered to be unlikely. It is expected that this population would recover over time through local recruitment and migration of individuals (although Woodside acknowledges that genetic studies indicates relatively little gene flow between populations discrete populations along the Western Australian coastline). This is consistent with the decline and recovery of coastal cetacean populations within the area affected by oil spills during the Gulf War (Preen 2004), which were significantly larger than the worst-case credible spill considered in this EP.

Bottlenose dolphins show site fidelity, although studied populations do show transient movements of individuals between populations and genetic exchange at relatively large spatial scales (100s of km) (Fury and Harrison 2008, Krützen et al. 2004). As such, no population-scale impacts to bottlenose dolphins are expected to occur, as any population within an affected area is expected to recover through an influx of animals and natural recruitment.

Dugongs

Potential impacts to dugongs from exposure to spilled hydrocarbons are described above in Mainland and Islands (nearshore waters). Dugongs are broadly (although often sparsely) distributed in coastal waters, with relatively high densities in coastal embayments such as Exmouth Gulf and Shark Bay. Stochastic modelling results indicated little potential for spilled hydrocarbons to impact directly upon Exmouth Gulf and Shark Bay, both of which host significant dugong populations.

Tagging studies of dugongs have indicated individual animals undertake long distance movements (Gales et al. 2004, Sheppard et al. 2006). Additionally, there is evidence of considerable genetic exchange between populations within Australia, and between populations in Australia and south-east Asia (McDonald 2005). This suggests that dugong populations cover a considerable spatial extent, and that a worst-case hydrocarbon spill from a loss of well containment would affect only a small portion of the dugong population off Western Australia.

Dugong populations exposed to large-scale oil spills have been shown to be resilient, with no significant decrease in population size (Preen 2004). When considering this resilience and the species' widespread population, the potential for population-scale impacts in the event of a worst-case loss of well containment is considered to be low.

Pinnipeds

The only significant pinniped population within the EMBA is the Australian sea lion population at the Abrolhos Islands. Given the distance of this population from the release location, any spilled hydrocarbons from a worst-case loss of well containment are expected to be highly weathered prior to reaching this population. Lethal impacts resulting from acute toxicity or hypothermia due to smothering are not expected to occur. No impacts to pinnipeds at a population scale are expected to occur in the event of a worst-case loss of well containment.

Turtles

Several species of turtle were identified as potentially occurring within the EMBA (**Section 4.5.2**). The distributions of each of these species extends beyond the EMBA, although significant habitats, including nesting beach (discussed below) do occur within the EMBA. The worst-case loss of well containment deterministic modelling results indicated that a number of known turtle nesting beaches may be contacted by accumulated hydrocarbons, including the Ningaloo Coast, Muiron Islands and Shark Bay. These areas are known to host nesting beaches for green, loggerhead and flatback turtles (**Section 4.5.2**).

The behaviour and biology of marine turtles makes these species relatively vulnerable to population-scale impacts compared to other fauna, such as dugongs. All species of marine turtles exhibit high nesting site fidelity by females, with gene flow between populations primarily mediated by movements of male turtles (FitzSimmons et al. 1997). Additionally, marine turtles rely on nesting beaches to reproduce, which makes them vulnerable to impacts from spilled hydrocarbon accumulations on shorelines through oiling of nesting females and emergent hatchlings, disturbance of nests from spill response activities (Lauritsen et al. 2017). A spill during nesting and hatching season poses an increased to marine turtle populations.

Results from studies of nesting beaches subject to extensive oil pollution from the Deepwater Horizon spill indicated a significant reduction (approximately 44%) in turtle nest density during the nesting season immediately following the spill (Lauritsen et al. 2017). Lauritsen et al. (2017) partially attributed this reduction to direct (e.g. direct mortality of adults due to oiling or toxicity) and indirect (e.g. shoreline disturbance from response activities) impacts from the spill. A significant increase in nesting density in the years immediately following the spill; nesting density returning to levels comparable to pre-spill densities within two nesting seasons (Lauritsen et al. 2017). This indicates that adult female turtles that avoided mortality may have deferred nesting during the spill until subsequent years. The significant decline in nesting density observed following the Deepwater Horizon spill represents a decline of approximately 36% of reproductive output of the turtle population in the study area (Lauritsen et al.

Summary of Potential Impacts to environmental values(s)	
	2017); given turtles may take over a decade to reach sexual maturity, the effects of such a reduction in reproductive output may take over a decade to appear in nesting-related metrics (which are commonly used to monitor turtle populations). Based on the deterministic modelling results and the potential for impact and recovery of turtles, a worst-case hydrocarbon spill from a loss of well containment may result in reductions in turtle numbers and nesting density, however, it would not be expected to result in elimination of a population. Impacts and subsequent recovery may take decades to occur. To date, no oil spills have been demonstrated to have resulted in elimination of a turtle population at any scale (Yender and Mearns 2010). Disastrous spills impacting important turtle habitat (including nesting areas) have not been shown to eliminate turtle populations, although direct and indirect impacts have been documented (e.g. Lauritsen et al. 2017, McDonald et al. 2017, Stacy et al. 2017, Vander Zanden et al. 2016). Turtle populations have been shown to be able to recover, even when populations have been reduced to small sizes after experiencing significant declines (Mazaris et al. 2017). As such, population scale impacts to marine turtles from a worst-case loss of well containment would be expected to exhibit recovery, although may take several decades to reach pre-impact population levels due to the relatively long lifespan and late sexual maturity of marine turtle species. **Seasnakes** Seasnake species in the area, identified by the worst-case deterministic run, are widely distributed, with considerable genetic exchange between populations (Lukoschek et al. 2008). Connectivity of suitable seasnake habitat (i.e. shallow coastal waters) exists between the areas identified by the worst-case deterministic run and unaffected areas, facilitating movement of individuals into affected areas following recovery. As such, population scale impacts to seasnakes are not expected to occur in the event of a worst-case loss of well containment. **Whale Sharks** Deterministic modelling of a worst-case loss of well containment indicated the potential for hydrocarbons above impact thresholds off the Ningaloo Coast, which hosts annual aggregations of whale sharks (**Section 4.5.2**). Studies of whale sharks aggregating at Ningaloo have shown individuals returning to the area over multiple years, with Meekan et al. (2006) suggesting these animals form a population of approximately 300 to 500 individuals. Inter-annual resighting typically occurred over a timeframe of 1-3 years, although resighting after a period of 12 years was recorded for one individual (Meekan et al. 2006). This suggests a worst-case loss of well containment during the seasonal aggregation would not affect all whale sharks known to aggregate off Ningaloo, as a portion of these animals would be absent at any particular time. Population genetics studies of whale sharks indicate relatively little differentiation between populations, indicating gene flow within and between populations at an ocean basin scale (Castro et al. 2007, Schmidt et al. 2009). As such, population scale impacts to whale sharks are not expected to occur in the event of a worst-case loss of well containment. **Sharks and Rays** Migratory oceanic shark species (excluding whale sharks, refer to discussion above) have wide distributions and are not considered to be particularly susceptible to a hydrocarbon spill from a worst-case loss of well containment. Inshore shark species such as sawfish are more vulnerable to population scale impacts due to their life history and spatial restriction of preferred habitats (Commonwealth of Australia 2015); however, worst-case deterministic modelling did not indicate impacts to critical sawfish habitat such as estuaries. **Birds** Seabird species with resident populations in the area potentially affected by a worst-case loss of well containment have broad distributions. Potential impacts such as mortality or reduced reproductive output may result in minor impacts to local populations. Migratory shorebirds are seasonally present in the area potentially affected (as determined by the worst-case deterministic scenario). However, entire populations of migratory species will not occur within the area potentially impacted, and hence, there is no potential for a worst-case loss of well containment. Studies of migratory bird populations impacted by the Deepwater Horizon spill indicated direct sub-lethal impacts to approximately 8.6% of individuals, and little evidence of direct mortality (Henkel et al. 2012). Potential impacts from a worst-case loss of well containment are expected to be consistent with these results, and population scale impacts to migratory birds are not expected to occur.

Summary of Potential Impacts to environmental values(s)	
Summary of potential impacts to marine primary producers	
Setting	***Receptor Group***
Mainland and Islands (nearshore waters)	**Coral Reef** The quantitative spill risk assessment and output EMBA indicate there would be potential for entrained and dissolved aromatic hydrocarbons (above 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 and dissolved hydrocarbons include the Ningaloo Coast. There is the potential for reefs along the Ningaloo Coast to be exposed to entrained and/or dissolved aromatic hydrocarbons concentrations that are considered to induce toxicity effects, particularly for reproductive and juvenile stages of invertebrate and fish species. Shoreline accumulation above impact thresholds may occur at the Rowley Shoals (Clerke and Imperieuse Reef), which host inter-tidal and shallow subtidal corals. Exposure to entrained hydrocarbons/dissolved aromatic hydrocarbons 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 this 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 result in impacts to the shallow water fringing coral communities/reefs of the mainland coast (e.g. Ningaloo Coast). 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 fertilization 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. Therefore, a hydrocarbon spill may result in large-scale impacts to coral reefs, with long-term effects (recovery >10 years) likely.

Summary of Potential Impacts to environmental values(s)	
	Seagrass Beds / Macroalgae and Mangroves Spill modelling has predicted entrained hydrocarbons and dissolved aromatic hydrocarbons, 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 utilised as important foraging and nursery grounds by a range of invertebrate and vertebrate species. Seagrass and macroalgal beds occurring in the intertidal and subtidal zone may be susceptible to impacts from entrained/dissolved 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/dissolved aromatic hydrocarbons may result in mortality, depending on actual entrained/dissolved 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. Depending on the trajectory of the entrained and dissolved hydrocarbon plume, macroalgal/seagrass communities at the Ningaloo Coast (patchy and low cover associated with the shallow limestone lagoonal platforms); refer to **Table 6-10** for a list of identified seagrass/macroalgae receptors, that may be exposed. Mangrove habitat and associated mud flats and salt marsh at Ningaloo Coast (small habitat areas), have the potential to be exposed (See **Table 6-10** for the full list of receptors). Hydrocarbons coating prop roots of mangroves can occur from surface hydrocarbons when hydrocarbons are deposited on the aerial roots. Hydrocarbons deposited on the aerial roots can block the pores used to breathe or interfere with the trees' salt balance resulting in sub-lethal and potential lethal effects. Mangroves can also be impacted by entrained/dissolved 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 (National Oceanic and Atmospheric Administration 2014). Entrained/dissolved 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 utilise these intertidal habitat areas for breeding, feeding and nursery habitat purposes.

Summary of Potential Impacts to environmental values(s)	
Summary of potential impacts to other habitats and communities	
Setting	***Receptor Group***
Offshore	**Benthic Fauna Communities** Benthic infauna communities in the vicinity of the well may be impacted resulting in changes to community structure. Furthermore, the low sensitivity benthic communities associated with the unconsolidated, soft sediment habitat and any epifauna (filter feeders) associated with the consolidated sediment habitat/limestone ridge habitat (e.g. the Ancient Coastline KEF, approximately 19 km away) 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. Evidence from the Deepwater Horizon spill in the Gulf of Mexico recorded low taxa richness and high nematode/harpacticoid-copepod ratios within 3 km of the release location and moderate impacts up to 17 km away (Montagna et al. 2013). The communities were likely exposed to dispersed hydrocarbons as the response included subsea dispersant application. A loss in benthic biodiversity has been correlated to a decline in deep-water ecosystem functioning (Danovaro et al. 2008). The location of the petroleum activity and the EMBA largely affect continental shelf waters, which are shallower than the Deepwater Horizon spill and as such may host more diverse infauna communities although the impacts are considered to be similar. Therefore, a loss of well containment may result in localised but long-term effects on community structure. **Demersal Fish** The continental slope demersal fish communities KEF in the region have been identified as a key ecological feature, and occurs within the Operational Area. Additionally, demersal species have also been observed within the Enfield Canyon (also within the Operational Area), associated with the occurrence of isolated boulders. Mortality and sub-lethal effects may impact populations located close to the loss of well containment and within the EMBA for entrained/dissolved aromatic hydrocarbons. 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, e.g. seafloor.
	Open Water – Productivity/Upwelling Primary production by plankton (triggered by sporadic upwelling events in the offshore waters of the Northwest Province) 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 result in changes in 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 (International Tanker Owners Pollution Federation 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 cause the displacement of 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 present in the EMBA.

Summary of Potential Impacts to environmental values(s)	
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) (International Tanker Owners Pollution Federation 2011). Fish spawning (including for commercially targeted species such as snapper and mackerel) occurs in nearshore waters at certain times of the year and 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 hydrocarbons to occur in the surface water layers above threshold concentrations in nearshore waters including, but not limited to the Ningaloo Coast and Shark Bay. This, and the potential for possible lower concentration exposure for dissolved aromatic hydrocarbons, have 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 worst 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 Deepwater Horizon (DWH) spill. Results indicated that 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.
	Non Biogenic Coral Reefs The coral communities fringing the offshore Ningaloo Coast region may be exposed to entrained hydrocarbons 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. In the event that 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. deep water communities of Ningaloo coast in 20–200 m) may occur depending on the depth of the entrained and dissolved aromatic hydrocarbons. See discussion above on potential impacts.

Summary of Potential Impacts to environmental values(s)	
	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 subjected to dissolved or entrained hydrocarbon. Potential impacts may occur due to surface hydrocarbon contact with intertidal areas, including sandy shores, mudflats and rocky shores, listed in **Table 6-10**. 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 (ITOPF 2011). 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/m^2 could impact the survival and reproductive capacity of benthic epifaunal invertebrates living in intertidal habitat (French-McCay 2009). The persistent of the hydrocarbon will be dependent on the wave exposure but can be months to years. It is predicted that a number of sandy shores along the WA coast and islands in the EMBA may have accumulation of hydrocarbons ≥ 100 g/m^2 as shown in **Figure 4-1**. The impact of hydrocarbon on rocky shores will be largely dependent 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 be dependent on the toxicity and weathering of the hydrocarbon. Similar to sandy shores accumulated hydrocarbons ≥ 100 g/m^2 could coat the epifauna along rocky coasts and impact the reproductive capacity and survival. There is potential for impact to rocky shores such as along Barrow Island, Montebello Islands, Lowendal Islands and the Muiron 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 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 shoreline accumulation at Barrow Island, Montebello Islands and the Muiron Islands. In-water toxicity of the 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 >100 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).

Summary of Potential Impacts to environmental values(s)	
Key Ecological Features	**Key Ecological Features** Potentially impacted by the hydrocarbon spill from a loss of well containment event are: • Canyons that link the Cuvier Abyssal Plan with the Cape Range Peninsula • Continental slope demersal fish communities • Ancient coastline at 125 m depth contour • Commonwealth waters adjacent to Ningaloo Reef • Exmouth Plateau • Glomar Shoals • Western demersal slope and associated fish communities • Wallaby Saddle • Mermaid reef and commonwealth waters surrounding Rowley Shoals • Ancient coastline at 90-120 m depth • Western rock lobster • Commonwealth marine environment within and adjacent to the west coast inshore lagoons • Commonwealth marine environment surrounding the Houtman Abrolhos Islands • Perth Canyon and adjacent shelf break, and other west coast canyons. 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 containment may impact the values of the KEFs affected (for the values of each KEF see **Section 4.7.7**). Potential impacts include: the contamination of sediments, impacts to benthic sediment fauna and 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 6-10**). 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.
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 and dissolved hydrocarbons in nearshore waters of identified islands and the mainland coast (refer to **Table 6-10**). 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** Studies of hydrocarbon concentrations in deep sea sediments in the vicinity of a catastrophic well blowout indicated hydrocarbon from the blowouts can be incorporated into deep ocean sediments. (Romero et al. 2015). Proposed mechanisms for hydrocarbon contamination of sediments include sedimentation of hydrocarbons and direct contact between submerged plumes and the seabed (Romero et al. 2015). In the event of a major hydrocarbon release at the seabed, modelling indicates that a pressurised release of crude would atomise into droplets that would be 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 as a consequence of hydrocarbon contamination for a small area within the immediate release site for a long to medium term.

Summary of Potential Impacts to environmental values(s)	
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 and hydrocarbons may accumulate (at or above the ecological threshold) at the Ningaloo Coast and WHA, Shark Bay WHA, Muiron Islands, Barrow Island, Lowendal Islands, Pilbara Islands, Abrolhos Islands and the Montebello Islands (refer to **Table 6-10**). 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 containment 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 VOCs 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. Due to the unlikely occurrence of a loss of well containment; the temporary nature of any methane or VOC emissions (from either gas surfacing or weathering of liquid hydrocarbons from a loss of well containment); 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 Exmouth approximately 47 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 Australian Marine Parks listed in refer to **Table 6-10** may be affected by the released hydrocarbons. In the unlikely event of a major spill and 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 as identified for the EMBA (refer to **Table 6-10**). Many of the protected areas identified contain marine fauna and biological communities, which are considered to be of important environmental value that the protected areas are intended to protect (**Section 4.7**). As outlined in the preceding table sections, a worst-case loss of well containment may impact upon a range of these values simultaneously, and different receptors in an affected area may recover at different rates. In the event of simultaneous impacts to environmental values within a protected area, the collective environment of the protected area may be compromised to a greater extent than the assessments of each individual value would indicate. Impact on the protected areas is discussed in the sections above for ecological the 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 environmental values(s)	
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 discusses above under 'Summary of potential impacts to other habitats and communities'). *Commonwealth fisheries:* The predicted EMBA resulting from a major spill may impact on the area fished by a number of Commonwealth fisheries including tune fisheries: Western Tuna and Billfish, Southern Bluefin Tuna, Western Skipjack Fishery (for which limited fishing activity has occurred in this area in recent years) and the North West Slope Trawl and Western Deepwater Trawl target pelagic fish species (refer to **Section 4.6.3**). 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. 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. *State Fisheries*: The predicted EMBA resulting from a major spill may impact on the area fished by a number of State fisheries (refer to **Section 4.6.3**). 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 well blowout 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 to **Section 4.6.3**), may also be affected by a major spill, however, the impacts to these far field fisheries will be similar to that described below for 'General Fisheries Impacts'. *General Fisheries Impacts:* 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 the establishment of an exclusion 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.
	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 takes 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' above. A major loss of hydrocarbon from the Petroleum Activities Program may lead to exclusion of marine nature-based tourist activities, resulting in a loss of revenue for operators.

Summary of Potential Impacts to environmental values(s)	
	Offshore Oil and Gas Infrastructure In the unlikely event of a major spill, surface hydrocarbons may affect production from existing petroleum facilities (platforms and FPSOs). 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 activity 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 Ngujima Yin FPSO (operated by Woodside). Other nearby facilities include the Santos operated Ningaloo Vision FPSO and the BHP operated Pyrenees Venture FPSO. Operation of these facilities is likely to be affected in the event of a well blow-out spill.
Mainland and Islands (Nearshore Waters)	**Fisheries – Commercial** *Nearshore Fisheries and Aquaculture:* In the unlikely event of a loss of well containment, there is the possibility that target species in some areas utilised by a number of state fisheries in nearshore waters of the Ningaloo Coast and Shark Bay, and aquarium fisheries in the nearshore waters that are within the EMBA could be affected. Targeted fish resources 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 the event of a major spill, the modelling indicated the entrained EMBA may extend to nearshore waters closest to the mainland coasts, including the actively fished areas of the designated Shark Bay Prawn and Scallop Managed Fishery. Prawn habitat utilisation differs between species in the post-larval, juvenile and adult stages (Dall et al. 1990) and 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, 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 the event of a major spill, the model predicted shallow subtidal and intertidal habitats at the Ningaloo 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 and 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 indigenous communities fish in the shallow coastal and nearshore waters of Ningaloo Reef, and therefore, may be potentially impacted if a hydrocarbon spill from a loss of well containment 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.

Summary of Potential Impacts to environmental values(s)	
	Tourism and recreation In the unlikely event of a major spill, the nearshore waters of the Ningaloo Coast 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. This locations offer a number of amenities such as fishing, swimming and 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 the event of 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, with the closest to the Operational Area being the Beatrice, located approximately 9 km away. Shipwrecks occurring in the subtidal zone will be exposed to entrained and dissolved hydrocarbons and 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 the following: 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/m^2) are predicted at Ningaloo Coast. It is acknowledged that the area contains numerous Indigenous 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 Indigenous groups (CALM, 1990). Additionally, artefacts, scatter and rock shelter are contained on Barrow and Montebello islands (no contact by surface hydrocarbons or accumulated hydrocarbons predicted for these areas). Within the EMBA a number of places are designated World, National and Commonwealth heritage places (**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(s)	
In the unlikely event of a major hydrocarbon spill due to a loss of well containment, the EMBA includes the areas listed in **Table 6-10**, including but not limited to, the sensitive marine environments and associated receptors of the Ningaloo Coast, Shark Bay, and any sensitive receptors in the open waters amongst 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 the Petroleum Activities Program. 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**).	

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS)***[19]	***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 Well Operations Management Plan (WOMP).	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 8.1
Woodside Engineering Standards Well Barriers specifies the process to be undertaken to maintain an overbalance on the reservoir during well intervention .	F: Yes CS: Minimal cost. Standard practice for Woodside activities	Implementing equipment and procedures will reduce the likelihood and consequence of a well kick.	Benefits outweigh cost/sacrifice.	Yes C 8.2
Woodside Well Blowout Contingency Planning Procedure details specifications for well design to assess the feasibility of performing a well kill operation.	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 9.1
Good Practice				
Subsea BOP specification and function testing is undertaken in accordance with internal Woodside Standards and international requirements: • original Equipment Manufacturer (OEM) Standards • Woodside Engineering Standard – Rig Equipment • Woodside Engineering Manual – Well Control Manual • API Standard 53 4th Edition.	F: Yes CS: Minimal cost. Standard practice for Woodside activities	Implementing specification and function testing will reduce the likelihood of loss of well integrity occurring. Although the consequence of a blowout would may be reduced, the reduction in likelihood reduces the overall risk.	Benefits outweigh cost/sacrifice.	Yes 9.2

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[19] Qualitative measure

<table>
<tr><th colspan="5">Demonstration of ALARP</th></tr>
<tr><th><i>Control Considered</i></th><th><i>Control Feasibility (F) and Cost/Sacrifice (CS)</i>[19]</th><th><i>Benefit in Impact/Risk Reduction</i></th><th><i>Proportionality</i></th><th><i>Control Adopted</i></th></tr>
<tr><td>These documents include detailed requirements for surface and subsea BOP function and testing, to prevent and respond to any loss of well containment.</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Mitigation: Oil Spill Response</td><td colspan="4">Refer to Appendix D</td></tr>
<tr><td colspan="5"><i>Professional Judgement - Eliminate</i></td></tr>
<tr><td>Do not undertake well intervention</td><td>F: No. While the current condition of the wells is such that they can be safely shut in, the option to undertake well intervention must be retained to allow Woodside to undertake well interventions if required to maintain the wells in a secure state and facilitate future decommissioning.
CS: Not considered – control not feasible</td><td>Not considered – control not feasible</td><td>Not considered – control not feasible</td><td>No</td></tr>
<tr><td colspan="5"><i>Professional Judgement – Substitute</i></td></tr>
<tr><td colspan="5">No additional controls identified.</td></tr>
<tr><td colspan="5"><i>Professional Judgement – Engineered Solution</i></td></tr>
<tr><td colspan="5">No additional controls identified.</td></tr>
<tr><td colspan="5"><i>Risk Based Analysis</i></td></tr>
<tr><td colspan="5">A quantitative spill risk assessment was undertaken (refer to Section 6.7.1)</td></tr>
<tr><td colspan="5"><i>Company Values</i></td></tr>
<tr><td colspan="5">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.</td></tr>
<tr><td colspan="5"><i>Societal Values</i></td></tr>
<tr><td colspan="5">Due to the Petroleum Activity Program’s proximity to sensitive receptors (e.g. Ningaloo Coast) and the potential extent of the EMBA, the loss of well containment current risk rating presents a Decision Type C in accordance with the decision support framework described in Section 1.10.1.1. Extensive consultation was undertaken for this program to identify the views and concerns of relevant stakeholders, as described in Section 5.
Woodside conducts consultation with relevant stakeholders. This consultation, conducted in 2017 and 2019 has been reviewed. Woodside sent a consultation information sheet to all identified relevant stakeholders regarding the Petroleum Activity Program (Section 5 and Appendix F). Woodside has consulted with AMSA and WA DoT on spill response strategies. In accordance with the Memorandum of Understanding between Woodside and AMSA, a copy of the Oil Pollution First Strike Plan (Appendix H) was provided to AMSA.</td></tr>
<tr><td colspan="5"><i>ALARP Statement</i></td></tr>
</table>

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS)***[19]	***Benefit in Impact/Risk Reduction***	***Proportionality***	***Control Adopted***
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 containment has been evaluated as having a high level of current risk rating. As per **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:

Principles of Ecological Sustainable Development (ESD)

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 explore 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 they operate, notably in the Exmouth Region, Dampier Archipelago and the Kimberley Region, including Rankin Bank and Scott Reef. Where scientific data do not exist, Woodside assumes that 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, systematic application of policies, standards, procedures and processes, Woodside considers that despite this risk, the extremely low likelihood of loss of well containment is acceptable.

Internal Context

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**).

Monitoring and Evaluation (operational monitoring) as a key response in the unlikely event of a hydrocarbon release will assess and track the extent of the hydrocarbon contact and revise the predicted extent of impact.

In addition, the Planning Area for scientific monitoring (refer to Section 5.7 of the Oil Spill Assessment and Mitigation Plan; **Appendix D**) can be re-assessed in the unlikely event of hydrocarbon release with consideration of the natural values and social-cultural values of state and Commonwealth protected areas (including AMPs), National and Commonwealth Heritage Listed places; tourism and recreation; and fisheries. The post-response SMP will consider assessment and monitoring in line with the affected receptors such as habitat and species, AMPs, fisheries.

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.

External Context - Societal Values (includes environmental consequence and stakeholder expectations)

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:

Demonstration of Acceptability

- Woodside has consulted with AMSA and WA DoT on spill response strategies. In accordance with the Memorandum of Understanding between Woodside and AMSA, a copy of the Oil Pollution First Strike Plan (**Appendix H**) was provided to AMSA and DoT.
- Other relevant stakeholders have been consulted (**Section 5**) and their feedback incorporated into this EP where appropriate.
- The impact assessment has determined that the likelihood of a major long-term environmental impact on the offshore environment or sensitive nearshore and shoreline habitats from a loss of well integrity is unlikely.
- 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 for relief well drilling is in place. 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 Well Operations Management Plan (WOMP).
- 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 9 No loss of well containment resulting in loss of hydrocarbons to the marine environment during Petroleum Activities Program	**C 8.1** Refer to **Section 6.6.7.**	**PS 8.1** Refer to **Section 6.6.7.**	**MC 8.1.1** Refer to **Section 6.6.7**.
			MC 8.1.2 Refer to **Section 6.6.7**.
	C 8.2 Refer to **Section 6.6.7**.	**PS 8.2** Refer to **Section 6.6.7**.	**MC 8.2.1** Refer to **Section 6.6.7**.
	C 9.1 Woodside Well Blowout Contingency Planning Procedure details specifications for well design to assess the feasibility of performing a well kill operation.	**PS 9.1** An approved Blowout Contingency Plan (as required by Well Blowout Contingency Planning Procedure shall exist prior to undertaking well intervention activities, including: feasibility and any specific considerations for relief well kill and well capping.	**MC 9.1.1** A Well Blowout Contingency Plan approved by the Drilling Engineering Manager.
	C 9.2 Subsea BOP specification and function testing is undertaken in accordance with internal Woodside Standards and international requirements: • original Equipment Manufacturer (OEM) Standards	**PS 9.2** BOP installed during well intervention activities. To ensure no loss of hydrocarbons from loss of well containment, the BOP shall have, at minimum: • one annular preventer	**MC 9.2.1** Records demonstrate that BOP and BOP control system specifications and function testing were undertaken in accordance with minimum standards for the expected well conditions. Compliance

Environmental Performance Outcomes, Standards and Measurement Criteria			
Outcomes	***Controls***	***Standards***	***Measurement Criteria***
	• Woodside Engineering Standard – Rig Equipment • Woodside Engineering Manual – Well Control Manual • API Standard 53 4th Edition. These documents include detailed requirements for surface and subsea BOP function and testing, to prevent and respond to any loss of well containment.	• 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. Detailed specifications and function testing shall be in accordance with the minimum standards for the expected well conditions, as detailed in the Woodside Engineering Standard – Rig Equipment, Woodside Engineering Well Control Manual, Original Equipment Manufacturer (OEM) Standards and API Standard 53 4th Edition.	with OEM, Woodside and API Criteria.

6.7.3 Unplanned Hydrocarbon Release: Loss of Well Containment from Wellhead Damage

Context		
Well Intervention and – **Section 3.6** Interference with or Displacement of Other Users – **Section 6.6.1** Disturbance to Seabed from Dropped Objects – **Section 6.7.9**	Physical Environment – **Section 4.4** Biological Environment – **Section 4.5** Socio-economic – **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 containment due to accidental damage to, or removal of, Xmas Tree.		X	X		X	X	X	B	D	0	L	LCS GP PJ RBA SV	Acceptable if ALARP	EPO 10

Description of Source of Risk

Credible Scenario – Loss of Well Containment due to Accidental Removal of Xmas Tree

All subsea wells have the Xmas Tree retained in situ following cessation of production. The Xmas Tree, along with the SCSSSV, provides barriers between the reservoir and the environment. Wells plugged during the Petroleum Activities Program will have barriers established via the installation of wireline plugs, cement plugs, or a combination of both, with the Xmas Tree planned to be retained following installation of the barriers.

Woodside has identified that damage to, or removal of, the Xmas Tree has the potential to occur over the life of the EP, potentially leading to a release of hydrocarbons.

The credible scenarios leading to a loss of containment from damage to, or accidental removal of, wellheads are:

- ***Scenario 1*** Subsea release of fluid from the well via ongoing leak from the annulus due to passing gas lift valve ongoing – release rate of approximately 63.6 m^3 per day; The release scenario is for an accidental, complete removal of the wellhead with the SSSV closed due to external impact from O&G activities. In this scenario the release pathway for the well fluids flow is via the non-sealing downhole gas lift valve through the well annulus to the environment at the well location. The release rate provided assumes a release from the Nganhurra's highest producing well (ENA-01) which has a 95% water cut (as per the latest reservoir testing). The release scenario has been modelled as the worst-case credible event using these inputs to determine the maximum release rate of 63.6m^3 at the release location.
- Any Woodside or O&G Industry activity which results in a dropped object or anchor drag will trigger further action (further inspection and notification) in order to address any potential damage to infrastructure. Therefore, it is not credible that any Woodside or industry activity in the area would result in an unreported incident resulting in a release duration longer than 77 days.
- ***Scenario 2*** The most likely cause of damage to, wellheads by an unknown third party is only credible, when it occurs as a result of a dropped object from an third party vessel as opposed to anchor drag or trawling. The release rate for this scenario would be 6 m^3 per day (for a potential period of five years).
- This is concluded from the following assumptions:

  - The loss of a wellhead occurring from a dragged third party anchor is deemed not credible as the expected vessel limit for anchoring is around 60 m, and the activity area is in water depths of 400-600 metres. Therefore, it is not credible that a well head could be removed from a dragged third party anchor.
  - The removal of a wellhead following trawling requires a snag load of 20 t which is not credible from a fishing vessel and in 400-600 metres water depth. There is also low commercial trawling fishing effort in the region which is confirmed by stakeholder consultation. In addition, infrastructure is marked on navigation charts as a 'Cautionary Area' requiring vessels to avoid navigating, anchoring or fishing within the area. All these factors add to the position that the removal of a wellhead from trawling activity is not credible.

- ***Scenario 3*** Subsea release of fluid above a deep set plug (plugged wells only) – total volume approximately 16 m^3 instantaneously released. The release volume is based on the volume of well fluids between deep set plug and subsea tree.

Scenario 1 is considered to represent the largest environmental impact from this risk, due to the higher rate of release. Scenario 2, despite lasting for a longer period of time, is considered to represent a smaller potential impact (i.e. 4,897.2 m^3 over 77 days vs 10,950 m^3 over five years), Woodside considered both to be represented by the Oil Spill Modelling which has been discussed further below, because both are of a lower volume.

These release volumes/rates are considered to be the maximum credible spills for the scenarios. Smaller releases may occur, which are considered to be assessed in the maximum credible spill scenarios considered. It's also noted that this leak scenario, once detected, could result in a release that occurs until a relief well has been drilled to intercept the well, this is the most credible scenario in the event.

Quantitative Hydrocarbon Spill Modelling – Loss of Well Containment due to Accidental Removal of Xmas Tree

Spill modelling was undertaken by RPS APASA, on behalf of Woodside, to determine the fate of hydrocarbon released from the ongoing loss of well containment scenario, based on the assumptions in **Table 6-12**. A leak from subsea infrastructure may go undetected for some time, therefore, modelling was carried out in a deterministic manner using SIMAP and OILMAP to understand behaviour of released oil over time.

The instantaneous release of 16 m^3 was not modelled, as this volume is much lower than that associated with the release already studied in the loss of well containment during intervention scenario and discussed in **Section 6.7.2**.

Table 6-12: Summary of modelled credible scenario – loss of well containment due to accidental removal of Xmas Tree

	Loss of well containment Modelled	**Scenario 1**	**Scenario 2**
Total discharge at seabed	180 days 11,447 m^3	77 days 4,897.2 m^3	1825 days 10,950 m^3
Water Depth	515 m	515 m	515 m
Fluid	Enfield Crude	Enfield Crude	Enfield Crude

Three simulations with arbitrary commencement times (1st January 2006, 1st April 2006 and 1st July 2006) and durations of 180 days were modelled, (the maximum capable by the modelling software) with outputs (spatially and temporally) compared to the impact thresholds provided in **Table 6-5** and the environmental sensitivities described in **Section 4**. A duration of 180 days is considered to conservatively represent the worst-case credible scenarios discussed above (i.e. equivalent volume over a representative duration).

Each simulation indicated that the released hydrocarbon is highly likely to disperse in close proximity to the release location, with no surface hydrocarbons above impact threshold (10 g/m^2), with 1 g/m^2 concentration occurring only in small isolated patches. Entrained hydrocarbons above (500 ppb) were concentrated in the vicinity of the Operational Area; this is consistent with the relatively slow release rate, water depth and hydrocarbon characteristics. No shoreline contact above surface or entrained thresholds or shoreline accumulations ≥100 g/m^2 was predicted. No dissolved hydrocarbons ≥500 ppb were predicted in any model run.

Impact Assessment

Potential Impacts Overview

The deterministic modelling results indicate the expected behaviour over time of hydrocarbons in the marine environment resulting from a slow ongoing loss of containment and inform a spill and are of use in undertaking an assessment of environmental impact and risk. This, in conjunction with the EMBA and associated impact assessment for the loss of well containment during well intervention (**Section 6.7.2**), is considered to provide a suitable basis for the assessment of environmental impacts, given the nature and scale of the credible worst-case spill scenario resulting from accidental removal of the Xmas Tree.

The potential environmental impacts and risks associated with a considerably larger spill scenario are presented in **Section 6.7.2**. The results of deterministic modelling show that hydrocarbons released at the slow ongoing release rate are only present in excess of thresholds in small isolated patches around the area of operation. The time periods modelled were 180 days which is the upper limit capable of by the modelling software, and during this timeframe patches of oil in excess of thresholds were observed to accumulate and then dissipate in the domain. Based on this understanding, and the much lower total release volume, it is highly unlikely that these isolated patches would migrate outside of the EMBA defined for the scenario described**,** although impacts are expected to be lower than the scenario described in **Section 6.7.2**. Additional assessment of the environmental risk and impacts from a loss of well containment due to accidental removal of the Xmas Tree is provided below.

The biological consequences of a release of Enfield crude from the accidental removal of the Xmas Tree on open water sensitive receptors relate to the potential for minor impacts to megafauna, plankton and fish populations (water column biota) in the vicinity of the Operational Area.

No impacts to other users, such as commercial fishing or oil and gas operators are expected due to the expected localised extent of the spilled hydrocarbons.

Summary of Potential Impacts to environmental values(s)

In the unlikely event of an unplanned hydrocarbon release to the marine environment due to loss of well containment due to wellhead damage , combined with the adopted controls, it is considered that any potential impact would be minor and short-term in nature to water quality in comparison to background levels and/or international standards with minor and short-term 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 loss of containment due to wellhead damage, as classified in **Table 2-3**, is defined as D, which equates to ‘minor, short-term impact (1-2 years) on species, habitat (but not affecting ecosystem function), physical or biological attributes’.

This scenario has a likelihood of remote which takes into consideration the water depth (400-600 m), limited presence of third party marine users in the area.

While the risk ranking of an undetected leak from a well is low, additional controls have been considered in order to reduce the overall timeframe of the leak scenario.

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS)***[20]	***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 Well Operations Management Plan (WOMP).	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.	Control based on legislative requirements – must be adopted	Yes C 8.1
Good Practice				
In the event of a loss of hydrocarbons to the marine environment from wellhead damage. Woodside will implement procedures outlined in the WOMP to ensure any release is	F: Yes CS: Minimal cost. Standard practice.	Implementation of WOMP including implementation of “Responding to Failure” Philosophy. will resulting in a reduction in	Benefits outweigh cost/sacrifice	Yes C 10.1

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS)[20]***	***Benefit in Impact/Risk Reduction***	***Proportionality***	***Control Adopted***
minimised to an ALARP and acceptable level, including implementation of the following "Responding to Failure" Philosophy; 1. Make the well safe / establish technical integrity. 2. Communicate/ notify internal/external stakeholders as required (and in accordance with Division 8 of the OPGGS Legislation Amendment (Well Operations) Regulation 2015). 3. Determine, through further diagnostics, analyses, and risk assessments, how integrity is best managed, through the MoC System (including consideration of Environmental Risks and determination of Well Control Incident Classification Level (as per Table 29 from WOMP)). 4. Where further action is required initiate well control response in line with Well Control Incident Classification Level. 5. Where required for Level 2 or 3 events activate Subsea First Response Toolkit and Capping Stack Operational Plan.		consequence and overall risk.		
Integrity Inspection of subsea wells on a five-yearly basis.	F: Yes CS: Significant. (AUD$640,000 per inspection)	Inspection may 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. 5 yearly inspection aligns with Woodside subsea intergrity standards.	Yes C 10.2

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS)[20]***	***Benefit in Impact/Risk Reduction***	***Proportionality***	***Control Adopted***
Inspection frequency of all subsea wells to be increased from every five years to annually.	F: Control is feasible. CS: An additional $640,000 AUD per inspection) required to increase the frequency of inspections to annual	Annual Inspection will not significantly reduce the likelihood of a spill occurring from a suspended well. Although changes in consequence may occur, the increase in insection frequency will not reduce the overall risk.	There is no overall risk reduction from the implementation of this control however the duration of the leak will be reduced from potentially five years (worst case) to one year. Due to the remote likelihood of this event from occurring and the cost associated with the implementation of this control, any benefit is considered disproportionate to the cost/sacrifice.	No
Use of satellite imagery to detect hydrocarbon leak	F: Control is not considered feasible as it requires surface expression of oil which is not anticipated. KSAT only detects surface oil, not entrained or dissolved. Consideration of increasing the frequency of satellite imagery is not considered feasible as it requires surface expression of oil which is not anticipated. CS: Not considered as control is considered not feasible.	n/a. Control is not considered feasible.	n/a. Control is not considered feasible.	No
Use of surface glider fitted with fluorometer to detect any hydrocarbon leak. Surface glider would be programmed at a periodic interval to upload data via satellite to Woodside online maps.	F: Control is not feasible. Surface glider does not take measurements at depth therefore it is not considered feasible for a leak scenario from a wellhead. CS: Not considered as control is considered not feasible.	Not considered – control not feasible	Not considered – control not feasible	No
Use of in-water glider fitted with fluorometer to detect any hydrocarbon leak. In-water glider would undertake continuous field	F: control is feasible as the technology is available. There are some limitations with the technology around	In-water glider Inspection will not reduce the likelihood of a spill occurring from a suspended	There is no overall risk reduction from the implementation of this control however the	No

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS)***[20]	***Benefit in Impact/Risk Reduction***	***Proportionality***	***Control Adopted***
measurements. Programmed interval for upload via satellite to Woodside online maps.	its reliability for the period of time required in the field and the accuracy of detection. CS: the presence of a in-water glider in the field for a 180 day survey (including vessel charter and all incidental project costs) is approximately $396,000. In order to increase the monitor's in-field presence to be available all year, the cost is estimated to be around $700,000 annually.	well. Although changes in consequence may occur, the increase in insection frequency will not reduce the overall risk.	duration of the leak will be reduced. Due to the cost associated with the implementation of this control, any benefit from the presence of an in water hydrocarbon detection monitor is considered disproportionate to the cost/sacrifice.	
Use of fixed subsea detection monitor fitted with surface buoy. Programmed surfacing to upload via satellite to Woodside online maps.	F: this control is considered feasible but is not a proven technology in Woodside. CS: estimated cost is $350,000 AUD per year for one monitor. As the monitors are acoustic, there will be multiple sensors required to cover the field. In order for this control to be effective, it will require real time data via a surface buoy. Expected cost to $1.2 million AUD to mobilise four monitors with real time data acquisition.	Fixed subsea detection monitor will not reduce the likelihood of a spill occurring from a suspended well. Although changes in consequence may occur, the increase in insection frequency will not reduce the overall risk.	There is no overall risk reduction from the implementation of this control however the duration of the leak will be reduced from potentially five years (worst case) to one year. Due to the remote likelihood of this event from occurring and the cost associated with the implementation of this control, any benefit is considered disproportionate to the cost/sacrifice.	No
Contract existing Woodside helicopter operating in Exmouth to undertake visual observations around the Enfield location in order to identify any potential hydrocarbon sheens on the water surface.	F: Control is not considered feasible as it requires surface expression of oil and the presence of a trained observer in order to provide an accurate observation. CS: Not considered as control is considered not feasible.	Not considered – control not feasible	Not considered – control not feasible	No
Contract existing Woodside supply vessels to undertake visual observations around the Enfield location in order to identify any potential	F: Control is not considered feasible as it requires surface expression of oil and the presence of a trained observer in	Not considered – control not feasible	Not considered – control not feasible	No

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS)[20]***	***Benefit in Impact/Risk Reduction***	***Proportionality***	***Control Adopted***
hydrocarbon sheens on the water surface.	order to provide an accurate observation. CS: Not considered as control is considered not feasible.			
Professional Judgement - Eliminate				
Utilise nearby Woodside facility or standby vessels to maintain monitoring of the gazetted NGA petroleum safety zone around the Enfield subsea infrastructure to prevent third party vessels from entering the area of the wells.	F: This control is feasible. Monitoring of the petroleum safety zone will need to be maintained in order to make this control effective. The nearby Ngujima Yin FPSO (7 km) could be tasked with maintaining watch of the petroleum safety zone, or as an alternative a standby vessel could be used. CS: Minor cost associated with utilising the Ngujima Yin FPSO to monitor the petroleum safety zone, additional effort is required for the facility to maintain watch over both its own petroleum safety zone as well as the additional safety zone of NGA. Significant cost associated with continued use of a dedicated standby vessel.	Constant monitoring may reduce the likelihood of a spill occurring from a suspended well. Although changes in consequence may occur, the increase in monitoring will not reduce the overall risk.	Costs associated with the implementation of monitoring control for gazetted zones is considered disproportionate given the minor overall risk reduction associated with the mplementation of such a control.	No
Implementation of geofencing software to monitor presence of third party vessels. Description: Use of geofencing software to create a virtual boundary, enabling Woodside to be alerted when a third party vessel enters the field and is in the vicinity of the wells.	Feasibility: Control would be feasible however technology is not yet available. CS: Minor additional cost associated with the set up and maintenance of the software as it is an extension to existing software for Woodside. However, the software extension is currently not active therefore is not available.	Not considered – control not feasible	This control would enable Woodside to identify any vessels in the vicinity of the wells. However as this control is not yet available it is unable to be implemented.	No
Professional Judgement – Substitute				

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS)***[20]	***Benefit in Impact/Risk Reduction***	***Proportionality***	***Control Adopted***
No additional controls identified				
Professional Judgement – Engineered Solution				
No additional controls identified				
Societal Values				
Due to the Petroleum Activity Program's proximity to sensitive receptors (e.g. Ningaloo Coast), the loss of well containment from wellhead damage current risk rating presents a Decision Type B in accordance with the decision support framework described in **Section 2.6**. Woodside conducts consultation with relevant stakeholders, as described in **Section 5** on the worst-case credible scenario – loss of containment from a well blowout. It is considered that the wellhead damage scenarios were represented by the Oil Spill Modelling and the consultation undertaken on the worst-case credible scenario. Woodside sent a consultation information sheet to all identified relevant stakeholders regarding the Petroleum Activity Program in 2017 (**Section 5** and **Appendix F**).				
ALARP Statement On the basis of the environmental risk assessment outcomes and use of the relevant tools appropriate to the decision type, Woodside considers the adopted controls appropriate to manage the impacts and risks of loss of well containment from wellhead removal. Note that Woodside has considered the impacts and risks of dropped objects, an event that may lead to wellhead removal, in **Section 6.7.9**. 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, loss of well containment from wellhead removal represent a low current risk rating that is unlikely to result in a potential impact greater than localised, minor contamination resulting in a decrease in water quality, and the potential for minor impacts to marine fauna. No contact with sensitive receptors above impact thresholds is expected. Further opportunities to reduce the impacts and risks have been investigated above. The adopted controls are considered good oil-field practice/industry best practice. 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 10 No loss of well containment resulting in loss of hydrocarbons to the marine environment from wellhead damage.	**C 8.1** Refer to **Section 6.6.7.**	**PS 8.1** Refer to **Section 6.6.7.**	**MC 8.1.1** Refer to **Section 6.6.7**.
	C 10.1 In the event of a loss of hydrocarbons to the marine environment from wellhead damage. Woodside will implement procedures outlined in the WOMP to ensure any release is minimised to an ALARP and acceptable level, including implementation of the	**PS 10.1** Wells managed in compliance with the accepted WOMP, including implementation of "Responding to Failure" Philosophy.	**MC 10.1.1** Records demonstrate adherence to requirements of WOMP in the event of a loss of hydrocarbons to the marine environment from wellhead damage.

<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>following “Responding to Failure” Philosophy;
1. Make the well safe / establish technical integrity.
2. Communicate/ notify internal/external stakeholders as required (and in accordance with Division 8 of the OPGGS Legislation Amendment (Well Operations) Regulation 2015).
3. Determine, through further diagnostics, analyses, and risk assessments, how integrity is best managed, through the MoC System (including consideration of Environmental Risks and determination of Well Control Incident Classification Level (as per Table 29 from WOMP)).
4. Where further action is required initiate well control response in line with Well Control Incident Classification Level.
5. Where required for Level 2 or 3 events activate Subsea First Response Toolkit and Capping Stack Operational Plan.</td><td></td><td></td></tr>
<tr><td></td><td>C 10.2
Integrity Inspection of subsea wells on a five-yearly basis.</td><td>PS 10.2
Wells inspected on a five-yearly basis to monitor for leaks and to ensure integrity is maintained.</td><td>MC 10.2.1
Subsea five-yearly inspection report.</td></tr>
<tr><td colspan="4">Detailed preparedness and response performance outcomes, standards and measurement criteria for the Petroleum Activities Program are present in Appendix D.</td></tr>
</table>

6.7.4 Unplanned Hydrocarbon Release: Vessel Collision

Context		
RTM – **Section 3.7** Project Vessels – **Section 3.10**	Physical Environment – **Section 4.4** Biological Environment – **Section 4.5** Socio-economic – **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. activity support vessels or other marine users).			X		X	X	X	A	D	1	M	LCS GP PJ RBA	Acceptable if ALARP	EPO 2, 3 & 11
Loss of hydrocarbons to marine environment due to a vessel collision with the RTM (e.g. other marine users).			X		X	X	X	A	D	1	M	LCS GP PJ RBA	Acceptable if ALARP	EPO 2, 3 & 11

Description of Source of Risk

Background

Project vessels will use marine diesel fuel. The MODU has a total marine diesel capacity of approximately 1000 – 1500 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.

A typical PIV vessel is likely to have multiple isolated marine diesel tanks distributed throughout the hull of the vessel. Individual marine diesel tanks are typically less than 500 m^3 in volume; however for the purposes of a conservative indication of the risks associated with a vessel collision for the Petroleum Activities Program, Woodside has assumed a largest marine diesel tank volume of 500 m^3 for the PIV. In the unlikely event of a vessel collision involving a PIV during the Petroleum Activities Program, the vessels will have the capability to pump marine diesel from a ruptured tank to a tank with spare volume in order to reduce the potential volume of fuel released to the environment.

The marine diesel storage capacity of activity support vessels can also be in the order of 1000 m^3 (total) that is distributed through multiple isolated tanks typically located mid-ships and can range in typical size from 22 to105 m^3.

Project vessels (including the MODU) will be intermittently present in the Operational Area or the duration of the Petroleum Activities Program. This intermittent presence in the area will result in a navigational hazard for commercial shipping within the immediate area (as discussed in **Section 4.6.6**).

While the RTM remains on station, it may present a navigational hazard for commercial shipping within the immediate area. Operational exclusion zone of 500 m is in place and reflected on navigational charts. Navigational lights and passive reflective radar are installed and in working condition. In the event the RTM loses integrity of an additional ballast compartment, it could sink by ~1.5 m to approximately 5 m above the waterline; if a further (third) ballast compartment failed, it could sink to approximately 5 m below the water line where it would present a submerged hazard to commercial shipping within the immediate area.

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, 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 activity support vessel off Barrow Island. Two other vessel collisions occurred in 2010, one in the port of Dampier, where an activity 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 connected 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 occurring.

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.

One instance of a vessel colliding with a navigation buoy was recorded by the ATSB in 2017, with damage to the buoy and ship limited to paintwork. No instances were found of a collision with a buoy (floating or submerged) resulting in a spill.

Credible Scenario

For a vessel collision to result in the worst-case scenario of a hydrocarbon spill from the vessel (the RTM is hydrocarbon free) 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 undertaken 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. The scenarios considered damage to single and multiple fuel storage tanks in the activity support vessel and MODU due to various combinations of vessel to vessel, vessel to MODU collisions and third party vessel or PIV or intervention vessel or support vessel collision with the RTM. In summary:

1. 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.
2. 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.
3. It is not a credible scenario that a collision between the activity support vessel and MODU would damage any storage tanks, due to the location of the tanks on both vessel types, and secondary containment.
4. It is highly unlikely that the full volume of the largest storage tank on an activity support vessel would be lost.
5. It is not a credible scenario that a collision between a third party vessel / PIV / intervention vessel / support vessel and the floating RTM (12 m wide and ~6 m above waterline) would occur and result in an oil spill from the vessel.
6. It is highly unlikely that a collision between a third party vessel / PIV / intervention vessel / support vessel and the RTM if it were submerged, would occur resulting in the full volume of the largest storage tank on a the vessel.

Theforth scenario considered was a collision between a project vessel and a third party vessel (i.e. commercial shipping, other petroleum-related vessels and commercial fishing vessels). This was assessed as being credible but highly unlikely given the distance of the Operational Area from the nearest shipping fairway (approximately 40 km away), the standard vessel operations and equipment in place to prevent collision at sea, the standby role of a support vessels (low vessel speed), the exclusion zone around the MODU and RTM and the construction and placement of storage tanks. The largest tank of the activity support vessel is unlikely to exceed 500 m^3 (**Table 6-13**).

The sixth scenario considered is in the event that the RTM lost integrity of an additional two ballast compartments, becoming a submerged hazard, where a third party vessel / PIV / intervention vessel / support vessel could collide with the RTM resulting in a loss of containment of marine diesel from the vessel. The vessel would need to impact the RTM directly resulting in significant damage to the front of the vessel and subsequent breach of the forward hull tanks. These tanks are often used for trim control and so do not typically contain fuel oil. Due to the shape of the RTM (circular profile) and stiffness of the mooring system, it is likely that any blow would be glancing resulting in damage to the immediate impact area then the RTM would be deflected by the impact and assuming no action were taken by the impacting vessel, the RTM would scrape along the side of the vessel. Wave action and resultant relative heave of the RTM and impacting vessel may exacerbate the damage caused by the RTM but the load applied would be low (caused by mooring system stiffness only).

This was assessed as being credible but highly unlikely given the RTM has been designed for surface shipping impact with compartment 13 foam filled to provide protection to the RTM/vessel should impact occur. In addition to this, the distance of the Operational Area from the nearest shipping fairway is approximately 40 km away, the RTM is marked on navigation charts and will remain within a marked 500 m exclusion zone while it is in the Operational Area. Should the RTM partially submerge, a standby vessel will be deployed to monitor the RTM 500 m exclusion zone and warn vessels of the hazard until either a marker buoy is connected to the RTM, or the RTM is removed from the Operational Area. The buoy will provide radar marking of the RTM and a visual indication on the surface that a submerged hazard exists. AMSA will be informed along with the AHO to facilitate update of charts indicating the hazard.

Table 6-13: Assessment of potential vessel spill scenarios

Scenario	Hydrocarbon Volumes	Preventative and Mitigation Controls	Credibility	Max. Possible Volume loss (m^3)
Breach of MODU fuel tanks due to activity support vessel or commercial shipping/ fisheries vessel collision.	MODU has a fuel oil storage capacity of approximately 966 - 1400 m^3, distributed through multiple tanks.	Fuel tanks are located on the inside of pontoons and protected by location below waterline, protection from other tanks e.g. bilge tanks. The draught of vessel and location of tanks in terms of waterline prevent the tanks from being breached.	Not credible Due to location of tanks	0
Breach of activity support vessel fuel tanks due to collision with a project vessel or MODU.	Activity support vessel has multiple marine diesel tanks typically ranging between 22-105 m^3 each.	Typically double wall, tanks which are located mid-ship (not bow or stern). Slow activity support vessel speeds when in close proximity to MODU / intervention vessel, PIV or activity support vessel.	Not credible Collision with MODU / intervention vessel or PIV at slow speeds is highly unlikely and if did occur is highly unlikely to result in a breach of activity support vessel (low energy contact from slow moving vessel).	0
Breach of PIV fuel tanks due to collision with a an activity support vessel	PIV vessel has multiple isolated tanks, largest volume of a single tank is likely to be ≤500 m^3	Tank locations mid-ship (not bow or stern). For the majority of subsea installation activities the PIV will be holding location. The PIV vessels may steam within the project area at around 12 knots; however normal maritime procedures would apply during such vessel movements.	Not credible Collision with activity support vessels at slow speeds is highly unlikely and if did occur is highly unlikely to result in a breach of PIV (low energy contact from slow moving vessel)	0
Breach of PIV, intervention vessel or activity support vessel fuel tanks due to activity support vessel - other vessel collision including commercial shipping/ fisheries	Intervention vessel, PIV and activity support vessels have multiple marine diesel tanks typically ranging between 22-500 m^3 each.	Typically double wall, tanks which are located mid-ship (not bow or stern) Vessels are not anchored and steam at low speeds when relocating within the Operational Area or providing stand-by	Credible Project vessel – other vessel collision could potentially result in the release from a fuel tank	500 m^3

		cover. Normal maritime procedures would apply during such vessel movements		
Breach of third party vessel / PIV / intervention vessel / support vessel fuel tank due to a collision with RTM	Third party vessels assumed to be equal or smaller than a PIV, intervention vessel or activity support vessel (between 22-500 m^3 each).	RTM is marked on navigation charts and within a 500 m exclusion zone. Also has navigation lights and a passive reflective radar. Compartment 13 is foam filled to provide protection to the RTM/vessel should impact with a vessel occur.	Not credible	0
Breach of third party vessel / PIV / intervention vessel / support vessel fuel tank due to a collision with submerged RTM	Third party vessels assumed to be equal or smaller than a PIV, intervention vessel or activity support vessel (between 22-500 m^3 each).	RTM is marked on navigation charts and within a 500 m exclusion zone. Compartment 13 is foam filled to provide protection to the RTM/vessel should impact with a vessel occur.	Credible Third party vessel / PIV / intervention vessel / support vessel collision could potentially result in the release from a fuel tank.	500 m^3

Quantitative Hydrocarbon Risk Assessment

Modelling was undertaken by RPS APASA, on behalf of Woodside, to determine the fate of marine diesel released from a collision within the Operational Area. The modelling assessed the extent of marine diesel spill volume of 500 m^3 for all seasons, using an historic sample of wind and current data for the region. A total of 200 simulations in various seasons were modelled with each simulation tracked for 42 days.

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 approximately 50% by mass would be expected to evaporate over the first day or two (Figure 6-2). After this time the majority of the remaining hydrocarbon is entrained into the upper water column. In calm conditions, entrained hydrocarbons are likely to resurface. Seven days following the spill, approximately 45-50% would evaporate, 40-45% would entrain and approximately 10% would decay and a small proportion would be dissolved (Figure 6-2).

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. The characteristics of the marine diesel used in the modelling are given in Table 6-14.

Table 6-14: Characteristics of the marine diesel used in the modelling

Hydrocarbon Type	Initial Density (g/cm^3) at 25°C	Viscosity (cP @ 25°C)	Component BP (°C)	Volatiles <180	Semi volatiles 180-265	Low Volatility (%) 265-380	Residual (%) >380
				Non-Persistent			Persistent
Marine Diesel (surrogate for marine gas oil – MGO)	0.829	4.0	% of total	6	34.6	54.4	5

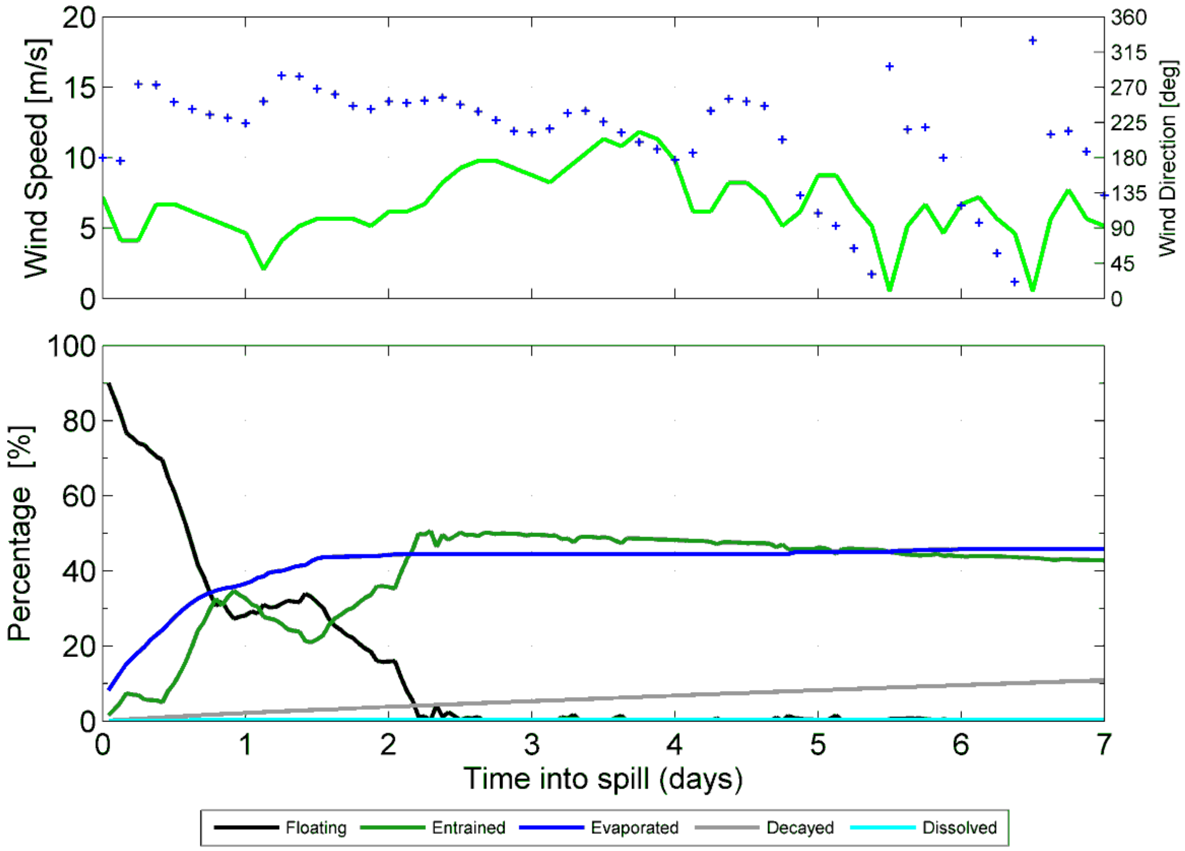

Figure 6-2: Proportional mass balance plot representing the weathering of marine diesel spilled onto the water surface as a one-off release (50 m^3 over one hour) and subject to variable wind at 27 °C water temperature and 25 °C air temperature

Impact Assessment

Potential Impacts Overview

Environment that May Be Affected

In the event that 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 spill would be localised and confined to open water, extending up to approximately 150 km from the release location.

Entrained hydrocarbons

In the event that this vessel collision scenario occurred, the probability of contact by entrained oil at concentrations above 100 ppb is predicted to be 1-7% at receptors associated with the Ningaloo Coast, 18% at the Gascoyne AMP, and 1% at Shark Bay AMP/WHA, Murion Islands AMP, Abrolhos Islands AMP, and Carnarvon Canyon AMP.

Dissolved hydrocarbons

Dissolved hydrocarbons above threshold concentrations (>500 ppb) were not predicted by the modelling to occur at any location. Therefore, no contact with any sensitive receptors is predicted.

Accumulated hydrocarbons

Accumulated hydrocarbons above threshold concentrations (>100 g/m^2) were predicted by the modelling to occur at Ningaloo Reef and the Murion Islands. The largest potential volume of oil accumulating on any shoreline is expected to be 196 m^3 at Ningaloo Coast North. Large potential volumes are also potentially forecast at the Murion Islands (38 m^3).

Summary of potential impacts

In the unlikely event of a spill of marine diesel as a result of vessel collision, the EMBA is expected to remain small and localised, restricted to the open ocean only (Commonwealth waters). Consequently, a EMBA summary table is not presented.

Potential impacts to protected species, other habitats and communities, water quality, protected areas and socio-economic sensitivities

The potential biological and ecological impacts associated with hydrocarbon spills are presented in **Section 6.7.2.** 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, humpback whales, whale sharks, and marine turtles may be encountered within the Operational Area and therefore, could be impacted by a marine diesel spill. 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. Additionally, the EMBA may overlap with the whale shark aggregation area (March to July) off the Ningaloo Coast. In the event that 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 dilution and weathering of any spill, the likelihood of ecological impacts to marine fauna (protected species), 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). With the relatively small EMBA and the fast population turn-over of open water plankton populations, it is 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, the relatively small EMBA and the rapid dispersion of marine diesel, it is considered that any potential impacts will be negligible. While other communities (e.g. demersal fish, benthic infauna and epifauna) and key sensitivities (e.g. KEFs identified in **Section 4.7.7**) may be within the EMBA, they are unlikely to be directly impacted by a marine diesel spill as hydrocarbons are confined to the top 40 m of the water column.

Water Quality

It is likely that water quality will be reduced at the release location of the spill to contamination levels above background levels and/or national/international quality standards; however, such impacts to water quality would be temporary and localised in nature due to the relatively reduced extent of the EMBA and the rapid dispersion of marine diesel. The potential impact is therefore expected to be low.

Protected Areas

The EMBA may extend into the Ningaloo Coast WHA and CMR. In the unlikely event of a spill, with surface or entrained hydrocarbons above threshold concentrations contacting the WHA or CMR, the potential impacts to ecological sensitivities are considered to be similar to those discussed above. No shoreline accumulation above threshold values is predicted for the Ningaloo coast (including the WHA).

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 **Table 4-11**) which overlap with the EMBA. Active fisheries within the EMBA primarily target demersal and benthic species (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 the relatively small area of the EMBA and hydrocarbons are confined to the top 40 m 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 on undertaking fishing within the area of the spill.

A loss of hydrocarbons due to vessel collision during the Petroleum Activities Program may lead to exclusion of marine nature-based tourist activities at Ningaloo coast, resulting in a loss of revenue for operators. Tourism is a major industry for the region and visitor numbers would likely reduce if a hydrocarbon spill were to occur. Given the nature of a marine diesel spill, impacts would be expected to be temporary in nature.

Summary of Potential Impacts to environmental values(s)

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 would be minor and short-term in nature to water quality in comparison to background levels and/or international standards with minor and short-term 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 2-4**, is defined as D, which equates to ‘minor, short-term impact (1-2 years) on species, habitat (but not affecting ecosystem function), physical or biological attributes’.

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS)***[21]	***Benefit in Impact/Risk Reduction***	***Proportionality***	***Control Adopted***
Legislation, Codes and Standards				
500 m safety exclusion zone established around MODU / intervention vessel / PIV and RTM.	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.	Controls based on legislative requirements – must be adopted.	Yes C 2.1
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.	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 2.4
Marine Order 21 (safety and emergency arrangements) 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,	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 2.5

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[21] Qualitative measure

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS)[21]***	***Benefit in Impact/Risk Reduction***	***Proportionality***	***Control Adopted***
position, course, speed, navigational status and other safety-related data.				
Good Practice				
Activity support vessel(s) on standby during well intervention activities to communicate with third-party vessels and assist in maintaining the safety exclusion zone.	F: Yes. CS: Minimal cost – support vessels available routinely in Operational Area during Petroleum Activities Program. Standard practice.	Provides a small reduction in likelihood of a collision with a third party vessel.	Benefits outweigh cost/sacrifice.	Yes C 2.2
Activity support vessel(s) assigned to surveillance will undertake the following actions: • Maintain a 24 hour radio watch on designated radio channel(s) • Undertake continuous surveillance and warn the MODU / intervention vessel / PIV (as required) of any approaching vessels reaching 500 m safety exclusion zone (or warn vessel approaching submerged RTM). Surveillance shall be conducted by a combination of the following: - Visual lookout - Radar watch - Other electronic systems available including automatic identification system (AIS) - Monitoring any additional/agreed radio communications channels - All other means available. • Monitor and advise the if: - MODU / intervention vessel / PIV / RTM navigation signals are defective Visibility becomes restricted.	F: Yes. CS: Minimal cost – support vessels available routinely in Operational Area during Petroleum Activities Program. Standard practice.	Provides a reduction in likelihood of a collision with a third party vessel.	Benefits outweigh cost/sacrifice.	Yes C 2.3

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS)***[21]	***Benefit in Impact/Risk Reduction***	***Proportionality***	***Control Adopted***
AHO notified of activity no less than four working weeks prior to undertaking activities within the Petroleum Activity Program.	F: Yes. CS: Minimal cost. Standard practice.	Notification to AHO 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 3.1
DPIRD notified of activities within three months of undertaking activities within the Petroleum Activity Program.	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.	Yes C 3.2
AMSA notified JRCC of activities 24-48 hours of undertaking activities within the Petroleum Activity Program.	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 3.3
Consultation undertaken with relevant stakeholders for activities within the Petroleum Activities Program that commence more than a year after EP acceptance	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 3.4
Ongoing monitring of the RTM for submergence and navigation systems are operational	F: Yes CS: Minimal cost. Good practise.	Provides a reduction in likelihood of a collision vessel with the RTM if submerged as control measures able to be implemented.	Benefits outweigh cost/sacrifice.	Yes C 2.7
Mitigation: oil spill response	Refer to **Appendix D**			
Professional Judgement – Eliminate				
No additional controls identified.				
Professional Judgement – Substitute				

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS)[21]***	***Benefit in Impact/Risk Reduction***	***Proportionality***	***Control Adopted***
No additional controls identified.				
Professional Judgement – Engineered Solution				
An engineering solution is being developed, which will result in a marker buoy being connected to the submerged RTM coloured to indicate a submerged hazard.	F: Yes CS: Practicable cost.	Provides a reduction in likelihood of a collision with vessel in the event the RTM becomes submerged.	Benefits outweigh cost/sacrifice.	Yes C 2.6
Risk Based Analysis				
A quantitative spill risk assessment was undertaken (see details above)				
ALARP Statement On the basis of the environmental risk assessment outcomes and use of the relevant tools appropriate to the decision type, 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 moderate 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). 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 11 No release of hydrocarbons to the marine environment due to a vessel collision associated with the Petroleum Activities Program.	**C 2.1** Refer to **Section 6.6.1**	**PS 2.1** Refer to **Section 6.6.1**	**MC 2.1.1** Refer to **Section 6.6.1**
	C 2.2 Refer to **Section 6.6.1**	**PS 2.2** Refer to **Section 6.6.1**	**MC 2.2.1** Refer to **Section 6.6.1**
	C 2.3 Refer to **Section 6.6.1**	**PS 2.3** Refer to **Section 6.6.1**	**MC 2.3.1** Refer to **Section 6.6.1**
	C 2.4 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,	**PS 2.4** Support vessels, primary installation vessels and MODU / intervention vessel compliant with Marine Order 30 (prevention of collisions) 2016 (which requires vessels to be visible at all times) to prevent	**MC 2.4.1** Marine Assurance inspection records demonstrate compliance with standard maritime safety procedures (Marine Orders 21 and 30).

Environmental Performance Outcomes, Standards and Measurement Criteria			
Outcomes	***Controls***	***Standards***	***Measurement Criteria***
	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.	unplanned interaction with marine users.	
	C 2.5 Marine Order 21 (safety and emergency arangements) 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 2.5** Support vessels, primary installation vessels and MODU / intervention vessel compliant with Marine Order 21 (safety of navigation and emergency procedures) 2016 to prevent unplanned interaction with marine users.	
	C 2.6 In event that the RTM becomes a submerged hazard, a standby vessel will be deployed until either a marker buoy is connected to the RTM to mark the submerged hazard, or the RTM is removed, or the navigation charts have been updated to reflect a submerged hazard.	**PS 2.6** Marker buoy installed to mark the location of the submerged RTM.	**MC 2.6.1** Records demonstrate a marker buoy is installed or navigation charts are updated with submerged hazard or the RTM is removed prior to standby vessel departing the submerged RTM.
	C 2.7 Ongoing monitoring of the RTM for submergence and navigational systems are operational.	**PS 2.7** RTM is monitored on a weekly basis either visually or by other means to check for submergence and navigational systems are operational.	**MC 2.6.1** Records demonstrate RTM is confirmed as still floating above waterline and navigation systems are operational.

Environmental Performance Outcomes, Standards and Measurement Criteria			
Outcomes	***Controls***	***Standards***	***Measurement Criteria***
EPO 3 Refer to **Section 6.6.1**	**C 3.1** Refer to **Section 6.6.1**	**PS 3.1** Refer to **Section 6.6.1**	**MC 3.2.1** Refer to **Section 6.6.1**
	C 3.2 Refer to **Section 6.6.1**	**PS 3.2** Refer to **Section 6.6.1**	**MC 3.2.1** Refer to **Section 6.6.1**
	C 3.3 Refer to **Section 6.6.1**	**PS 3.3** Refer to **Section 6.6.1**	**MC 3.3.1** Refer to **Section 6.6.1**
	C 3.4 Refer to **Section 6.6.1**	**PS 3.4** Refer to **Section 6.6.1**	**MC 3.4.1** Refer to **Section 6.6.1**
	C 3.5 Notify AHO and AMSA in event that the RTM becomes a submerged hazard.	**PS 3.5** Notification to AHO and AMSA of submerged RTM hazard to allow generation of navigation warnings (Maritime Safety Information Notifications (MSIN) and Notice to Mariners (NTM) (including AUSCOAST warnings where relevant)).	**MC 3.5.1** Consultation records demonstrate that AHO and AMSA have been notified of RTM submerging.
Detailed preparedness and response performance outcomes, standards and measurement criteria for the Petroleum Activities Program are present in **Appendix D**.			

6.7.5 Unplanned Hydrocarbon Release: Bunkering

Context		
Project Vessels – **Section 3.10**	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.			X			X		A	E	3	M	LCS GP PJ RBA	Acceptable if ALARP	EPO 12

Description of Source of Risk

Credible Scenario

Bunkering of marine diesel of project vessels may occur within the Operational Area. 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 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, resulting in approximately 8 m^3 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 be ceased immediately. The credible volume of such a release during helicopter refuelling would be in the order of <100 L.

Quantitative Spill Risk Assessment

Given the physical and chemical similarities, and the relatively small credible spill volumes, marine diesel is considered to be a suitable substitution for aviation jet fuel for the purpose of this environmental risk assessment. Woodside has commissioned RPS APASA to model a surface spill volume of 8 m^3 in the offshore waters of northwest Western Australia. The results of these models have indicated that exposure to surface hydrocarbons above the 10 g/m^2 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 m^3 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 m^3 marine diesel release was not undertaken for this Petroleum Activities Program.

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 to Water Quality and Species

Previous modelling studies for 8 m^3 marine diesel releases, spilt at the surface as result of bunkering activities, indicated that the potential for exposure to surface hydrocarbons exceeding 10 g/m^2 was confined to within the immediate vicinity (approximately 1 km) of the release sites. Therefore, it is considered that there is no potential for contact with sensitive receptor locations above surface (10 g/m^2), entrained (500 ppb) or dissolved (500 ppb) threshold concentrations from an 8 m^3 spill of marine diesel within the Operational Area.

Summary of Potential Impacts to environmental values(s)

The potential biological and ecological impacts associated with much larger hydrocarbon spills are presented in **Section 6.7.2** and **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 and 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)***[22]	***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 12.1
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. • There shall be dry-break couplings and flotation on fuel hoses. There shall be an adequate number of appropriately	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 12.2

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[22] Qualitative measure

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS)[22]***	***Benefit in Impact/Risk Reduction***	***Proportionality***	***Control Adopted***
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 12.3
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
The MODU brought into port to refuel.	F: No. Does not eliminate the fuel transfer risk. It is not operationally practical to transit	Eliminates the risk in the Operational Area; however, moves risk to another location.	Disproportionate. The cost/sacrifice outweighs the benefit gained.	No

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS)***[22]	***Benefit in Impact/Risk Reduction***	***Proportionality***	***Control Adopted***
	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.	Therefore, no overall benefit.		
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, 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 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 and temporary exceedance over national/international water quality standards and a localised, minor and temporary disruption to a small proportion of the population and no impact on critical habitat or activity of protected species. 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 12 No unplanned loss of hydrocarbons to the marine environment from bunkering greater than a consequence level of F[23] during the Petroleum Activities Program.	**C 12.1** Marine Order 91 (marine pollution prevention – oil) 2014, requires SOPEP/SMPEP (as appropriate to vessel class).	**PS 12.1** Appropriate initial responses prearranged and drilled in case of a hydrocarbon spill, as appropriate to vessel class.	**MC 12.1.1** Marine Assurance inspection records demonstrate compliance with Marine Order 91.
	C 12.2 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 12.2.1** Ensure damaged equipment is replaced prior to failure.	**MC 12.2.1** Records confirm the MODU bunkering equipment is subject to systematic integrity checks.
		PS 12.2.2 Minimise inventory loss in the event of a failure.	**MC 12.2.2** Records confirm presence of dry break of couplings and flotation on fuel hoses.
		PS 12.2.3 Ensure adequate resources are available to allow implementation of SOPEP.	**MC 12.2.3** Records confirm presence of spill kits.
	C 12.3 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 12.3** Comply with Contractor procedures for managing bunkering/helicopter operations.	**MC 12.3.1** Records demonstrate bunkering/refuelling performed in accordance with contractor bunkering procedures.
Detailed oil spill preparedness and response performance outcomes, standards and measurement criteria for the Petroleum Activities Program are presented in **Appendix D**.			

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[23] 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**.

6.7.6 Unplanned Discharge: Loss of Chemicals / Hydrocarbons from Project Vessels

Context	
Well Intervention Fluids – **Section 3.9.1** Project Vessels – **Section 3.10**	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 other hydrocarbons / chemicals from project vessels deck activities and equipment (e.g. cranes) to the marine environment, including helicopter refuelling and subsea ROV hydraulic leaks.			X		X	X		A	E	2	M	LCS GP PJ	Acceptable if ALARP	EPO 13

Description of Source of Risk

Deck spills can result from spills from stored hydrocarbons/chemicals or equipment. Project vessels typically store hydrocarbon/chemicals in various volumes (20 L, 205 L; up to approximately 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). Helicopter refuelling may also take place within the Operational Area, on the helipad of project vessels.

Minor leaks during wire line activities (i.e. intervention activities) 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
- back loading of raw slop fluids in an Intermediate Bulk Containers
- stuffing box leak / under pressure
- draining of lubricator contents
- excess grease / lubricant leaking from the grease injection head
- wind-blown lubricant dripping from cable / on deck
- lubricant used to lubricate hole.

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.

Subsea spills can result from a loss of containment of fluids from subsea equipment including the BOP or ROVs. A review of these spills to the marine environment in the past 12 months showed subsea spills did not exceed approximately 26 L in Woodside's Drilling function.

The ROV hydraulic fluid is supplied through hoses containing approximately 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.

Impact Assessment
Potential Impacts to Water Quality, Ecosystems / Habitats and Species
Accidental spills of hydrocarbons or chemicals from project vessels will decrease the water quality in the immediate area of the spill; however, the impacts are expected to be temporary and very localised due to dispersion and dilution in the open ocean environment. The potential biological and ecological impacts associated with hydrocarbon spills are presented in **Section 6.7.2**, further detail on impacts specific to minor deck and subsea spills is 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) and sediment quality (minor subsea spill) that are within the spill affected area and no impacts to commercial fisheries are expected. Please 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, given the minor volumes likely to be involved, the potential for impacts is likely to be highly localised to the immediate spill locations and hence potential impacts are considered 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 spilt and the localised and temporary nature of the impacts.
Summary of Potential Impacts to environmental values(s)
Given the adopted controls, it is considered that minor hydrocarbon/chemical spills to the marine environment will not result in a potential impact to water quality greater than slight and temporary contamination above background levels, quality standards or known effect concentrations and will not result in a potential impact greater than slight and temporary disruption to a small proportion of biological populations with no impact on critical habitat or activity.

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS)***[24]	***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.	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 12.1
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 13.1
Good Practice				
Where there is potential for loss of primary containment of oil and chemicals on the MODU, deck drainage will 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

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[24] Qualitative measure

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS)***[24]	***Benefit in Impact/Risk Reduction***	***Proportionality***	***Control Adopted***
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 13.2
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 13.3
Detailed oil spill preparedness and response performance outcomes, standards and measurement criteria for the Petroleum Activities Program are presented in **Table 7-6.**				
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 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 moderate risk that is unlikely to result in potential impact greater than slight short term localised, minor and temporary disruption but not impacting on ecosystem function. 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. 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 13 No unplanned spills to the marine environment from deck activities greater than a consequence level of E[25] during the Petroleum Activities Program.	**C 5.3** Refer to **Section 6.6.3**	**PS 5.3** Refer to **Section 6.6.3**	**MC 5.3** Refer to **Section 6.6.3**
	C 12.1 Refer to **Section 6.7.5**	**PS 12.1** Refer to **Section 6.7.5**	**MC 12.1.1** Refer to **Section 6.7.5**
	C 13.1 Liquid chemical and fuel storage areas are bunded or secondarily contained when they are not being handled/ moved temporarily.	**PS 13.1** Failure of primary containment in storage areas does not result in loss to the marine environment.	**MC 13.1.1** Records confirms all liquid chemicals and fuel are stored in bunded/ secondarily contained areas when not being handled/moved temporarily.
	C 13.2 Spill kits positioned in high risk locations around the rig (near potential spill points such as transfer stations).	**PS 13.2** Spill kits to be available for use to clean up deck spills.	**MC 13.2.1** Records confirms spill kits are present, maintained and suitably stocked.
	C 13.3 Primary installation vessels have self-containing hydraulic oil drip tray management system.	**PS 13.3** Contain any on-deck spills of hydraulic oil.	**MC 13.2.1** Records demonstrate project installation vessels are equipped with self-containing hydraulic oil drip tray management system.

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[25] Defined as ‘Slight, short term local impact (< one 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 Discharge: Loss of Solid Hazardous / Non-hazardous Wastes

Context	
Project Vessels – **Section 3.10**	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 to the marine environment (excludes sewage, grey water, putrescible waste and bilge water).			X			X		A	F	2	L	LCS GP PJ	Broadly acceptable	EPO 14

Description of Source of Risk

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. Wastes on-board are managed in accordance with the on-board waste management plan. Some wastes may be incinerated (refer to **Section 6.6.7**). Based on industry experience, waste items lost overboard are typically wind-blown rubbish such as container lids, cardboard etc. Such losses typically have occurred during back loading activities, periods of adverse weather and incorrect waste storage.

Impact Assessment

Potential Impacts to Socio-economic Environment

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(s)

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, with no lasting effect.

Demonstration of ALARP				
Control Considered	**Control Feasibility (F) and Cost/Sacrifice (CS)**[26]	**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 14.1
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 14.2
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.	F: Yes. CS: Minimal cost. Standard practice.	Reduces the likelihood of an unplanned release. The consequence is unchanged.	Benefit outweighs cost sacrifice.	Yes C 14.3
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:	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	Benefit outweighs cost sacrifice.	Yes C 14.4

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[26] Qualitative measure

Demonstration of ALARP				
Control Considered	**Control Feasibility (F) and Cost/Sacrifice (CS)[26]**	**Benefit in Impact/Risk Reduction**	**Proportionality**	**Control Adopted**
- 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).		reduction in consequence is possible.		
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 localised, not siginifican to environmental receptors with 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 (Marine Order 95). 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 14 No unplanned releases of solid hazardous or non-hazardous waste to the marine environment greater than a consequence	**C 14.1** 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 14.1** MODU and project vessels compliant with Marine Order 95 – pollution prevention – garbage.	**MC 14.1.1** Records demonstrate MODU and project vessels are compliant with Marine Order 95 – pollution prevention (as appropriate to vessel class).

Environmental Performance Outcomes, Standards and Measurement Criteria			
Outcomes	***Controls***	***Standards***	***Measurement Criteria***
level of F during the Petroleum Activities Program.	**C 14.2** 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 14.2** Hazardous and non-hazardous waste will be managed in accordance with the Drilling and Completions waste arrangements.	**MC 14.2.1** Records demonstrate compliance against Drilling and Completions waste arrangements.
	C 14.3 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 14.3** Hazardous and non-hazardous waste will be managed in accordance with the Installation Vessel waste arrangements.	**MC 14.3.1** Records demonstrate compliance against Installation Vessel waste arrangements.
	C 14.4 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 14.4** Any hazardous solid waste dropped to the marine environment will be recovered where safe and practicable to do so.	**MC 14.4.1** 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 3.10**	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***
Accidental collision between project vessels and threatened and migratory marine fauna.						X		A	E	1	L	LCS GP PJ	Broadly acceptable	EPO 15

Description of Source of Risk

The project vessels operating in and around the Operational Area may present a potential hazard to cetaceans and other protected marine fauna such as whale sharks and marine reptiles. 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) and the type of animal potentially present and their behaviours.

Impact Assessment

Potential Impacts to Socio-economic Environment

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.

Project vessels within the Operational Area are likely to be travelling less than 8 knots (and will often be stationary), therefore, the chance of a vessel collision with protected species resulting in lethal outcome considered unlikely, as fauna have the opportunity to move away from project vessels. No known key aggregation areas (resting, breeding or feeding) are located within or immediately adjacent to the Operational Area; however, the Operational Area overlaps the migration BIAs for humpback and pygmy blue whales (**Section 4.5.2**). The timing of the activity could occur at any time throughout the year (all seasons); therefore, it is possible that activity will overlap with these whale migration periods (**Table 4-8:**). This could result in increased numbers of pygmy blue and humpback whales transiting the Operational Area during migration periods.

According to the data of Vanderlaan and Taggart (2007), it is estimated that the risk is less than 10% at a speed of 4 knots. Vessel-whale collisions at this speed are uncommon and, based on reported data contained in the National Ocean and Atmospheric Administration database (Jensen and Silber 2004) there only two known instances of collisions when the vessel was travelling at less than 6 knots, both of these were from whale watching vessels that were deliberately placed amongst whales. Given the duration of activities within the Operational Area and the slow speeds at which project vessels operate, collisions with cetaceans such as pygmy blue and humpback whales are considered very unlikely.

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 Northwest Province waters including the Operational Area during their migrations to and from Ningaloo Reef. Note that foraging BIAs off Ningaloo and the NWS do not overlap the Operational Area.

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 (approximately 400-600 m), it is considered that the Operational Area is unlikely to represent important habitat for marine turtles, although individuals may infrequently transit the area.

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 activity support vessels (generally less than 8 knots or stationary, unless operating in an emergency).

Summary of Potential Impacts to environmental values(s)

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 (<1 year) on species, but not affecting ecosystem function.

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS)***[27]	***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[28]: • 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.	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 15.1

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[27] Qualitative measure

[28] 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)[27]***	***Benefit in Impact/Risk Reduction***	***Proportionality***	***Control Adopted***
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, 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 slight, short term and not affecting ecosystem 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 Part 8 (Division 8.1) of the *EPBC Act Regulations 2000*. 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	***Outcomes***	***Outcomes***	***Outcomes***
EPO 15 No vessel strikes with protected marine fauna (whales, whale sharks, turtles) during the Petroleum Activities Program.	**C 15.1** EPBC Regulations 2000 – Part 8 Division 8.1 Interacting with cetaceans, including the following measures[29]: - 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 15.1** 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 15.1.1** Records demonstrate no breaches of EPBC Regulations 2000 – Part 8 Division 8.1 Interacting with cetaceans.
		PS 15.2 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 15.2.1** Records demonstrate reporting cetacean ship strike incidents to the National Ship Strike Database.

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[29] 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 Dropped Objects or dragged subsea equipment

Context	
Well intervention – **Section 3.6** RTM Removal – **Section 3.6** Project Vessels – **Section 3.10**	Physical Environment – **Section 4.4** Biological Environment – **Section 4.5**

Impacts and Risks Evaluation Summary

	Environmental Value Potentially Impacted							*Evaluation*						
Source of Risk	***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 subsea infrastructure during laydown or removal activities / dragged subsea equipment					X			A	E	1	L	LCS GP PJ	Broadly acceptable	EPO 16
Accidental sinking of the RTM during removal.					X			A	E	1	L	LCS GP PJ		

Description of Source of Risk

Dropped Objects/ Dragged Subsea Equipment

During the Petroleum Activities Program, the controlled lifting and laydown of subsea infrastructure within the Operational Area is expected to occur. During these activities there is the potential for subsea infrastructure to disturb the seabed (refer to **Section 6.6.2**). There is also the potential for objects to be dropped overboard from project vessels to the marine environment, or for subsea equipment to be dragged on the seabed. The area of disturbance to the seabed that could result could range depending on the size of the object or the distance of the dragged equipment.

In the event of a dropped object or dragged subsea equipment, there is the potential for damage to the subsea infrastructure. During the preservation period, there is the potential for dropped objects or dragged subsea equipment to rupture flushed infrastructure, which could lead to the unintentional discharge of treated seawater and minor quantities of residual hydrocarbons (refer to **Section 6.6.4**). In the unlikely event of interaction with a Xmas tree, there is the potential for a well loss of containment leading to the release of hydrocarbons (refer to **Section 6.7.3**). Note the release volume for this scenario is significantly smaller than the credible worst-case loss of well control during intervention, as the SSSV and / or wireline and / or cement plug(s) are assumed to be unaffected (as per the credible spill scenario presented in **Section 6.7.3**).

RTM Sinking

There is potential for the RTM to sink to the seabed prior to or during the removal of the structure from the Operational Area. Given the mooring lines would still be attached, the RTM is expected to settle within the area bound by the mooring anchors.

In the highly unlikely event that the RTM sinks to the seabed, it will result in localised disturbance to the seabed at that location. The potential disturbance footprint of the RTM would be approximately 83 m by 8.5 m (i.e. approximately 700 m^2). Note that there are no residual hydrocarbon or chemicals on-board the RTM during the preservation period. The RTM is composed almost entirely of steel, with a paint coating.

Impact Assessment
Potential Impacts to Ecosystems / Habitats
In the unlikely event that a piece of subsea infrastructure was dropped to the seabed, subsea equipment is dragged along the seabed, or the RTM sinks, such an event would add to the estimated seabed disturbance footprint for planned activities (approximately 700 m^2). However, additional disturbance would be confined to the Operational Area, within which the seabed consists of soft sediments, widely represented throughout the region. Therefore, any cumulative impacts would be slight, in addition to the expected disturbance footprint for planned activities (**Section 6.6.2**). In the unlikely event of rupturing infrastructure containing preservation fluid (treated seawater), the credible volume of discharged treated seawater is consistent with the planned discharge volume. Refer to **Section 6.6.4** for an assessment of the environmental risks and impacts from a discharge of treated seawater. In the unlikely event of a loss of well containment, the worst-case credible hydrocarbon release scenario is consistent with the loss of well containment presented in **Section 6.7.2**; refer to **Section 6.7.2** for an assessment of the environmental risks and impacts due to a loss of well containment during the preservation period.
Summary of Potential Impacts to Environmental Values(s)
Given the adopted controls and the predicted small footprint of a dropped object or dragged subsea equipment, it is considered that a dropped object or dragged subsea equipment will not result in a potential impact greater than slight short-term damage of benthic subsea habitats. Refer to **Sections 6.6.2, 6.6.4** and **6.7.2** for discussion of seabed disturbance, treated seawater discharge and loss of well containment respectively.

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS)***[30]	***Benefit in Impact/Risk Reduction***[31]	***Proportionality***	***Control Adopted***
Legislation, Codes and Standards				
No additional controls identified.				
Good Practice				
MODU/project vessel ROV, crane or support vessel may be used to attempt recovery of objects 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 and therefore no change to the likelihood. Since the objects may be recovered, a reduction in consequence is possible.	Benefit outweighs cost sacrifice.	Yes C 14.4
The MODU/primary installation vessels work procedures for lifts, bulk	F: Yes. CS: Minimal cost. Standard practice.	Occurs after a dropped object event and therefore no change to the	Benefits outweigh cost/sacrifice.	Yes C 16.1

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[30] Qualitative measure

[31] Measured in terms of reduction of likelihood (L), consequence (C) and current risk rating (CRR)

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS)[30]***	***Benefit in Impact/Risk Reduction[31]***	***Proportionality***	***Control Adopted***
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.		likelihood. Since the object may be recovered, a reduction in consequence is possible.		
MODU/primary installation vessel inductions include control measures and training for crew in dropped object prevention.	F: Yes. CS: Minimal cost. Standard practice.	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.	Benefits outweigh cost/sacrifice.	Yes C 16.2
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, Woodside considers the adopted controls appropriate to manage the impacts and risks 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.				

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 slight and short term 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. Therefore, Woodside considers the adopted controls appropriate to manage the impacts and risks to marine sediment from dropped objects to an acceptable level.

Environmental Performance Outcomes, Standards and Measurement Criteria			
Outcomes	***Controls***	***Standards***	***Measurement Criteria***
EPO 16 No incidents of dropped objects to the marine environment greater than a consequence level of F[32] during the Petroleum Activities Program.	**C 14.4** Refer to **Section 6.7.7**	**PS 14.4** Refer to **Section 6.7.7**	**MC 14.4.1** Refer to **Section 6.7.7**
	C 16.1 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 16.1** Lifts, bulk transfers and cargo loading managed in compliance with the work procedures, including implementation of PTW and JSA systems.	**MC 16.1.1** Records demonstrate adherence to requirements of work procedures and in accordance with PTW and JSA systems.
	C 16.2 MODU/primary installation vessel inductions include control measures and training for crew in dropped object prevention.	**PS 16.2** Awareness of requirements for dropped object prevention.	**MC 16.2.1** Records show dropped object prevention training is provided to the MODU/primary installation vessels.

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[32] 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.**

6.7.10 Physical Presence: Accidental Introduction of Invasive Marine Species

Context		
Project Vessels – **Section 3.10**	Physical Environment – **Section 4.4** Biological Environment – **Section 4.5**	Stakeholder Consulation – **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					X	X		A	E	0	L	LCS	Broadly Acceptable	EPO 17

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 undertaking petroleum activities will be transiting to and from the Operational Area; potentially including traffic mobilising from beyond Australian waters. These vessels may include the MODU, AHVs, intervention vessel, PIVs and project vessels (**Section 3.10**).

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 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 as cargo is loaded or to balance vessels under load. The RTM which has been on location for a considerable period may also be subject to some level of marine fouling as it is within the photic zone. However the RTM was inspected and marine growth sampled in February 2019 for IMS. The conclusion was that no evidence for IMS of concern was detected.

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.

Despite the potential consequence of the establishment of a marine pest within a high value environment as a result of introduction, unlike coastal or sheltered nearshore waters, the deep offshore open waters of the Operational Area are not conducive to the settlement and establishment of IMS. IMS typically require hard substrate in the photic zone to become established; the only hard substrate in the Operational Area within the photic zone consists of the RTM, which has been inspected and sampled for IMS with no IMS of concern detected.

Given the depth of Operational Area, facility components on the seabed are not considered suitable for the establishment of IMS, as potential IMS are generally restricted to relatively shallow coastal water.

In addition Woodside has historically been applying the Woodside's IMS risk assessment process to activities undertaken in the Operational Area prior to cessation of operations and the current risk of established IMS is low.

The Petroleum Activities Program will be undertaken in an open ocean, offshore location away from shorelines and/or critical habitat, more than 12 nm from a shore and in waters 400 – 600 m deep. The hard substrate in the Operational Area that may be suitable for IMS attachment will either be removed during the Petroleum Activities Program, or become unsuitable for IMS establishment (i.e. lowered to the seabed). The impacts of IMS establishment in this offshore location would have a lower consequence than introduction within a nearshore location, as the introduction of IMS and associated establishment is considered highly unlikely.

Summary of Potential Impacts to Environmental Values(s)

Given the adopted controls and the remote likelihood of the introduction, establishment and impact of an IMS occurring within the Operational Area, IMS is considered to only present a slight potential impact to marine ecosystems or habitats.

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				
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 17.1
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	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	Benefits outweigh cost/sacrifice.	Yes C 17.2

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[33] Qualitative measure

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS)[33]***	***Benefit in Impact/Risk Reduction***	***Proportionality***	***Control Adopted***
internal systems, IMS inspections or cleaning) will be implemented to minimise the likelihood of IMS being introduced.		reduced. No change in consequence would occur.		
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
RTM inspected and tested for IMS of concern	F: Yes CS: Reasonable cost.	Inspection of and sampling for IMS to detect any IMS of concern will allow management of IMS during RTM repurposing.	Benefits outweigh cost/sacrifice.	Yes C 17.3
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	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	No

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS)***[33]	***Benefit in Impact/Risk Reduction***	***Proportionality***	***Control Adopted***
	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.		by using only Australian based vessels. Consequently, this risk is considered not reasonably practicable.	
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 marine pests will not result in a potential impact greater than slight short term impact on species or habitat within the Operational Area. Further opportunities to reduce the impacts and risks have been investigated above. The adopted controls are considered good oil-field practice/industry best practice. 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 17 No introduction and establishment of invasive marine species into the Operational Area as a result of the Petroleum Activities Program.	**C 17.1** 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 17.1** Prevents the translocation of IMS within the vessel's ballast water from high risk locations to the Operational Area.	**MC 17.1.1** Ballast Water Records System maintained by vessels which verifies compliance against Australian Ballast Water Management Requirements.
	C 17.2 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 17.2** Minimise the likelihood of translocating IMS within a vessel's biofouling to the Operational Area.	**MC 17.2.1** Records of IMS risk assessments maintained for all project vessels conducting the Petroleum Activities Program.
			MC 17.2.2 Records of management measures which have been implemented where identified through the IMS vessel risk assessment process are maintained.
	C 17.3 RTM inspected and tested for IMS of concern[34]	**PS 17.3** Minimise the likelihood of translocating IMS from the RTM into shallow waters.	**MC 17.3.1** Records confirm that the RTM has been inspected and tested for IMS of concern.

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[34] Note that this has already been completed.

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 that 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 Operator, is responsible for ensuring that the Petroleum Activities Program is managed in accordance with this Implementation Strategy and the WMS (see **Section 1.9**).

7.2 Systems, Practice and Procedures

All operational activities are planned and carried out in accordance with relevant legislation and standards, management measures (i.e. controls) identified in this EP and internal environment standards and procedures (**Section 7**).

The systems, practises and procedures that will be implemented are listed in the Perfomance Standards (PS) contained in this EP. Document names and references numbers may change during the statutory duration of this EP and in 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 of this EP are described in **Table 7-1**. Roles and responsibilities for oil spill preparation and response are outlined in **Appendix D**.

Table 7-1: Roles and responsibilities

Title (role)	Environmental Responsibilities
Office-based Personnel	
NGA Asset Manager	• Ensures compliance with Woodside's HSE Policy, all relevant environmental legislative requirements and environmental operational controls as detailed in this EP. • Reports environmental incidents to the Developments Environment Manager and ensures follow up actions are carried out. • Liaises with regulatory authorities as required. • Ensures resources are available to deliver this EP. • Ensures review of daily, weekly and monthly reporting from the PIV and support vessels. • Consults with the Developments Environment Manager to develop corrective actions addressing any environmental issues in relation to the Petroleum Activities Program. • Ensures the importance of appropriate levels of training, competency and environmental awareness are communicated amongst the PIV and support vessel personnel. • Ensures action items from environmental audits are completed. • Ensures the importance of appropriate levels of training, competency and environmental awareness are communicated amongst the PIV and support vessel personnel. • Ensures action items from environmental audits are completed.
Woodside Developments Environment Manager	• Overall coordination of environmental management across the Developments Division to ensure the performance outcomes, standards and measurement criteria of the offshore EPs are met. • Verifying Developments Division understands and adheres to legislative and regulatory requirements, EPs and the WMS. • Guiding and driving the direction of environmental management across the Developments Division, maintaining alignment with the Corporate Environment functional direction. • Facilitating environmental approval documentation for the Developments Division and its timely submission in accordance with regulatory requirements and Woodside standards. • Providing governance on environmental standards and EP compliance. • Monitoring and communicating to internal stakeholders any relevant changes to legislation, policies, regulator organisation that may impact the EP or business. • Developing and maintaining appropriate environmental processes for Developments and contractors. • Developing environmental improvement plans, targets and KPI's with divisional management. • Supporting the divisional environmental performance through implementation of effective environmental training programs. • Monitoring and review progress against environmental improvement plans, targets and KPI's with divisional management to drive continuous improvement.

Title (role)	Environmental Responsibilities
Woodside Developments Environment Adviser	• Verifying Developments Division understands legislative and regulatory requirements, EPs and the WMS. • Developing, review and control revisions of the EP and maintaining in accordance with EP commitments. • Assisting in implementing and facilitating environmental improvement plans. • Ensuring appropriate personnel have access to the EP and understand the outcomes, standards and measurement criteria and their environmental responsibilities for the activity. • Liaising with applicable regulatory authorities and stakeholders as required. • Developing and maintaining environmental training inductions, awareness refreshers and environment toolbox topics for deployment to offshore personnel. • Coordinating environmental monitoring and reporting requirements from the EP including environmental performance and compliance reporting; • Monitoring progress against environmental improvement plans. • Participating in environmental audits/inspections to ensure regular checking of compliance with the EP. Communicating findings to management and assisting with closeout of audit actions. • Assisting with review, investigation and reporting of environmental incidents. • Preparation and delivery/dissemination of environmental training material.
Woodside Corporate Affairs Adviser	• Prepare and implement the Stakeholder Consultation Plan for Petroleum Activities Program. • Report on stakeholder consultation. • Ongoing liaison as required.
Project Engineers	• Changes to the decommissioning program are communicated to the Decommissioning Environmental Adviser. • All decommissioning chemical components and other fluids that are be used have been reviewed by the Project Environmental Adviser.
Woodside Marine Assurance Superintendent	• Conducts relevant audit and inspection to confirm vessels are in compliance with relevant Marine Orders and Woodside Marine Charters Instructions requirements to meet safety, navigation and emergency response requirements.
Woodside Corporate Incident Coordination Centre (CICC) Duty Manager	On receiving notification of an incident, the Woodside CICC Duty Manager shall: • establish and take control of the IMT and establish an appropriate command structure for the incident • assess situation, 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 (IAP) including setting objectives for action • approve, implement and manage the IAP • communicate within and beyond the incident management structure • manage and review safety of responders • address the broader public safety considerations

Title (role)	Environmental Responsibilities
	• conclude and review activities.
Vessel-based Personnel	
Vessel Master	• The vessel management system and procedures are implemented. • Personnel commencing work on the vessel receive an environmental induction that meets the relevant requirements specified in this EP. • Personnel are competent to undertake the work they have been assigned. • SOPEP drills are conducted as per the vessel's schedule. • The vessel Emergency Response Team (ERT) has been given sufficient training to implement the SOPEP. • Any environmental incidents or breaches of relevant environmental performance outcomes or performance standards detailed in this EP, are reported immediately to the Woodside Representative. Corrective actions for incidents or breaches are developed, communicated to the Woodside Representative, and tracked to close out in a timely manner. Close out of actions is communicated to the Woodside Representative.
Vessel HSE Advisers	• Verify that the environmental performance outcomes and performance standards are undertaken as detailed in this EP. • Support the Project Manager and the NGA Asset Manager to ensure the environmental performance outcomes are met and the performance standards detailed in this EP are implemented on the project vessels. • Verify environmental incidents or breaches of outcomes, standards or criteria outlines in this EP, are reported as per the Woodside Corporate Event Notification Matrix. • Confirm periodic environmental inspections are completed. • Review Contractors procedures, Input into Toolbox talks and JSAs. • Provide day-to-day environmental support for activities in consultation with the Project Environmental Adviser.
Vessel Logistics Coordinators	• Waste is managed on the relevant activity support vessels and sent to shore as per the relevant Waste Management Plan.
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

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 undertakes assessments of a proposed contractor's environmental management systems to determine the level of compliance with the standard AS NZ ISO 14001. This assessment is undertaken for the Petroleum Activities Program as part of the pre-mobilisation process. The assessment determines whether there is a clearly defined organisational structure that clearly defines the roles and responsibilities for key positions. The assessment also assesses 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 before the mobilisation to or on arrival at the activity location. The induction covers the HSE requirements and environmental information specific to the activity location. A record of attendance will be maintained.

The Petroleum Activities Program induction may cover the following information:

- ecological and socio-economic values of the activity location
- description of the activity
- regulations relevant to the activity
- woodside 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

Prior to commencing each component of the Petroleum Activities Program, a Woodside representative will hold a pre-activity meeting on-board project vessels with all relevant personnel. The pre-activity meeting provides an opportunity to reiterate specific environmental sensitivities or commitments associated with the activity. Attendance lists are recorded and retained. Relevant sections of the pre-activity meeting will also be communicated through to the support vessel personnel.

During operations, regular HSE meetings will be held on project vessels which cover all crew. During these meetings, recent environmental incidents are reviewed and awareness material presented on a regular basis. Attendance is recorded and lists retained on the project vessels.

7.4.4 Management of Training Requirements

All personnel on the 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. Spill response training is mandatory for relevant teams. Environmental awareness is also included in inductions.

7.5 Monitoring, Auditing, Management of Non-Conformance and Review

7.5.1 Monitoring

Woodside and its Contractors will undertake 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** and **Appendix D**.

The collection of this data (against the measurement criteria) will form part of the permanent record of compliance maintained by Woodside and 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 undertaken during well intervention activities and inspections, which include leading indicator compliance
- quarterly review of waste management and recycling records
- use of MODU / intervention vessel, PIV and activity support vessel contractor's risk identification program that requires personnel to record and submit safety and environment risk observation cards on a routine basis
- collection of evidence of compliance with the controls detailed in the EP relevant to offshore activities by the Woodside Offshore HSE Adviser (or equivalent) (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 Developments 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:

- DoEE EPBC Act listed species status, listed species Recovery/Management and Conservation Plans, and other environmental matters is reviewed quarterly and recorded by Environment

Science team. The outcome of each review is summarised and issued to the relevant Environment personnel responsible for implementing the EP 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 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 and Inspections

Environmental performance auditing will be undertaken to:

- identify potential new, or changes to existing 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; and
- confirm compliance with the Performance Outcomes, Controls and Standards detailed in this EP.

Proposed audits include:

- Start up or pre-mobilisation audits; and
- Offshore environmental inspections.

Non-conformances identified will be reported and/or tracked in accordance with **Section 7.5.3**. Audit findings relevant to continuous improvement of environmental performance are tracked through a compliance action register.

7.5.2.1 Start-Up/Pre-Mobilisation Audit

An audit will be undertaken to align with each key project campaign. Start-up or pre-mobilisation audits will be undertaken before the following commence:

- RTM removal (**Section 3.6**)
- Well intervention campaign (**Section 3.9**).

The scope of these audits will focus on ensuring all personnel are aware of environmental commitments and appropriate environmental controls are in place.

7.5.2.2 Environmental Inspections

Environmental inspections will also be undertaken fortnightly for each campaign by offshore personnel. Selected risk areas will be inspected during routine visits throughout the campaign, determined by risk, previous incidents and operation specification requirements.

7.5.3 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 to record and report 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.

7.5.4 Review

7.5.4.1 Management Review

Within the Environment Function, senior management regularly monitor and review environmental performance and the effectiveness of managing environmental risks and performance. Within in each Function and Business Unit Leadership Team Managers review environmental performance on a regular basis.

7.5.4.2 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 / intervention vessel, PIV and activity support vessel operators
- formal and informal industry benchmarking
- cross asset learnings
- engineering and technical authorities discipline communications and sharing.

7.5.4.3 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 4)** 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 2.5**) 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, etc.), 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 6**) will be maintained.

Record keeping will be in accordance with Regulation 14(7) that addresses maintaining records of emissions and discharges.

7.8 Reporting

To meet the environmental performance outcomes and standards outlined in this EP, Woodside undertake reporting 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 activities are prepared and issued to key support personnel and stakeholders, by relevant managers responsible for the activity. The report provides performance information on the activities, heath, safety and environment, 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. These reports cover a number of subject matters, 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	NOPSEMA	Monthly, by the 15th of each month.	Details of recordable incidents that have occurred during the Petroleum Activities Program for previous month (if applicable).
Environmental Performance Report	NOPSEMA	Annually, with the first report submitted within 12 months of the commencement of the Petroleum Activity 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 notify 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 of the Environment Regulations.

7.8.3 Incident Reporting (Internal)

The process for reporting environmental incidents is described in **Sections 7.8.3 and 7.8.4** of this EP. It is the responsibility of the Woodside Project Manager to ensure that reporting of environmental incidents meets Woodside's and regulatory reporting requirements as detailed in the Woodside Health, Safety and Environment Event Reporting and Investigation Procedure and this section of this EP.

7.8.4 Incident Reporting (External) – Reportable and Recordable

7.8.4.1 Reportable Incidents

Definition

A reportable incident as 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 C+ (as defined under Woodside's Risk Table (refer to **Table 2-3**))

- an incident that has the potential to cause environmental damage with a Consequence Level C+ (as defined under Woodside's Risk Table (refer to **Section 2**).

The environmental risk assessment (**Section 6**) for the Petroleum Activities Program identifies those risks with a potential consequence level of C+ for environment. The incidents that have the potential to cause this level of impact include hydrocarbon loss of containment events to the marine environment resulting from a loss of well integrity.

Any such incidents represent potential events which would be reportable incidents. Incident reporting is undertaken with consideration of NOPSEMA (2014) guidance stating, 'if in doubt, notify NOPSEMA', and assessed on a case-by-case basis 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 (NOPTA) 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 FM0929 – Reportable Environment Incident (**Appendix E**) 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 NOPTA 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 the occurrence, and DoEE notified if MNES are to be affected by the oil spill incident.

7.8.4.2 Recordable Incidents

Definition

A recordable incident as 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:

- 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 Operational Area.

Table 7-3: External Incident Reporting Requirements

Event	Responsibility	Notifiable party	Notification requirements	Contact	Contact detail
Any marine incidents during Petroleum Activities Program	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 Rescue Coordination Centre (RCC) Australia	If the ship is at sea, reports are to be made to: Free call: 1800 641 792 Phone: 08 9430 2100 (Fremantle)
Oil pollution incidents in Commonwealth waters	Vessel Master	AMSA RCC	Without delay as per Protection of the Sea Act, part II, section 11(1), AMSA RCC notified verbally via the national emergency 24-hour notification contact of the hydrocarbon spill; follow up with a written Pollution Report as soon as practicable after verbal notification	AMSA 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	Vessel Master	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
Any oil pollution incident which has the potential to enter a WA State waters	CICC DM or delegate	WA Department fo Transport	Marine Duty Manager to verbally notify DoT that a spill has occurred and request use of equipment stored in the Exmouth supply shed at Harold E Holt. Follow up with a written POLREP as soon as practicable following verbal notification.	DOT Duty Officer	Phone: 08 9480 9924

Event	Responsibility	Notifiable party	Notification requirements	Contact	Contact detail
			Additionally DoT to be notified if spill is likely to extend into WA State waters. Request DoT to provide Liaison to WEL IMT.		

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 Woodside Oil Pollution Emergency Arrangements (OPEA) (Australia).

External incident reporting requirements required under the Offshore Petroleum and Greenhouse Gas Storage (Safety) Regulations including under sub regulation 2.42, notices and reports of dangerous occurrences will be reported to NOPSEMA under the approved activity safety cases.

7.9 Emergency Preparedness and Response

7.9.1 Overview

Under Regulations 14(8) the implementation strategy must contain an Oil Pollution Emergency Plan (OPEP) and provide for the updating of the OPEP. Regulation 14(8AA) outlines the requirements for the OPEP which must include adequate arrangements for responding to and monitoring of 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 as low as reasonably practicable and an acceptable level	Regulation 13 (5), (6), 14 (3)	Oil Spill Preparedness and Response Mitigation Assessment for Nganhurra Facility Operations Cessation Environment Plan (**Appendix D**)
Description of the oil pollution emergency plan	Regulation 14 (8)	Environment Plan: **Section 7.9.1** and **7.9.2**. Woodside's oil pollution emergency plan has the following components: • Woodside Oil Pollution Emergency Arrangements (Australia) • Nganhurra Operations Cessation Oil Pollution First Strike Plan (**Appendix H**) • Oil Spill Preparedness and Response Mitigation Assessment for Nganhurra Facility Operations Cessation Environment Plan (**Appendix D**)
Details 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 Nganhurra Facility Operations Cessation Environment Plan (**Appendix D**) Nganhurra Operations Cessation Oil Pollution First Strike Plan (**Appendix H**)
Details the arrangements for the updating and testing the oil pollution response arrangements	Regulation 14 (8), (8A), (8B), (8C)	Environment Plan: **Section 7.9.6** Oil Spill Preparedness and Response Mitigation Assessment for Nganhurra Operations Cessation Environment Plan (**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 Nganhurra Operations Cessation Environment Plan (**Appendix D**)
Demonstrates that the oil pollution response arrangements are consistent with the national system for oil pollution preparedness and control.	Regulation 14 (8E).	Woodside OPEA (Australia)

7.9.2 Emergency Response Preparation

The Corporate Incident Coordination Centre (CICC), 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 ICC, under the leadership of the ICC DM, 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 OPEA (Australia).

Woodside has an Emergency Response Plan (ERP) in place relevant to the Petroleum Activities Program. The ERP provides procedural guidance specific to the activity and location of operations to control, coordinate and respond to an emergency or incident. For a well intervention activity the ERP will be a bridging document to the contracted rigs emergency documentation. This document provides a summary of 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 ERPs 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 OIM will assume overall onsite command and act as the Incident Controller (IC). All persons aboard the MODU/vessels will be required to act under the IC's directions. The MODU/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 center or WCC if requested by the IC.
- 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 center or WCC if requested by the IC.

The project vessels will have on-board equipment for responding to emergencies including but not limited to medical equipment, fire-fighting equipment and oil spill response equipment.

7.9.3 Hydrocarbon and Other Hazardous Materials Spill

A significant hydrocarbon spill during the Petroleum Activities Program is unlikely, but should such an event occur, it has the potential to cause serious environmental and reputational damage if not managed properly. The Nganhurra Operations Cessation Oil Pollution First Strike Plan, which provides operational response guidance to the activity/area and **Appendix D** of this EP, covers spill response for this Petroleum Activities Program (**Appendix H**).

In accordance with Woodside's Hydrocarbon Spill Preparedness and Response Procedure, the oil spill preparedness manager is responsible for the management of Woodside's oil spill response equipment, and for the maintenance of hydrocarbon 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 OPEA (Australia). AMSA and Woodside have a Memorandum of Understanding in place to support Woodside in the event of an oil spill.

The Nganhurra Operations Cessation Oil Pollution First Strike Plan provides immediate actions required to commence a response (**Appendix H**).

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

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 through the use of 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 in the event 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 ICC.

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 (CMT) 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 ICC 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

Testing of Woodside's capability to respond to incidents will be conducted in alignment with the Emergency and Crisis Management Procedure. 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 EM and CM exercise development. 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 we have 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 learnt or areas for improvement are identified and incorporated into emergency procedures where appropriate.

Table 7-5: Testing of response capability to incidents

	Response Testing
Level 1 Response	One Level 1 oil spill response exercise to be conducted within two weeks of commencing: • project activities (i.e. RTM removal) • each well intervention campaign. The drill will test elements of the recommended response identified in the Nganhurra Operations Cessation Oil Pollution First Strike Plan (**Appendix H**), in relation to the level of the incident.
	One Level 1 emergency drill to be conducted per week, during the activity.
Level 2 Response	Minimum one emergency management exercise biennially, except if a MODU is to be used for any activities in which a minimum one exercise per MODU will be conducted per year and one within one month of commencing a new activity in a new region.
Level 3 Response	The number of CMT exercises conducted each year are determined by the CEO, in consultation with the GM S&EM.

7.9.6 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 arrangement is adequately tested, the Security and Emergency Management Capability and Development Team ensures tests are conducted in alignment with the Hydrocarbon Spill Arrangements Testing Schedule.

Woodside's 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 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 (**Appendix H**). 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 Oil Pollution First Strike Plan will be tested in alignment with **Table 7-5**. 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. Specific performance outcomes and standards relating to testing of oil spill arrangements are detailed in **Table 7-6**.

7.9.7 Cyclone and Dangerous Weather Preparation

As the timing of some activities associated with the Petroleum Activities Program are not yet determined, it is possible that project activities will overlap with the cyclone season (November to April, with most cyclones occurring between January and March). If undertaking activities within cyclone season, the Contractor 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.

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).

7.10 Implementation Strategy and Reporting Commitments Summary

Table 7-6 provides a summary of 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.
	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 execution campaign, 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 MODU 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 well intervention 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** Monitoring information will be collected using Woodside tools and systems	**MC-IS 2.1.1** Monitoring reports including daily reports, periodic reports, risk observation cards, environmental discharge reports
	PS IS-2.2 Periodic review of the Woodside Environmental Knowledge Management System to maintain currency of receptor knowledge.	**MC-IS 2.2.1** Review records Corporate Environment Baseline Database

Implementation Strategy (IS) Performance Outcome	Implementation Strategy Performance Standard	Implementation Strategy Measurement Criteria
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.	**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 A pre-mobilisation inspection/audit report will be conducted by a relevant person prior to the commencement of subsea installation and pre-commissioning scopes.	**MC IS-3.4.1** Completed pre-mobilisation inspection/audit report.
	PS IS-3.5 At least one operational compliance audit relevant to applicable EP commitments will be conducted by a Woodside environment adviser for the subsea campaign	**MC IS-3.5.1** Completed Operational Compliance Audit report.
	PS IS-3.6 Contractor-specific HSE audits will be conducted of the primary installation vessels and associated support vessels.	**MC IS-3.6.1** Completed HSE audits report.
	PS IS-3.7 Vessel based HSE inspections will be conducted fortnightly by vessel HSE personnel	**MC IS-3.7.1** Completed HSE inspection checklists.
	PS IS-3.8 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-3.8.1** MODU or vessel compliance action register records that demonstrate tracking of audit findings.
	PS IS-3.9 Marine assurance will be undertaken in accordance with Woodside's internal assurance process and is mandatory for all vessels hired for Woodside.	**MC IS-3.9.1** 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.

Implementation Strategy (IS) Performance Outcome	Implementation Strategy Performance Standard	Implementation Strategy Measurement Criteria
PO IS-5 Woodside will perform regular reviews to monitor environmental performance and share knowledge and learning.	**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-5.2 Woodside's Drilling and Completions Environment Team is to perform six-monthly reviews of the effectiveness of the implementation strategy and associated tools	**PS IS-4.2.1** Records demonstrate six-monthly reviews of the effectiveness of the implementation strategy.
	PS IS-5.3 After action review conducted at the end of each well for learning and knowledge sharing, including review of environmental incidents as relevant.	**PS IS-5.3.2** After action review report
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 change relevant to this EP to be managed in accordance with Regulation 17 of the Environment Regulations	**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 internal and external reporting requirements relevant to this EP will be met.	**PS IS-7.1** Regular HSE meetings Monthly and quarterly HSE performance reports	**MC IS-7.1.1** HSE performance reports. Minutes of HSE meetings
	PS IS-7.2 Woodside will submit an environmental performance report to NOPSEMA (annually, with the first report submitted within 12 months of commencing the activity) .	**MC IS-7.2.1** Record of submission of environmental performance reports to NOPSEMA.
	PS IS-7.3 Woodside will submit a monthly recordable incident report to NOPSEMA.	**MC IS-7.3.1** Record of submission of monthly recordable incident report 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, 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 MODU 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 Planned and unplanned emissions and discharges will be documented, and records maintained.	**PS IS-9.1** The volumes of planned and unplanned emissions and discharges that could result from the risks described in **Section 6.6** and **6.6.2** are documented in the daily reports.	**MC IS-9.1.1** Records of planned and unplanned emissions and discharges are maintained in daily 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.

Implementation Strategy (IS) Performance Outcome	Implementation Strategy Performance Standard	Implementation Strategy Measurement Criteria
	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.
	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 inspection and/or 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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9 GLOSSARY AND ABBREVIATIONS

9.1 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©.
ALARP	A legal term in Australian safety legislation, it is taken here to mean that all contributory elements and stakeholders have been considered by assessment of costs and benefits, and which identifies a preferred course of action
API (gravity)	is 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 – this is 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 µPa (RMS)	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 µPa), 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 µPa^2/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 µPa^2.s	Normal unit for sound exposure level
Demersal	Living close to the floor of the sea (typically of fish)
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
EC50	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 the starfishes, sea urchins, and sea cucumbers, which have an internal calcareous skeleton and 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 carried out
Environment Regulations	OPGGS (Environment) Regulation 2009
Environmental approval	The action of approving something, which has the potential to have an adverse impact on 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
IC50	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 comp'ny's environmental performance. An EMS provides a framework for managing environmental responsibilities so that they become more efficient and more integrated into overall business operations.

Term	Meaning
LC50	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 minimize 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 minimization of accidental discharge of such substances
Meteorology	The study of the physics, chemistry, and dynamics of the ea'th'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
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
AHO	Australian Hydrographic Office
AHS	Australian Hydrographic Service
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
APASA	Asia Pacific Applied Science Associates
API	American Petroleum Institute
APPEA	Australian Petroleum Production and Exploration Association
ASAP	As soon as practicable
ATSB	Australian Transport Safety Bureau
AusSAR	Australian Search and Rescue
bbl	Oil barrel
BoM	Bureau of Meteorology
BOP	Blow-out Preventer
CICC	Corporate Incident Communication Centre
CMR	Commonwealth Marine Reserve
CSIRO	Commonwealth Scientific and Industrial Research Organisation
CV	Company Values
dB	Decibel
DBCA	Department of Biodiversity, Conservation and Attractions
DEC	Department of Environment and Conservation
DEWHA	Department of Environment, Water, Heritage and the Arts
DMIRS	Department of Mines, Industry Regulation and Safety
DMP	Department of Mines and Petroleum
DNV	Det Norske Veritas
DoD	Department of Defence
DoEE	Department of Environment and Energy
DoF	Department of Fisheries
DoT	Department of Transport
DP	Dynamically Positioned
DPAW	Department of Parks and Wildlife
DPIRD	Department of Primary Industries and Regional Development
DSEWPaC	Department of Sustainability, Environment, Water, Population and Communities
DWER	Department of Water and Environmental Regulation
EC50	half maximal effective concentration
EMBA	Environment that May Be Affected

Abbreviation	Meaning
EMS	Environmental Management System
ENVID	Environmental hazard Identification
EP	Environment Plan
EPBC Act	Environment Protection and Biodiversity Conservation Act, 1999.
ERP	Emergency Response Plans
FPSO	Floating Production, Storage and Offtake vessel
g/m^2	Grams per square metre
GP	Good Practice
HSE	Health, Safety and Environment
HZ	Hertz
IAP	Incident Action Plan
IMO	International Maritime Organisation
IMS	Invasive Marine Species
IOPP	International Oil Pollution Prevention
IPIECA	International Petroleum Industry Environmental Conservation Association
ISPP	International Sewage Pollution Prevention Certificate
ITF	Indonesian ThroughFlow
ITOPF	International Tanker Owners Pollution Federation
IUCN	International Union for Conservation of Nature
KEF	Key Ecological Feature
km	Kilometre
KPI	Key Performance Indicator
L	Litres
LC50	Lethal concentration, 50%
LCS	Legislation, Codes and Standards
LNG	Liquefied Natural Gas
MODU	Mobile Offshore Drilling Unit
MoU	Memorandum of Understanding
MPA	Marine Protected Areas
MUZ	Multiple use zone
nm	Nautical mile (1852 m) a unit of distance on the sea
NOAA	National Oceanic and Atmospheric Administration
NOECs	No-observed-effect concentrations
NOPSEMA	National Offshore Petroleum Safety and Environmental Management Authority
NOPTA	National Offshore Petroleum Titles Administrator
OCNS	Offshore Chemical Notification Scheme
OIM	Offshore Installation Manager
OPEA	Oil Pollution Emergency Arrangements
OPEP	Oil Pollution Emergency Plan

Abbreviation	Meaning
OPGGS Act	Offshore Petroleum and Greenhouse Gas Storage Act
OSPAR	Oslo and Paris Commission for the Convention for the Protection of the Marine Environment of the North-East Atlantic
PJ	Professional Judgement
PPA	Pearl Producers Association
ppb	Parts Per Billion
ppm	Parts Per Million
PTW	Permit To Work
RBA	Risk Based Analysis
RCC	Rescue Coordination Centre
RMS	Root Mean Square
ROV	Remotely Operated Vehicle
SIMAP	Spill Impact Mapping and Analysis Program
SOPEP	Ship Oil Pollution Emergency Plan
SPL	Sound Pressure Levels
SV	Societal Values
TPH	Total Petroleum Hydrocarbons
UKOOA	United Kingdom Offshore Operators Association
WA	Western Australia
WAF	Water Accommodated Fractions
WAFIC	Western Australian Fishing Industry Council
WCC	Woodside Communication Centre
WEL	Woodside Energy Ltd
WHA	World Heritage Area
WLSADS	Woodside Well Location and Site Appraisal Data Sheet
WMS	Woodside Management System
WOMP	Well Operations Management Plan
Woodside	Woodside Energy Ltd

APPENDIX A: WOODSIDE ENVIRONMENT & RISK MANAGEMENT POLICIES

APPENDIX B: RELEVANT REQUIREMENTS

APPENDIX C: EPBC ACT PROTECTED MATTERS SEARCH

APPENDIX D: OIL SPILL PREPAREDNESS AND RESPONSE STRATEGY SELECTION AND EVALUATION

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

APPENDIX F: STAKEHOLDER CONSULTATION

APPENDIX G: DEPARTMENT OF ABORIGINAL AFFAIRS (DAA) HERITAGE INQUIRY SYSTEM RESULTS

APPENDIX H: FIRST STRIKE PLAN