Greater Enfield Tieback Environment Plan Summary

Development Division

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Revision 1

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1. INTRODUCTION

Woodside Energy Ltd (Woodside), as nominated Titleholder (on behalf of the Joint Venture comprising Woodside Energy Ltd and Mitsui E&P Australia Pty Ltd), under the *Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009 (Cth)* (referred to as the Environment Regulations), proposes to undertake drilling, subsea installation and pre-commissioning for the project known as the Greater Enfield Tieback, hereafter referred to as the Petroleum Activities Program. The Petroleum Activities Program is being undertaken to develop proven hydrocarbon reserves in permit areas WA-28-L and WA-59-L. These reserves will be accessed by a series of wells (and associated subsea infrastructure) which will be tied back to the existing *Ngujima-Yin* floating production, storage and offloading (NY FPSO) facility.

This Environment Plan (EP) Summary has been prepared to meet the requirements of Regulations 11(3) and 11(4) of the Environment Regulations, as administered by the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA). This document summarises the Greater Enfield Tieback Environment Plan (the EP) accepted by NOPSEMA under Regulation 10A of the Environment Regulations.

1.1 Defining the Activity

The Petroleum Activities Program is to be undertaken in permit areas WA-28-L and WA-59-L, and comprises the following:

- Development drilling and completions of up to 12 wells, including:
    - six production wells
    - six water injection wells
- Subsea hardware installation and pre-commissioning
- Flowline installation and pre-commissioning, including a rigid production flowline (WA-28-PL).

2. LOCATION OF THE ACTIVITY

The Petroleum Activities Program will primarily occur within Woodside operated production licences WA-28-L and WA-59-L in the Exmouth Basin, located approximately 60 km north, north-west of the town of Exmouth (**Figure 2-1**). The pipeline route (flowlines and umbilicals) associated with the project will also traverse through production licence WA-32-L (Woodside Energy Ltd and BHP Billiton Petroleum (Australia) Pty Ltd as Operator).

The Operational Area (**Figure 2-1**) defines the spatial boundary of the Petroleum Activities Program. For the purposes of this EP, the Operational Area encompasses a radius of 4,000 m from all project related infrastructure (well locations and subsea infrastructure).The 4,000 m Operational Area allows a reasonable distance for Mobile Offshore Drilling Unit (MODU) and subsea infrastructure installation activities including simultaneous operations (SIMOPS) management. The Operational Area for drilling activities includes a 500 m designated petroleum safety zone around the relevant well centre location to manage vessel movements and interaction. The 500 m petroleum safety zone is under the control of the MODU.

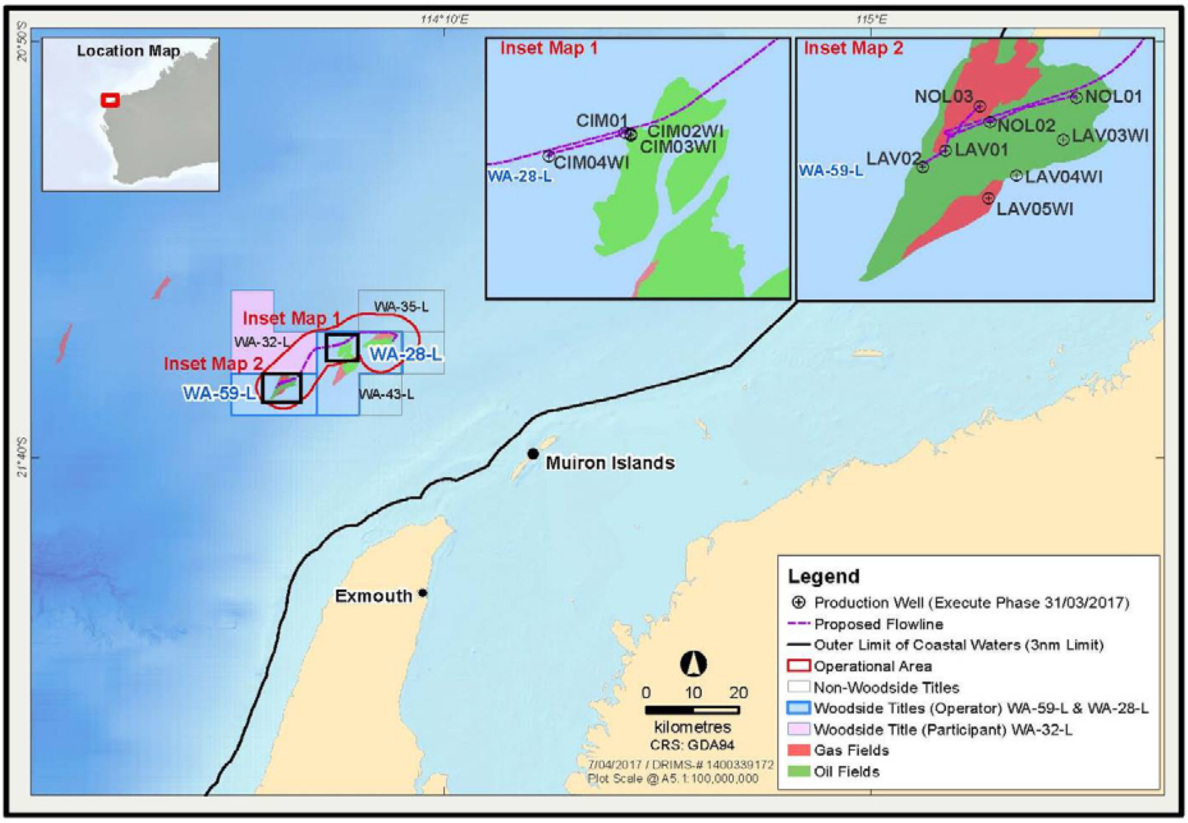

Figure 2-1: Location of the Petroleum Activities Program and Operational Area

Approximate location details for the Petroleum Activities Program are provided in **Table 2-1**. Closest landfall to the Operational Area is at the North West Cape, which lies on the Australian mainland approximately 33 km south, south-east of the Operational Area.

Table 2-1: Approximate locations details for the Petroleum Activities Program

Activity	Water Depth (m)*	Latitude†	Longitude†	Production Licence
Well locations				
LAV01	845	21° 31' 23"S	113° 50' 40"E	WA-59-L
LAV02	849	21° 31' 36"S	113° 50' 22"E	WA-59-L
LAV03WI	805	21° 31' 15"S	113° 52' 09"E	WA-59-L
LAV04WI	804	21° 31' 43"S	113° 51' 33"E	WA-59-L
LAV05WI	820	21° 32' 00"S	113° 51' 12"E	WA-59-L
NOL01	804	21° 30' 42"S	113° 52' 19"E	WA-59-L
NOL02	824	21° 31' 01"S	113° 51' 13"E	WA-59-L
NOL03	826	21° 30' 49"S	113° 51' 06"E	WA-59-L
CIM01	530	21° 26' 23"S	113° 57' 56"E	WA-28-L
CIM02WI	526	21° 26' 25"S	113° 58' 00"E	WA-28-L
CIM03WI	526	21° 26' 26"S	113° 58' 01"E	WA-28-L
CIM04WI	562	21° 26' 41"S	113° 57' 01"E	WA-28-L
Rigid Production Flowline Route (WA-28-PL)				
Starting Point – tie in point at the Multiphase Pump (MPP)	844	21° 31' 10.37482"S	113° 50' 41.61352"E	WA-59-L
End Point - RESDV at NY FPSO	342	21° 26’ 2.49228”S	114° 04’ 1.34888”E	WA-28-L

3. DESCRIPTION OF THE ACTIVITY

3.1 Purpose of the Activity

The Greater Enfield Tieback will produce hydrocarbons from three hydrocarbon fields: Norton-over-Laverda (NOL), Laverda Canyon (LAV) and Cimatti (CIM). The project incorporates a subsea tie-back to the existing NY FPSO and integrates the oil production, water injection and gas lift systems.

The Project currently has an estimated production field life of 10 years and therefore associated subsea infrastructure is expected to remain in place for at least this period of time.

3.2 Timing of the Activity

Drilling is scheduled to start between Q4 2017 and end Q1 2018 and is expected to take up to two and a half years in total (including mobilisation, demobilisation and contingency). Woodside intends to undertake SIMOPS during the Petroleum Activities Program, with the subsea installation and associated activities occurring concurrently with the drilling campaign. SIMOPS may also occur as part of drilling operations with other vessels accessing well infrastructure as part of the drilling activity, while the rig is on location. The Petroleum Activities Program is expected to take up to two and a half years to complete.

Timing and duration of these activities is subject to change due to project schedule requirements, MODU/vessel availability, unforeseen circumstances and weather.

The EP has risk assessed the Petroleum Activities Program as occurring throughout the year (all seasons) to provide operational flexibility for requirements and schedule changes and vessel / MODU availability.

3.3 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 sections and will include as a minimum:

- Deep-water semi-submersible MODU for the drilling and completion of wells;
- Intervention support vessel or light construction vessel for installation of some well infrastructure;
- Installation Support Vessels (ISVs) for the installation and pre-commissioning of the flowlines and subsea infrastructure;
- Diving Support Vessel (DSV) for installation of subsea infrastructure and pre-commissioning activities;
- Activity support vessels for transportation of hardware from port/staging area to the operational area and installation vessels; and
- Activity support vessels for general re-supply and support for the MODU and the ISVs.

During peak activity periods (e.g. when drilling operations and key subsea scopes run concurrently) Woodside anticipates multiple project vessels present within the Operational Area. Based on current planning (and for the purposes of impact assessment) vessels would include one MODU and three drilling activity support vessels (or light construction vessel) and an ISV/DSV and two subsea activity support vessels.

3.3.1 MODU

A MODU will be utilised for each drilling and completion activity of the Greater Enfield Project. The Atwood Condor, an ultra-deepwater dynamically positioned semisubmersible

MODU is currently contracted to the Greater Enfield Project. Specifications of the Atwood Condor are summarised in **Table 3-1**.

Due to variabilities, such as contractual and operational matters, the MODU used may be subject to change. In the event that this occurs, a MODU meeting the required technical specifications and with similar specifications as listed below will be utilised. Whilst the Atwood Condor is a dynamically positioned MODU, drilling activities could be undertaken utilising a moored MODU. Therefore the scope of this EP covers the use of a MODU with either station keeping specification.

Table 3-1: Current MODU specification ranges

Component	Specification Range
Rig Type/Design/Class	Ultra Deepwater Semi-submersible MODU
Accommodation	200 persons
Station Keeping	Dynamically Positioned
Water Depth	Up to 3050 m
Drilling Depth	Up to 12,200 m
Bulk Material 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

Holding Station: Dynamic Positioning (DP) MODU only

Dynamic positioning uses satellite navigation and radio transponders in conjunction with thrusters to maintain the position of the MODU at the required location. Information relating to the position of the MODU is provided via a number of seabed transponders, which emit signals that are detected by receivers on the MODU 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 the drilling at each well and at the end are recovered, generally by remotely operated vehicle (ROV). Clump weights are recovered if practicable to do so or may be left in situ.

Holding Station: Mooring Installation and Anchor Holding Testing (Moored MODU only)

A moored MODU utilises a mooring system to maintain the rigs position while drilling, using a system of chain, wire and fibre rope and anchors, which may be pre-laid before the MODU arrives at the location or laid utilising the rig system with support of an anchor handling vehicle (AHV). A mooring analysis will be undertaken to determine the specific mooring layout for the Petroleum Activities Program at each well location. If required, MODU mooring will be in accordance with American Petroleum Institute (API) 2SK (Design And Analysis Of Station-Keeping Systems For Floating Structures) and aligned with the Australian Petroleum Production and Exploration Association (APPEA) guideline MODU Mooring in Australian Tropical Waters of which Woodside was a key contributor.

Installation of mooring anchors will involve some disturbance to the seabed. AHVs are used in the deployment and recovery of the mooring system.

Anchor Proof Testing (Moored MODU only)

As part of mooring installation, anchors are tensioned/pre-loaded by an AHV or similar vessel to ensure adequate embedment. Depending on specifics of the mooring design, additional holding testing may be conducted at the well locations where additional load is applied to the anchors. This is typically undertaken by the MODU through a cross-tensioning process but could be undertaken as part of pre-lay mooring activities.

3.3.2 Subsea Installation Vessels

The Petroleum Activities Program subsea and flowline installation scopes of work will require a variety of subsea ISVs with sufficient capacity to accommodate hardware and equipment such as flowlines, flexible jumpers, electric hydraulic umbilical (EHU), MPPs and the pre-commissioning/dewatering spreads.

A typical ISV for subsea and flowline installation will be a dynamically positioned vessel (usually DP2 Class) equipped with a primary differential global surface positioning system (DGPS) and an independent secondary DGPS backup system.

For subsea installation including flexibles and umbilicals, vessels are equipped with a variety of material handling equipment which includes cranes, winches, ROVs and ROV Launch and Recovery Systems (LARS). Lifting operations involve loading and unloading of equipment from support and supply vessels onto the ISV and subsequently onto the seabed. Cranes are typically equipped with active heave compensation and auto tension modes and have lifting capacities in excess of expected lifting loads to be encountered during operations.

For rigid flowline installation, a typical ISV will incorporate an enclosed or below deck firing line along the length of the vessel. The firing line incorporates welding, non-destructive testing (NDT) and field joint coating station used to construct the flowline. The constructed flowline is then lowered to the seabed via the vessels stinger which assists to supports the weight of the flowline as it transitions to the seabed. The vessel will be equipped with a variety of material handling equipment which includes cranes, winches and ROV LARS. Lifting operations will predominately involve the lifting of pipe joints onto the ISV to be inserted into the firing line to construct the flowline. The pipe will be lifted from supply vessels and stored on the vessel. ROV's will be launched to periodically inspect the flowline as it is laid to the seabed.

3.3.3 Activity Support and Other Vessels

During the Petroleum Activities Program, the MODU and ISVs will be supported by other vessels, such as general support vessel(s) and AHVs.

Support vessels are used to transport equipment and materials between the MODU and ISVs and Port (e.g. Dampier, Exmouth or international locations of fabrication/supply) or staging areas. One vessel will be present at the MODU on standby at all times and other/s will transit out of the Operational Area to Port for emergency and non-routine operations.

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

The support vessels are also available to provide support, should an environmental event occur (e.g. a hydrocarbon spill to the marine environment).

3.3.4 Vessel Refuelling

The MODU, ISVs and activity support vessels will use diesel-powered generators for power generation and diesel for their main engines. Support vessels may also be duel-fuelled Liquefied Natural Gas (LNG-powered).

The MODU, ISVs and potentially other activity support vessels will be refuelled via support vessels, as required. 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.

3.4 Other Support

3.4.1 Remotely Operated Vehicles

The MODU, ISVs and support vessels may be equipped with a ROV system that is maintained and operated by a specialised contractor aboard the vessel. ROVs may be used prior to and during subsea and drilling operations, for activities such as:

- Anchor proof testing monitoring;
- Pre-drill seabed and hazard survey;
- Subsea installation and placement assistance;
- Ongoing visual monitoring;
- Blowout preventer (BOP) land-out and recovery;
- BOP well control contingency; and
- Post-well seabed survey.

The ROV can be fitted with various tools and camera systems that can be used to capture permanent records (both still images and video) of the operations and immediate surrounding environment. Hydraulic arms on the ROV enable the use of tools to undertake maintenance or complete installation work on subsea equipment. Minor hydraulic releases may occasionally occur, for example if hydraulic lines are damaged during subsea work (unplanned) or when the ROV performs a hot-stab on subsea equipment or for tool change-out (planned).

ROVs may also be used during subsea hardware and flowline installation for activities such as:

- Pre-completions wellhead/site inspection (seabed and hazard survey);
- Monitoring of subsea infrastructure (including flowline) touch-down onto the seabed;
- Corrections of free-spans (parts of the laid flowline not touching the seabed) during flowline installation;
- Monitoring of subsea infrastructure, gas watch, and unplanned discharges;
- Operation of subsea infrastructure;
- Post-well seabed and ‘as-laid’ / ‘as-built’ surveys; and
- Connection of subsea infrastructure.

The ROV is deployed from the vessel in a tether management system (TMS), or an umbilical and TMS that provides electrical power, data transmissions and operation transmissions to and from the ROV.

3.4.2 Helicopters

During the Petroleum Activities Program, crew changes are undertaken using helicopters as required. Helicopters may be refuelled on the heli-deck. 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.

All other helicopter operations have been excluded from this EP on the basis that (with the exception of refuelling) helicopter operations within the Operational Area is limited to the landing and take-off of the helicopter on the heli-deck.

3.5 Drilling Activities

Well construction activities are conducted in five main stages, as described below. Detailed well design will be submitted to NOPSEMA as part of the Well Operation Management Plan (WOMP), as required under the *Offshore Petroleum and Greenhouse Gas Storage (Resource Management and Administration) Regulations 2011*.

3.5.1 Ongoing MODU Activities

The MODU is refuelled approximately once a month via support vessels. Other fuel transfers that may occur on-board the MODU include refuelling of cranes, helicopters or other equipment as required.

The MODU and activity support vessels will display navigational lighting. Lighting levels will be determined primarily by operational safety and navigational requirements under relevant legislation, specifically the *Navigation Act 2012*. The MODU and supply vessels will be lit to maintain operational safety on a 24 hour basis.

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

Loading and back-loading is undertaken using cranes on the MODU to lift materials in appropriate offshore rated containers (ISO tanks, skip bins, containers) between the MODU and support vessel.

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

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

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

3.5.2 Top Hole Section Drilling

The Petroleum Activity Program drilling commences with the top hole section, as follows:

- The MODU arrives and establishes position over the well site;
- Top hole sections are drilled riserless using seawater with pre-hydrated bentonite sweeps/guar gum (PHG) sweeps or drilling fluids to circulate drilled cuttings from the wellbore;
- Once the top-hole sections are drilled, steel tubulars (called conductor or casing) are inserted into the wellbore to form the surface casing, and secured in place by pumping cement into the annular space back to the seabed, which may involve a discharge of excess cement at the seabed; and

- At some well locations, top-hole section drilling may be done using the batch drilling process. Batch drilling is where a number of wells are drilled together and the same section of each hole is drilled one after another, before going back and drilling the next section of each well until the target depth is reached for each well at the well centre.

3.5.3 BOP and Marine Riser Installation

After setting the surface casing, a BOP is installed on the wellhead to provide a means for sealing, controlling and monitoring the well during drilling operations. The operation of the BOP components uses open hydraulic systems (utilising water-based BOP control fluids) and each time the BOP is operated (including testing), small volumes (~2000 – 2200 L of water based fluid containing 60-66 L of control fluid additive) of BOP control fluid are discharged to the marine environment. Hydraulic fluid used for operation of the BOP rams is subject to the chemical assessment.

A marine riser is installed to provide a physical connection between the well and MODU. This enables a closed circulation system to be maintained where weighted Water Based Mud (WBM) or Non Water Based Mud (NWBM) drilling fluids and cuttings can be circulated from the wellbore back to the MODU via the riser.

3.5.4 Bottom Hole Section Drilling

A closed system (riser in place), is used for drilling bottom-hole sections to the planned wellbore Total Depth (TD). Bottom hole sections are planned to be drilled using a combination of WBM and NWBM drilling fluids.

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

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

Cementing operations are also undertaken to maintain well control and structural support of the casing as required, set a plug in an existing well in order to sidetrack and/or plug a well so that it can be abandoned. Cements are transported as dry bulk to the MODU by the support vessels, mixed as required by the cementing unit on the MODU and are pumped by high pressure pumps to the surface cementing head then directed down the well.

Excess cement (dry bulk) after well operations are completed, will either be held on-board and used for subsequent wells; provided to the next operator at the end of the program or is infrequently discharged to the marine environment along with cement that does not meet technical requirements.

3.5.5 Formation Evaluation

Formation evaluation is the interpretation of a combination of measurements taken inside a wellbore to detect and quantify hydrocarbon presence in the rock adjacent to the well once TD is reached. Formation Evaluation While Drilling (FEWD) is the process by which the presence and quantity of hydrocarbon in a reservoir is measured according to its response to radioactive and electrical input. FEWD tools will be incorporated into the drillstring during development drilling and may include gamma ray, Directional Deep resistivity, callipers, density-neutron, Sonic and tools which can measure formation pressures. Some FEWD tools contain radioactive sources, however, no radioactive material will be released to the environment and radiation fields are not generally detectable outside the tool when the tool is not energised, therefore, they do not present an environmental risk.

Wireline logging is not planned for the purposes of formation evaluation. If required, a wireline Ultrasonic Imaging Tool (USIT) or Cement Bond Log (CBL) may be run in some wells to estimate casing wear or cement integrity.

3.5.6 Completion Activities

Once a well has been drilled, well completion activities will be undertaken including installation of sand control screens, production tubing and xmas tree, followed by well suspension. Due to the high likelihood of formation failure during operation, all lower completions require down-hole sand control.

Installation of well infrastructure will consist of deploying the Flow Support Base (FSB) onto an already installed 36" conductor, followed by verification testing of the FSB connector. After the flow base is installed, the horizontal xmas tree will be deployed and locked to the 18 ¾" wellhead, followed by verification testing of the 18 ¾" connector, flowline connector and Subsea Control Module as required. The installation will be supported by ROV with installation by wire from rig or vessel.

Following drilling of the reservoir section, stand-alone screens will be run. Swell packers will also be deployed along the stand-alone screen section to restrict annular flow and minimise the risk of screen erosion. Inflow Control Devices will be used in some of the lower completions to help balance inflow along high angle reservoir sections. To ensure adequate injectivity, a delayed breaker treatment will be circulated around the sand control screens in water injection wells.

Cimatti and Laverda lower completions are planned as single laterals. The Norton field will utilise multi-lateral completions. Three laterals are planned for each Norton well; these reservoir sections will also be completed with stand-alone screens.

Conventional upper completion designs are proposed for all fields; 5 ½" and 7" tubing sizes are planned. A down-hole pressure gauge will be run in each well to help support well performance optimisation. Tubing retrievable surface controlled subsurface safety valves will also be run in each well.

Prior to installing the upper completion, wells will generally be displaced from the drilling fluid system to completion brine. A chemical cleanout fluids train will be circulated between the two fluids, then seawater or brine circulated until operational cleanliness specifications are met. For completion brine, this will typically be filtered brine with <70 Nephelometric turbidity units (NTU) and/or <0.05% Total Suspended Solids (TSS). This results in a brine and seawater discharge after this operation. In the reference case, there is no plan to have brine contaminated with NWBM as the reservoir section will be drilled with WBM. However, should there be residual completion/clean-up brine contaminated with NWBM drilling fluid or base oil, it will be captured and stored on the MODU for treatment prior to discharge, or returned to shore if treatment is not possible. For initial clean-up fluids (usually returned to the rig within the first few hours of circulation) which are predominantly drilling mud (concentration of mud compared to brine is a higher percentage of mud); NWBM will be retained and returned to shore and WBM will be discharged as per requirements in this EP.

During completions activities a Casing Orientation Tool (COT) may be used, which allows real time orientation telemetry to be sent from downhole. This COT is much like a measurement-while-drilling tool (MWD), and contains 4 batteries each containing approximately 1.9 grams of lithium. Ultimately these batteries are left downhole, cemented as part of the casing string. The battery will have no charge after approximately 30 days. Other indicators may also be used such as Pip Tags (A pip tag is a weak gamma ray source and Chemical Tracers).

Following facility start-up and as part of hydrocarbon commissioning, production wells will be cleaned-up back to the FPSO. Water injection will also be initiated. Production and injection activities do not form part of the scope of this EP and will be addressed in the NY Operations EP.

Installation of Well Infrastructure via Vessel

There is potential that installation of some well infrastructure (FSB and Horizontal Xmas Tree (HXT)) may be installed using an intervention support vessel or light construction vessel instead of the MODU. The activity is as described above, except will utilise a vessel (instead of MODU) with an active heave compensated crane, work-class ROV and sufficient deck space/capacity. The installation will not include well access (i.e. no change to in-place well barriers).

3.6 Rigid Flowline Installation Activities

3.6.1 Pre-lay Survey

The flowline installation contractor will perform a pre-lay survey prior to commencement of the flowline installation. The pre-lay survey will be performed by a dedicated pre-lay survey vessel (which is typically similar in size to support vessels) or potentially the ISV.

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

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

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

3.6.2 Underwater Acoustic Positioning

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

3.6.3 Installation of Flowline Supporting Structures

If required, supporting structures (e.g. buckle initiators and Flowline End Termination (FLET) foundations) will be installed by the ISV or pre-lay survey vessel prior to commencing the flowline installation. Placement of buckle initiators at regular intervals along the flowline route limits the amount of pipe that can feed into each buckle site thus mitigating the likelihood of a wet buckle. FLET foundations provide a solid foundation for the FLET structure to be landed on.

In the event such supporting structures are required they will be transported to the field/staging area by general cargo vessel/heavy lift ship and then transferred by supply vessel to the ISV on site for installation.

The structures will be lifted off the ISV and lowered to the seabed by the ISV main crane. The structures will be positioned accurately on the seabed using the installed LBL array or USBL. An ROV from the ISV will be used to orientate the structures during installation.

3.6.4 Flowline Initiation / Initiation Anchor Deployment

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

3.6.5 Span Rectification

Spans (i.e. undulations in the seabed that do not provide sufficient support to the flowline) identified during the geophysical survey of the flowline route will be rectified prior to the commencement of flowline installation by the installation of structures such as concrete mattresses. The dimensions for each concrete mattress are typically 12 m by 3 m. The concrete mattresses will be transported either directly by ISV or by a support vessel to the ISV on site for installation. The mattresses will be lifted off the ISV and lowered to the seabed by the ISV main crane. The ROV from the ISV will be used to orientate the mattresses during installation.

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

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

3.6.6 Rigid Flowline, Inline Tee and FLET Installation

The flowline installation contractor will mobilise an ISV for flowline installation which is likely to be a typical DP S-lay ISV. The vessel will assist in installing the flowlines to the seabed and associated inline tees and FLETs. Details of the rigid flowline infrastructure is summarised in **Table 3-2** below.

Table 3-2: Rigid flowline infrastructure

Description	Detail	Dimensions (approx.)
Carbon Steel Rigid Flowlines (pipelines)	16" Production Line	31 km long
	10" Water Injection Line	31.6 km long
Subsea structures	Production In Line Tee (ILT)	10 m x 6.5 m x 3 m
	Water Injection ILT	12 m x 10 m x 4.5 m
	FLETs	17 m x 12 m x 5 m (LAV Prod) 17 m x 12 m x 6 m (FPSO Prod) 12 m x 10 m x 4.5 m (LAV WI) 12 m x 10 m x 4.5 m (FPSO WI)
	PLR (subsea pig launch and receive facility)	Incorporated within FLET
	Flowline supporting structures	Various

The ISV will operate in DP throughout flowline installation activities and will therefore, not require anchoring. In S-Lay installation, the constructed flowline is continuously lowered off the stern of the vessel to the seabed as the ISV moves forward. Tension is applied to the flowline by the vessels tensioners and forward DP thrust to prevent the flowline from buckling as it is lowered to the seabed. The ISV will proceed forward at a speed of approximately 2.5-3 km per day.

The flowline will be laid initially without the FLET installed. ILT will be installed during the flowline installation. They will be installed aft of the firing line and laid with the flowline.

The ISV will then return and recover the ends of the flowlines and install the FLETs, to facilitate initiation and termination of the flowline, hydrotesting following installation of the flowline and connection of the flowline to the flexible risers and wells.

A wet buckle is an event which causes pipeline rupture and flooding with seawater. A contingency spread will be made available to be deployed to the flowline to displace any seawater in the event a wet buckle occurs during installation.

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

Other activities included in general flowline installation include:

- Welding and non-destructive testing on board;
- field joint coating and anode attachment;
- Line pipe transport from port to the ISV; and
- As-laid and as-built surveys (data gathering for free-span rectification, deviations from straightness etc.).

3.6.7 Flood, Clean, Gauge and Hydrotesting Pressure Testing

The rigid production and water injection flowlines will be laid empty (i.e. filled with air). They will then be flooded, cleaned, gauged and tested (FCGT) by the ISV or a separate support vessel.

As part of FCGT activities, the lines will first be flooded with treated seawater to fill the lines. Cleaning and gauging of the lines will then be performed by propelling a pig train through the flowline utilising flooded filtered treated seawater. The flowlines will be pigged in a controlled manner to clean the internal surface of the flowline and to determine if any unacceptable restrictions and/or obstructions exist in the line. For the rigid production line, an in-line inspection (ILI) to determine a baseline position of the line for future inspection will also be performed by including an intelligent pig as part of the FCGT pig train.

Pigging is performed by using a series of pigs which run through the flowline utilising chemically treated seawater delivered via a downline from the vessel to drive the pigs. The chemically treated seawater will have sufficient chemical concentration to provide a minimum level of protection for the lines, and is proposed to be a mix of seawater and appropriate preservation chemical to control the potential for corrosion and to protect the interior of the flowline from biofouling (proposed to be Hydrosure O3670-R). Treated seawater composition is designed specifically for use in this application, and is commonly used in flowline installation around the world.

The pig train will consist of bi-directional pigs, some fitted with a gauge plate or sensor for verifying the internal diameter of the flowline and indicates the presence of buckles. The water injection flowline pig train will also contain a calliper pig.

As the lines are required to first be filled with treated seawater, the full volume of the lines will be displaced and therefore discharged as a result of the FCG and ILI pig runs. As treated seawater will separate each pig in the train, it is estimated an additional ~1% of the line volume will also be discharged. Treated seawater will also be pumped behind the pig train to refill the lines. Approximately 20% overpumping is required to ensure the pig train has successfully arrived at the pig receiver and therefore this amount will also require discharge. The estimated discharge volumes, including chemical additives are shown in **Table 3-3**. There is also potential that some debris remaining from pipeline installation activities within the line may be discharged with this water.

At the completion of the FCGT/ILI pigging when the pigs are received, the gauge plates will be checked and the data validated from the ILI Pig (production line) or Calliper Pig (water injection line). The lines are left filled with treated seater for preservation purposes. Once verified the production flowline will undergo final fill and preservation in preparation for hydrocarbon commissioning. This will involve an additional pig run to displace the inhibited water in the lines and fill the line with a treated seawater and monoethylene glycol (MEG) mix. The MEG is required to reduce the risk of hydrates during start-up. Hydrosure will also be required for preservation (Refer **Table 3-3**) and a small amount of pre-film agent added for additional flowline protection. A dye will also be added for leak detection. The water injection line is not required to be MEG filled and therefore will remain filled with inhibited seawater at the completion of the FCGT activity.

Hydrotesting of the rigid pipelines will be conducted at a later point of time where flexible installation is complete.

In the event of an issue that indicates remedial construction work is required, or in case of a pipeline wet buckle scenario during pipelay, contingency plans will be implemented and the affected lines may be dewatered to sea to allow the repairs to be undertaken. The potential contingency discharge volumes are also shown in **Table 3-3.**

FCGT activities will be undertaken in accordance with Engineering Standard Pipelines Flooding, Cleaning, Gauging and Hydrotesting. All chemicals used in FCGT activities will be subject to a chemical selection assessment process.

Table 3-3: Estimated Discharges from FCGT and Subsea Commissioning Activities (including contingency)

Activity	Description	Line Discharge %	Line Volume Discharge (m^3)	Hydrosure Volume (L)	Fluorescein Volume (L)	MEG %	MEG Volume (m^3)
1	Production FCG-ILI Ahead of Pigs	100%	3000	1200	0	0%	0
	Production FCG-ILI Between Pigs	1%	30	12	0	0%	0
	Production FCG-ILI Behind Pigs	20%	600	240	0	0%	0
	Production MEG Fill Ahead of Pig	100%	3000	1200	0	0%	0
	Production MEG Behind Pig	10%	300	165	15	30%	90
	Production FCG-ILI-MEG Fill Total^	**231%**	**6930**	**2817**	**15**	**-**	**90**
2	Water Injection FCG Ahead of Pigs	100%	1300	520	0	0%	0
	Water Injection Between Pigs	1%	13	5.2	0	0%	0
	Water Injection FCG Behind Pigs	20%	260	143	13	0%	0
	Water Injection FCG Total	**121%**	**1573**	**668.2**	**13**	**-**	**0**
3	Production Hydrotests (LAV)	NA	8	4.4	0.4	80%	6.4
	Production Hydrotests (Rigid + CIMA)	NA	120	66	6	30%	36
	Water Injection Hydrotests	NA	80	44	4	0%	0
	Hydrotesting Total Discharge	**NA**	**208**	**114.4**	**10.4**	**-**	**42.4**
4	Production Flowback Flex Connections	PER CONNECTION	0.1	0.055	0.005	80%	0.08
	Gas Lift Flex Connections	PER CONNECTION	0.1	0.055	0.005	50%	0.05
	CWF Flexible Connections	PER CONNECTION	0.1	0.055	0.005	0%	0
	Flexible Connection Total Discharge	**-**	**3.6**	**1.98**	**0.18**	**-**	**1.74**
5	14" Production Riser SW Flush	100%	95	52.25	0	0%	0
	14" Production Riser MEG Flush	0%	0	0	0	30%	0
	10" Production Riser SW Flush	100%	45	24.75	0	0%	0
	10" Production Riser MEG Flush	0%	0	0	0	30%	0
	8" WI Riser SW Flush	100%	60	33	3	0%	0
	Riser Flushing Total Discharge	**-**	**200**	**110**	**3**	**-**	**0**

7	**(Contingency) Wet buckle Dewater**	**120%**	**3600**	**1440**	**0**	**0%**	**0**
8	**(Contingency) Dewater**	**110%**	**3300**	**1815**	**165**	**30%**	**990**

^two separate activities/discharge events (i.e. first event =121% discharge, second event = 110%. Refer explanatory text)

3.7 Subsea structure and Umbilical, Risers and Flexible (URF) installation, tie-in and pre-commissioning activities

Flexibles and umbilicals will be installed in two campaigns. The first campaign will use an ISV, where flexibles and umbilicals stored on reels will be installed via the vessels moonpool over a chute, or potentially via the vessels Vertical Lay System (VLS). The second campaign will install flexibles and umbilicals both from reels and from the two carousels on board the vessel. Flexibles and umbilicals will be installed using a vertical lay system via the moonpool or over the side.

Flexibles will either be pre-filled with a seawater and methanol mix, or free flooded and then flushed with treated seawater. Umbilicals will be installed pre-filled, with control fluid in the hydraulic lines and MEG (90% MEG, 10% water) in the chemical lines.

3.7.1 Proposed Subsea Infrastructure

The subsea structures and URF installation scope of work will comprise of installation of equipment summarised in **Table 3-4**.

Table 3-4: Subsea infrastructure and hardware

Description	Detail	Dimensions (approx.)
Multiphase Pumps	Provides pressure boost from the LAV and NOL wells to the FPSO	One station housing two pumps (10 m x 10 m)
Umbilical Termination Assembly (UTA)	Assembly which allows multiple subsea control modules to be connected to the same power and controls umbilicals	6 m x 5 m (x 8)
Flexibles	Flowlines	8” ID flexible production flowlines connecting production wells to the MPP Station 6” ID flexible production flowline connecting CIM well to the rigid flowline 6” ID flexible gas lift flowline for artificial lift of Cimatti 8” Water injection flexible flowlines 8” ID flexible flowlines to facilitate flowback of water injection wells via the production system 14” ID flexible production flowline between the rigid flowline and riser
	Risers	10” ID flexible production riser

		8" ID flexible water injection riser
	Jumpers	For tie-in of wells to the MPP Station and the rigid production flowline
Power and Controls umbilical	Electric Hydraulic control lines which provide power, signal & hydraulics to the MPP station and well Xmas Tree and down-hole controls	MPP and subsea controls umbilical. Each, approximately 30 km long and 229 mm and 187 mm diameter respectively
Flying leads (hydraulic and electrical)	Hydraulic or electrical lines that connect the UTA's to the wells or MPP station	Various lengths
Subsea support structures	Parking stands, canyon crossing anchors etc.	Various

Subsea components will either be pre-filled (e.g. freshwater, treated seawater or MEG) or installed free-flooded and flushed with treated sea-water post installation. Subsea structures will be landed on the seabed using lifting equipment on the ISV with ROV assistance to achieve the required positional and heading tolerances. Wet-storage on the seafloor may occur for pieces of equipment that are required to be moved into location prior to tie-in. The installation sequence for subsea structures is to be determined and will be finalised following detailed SIMOPS planning.

A flexible water injection flowline and umbilical are required to cross over the Enfield Canyon. At the point of crossing, the canyon is approximately 19 m deep and approximately 500 m wide. Flowlines will be installed with buoyancy modules to cross over the canyon, approximately 200 m above the sea floor. The flowline will be anchored either side of the canyon crossing using horizontal hold-back anchor at each side.

3.7.2 Installation of Long Base Line Array

An array of LBL transponders may be installed on the seabed by the ISV prior to installation of the subsea infrastructure.

3.7.3 Stabilisation, Protection and Support Mattresses

Concrete mattresses may be installed for various reasons, such as subsea structure scour protection, umbilical stabilisation, in-line tee stabilisation, flying lead crossing supports and umbilical freespan (if required). ROVs will assist with the installation of concrete mattresses. A mattress lifting frame complete with USBL survey beacons will be used by the ISV crane to lift and position the mattresses on the seabed with ROV assistance.

Deployment overboard of all lifts will be undertaken in an area offset from subsea infrastructure, whereby, the item is lifted overboard, lowered to 10 m above the seabed and located by ROV before the ISV 'walks' towards the landing target area for final land out. This approach minimises the risk of damage by dropped objects. The mattress lift frame will be retrieved after each mattress installation and re-used for each subsequent mattress deployment. Remediation may be required where large gaps occur between subsea infrastructure and the sea floor. In identified areas, planned controls in the form of mattresses will be installed. In other areas, as detected during or after installation, smaller levels of remediation may be required. In these circumstances, grout bags may be used to stabilise spools or other items.

3.7.4 Hook-up of Infrastructure

Following installation of the subsea infrastructure, flexible connections will be made linking the wells to the relevant infrastructure and flowlines. There will be minor discharges to the marine environment when these connections are made. Some infrastructure will be connected as part of the installation work, however other connections will be made following completion of wells and installation of remaining equipment.

When installed, the flexibles will be left flooded with preservation fluid.

3.7.5 Pre-commissioning of Subsea System

Pressure testing is undertaken to test the integrity of subsea infrastructure, test isolations and identify any leaks. A pressure pump will be operated from the ISV equipped with a suitable gauge for assessing the pressure-volume relationship and connected to the subsea system via a downline. Failure of testing equipment or integrity of the tested infrastructure may lead to a loss of hydrotest fluids to the marine environment.

Pressure in the isolated section of the flowline or subsea component is monitored to check for any drop in pressure and/or the location of leaks detected by visual inspection. If a leak is identified, an ROV will be used to locate and observe the leak. There will be small localised discharges around each of the test locations as that infrastructure is tested and the flowlines are depressurised. There may also be small localised discharges at a connection points if they are not made correctly, however this will quickly be detected during pumping due to failure to reach test pressure. Pressure test mediums will match the contents of the system being tested.

The hydrotest pressure will be held for a period of time as per the relevant standard to test the subsea equipment integrity.

3.7.6 Connection to FPSO

Risers and dynamic umbilicals are pulled through and hung off temporarily on the STP buoy whilst it is disconnected from the FPSO. Pull through will use a temporary subsea winch fixed on top of the STP Buoy. Ballast water will be required to be drained from the buoy to maintain the current draught (nominal 40 m). Permanent hang offs will be completed later, when the Buoy is pulled back into the FPSO. The amount of water to be removed will be equivalent to the added weight of the new umbilicals and dynamic risers.

The ballast water currently within the STP is believed to present a low environmental risk as it was filled on station with seawater when first installed. The water will however be tested prior to the installation campaign to inform whether disposal to the environment is acceptable or an alternative option is required.

3.7.7 Marine Growth Removal

Prior to tie-in and hook-up of installed risers to the existing STP, it may be necessary to remove marine growth build up from the STP. 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; and
- 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.

3.8 Project Fluids

3.8.1 Assessment of Project Fluids

All downhole chemicals that may be operationally released or discharged to the marine environment by the Petroleum Activities Program are required to be selected and approved as per Woodside Environment Procedure - Drilling and Completions Chemical Approval, Review and Improvement. These procedures are used to demonstrate that the potential impacts of the chemicals selected are acceptable, ALARP and consistent with the Environmental Performance Standards Procedure.

Chemicals fall into the following assessment types:

- No further assessment: All chemical substances listed on the United Kingdom's Offshore Chemical Notification Scheme (OCNS) Ranked List of Notified Chemicals have a 'Hazard Quotient' or 'OCNS Group' which is determined by Centre for Environment Fisheries and Aquaculture Science (CEFAS) based on data provided to them by the chemical vendor. This information may include toxicity, biodegradation, bioaccumulation, normal dose rate, scale of use per installation, and discharge rates and volumes for typical use. Chemicals that have OCNS Hazard Quotient corresponding to ratings of Gold, Silver, E or D on the OCNS Ranked List of Notified Chemicals, and have no substitution or product warning do not require further assessment, as they are considered not represent a significant impact on the environment under standard use scenarios and are therefore, are considered As Low As Reasonably Practicable (ALARP) and acceptable
- Further assessment / ALARP justification required: Chemicals not meeting the criteria above (i.e. OCNS Hazard Quotient white, blue, orange, purple, A, B, C or have product/substitution warning) or those that are not on the OCNS Ranked List of Notified Chemicals, require further assessment to understand the environment impacts of the discharge into the marine environment. This assessment includes:
    - Chemicals with no OCNS ranking;
    - Chemicals with an HQ band of white, blue, orange, purple or an OCNS ranking of A,B or C; or
    - Chemicals with an OCNS product or substitution warning.

3.8.2 Drilling Fluid System

Water Based Mud System

The Petroleum Activities Program will use a WBM drilling fluid system. In addition to the base fluid, drilling muds contain a variety of chemicals, incorporated into the selected drilling fluid system to meet specific technical requirements (e.g. mud weight required to manage pressure).

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

WBM drilling fluids that cannot be re-used (e.g. due to bacterial deterioration or do not meet required drilling fluid properties) or are mixed in excess of required volumes, may be operationally discharged to the ocean after passing through the Solid Control Equipment (SCE), under the MODU's Permit to Work (PTW) system, using seawater flushing. Opportunities to reuse the WBM drilling fluids at the end of the Petroleum Activities Program are reviewed across current Woodside drilling activities.

Non-water Based Mud System

NWBM drilling fluids are planned to be used for the 12-1/4” hole sections of the five Laverda wells. Its usage has been justified in accordance with the Woodside D&C Operations Manual – Drilling and Completions Fluids Procedure. This considers technical factors relevant to wellbore conditions, such as; well temperature, well shape and depth, reactivity of the formation to water and well friction and consideration of environment, health, safety and waste management.

Although not planned, there is a contingency to change from WBM to NWBM for some hole sections in NOL and Cimatti wells in the event of unplanned technical difficulties which compromise well objectives on initial wells in these fields. The applicable hole sections for this contingency are the 12-1/4” hole sections of the NOL wells and the 17-1/2” and 12-1/4” sections of the Cimatti wells.

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

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

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

Drill cuttings generated from the well are expected to range from very fine to very coarse (<1 cm) particle/sediment sizes. Cuttings generated during drilling of the top hole sections are discharged at the seabed.

The bottom hole sections will be drilled with a marine riser that enables cuttings and drilling fluid to be circulated back to the MODU, where the cuttings are separated from the drilling fluids by the SCE. The SCE uses shale shakers to remove coarse cuttings from the drilling mud. After processing by the shale shakers, the recovered mud from the cuttings may be directed to centrifuges, which are used to remove fine solids (~4.5 to 6 µm). The cuttings are discharged below the water line and the mud is recirculated into the fluid system.

If NWBM are needed to drill a well section, the cuttings from the NWBM drilling fluid system will also pass through a cuttings dryer to reduce the average oil on cuttings for the entire well (section using NWBM) to 10% or less by dry weight prior to discharge.

3.8.3 Subsea Equipment Preservation Chemicals

Following completions activities, the wells will be left with subsea equipment (such as xmas trees) installed, awaiting connection to the FPSO. All subsea equipment will contain preservation fluids to prevent corrosion and any other deterioration of the equipment before production. This fluid will be flushed to the FPSO when production from the well commences, and therefore does not form part of the scope of this EP. The most likely combination of chemicals includes MEG, biocide and oxygen scavenger. Selection of chemicals will be undertaken in accordance with the Chemical Selection Process and will take into consideration method of completion selected and will be influenced by technical, operational and environmental considerations

Prior to leaving the subsea hardware flooded and ready for start-up, pre-commissioning and final hydrotests of the subsea infrastructure will result in discharge of treated seawater. Typically, the treated seawater contains chemicals such as Hydrosure O3670-R at 500 ppm, Fluorescein dye at 50 ppm and MEG.

3.9 Unplanned Contingency Activities

The following sections present contingencies that may be required if operational or technical issues occur during the Petroleum Activities Program. These contingencies do not represent significant additional risks or impacts but may generate additional volumes of fluids being discharged such as drilling cuttings and muds, hydrotest or Flood, Clean and Gauge testing (FCGT) fluids.

3.9.1 Well Flow Back

Short duration well flow back to the MODU, particularly for water injection wells, may be required in certain circumstances, such as reduced well injectivity. Well flow back will involve flowing well fluids back to the rig through temporary test equipment located on the MODU. Hydrocarbons and fluids will be separated and flared off to the atmosphere with any non-combustible products being collected. If required, the duration of well flow back is expected to be up to 24 hours per well. However, the duration is dependent on reservoir characteristics and other factors.

3.9.2 Workover

It is possible the well may be worked over by recovering and replacing the completion string and associated components. The environmental aspects of a workover operation are the same as those for undertaking drilling activities, with no significant changes to existing environmental risks or any additional environmental risks likely.

3.9.3 Respud

A respud may be required if the conductor or well head slumps or fails installation criteria (typically during top hole drilling). Respuding involves moving the MODU to a suitably close location (e.g. ~50 m from the original location) to recommence drilling. A respud activity would result in repeating top hole drilling.

3.9.4 Sidetrack

The option of a sidetrack instead of a respud may be selected if operational issues are encountered. The environmental aspects of a sidetrack well are the same as those for undertaking routine drilling activities. The net environmental effects will be limited to an increase in the volume of cuttings generated, potential increase in the use of WBM or NWBM and the additional emissions (atmospheric and waste) associated with an extended drilling program.

3.9.5 Well Suspension

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

3.9.6 Wireline Logging

Wireline contingencies that may be in place for development drilling include GR and Casing Collar Locator (CCL) for depth correlation, USIT and CBL to verify cement integrity, formation pressures (XPT), Density, Netron and Resistivity and punch perforators/ tubing cutters suitable for all tubing sizes. Wireline contingency work will be carried out with appropriate isolation barriers in place, i.e. an overbalanced fluid column. If wireline work is required to take place in a live well, or where there is a risk of barrier failure, then the operation will be carried out with full pressure control equipment at the surface.

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

3.9.7 Well Intervention

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

3.9.8 Well Abandonment

Due to the Petroleum Activities Program covering the drilling of production wells, it is not envisaged that any of the planned wells will be required to be abandoned. For technical reasons, it may be required to abandon the lower section of a well, prior to sidetracking, or in the event that a respud is required.

3.9.9 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. due to a 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 drilling fluids/cuttings in the riser following disconnection.

3.9.10 Sediment Relocation

If required, a ROV-mounted or diver operated suction pump/dredging unit may be used to relocate sediment prior to infrastructure installation in specific areas. This activity is limited to the localised relocation of sediment material prior to infrastructure installation at specific areas.

3.9.11 Flowline Installation Contingencies

The Pipelay contractor will develop contingency procedures for managing foreseeable, but unplanned, situations which may arise during the installation of the flowline. This procedure addresses a number of contingency conditions, including:

- wet buckle contingency – dewatering;
- dry buckle contingency;
- salt water contamination during transit;

- loss of tension during installation;
- DP run-off (loss of position);
- loss of one/two reference stations;
- loss of power to DP system during installation;
- loss of power during flowline abandonment and recovery;
- stuck pig contingency;
- smart gauge plate failure to communicate with ROV; and
- smart gauge plate indicating fault in flowline.

Potential contingent activities with significant environmental impacts are described below.

Walking Structures

Walking anchors may be used to prevent axial movement of the flowline. The anchors aid in resisting the generated axial loads within the flowline, thereby limiting movement of the PLET at the end of the flowline and In Line Tee Assembly (ILTA) structures and corresponding tie-in spools.

Anti-walking structures may also be deployed and installed along the route of the production flowline either as part of flowline installation activities or after the flowline is laid and anti-walking structures are required. These may consist of either clump weights, anchors or suction or driven piles depending on technical specifications.

The walking anchors consist of the following components for each location:

- pile template;
- suction piles or driven piles;
- chain tether between pile template and anchor connection on flowline; and
- flowline anchor connection.

If piles are required, they may be a combination of suction and driven/impact piles. Dimensions of the piles are to be determined but are likely to be between 1.3 and 1.5 m diameter and required to be driven to approximately 30 m deep. If required, it is estimated that up to 12 piles may be used.

Flowline Dewatering

Contingency flowline dewatering may be required if the preservation fluid requires replacement prior to FPSO reconnect or should dewatering at the FPSO fail or be deemed unfeasible. Full dewatering and fluid replacement is unlikely, however if required will result in approximately 120% of the pipeline volume (3600 m^3 of treated water).

Contingency dewatering may also be required in the event of a wet buckle. A wet buckle is where there is an uncontrolled ingress of seawater in the flowline when pipelay parameters are not maintained (e.g. tension or configuration). The steps to be followed in this contingency may include assessment of damage, dewatering and venting and recovery of pipe from seabed for repair. In the case of a wet buckle, untreated seawater will be removed from the flowline within five days of first exposure. To achieve this, a dewatering spread will be on stand-by during all pipe-lay activities. The flowline will be pigged with slugs of treated potable water in between pigs with the final pig propelled by air to ensure that the chloride ion concentration does not exceed 200 ppm. The potable water will be treated with the same chemicals, in the same concentrations, as for the routine (non-contingent) FCGT process.

In the event of a wet buckle it is estimated approximately 20% of the pipeline volume (~600 m^3) of treated potable water will require discharge at a rate of 4 m^3 per minute over approximately 3 hours duration. This volume is however dependent on the length of the flowline already installed prior to the event and the amount of seawater ingress into the line, but will likely be less than the full pipeline volume. Further, the contingent and base case discharges are not consecutive events and will be at a minimum two days apart (as it will take time to cut the buckled pipe, run pigs, dewater and continue installation). Therefore, any discharges during the contingent scenario would have dissipated before the final dewatering is undertaken.

Stuck or Failed Pig Contingency

In the event that a pig becomes stuck in the flowline, it will be necessary to attempt to reverse it out or force it out, using elevated pressures. In an extreme situation the flowline may need to be breached to free the pig. This will also necessitate the discharge of higher than planned volumes of treated seawater being used to push/free the pig.

Intelligent pig runs assess various factors of pipeline integrity. If the pipeline fails an integrity criteria it may be necessary for a section of pipeline to be repaired or replaced. In this case the line may also need to be breached also resulting in a discharge of treated seawater.

For the above pigging contingency events it is estimated approximately 20% of the pipeline volume (~600 m^3 of treater water) may require to be discharged per event.

4. DESCRIPTION OF THE RECEIVING ENVIRONMENT

In determining the spatial extent of the environmental sensitivities that may be affected, Woodside considered both the Operational Area (for planned and unplanned activities), as well as the credible zone of consequence (ZoC) of the credible worst case hydrocarbon spill scenario (**Section 5.2**).

4.1 Physical Environment

The Operational Area is located in Commonwealth waters within the Northwest Shelf Province (NWS), in water depths ranging from 350 to 850 m. The NWS is part of the wider North West Marine Region (NWMR) as defined under the Integrated Marine and Coastal Regionalisation of Australia. The NWS encompasses the continental shelf between North West Cape and Cape Bougainville and varies in width from approximately 50 km at Exmouth Gulf to greater than 250 km off Cape Leveque and includes water depths of 0–200 m.

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. There are often distinct transition periods between the summer and winter regimes, which are characterised by periods of relatively low winds. Rainfall in the NWMR typically occurs during the wet season (summer), with highest falls observed during late summer and autumn, often associated with the passage of tropical low pressure systems and cyclones. Rainfall outside this period is typically low.

Winds vary seasonally, with a tendency for winds from the south-west quadrant during summer months (Oct – Jan) and the north-east quadrant in autumn and winter months (Apr - Aug). Tropical cyclone activity can occur between November and April and is most frequent during January to March.

The large-scale ocean circulation of the NWMR is primarily influenced by the Indonesian Throughflow (ITF) and the Leeuwin Current. The ITF and Leeuwin Current are strongest during late summer and winter. In addition to the synoptic-scale current dynamics, tidally driven currents are a significant component of water movement in the NWMR. Tides in the 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.

The offshore, oceanic seawater characteristics of the NWS exhibit seasonal and water depth variation in temperature and salinity being greatly influenced by major currents in the region. Surface waters are relatively warm year round due to the tropical water supplied by the ITF and the Leeuwin Current. Variation in surface salinity along the NWS throughout the year is minimal, with slight increases occurring during the summer months due to intense coastal evaporation. Turbidity is primarily influenced by sediment transport by oceanic swells and primary productivity.

The Operational Area is located in waters approximately 350 to 850 m deep on the continental shelf. Bathymetry data acquired within the Operational Area indicates the area is situated in an area of complex bathymetry.

A sediment classification scheme (encompassing most of the Vincent Development area), based on acoustic data, indicated that the upper slope habitat (in depths of approximately 200 to 500 m) were generally composed of coarser and/or more consolidated sediments as compared to the mid-slope (500 to 1,000 m). Sediments within the Enfield Canyons where they overlap with the Operational Area were found to comprise sand, silt, clays and fines. Isolated areas of hard substrate within the Enfield Canyons were characterised by isolated boulders, and found to be featureless.

4.2 Biological Environment

4.2.1 Habitats

No Critical Habitats or Threatened Ecological Communities as listed under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) are known to occur within the Operational Area.

Enfield Canyon Environmental Survey

Woodside completed a survey of a portion the Enfield canyon tributary, comprising the North and South Enfield Canyons, situated within the Operational Area. The deepwater survey areas were selected to represent the proposed infrastructure locations associated with the Greater Enfield Development as well as the possible range of different habitat types within the canyon environment. The development area (Area A) and non-development area Area B as depicted in **Figure 4-2** . Area A was the deepest survey location and encompassed a portion of the North and South Enfield Canyons. Area B was a representative portion of North Enfield Canyon and incorporated the head of the North Enfield Canyon. Representative images of the seabed and biota for Area A and hard substrate habitat within area B are presented in **Figure 4-1. Figure 4-3** details a representation of the benthic habits of Area A (based on extrapolation of the survey results) together with the associated infrastructure for the Petroleum Activity Program.

Results concluded that filter feeding assemblages were consistent with previous surveys in the region and consisted primarily of cnidarians, echinoderms and sponges. Benthic habitats of the NWS bioregion are comprised predominantly of bare, unconsolidated, muddy substrate types. Such habitat is broadly represented throughout the NWS and typically supports sparse assemblages of filter and deposit-feeding epibenthic fauna. Environmental surveys in the area have shown a diverse but broadly representative infaunal community, dominated by polychaete worms and crustaceans. 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.

North West Cape Continental Shelf and Slope Survey

The Australian Institute of Marine Science (AIMS) undertook a broader survey of the benthic environment and associated fauna on the continental shelf and slope (in between depths of 50 m-900 m) within and around the Operational Area.

The seabed was primarily sampled via benthic sled to take samples of macrobenthic organisms from depths of 50 m to 850-900 m. Supplementary *in situ* video was collected during the survey tows (via a camera installed on the sled) in order to provide context on the benthic communities sampled. Additional sampling of the seabed was undertaken via a van Veen grab in depths between 50 m-150 m, with preliminary analysis of infauna performed at the University of Western Australia.

Benthic Habitats

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 350 – 850 m), these benthic primary producer groups will not occur in the Operational Area but are present within the wider region.

Within the wider region, benthic primary producer habitat such as zooxanthellate corals, seagrasses, macroalgae and mangroves are known to occur. Coral reefs habitats have a high diversity of corals, associated fish and other species. Coral reef habitats are an integral part of the marine environment within the wider region of the ZoC for several locations in the wider regional, including, but not limited to the:

- Ningaloo Coast World Heritage Area (WHA) (17 km south-west);
- Muiron Islands (35 km south-west);
- Barrow Island (140 km north-east);
- Montebello Islands (170 km north-east);
- Rankin Bank (225 km north-east);
- Glomar Shoals (325 km north-east);
- Houtman Abrolhos Islands (760 km south);
- Seringapatam Reef (1,180 km north);
- Scott Reef (North and South) (1,140 km north);
- Rowley Shoals,
  - Imperieuse Reef (650 km north),
  - Clerke Reef (720 km north),
  - Mermaid Reef (756 km);
- Ashmore Reef (1,390 km north); and
- Kimberley coast (including Dampier Peninsula, Adele and Lacepede Islands, Buccaneer and Bonaparte Archipelagos) (880 km north).

Seagrass beds and macroalgae habitats are present in the wider region, and are widely distributed in shallow coastal waters that receive sufficient light to support seagrasses and macroalgae. Mangroves can be found in the wider region in locations such as Ningaloo, Exmouth Gulf, Shark Bay and the Pilbara shoreline

Filter Feeders

Filter feeders such as sponges, ascidians, soft corals, sea stars, sea urchins and gorgonians are animals that feed by actively or passively by filtering suspended organic matter and prey items (plankton). Such filter feeding biota is associated with hard substrate and the geophysical surveys of the Operational Area as well as the Enfield Canyon survey confirmed few areas of hard substrate. Few areas of hard substrate were noted during the Enfield Canyon and Operational Area. Isolated areas of hard substrate noted during the initial geophysical surveys were subsequently sampled during the Enfield Canyon survey and were found to be isolated boulders that provided habitat for deepwater soft corals (sea fans) also recorded from the head of the canyon **(Figure 4-2** and **Figure 4-3**).

Several surveys of benthic filter feeder communities in and around the Operational Area have been undertaken. In general, epifauna was sparsely distributed within the canyon features, with biota observed in less than 10% of the footage from Area A. Discrete areas of hard substrate hosting sessile filter feeding communities may be associated with the Ancient Coastline at the 125 m Depth Contour KEF (approximately 17 km from the Operational Area at its closest point).

Further afield within the ZoC, filter feeders make up minor components of the benthic communities at Rankin Bank (approximately 225 km away), approximately 3% of the benthic cover, with sponges among the most abundant filter feeders. Benthic communities are similar to those recorded at other shoals in the NWMR and are considered to be representative of the broader benthic communities within the ZoC.

Within the wider ZoC, 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. 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. Offshore filter feeders and deepwater benthic communities occur within the ZoC at Rankin Bank.

The NWMR has been identified as a sponge diversity hotspot with a high variety of areas of potentially high and unique sponge biodiversity. 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.

Area B

Area A

Area B

Area A

Figure 4-1 images of the seabed and biota within Area A and B of the Enfield Canyon environmental survey.

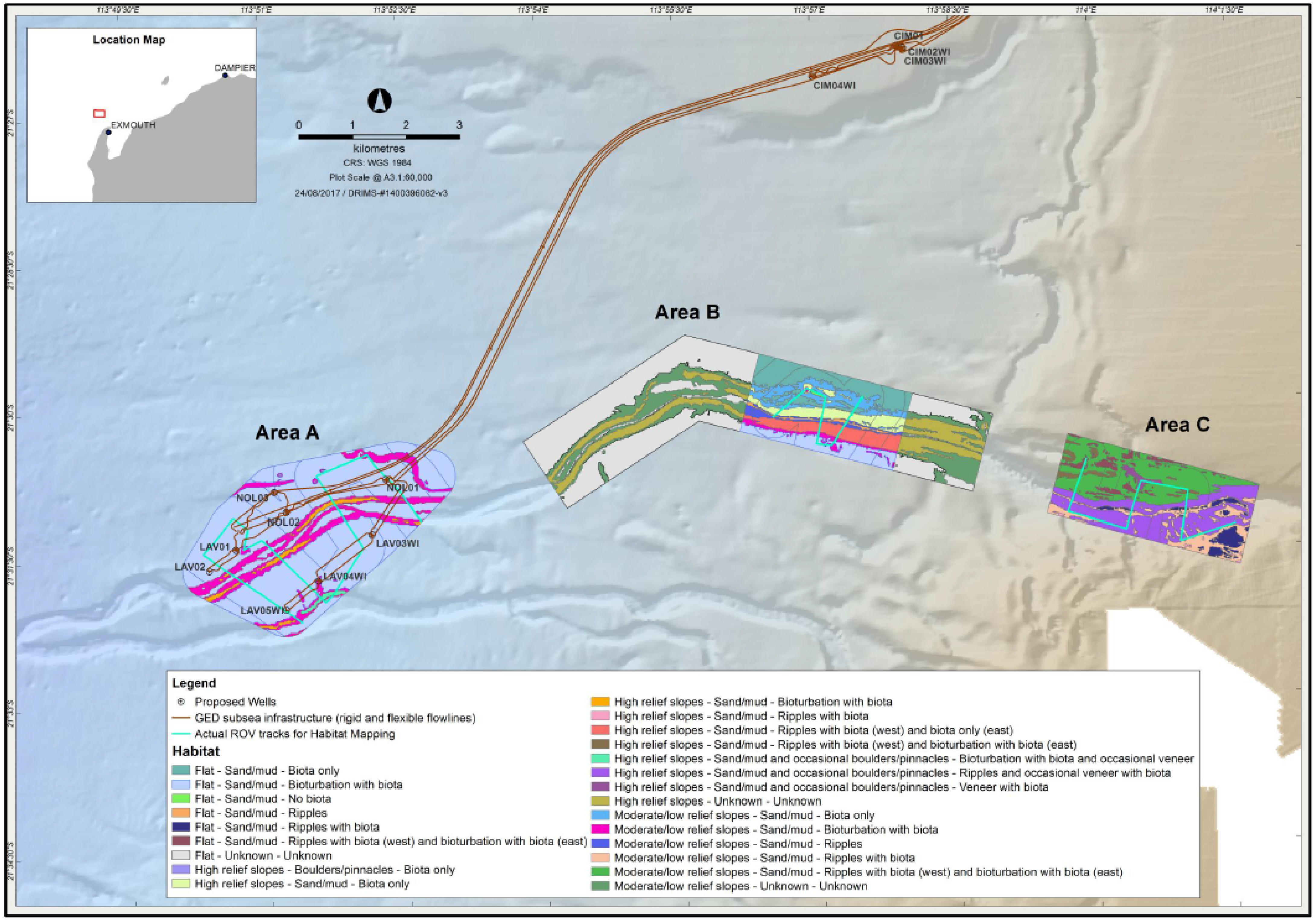

Figure 4-2 Benthic habitat map of the Enfield region

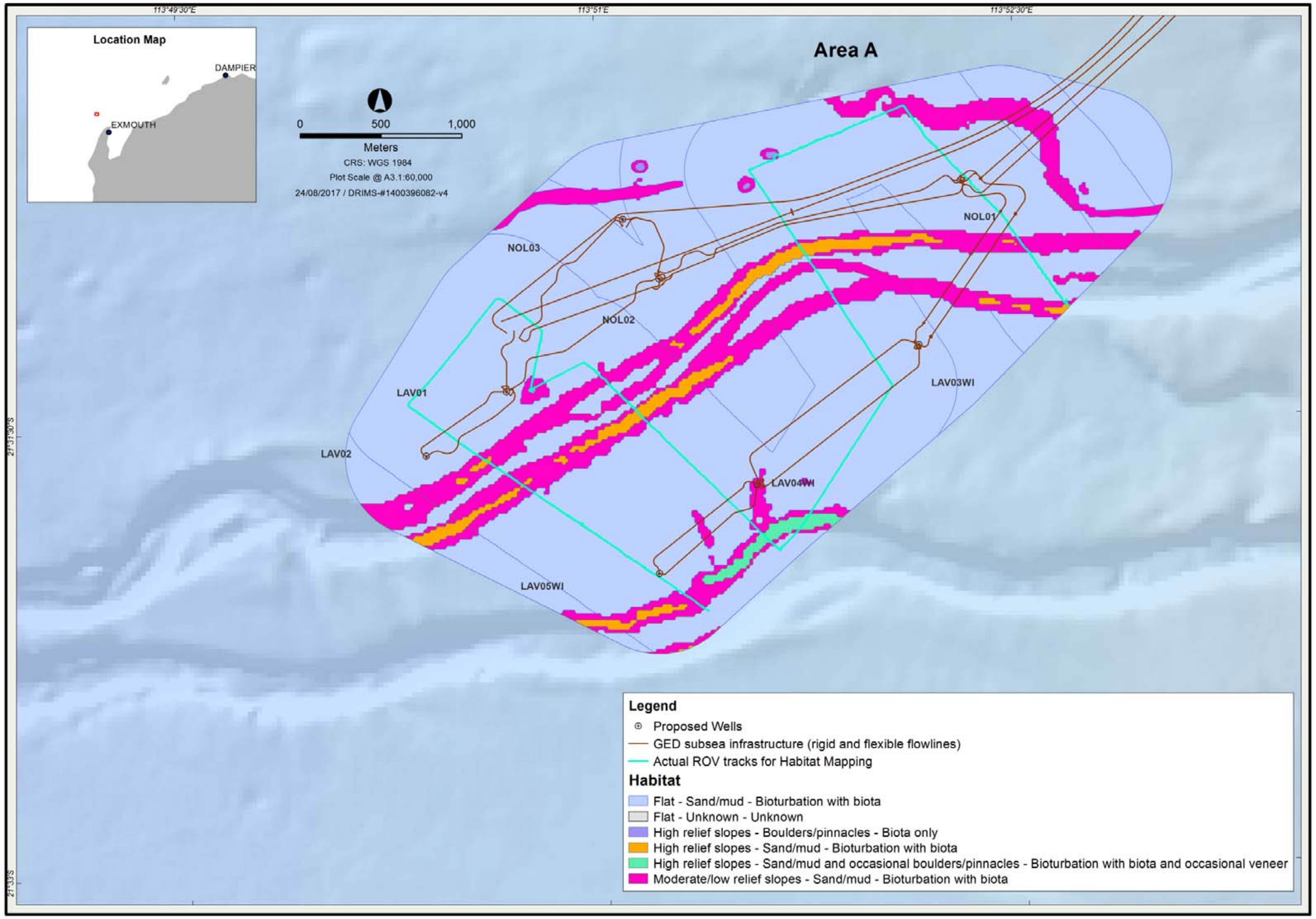

Figure 4-3 Detailed map of the infrastructure and benthic habitats within Area A.

Pelagic and demersal fish populations

The Operational Area appears to have a relatively high diversity of fish but low abundance. The Continental Slope Demersal Fish Communities is a KEF in the Operational Area. Fish species in the NWMR (including the Operational Area and much of the ZoC) 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. 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 wider ZoC, 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.

Plankton

Plankton within the Operational Area is expected to reflect the conditions of the NWMR. Primary productivity of the NWMR appears to be largely driven by offshore influences, with periodic upwelling events and cyclonic influences driving coastal productivity with nutrient recycling and advection.

4.2.2 Species

A total of 109 EPBC Act listed species considered to be matters of national environmental significance (MNES) (i.e. listed as threatened or migratory) were identified as potentially occurring within the Operational Area and wider ZoC. Of the species identified by the PMST report, 51 are listed as threatened and 95 are migratory under the EPBC Act (**Table 4-1**). Each of these MNES, including relevant conservation advice, was considered during the development of the EP.

Table 4-1: EPBC Act listed threatened and migratory fauna potentially occurring within the Operational Area and wider ZoC

Species Name	Common Name	Threatened Status	Migratory Status	Ops. Area / ZoC
Mammals				
Balaenoptera bonaerensis	Antarctic Minke Whale, Dark-shoulder Minke Whale	N/A	Migratory	Ops Area
Balaenoptera borealis	Sei Whale	Vulnerable	Migratory	Ops Area
Balaenoptera edeni	Bryde's Whale	N/A	Migratory	Ops Area
Balaenoptera musculus	Blue Whale	Endangered	Migratory	Ops Area
Balaenoptera physalus	Fin Whale	Vulnerable	Migratory	Ops Area
Eubalaena australis	Southern Right Whale	Endangered	Migratory	Ops Area
Megaptera novaeangliae	Humpback Whale	Vulnerable	Migratory	Ops Area
Orcinus orca	Killer Whale, Orca	N/A	Migratory	Ops Area
Physeter macrocephalus	Sperm Whale	N/A	Migratory	Ops Area
Caperea marginata	Pygmy Right Whale	N/A	Migratory	ZoC
Dugong dugon	Dugong	N/A	Migratory	ZoC
Lagenorhynchus obscurus	Dusky Dolphin	N/A	Migratory	ZoC
Neophoca cinerea	Australian Sea Lion	Vulnerable	N/A	ZoC
Orcaella brevirostris	Irrawaddy Dolphin	N/A	Migratory	ZoC
Sousa chinensis	Indo-Pacific Humpback Dolphin	N/A	Migratory	ZoC
Tursiops aduncus (Arafura/Timor Sea populations)	Spotted Bottlenose Dolphin (Arafura/Timor Sea populations)	N/A	Migratory	ZoC
Reptiles				
Caretta caretta	Loggerhead Turtle	Endangered	Migratory	Ops Area
Chelonia mydas	Green Turtle	Vulnerable	Migratory	Ops Area
Dermochelys coriacea	Leatherback Turtle, Leathery Turtle, Luth	Endangered	Migratory	Ops Area
Eretmochelys imbricata	Hawksbill Turtle	Vulnerable	Migratory	Ops Area
Natator depressus	Flatback Turtle	Vulnerable	Migratory	Ops Area
Aipysurus apraefrontalis	Short-nosed Seasnake	Critically endangered	N/A	ZoC
Aipysurus foliosquama	Leaf-scaled Seasnake	Critically	N/A	ZoC

		endangered		
Crocodylus porosus	Salt-water Crocodile, Estuarine Crocodile	N/A	Migratory	ZoC
Lepidochelys olivacea	Olive Ridley Turtle, Pacific Ridley Turtle	Endangered	Migratory	ZoC
Sharks and Rays				
Carcharodon carcharias	White Shark, Great White Shark	Vulnerable	Migratory	Ops Area
Isurus oxyrinchus	Shortfin Mako, Mako Shark	N/A	Migratory	Ops Area
Isurus paucus	Longfin Mako	N/A	Migratory	Ops Area
Manta birostris	Giant Manta Ray, Chevron Manta Ray, Pacific Manta Ray, Pelagic Manta Ray, Oceanic Manta Ray	N/A	Migratory	Ops Area
Pristis zijsron	Green Sawfish, Dindagubba, Narrowsnout Sawfish	Vulnerable	Migratory	Ops Area
Carcharias taurus (west coast population)	Grey Nurse Shark (west coast population)	Vulnerable	N/A	ZoC
Glyphis garricki	Northern River Shark, New Guinea River Shark	Endangered	N/A	ZoC
Lamna nasus	Porbeagle, Mackerel Shark	N/A	Migratory	ZoC
Manta alfredi	Reef Manta Ray, Coastal Manta Ray, Inshore Manta Ray, Prince Alfred's Ray, Resident Manta Ray	N/A	Migratory	ZoC
Pristis clavata	Dwarf Sawfish, Queensland Sawfish	Vulnerable	Migratory	ZoC
Pristis pristis	Largetooth Sawfish, Freshwater Sawfish, River Sawfish, Leichhardt's Sawfish, Northern Sawfish	Vulnerable	Migratory	ZoC
Rhincodon typus	Whale Shark	Vulnerable	Migratory	ZoC
Birds				
Actitis hypoleucos	Common Sandpiper	N/A	Migratory	Ops Area
Anous stolidus	Common Noddy	N/A	Migratory	Ops Area
Calidris acuminata	Sharp-tailed Sandpiper	N/A	Migratory	Ops Area
Calidris canutus	Red Knot, Knot	Endangered	Migratory	Ops Area
Calidris ferruginea	Curlew Sandpiper	Critically endangered	Migratory	Ops Area
Calidris melanotos	Pectoral Sandpiper	N/A	Migratory	Ops Area
Fregata ariel	Lesser Frigatebird, Least Frigatebird	N/A	Migratory	Ops Area
Macronectes giganteus	Southern Giant-Petrel, Southern Giant Petrel	Endangered	Migratory	Ops Area
Numenius madagascariensis	Eastern Curlew, Far Eastern Curlew	Critically endangered	Migratory	Ops Area
Pandion haliaetus	Osprey	N/A	Migratory	Ops Area
Pterodroma mollis	Soft-plumaged Petrel	Vulnerable	N/A	Ops Area
Puffinus carneipes	Flesh-footed Shearwater, Fleshy-	N/A	Migratory	Ops Area

	footed Shearwater			
Sternula nereis nereis	Australian Fairy Tern	Vulnerable	N/A	Ops Area
Acrocephalus orientalis	Oriental Reed-Warbler	N/A	Migratory	ZoC
Anous tenuirostris melanops	Australian Lesser Noddy	Vulnerable	N/A	ZoC
Arenaria interpres	Ruddy Turnstone	N/A	Migratory	ZoC
Calidris alba	Sanderling	N/A	Migratory	ZoC
Calidris ruficollis	Red-necked Stint	N/A	Migratory	ZoC
Calidris tenuirostris	Great Knot	Critically endangered	Migratory	ZoC
Calonectris leucomelas	Streaked Shearwater	N/A	Migratory	ZoC
Charadrius bicinctus	Double-banded Plover	N/A	Migratory	ZoC
Charadrius leschenaultii	Greater Sand Plover, Large Sand Plover	Vulnerable	Migratory	ZoC
Charadrius mongolus	Lesser Sand Plover, Mongolian Plover	Endangered	Migratory	ZoC
Charadrius veredus	Oriental Plover, Oriental Dotterel	N/A	Migratory	ZoC
Diomedea amsterdamensis	Amsterdam Albatross	Endangered	Migratory	ZoC
Diomedea dabbenena	Tristan Albatross	Endangered	Migratory	ZoC
Diomedea epomophora (sensu stricto)	Southern Royal Albatross	Vulnerable	Migratory	ZoC
Diomedea exulans (sensu lato)	Wandering Albatross	Vulnerable	Migratory	ZoC
Diomedea sanfordi	Northern Royal Albatross	Endangered	Migratory	ZoC
Fregata andrewsi	Christmas Island Frigatebird, Andrew's Frigatebird	Vulnerable	Migratory	ZoC
Fregata minor	Great Frigatebird, Greater Frigatebird	N/A	Migratory	ZoC
Gallinago megala	Swinhoe's Snipe	N/A	Migratory	ZoC
Gallinago stenura	Pin-tailed Snipe	N/A	Migratory	ZoC
Glareola maldivarum	Oriental Pratincole	N/A	Migratory	ZoC
Halobaena caerulea	Blue Petrel	Vulnerable	N/A	ZoC
Heteroscelus brevipes	Grey-tailed Tattler	N/A	Migratory	ZoC
Limosa lapponica	Bar-tailed Godwit	N/A	Migratory	ZoC
Limosa lapponica baueri	Bar-tailed Godwit (baueri), Western Alaskan Bar-tailed Godwit	Vulnerable	Migratory	ZoC
Limosa lapponica menzbieri	Northern Siberian Bar-tailed Godwit, Bar-tailed Godwit (menzbieri)	Critically endangered	Migratory	ZoC
Limosa limosa	Black-tailed Godwit	N/A	Migratory	ZoC
Macronectes halli	Northern Giant Petrel	Vulnerable	Migratory	ZoC
Numenius minutus	Little Curlew, Little Whimbrel	N/A	Migratory	ZoC
Numenius phaeopus	Whimbrel	N/A	Migratory	ZoC

Pachyptila turtur subantarctica	Fairy Prion (southern)	Vulnerable	N/A	ZoC
Papasula abbotti	Abbott's Booby	Endangered	N/A	ZoC
Phaethon lepturus	White-tailed Tropicbird	N/A	Migratory	ZoC
Phaethon lepturus fulvus	Christmas Island White-tailed Tropicbird, Golden Bosunbird	Endangered	N/A	ZoC
Phaethon rubricauda	Red-tailed Tropicbird	N/A	Migratory	ZoC
Phalaropus lobatus	Red-necked Phalarope	N/A	Migratory	ZoC
Phoebetria fusca	Sooty Albatross	Vulnerable	Migratory	ZoC
Pluvialis fulva	Pacific Golden Plover	N/A	Migratory	ZoC
Pluvialis squatarola	Grey Plover	N/A	Migratory	ZoC
Puffinus pacificus	Wedge-tailed Shearwater	N/A	Migratory	ZoC
Sterna albifrons	Little Tern	N/A	Migratory	ZoC
Sterna anaethetus	Bridled Tern	N/A	Migratory	ZoC
Sterna caspia	Caspian Tern	N/A	Migratory	ZoC
Sterna dougallii	Roseate Tern	N/A	Migratory	ZoC
Sula dactylatra	Masked Booby	N/A	Migratory	ZoC
Sula leucogaster	Brown Booby	N/A	Migratory	ZoC
Sula sula	Red-footed Booby	N/A	Migratory	ZoC
Thalassarche carteri	Indian Yellow-nosed Albatross	Vulnerable	Migratory	ZoC
Thalassarche cauta (sensu stricto)	Shy Albatross, Tasmanian Shy Albatross	Vulnerable	Migratory	ZoC
Thalassarche cauta cauta	Shy Albatross, Tasmanian Shy Albatross	Vulnerable	Migratory	ZoC
Thalassarche cauta steadi	White-capped Albatross	Vulnerable	Migratory	ZoC
Thalassarche impavida	Campbell Albatross, Campbell Black-browed Albatross	Vulnerable	Migratory	ZoC
Thalassarche melanophris	Black-browed Albatross	Vulnerable	Migratory	ZoC
Thalasseus bergii	Crested Tern	N/A	Migratory	ZoC
Tringa glareola	Wood Sandpiper	N/A	Migratory	ZoC
Tringa nebularia	Common Greenshank, Greenshank	N/A	Migratory	ZoC
Tringa stagnatilis	Marsh Sandpiper, Little Greenshank	N/A	Migratory	ZoC
Tringa totanus	Common Redshank, Redshank	N/A	Migratory	ZoC
Xenus cinereus	Terek Sandpiper	N/A	Migratory	ZoC

Species in the Operational Area

Pygmy blue whales may occur in the Operational Area, particularly during their northern and southern migrations. A migration biologically important area (BIA) for migrating blue whales overlaps the Operational Area. Pygmy blue whales may be present (annual seasonal migration with peak past Exmouth towards Indonesia (April – August), southerly return following WA coastline (October – late December)). Migrating humpback whales may transit the Operational Area from June to August and late November to December, during their northern and southern migrations. It is noted that a humpback whale migratory corridor BIA overlaps the Operational Area. Other cetacean species may infrequently transit the Operational Area; however, the Operational Area does not represent any critical habitat (feeding, resting or breeding aggregation areas) for cetacean species that may occur in the region.

There is the potential for five species of marine turtle (listed as threatened and migratory) to occur within the Operational Area. These are the loggerhead turtle, green turtle, leatherback turtle, hawksbill turtle and the flatback turtle. The Operational Area does not contain any BIAs or known critical habitat for any species of marine turtle; however, given observation of turtles in open, offshore water they may transit the Operational Area. Given the water depth of the Operational Area, seasnake sightings will be infrequent and likely comprise few individuals within the Operational Area.

Several shark/ray species, including the great white shark, green sawfish, shortfin mako, longfin mako and giant manta ray may be present within the Operational Area, for short durations when individuals transit the area.

The Operational Area may be occasionally visited by migratory and oceanic birds, such as sandpipers, petrels and osprey, but does not contain any emergent land that could be utilised as roosting or nesting habitat and contains no known critical habitats for any species. A BIA for the migratory wedge-tailed shearwater overlaps the Operational Area, which related to breeding between mid-August and April in the Pilbara.

Species in the Wider Region

In addition to the marine mammals identified within the Operational Area, other species of marine mammal are expected to occur in the wider region, including whales, dugongs (associated with seagrass habitats), coastal dolphins and Australian sea lions (closest known colony at the Abrolhos Islands).

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. Species exhibit habitat preferences depending on water depth, benthic habitat, turbidity and season. The short-nosed seasnake and the leaf-scaled seasnake, as well as other non-MNES species will occur throughout the wider ZoC, but are unlikely to be present in the Operational Area.

Evidence indicates whale sharks are present on the NWS in the months of April, July, August, September and October, corresponding with the whale shark's seasonal migration to and from the Ningaloo Reef. Timing of the whale sharks' migration to and from Ningaloo coincides with the coral mass spawning period and period of high productivity 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 to 50 m depth. The numbers of individual whale sharks that transit through the Operational Area is expected to be low based on the number of whale sharks aggregating at Ningaloo and on the different migration paths that the sharks may follow.

Offshore islands in the wider region, including Montebello/Barrow/Lowendal Island Groups, Muiron Islands, Pilbara Islands, Ashmore Reef, Kimberley coast, Shark bay and Abrolhos Islands are important seabird and shorebird nesting and foraging habitats. The Operational Area may be occasionally visited by migratory seabirds and shorebirds, but it does not contain critical habitats for any species.

4.2.3 Socio-economic and Cultural

Fisheries, Commonwealth and State:

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

Commonwealth fisheries designated management areas within or adjacent to the Operational Area include the following:

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

The majority of fishing effort for these fisheries occurs outside of the Operational Area.

State fisheries designated management areas within or adjacent to the Operational Area include the following:

- Abalone Managed Fishery;
- Abrolhos Islands and Mid West Trawl Managed Fishery;
- Broome Prawn Managed Fishery;
- Exmouth Gulf Prawn Managed Fishery;
- Gascoyne Demersal Scalefish Fishery;
- Mackerel Managed Fishery;
- Marine Aquarium Fishery;
- Nickol Bay Prawn Managed Fishery;
- Northern Demersal Scalefish Fishery;
- Onslow Prawn Managed Fishery;
- Open Access South Coast Demersal Scalefish Fishery;
- Pearl Oyster Managed Fishery, Pearl Leases;
- Pilbara Demersal Scalefish Fisheries (Pilbara Trawl, Trap and Line);
- Shark Bay Blue Swimmer Crab, Prawn and Scallop Managed Fisheries;
- Shark Bay Seine and Mesh Net Managed Fishery;
- South Coast Crustacean Managed Fishery;
- South Coast Open Access Netting Fishery;
- South Coast Purse Seine Fishery;
- South Coast Salmon Managed Fishery;
- South West Coast Salmon Managed Fishery;
- South West Trawl Fishery;
- Southern Demersal Gillnet & Demersal Longline Fishery;

- Specimen Shell Fishery;
- West Coast Deep Sea Crustacean Managed Fishery;
- West Coast Demersal Gillnet & Longline, and Scalefish Fisheries; and
- West Coast Purse Seine and Rock Lobster Fisheries.

There are no aquaculture activities within or adjacent to the Operational Area.

There are no designated traditional, or customary, fisheries recorded within or adjacent to the Operational Area as these are typically restricted to shallow coastal waters and/or areas with habitat structure such as reefs.

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. Due to the Operational Area's water depth (approximately 350 - 850 m) and distance offshore, recreational fishing is unlikely to occur in the Operational Area, although historical charter fishing has been recorded within WA-28-L.

Shipping:

The NWMR supports significant commercial shipping activity, the majority of which is associated with the mining and oil and gas industries. The Australian Maritime Safety Authority (AMSA) has introduced a network of marine fairways across the NWMR of WA to reduce the risk of vessel collisions with offshore infrastructure. The fairways are not mandatory but AMSA strongly recommends commercial vessels remain within the fairway when transiting the region. It is noted that none of these fairways intersect with the Operational Area; the nearest fairway is approximately 50 km north-west of the Operational Area. In addition, the 2016 AMSA vessel intensity data suggests minimal shipping density over the Operational Area (1-5000 tracked vessels), with this finding also supported through consultation with AMSA (**Figure 4-4**).

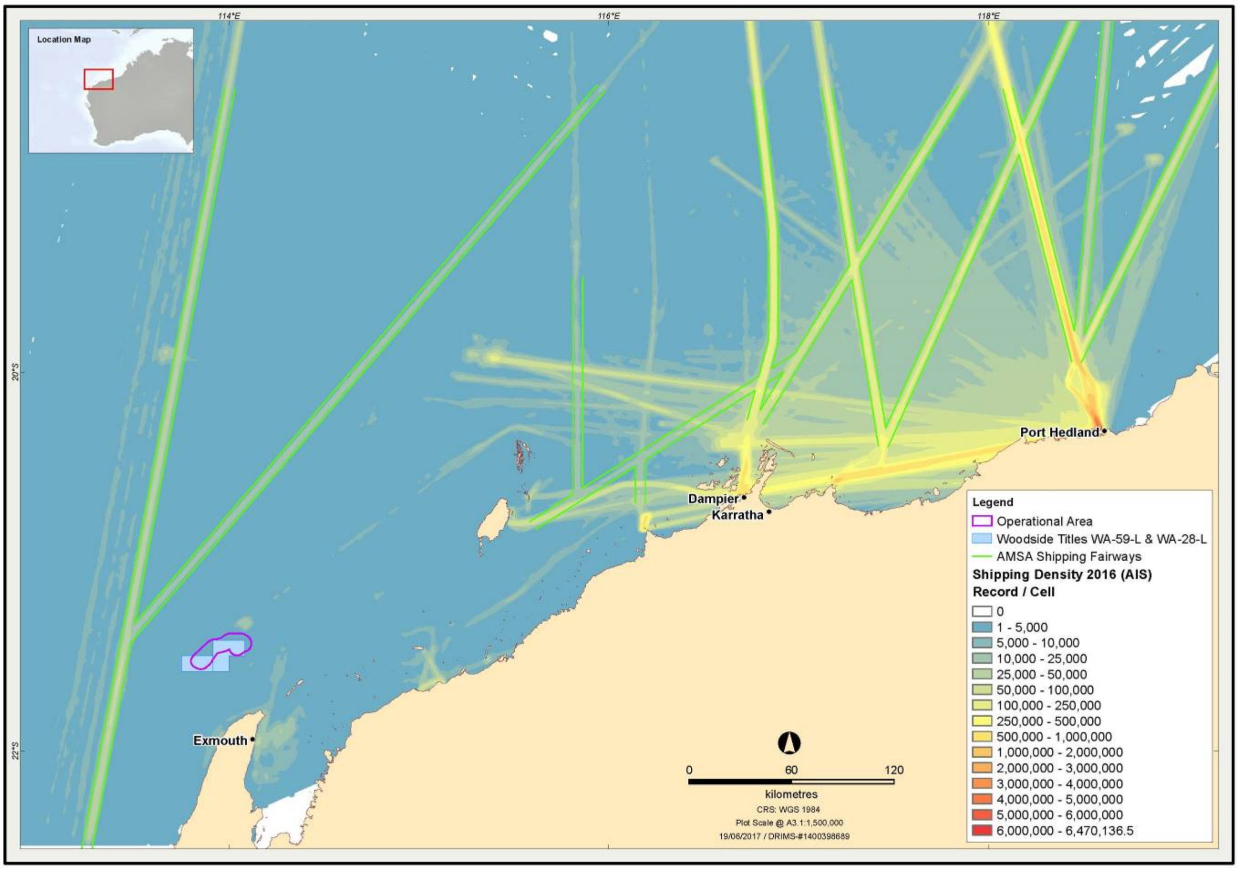

Figure 4-4: Vessel density map for the Operational Area from 2016, derived from AMSA satellite tracking system data (vessels include Cargo, LNG Tanker, Passenger Vessels, support vessels and others/unnamed vessels).

Oil and Gas Infrastructure

The Operational Area is located within an area of established oil and gas operations in the broader NWMR. The Operational Area overlaps both the NY FPSO (Woodside) and Ningaloo Vision FPSO (Quadrant) facilities, and is approximately 0.3 and 7.9 km south-east of the Nganhurra and Pyrenees venture FPSOs (**Figure 4-5**).

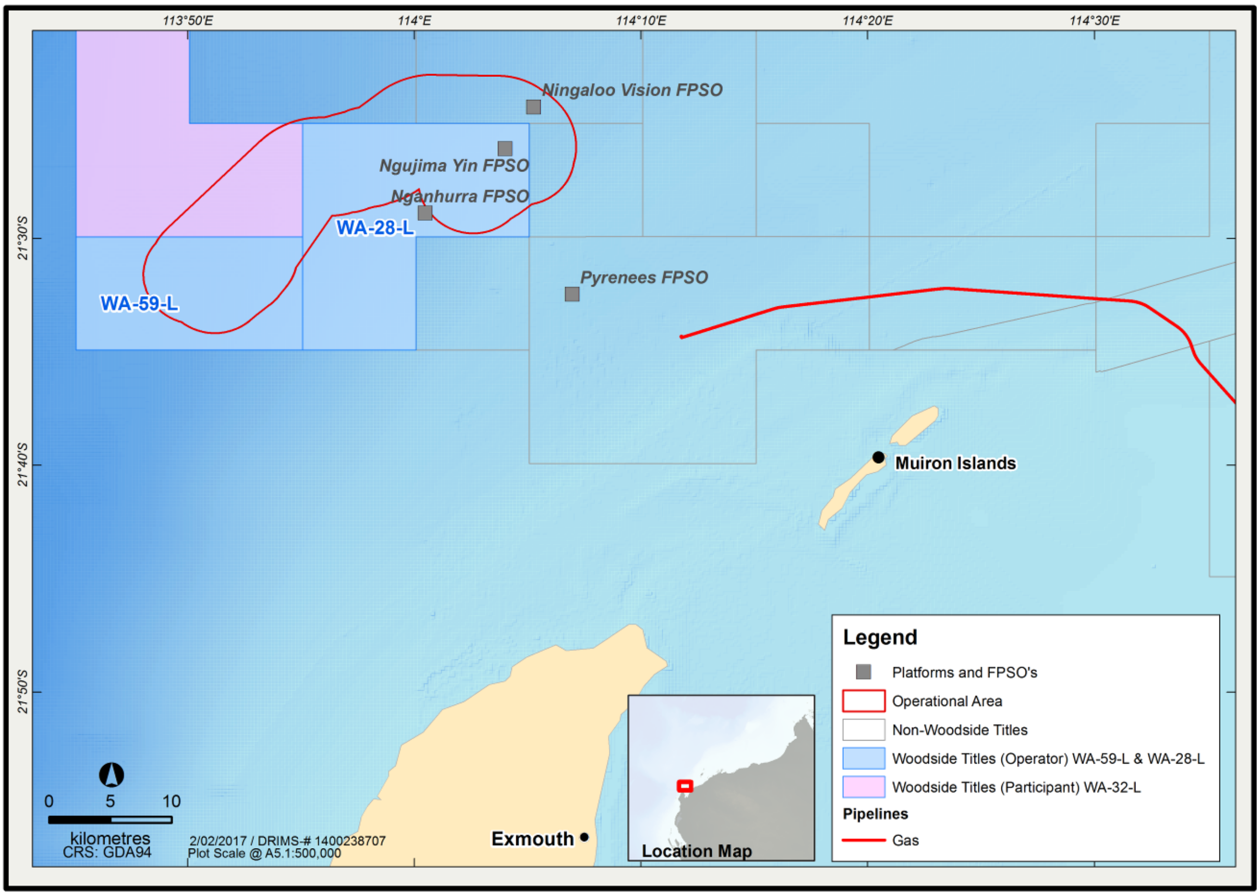

Figure 4-5: Oil and gas Infrastructure with reference to the location of the Operational Area

Defence

There are designated defence practice areas in the offshore marine waters off Ningaloo and the North West Cape. The Operational Area is within the northern tip of one of the defence practice areas (**Figure 4-6**). A Royal Australian Air Force base is located at Learmonth, on North West Cape, lies approximately 25 km south of the Operational Area.

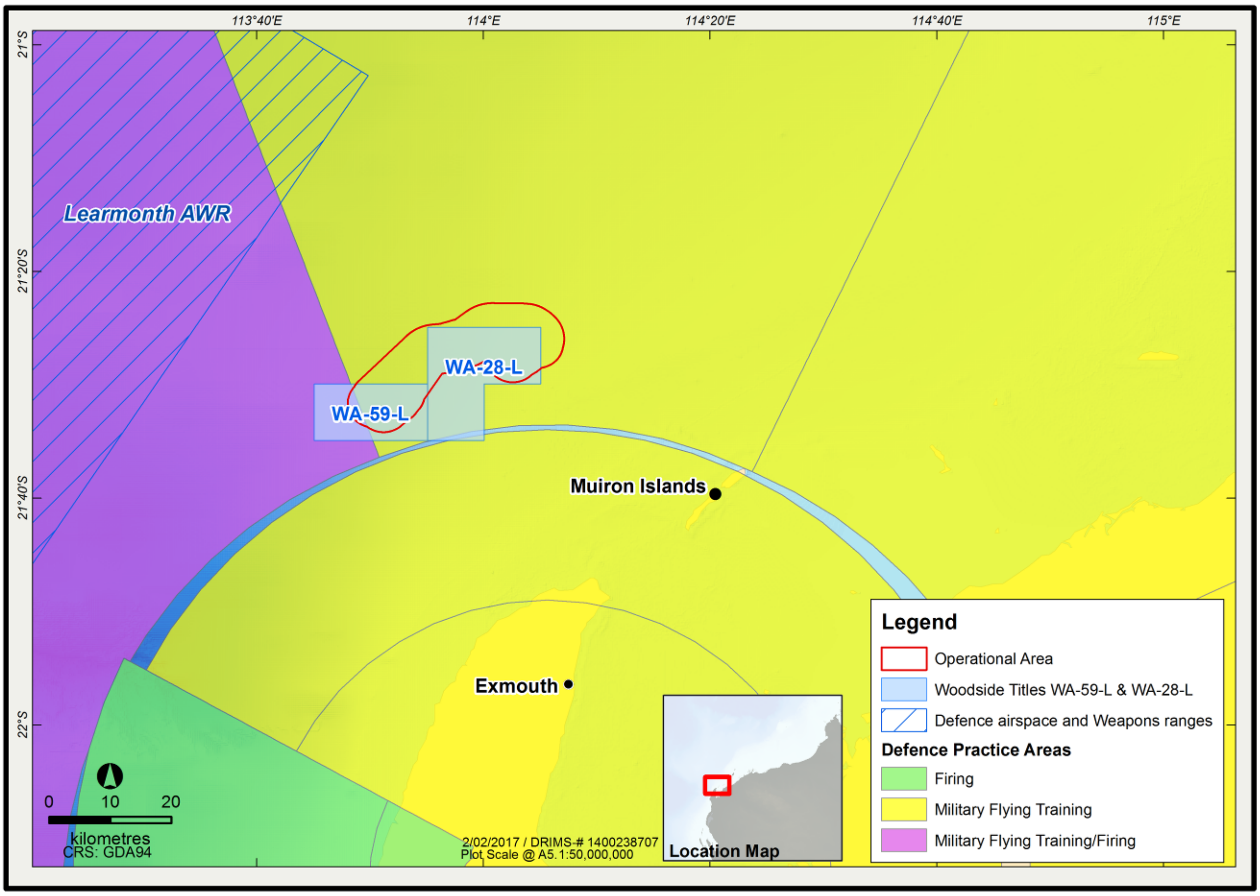

Figure 4-6: Department of Defence Demarcated Marine Offshore Areas for military and defence practice with reference to the location of the Operational Area

4.3 Values and Sensitivities

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 Montebello/Barrow/Lowendal Island Group and the Ningaloo WHA, and the associated resident, temporary or migratory marine life including species such as marine mammals, turtles and birds. Many sensitive receptor locations are protected as part of Commonwealth and State managed areas (**Figure 4-7**).

The closest marine reserve to the Operational Area is the boundary of the Gascoyne Commonwealth Marine Reserve (CMR) which is located approximately 5 km from the Operational Area. Two Key Ecological Features (KEFs) overlap the Operational Area, the Continental Slope Demersal Fish Communities KEF and the Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula KEF. Values and sensitivities of the established marine protected areas and other sensitive areas in the wider regional setting are listed in **Table 4-2**.

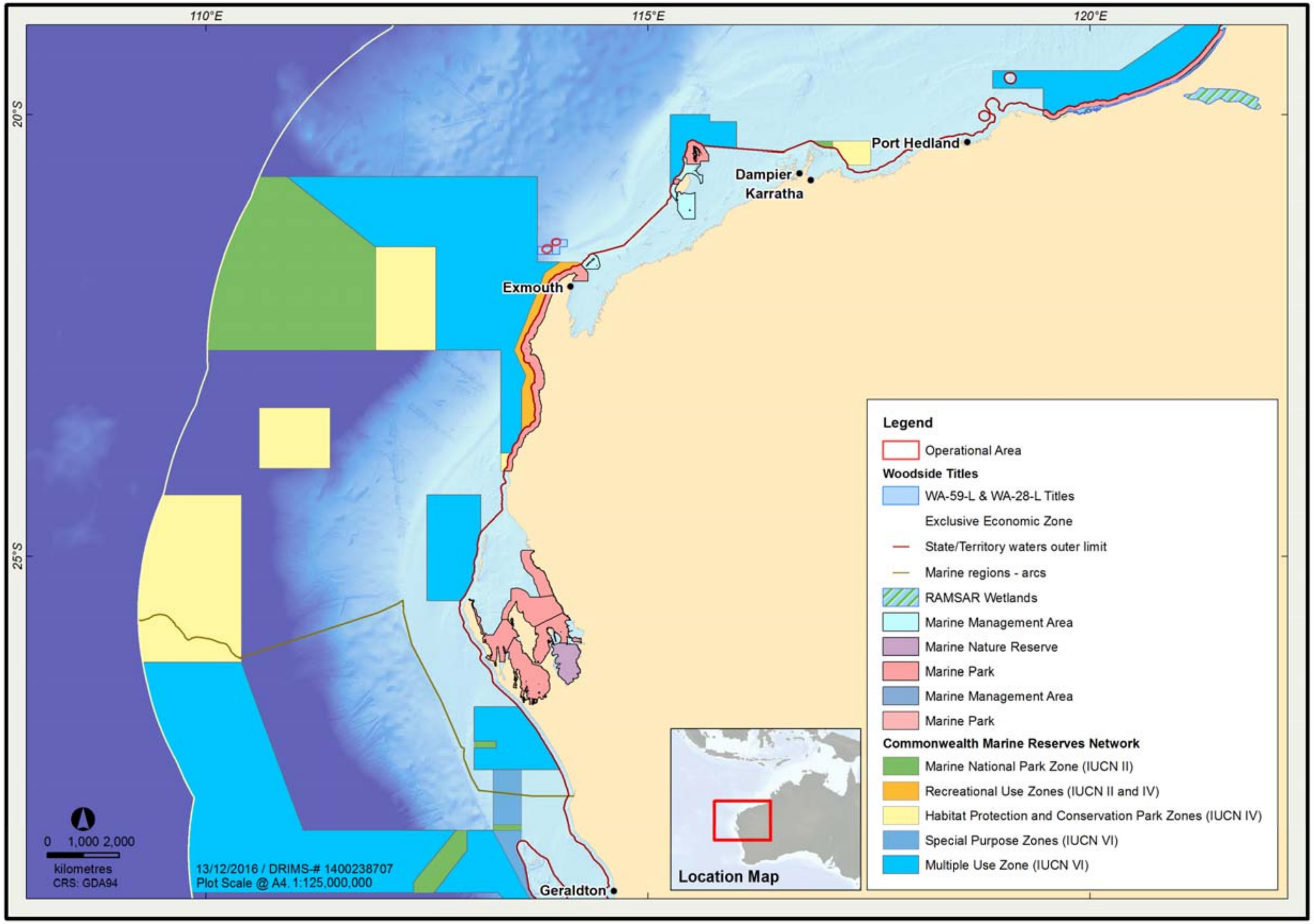

Figure 4-7: Established and Proposed Commonwealth and State Marine Protected Areas in relation to the Operational Area

Table 4-2: Summary of established Marine Protected Areas (MPAs) and other sensitive locations in the region relating to the Operational Area

	Distance from Operational Area to Values / Sensitivity boundaries (km)	International Union for the Conservatoin of Nature (IUCN) Protected Area Category
Commonwealth Marine Reserves		
Gascoyne	5	II, IV& VI
Ningaloo	17	II
Montebello	140	VI
Shark Bay	310	VI
Carnarvon Canyon	315	IV
Abrolhos	465	II, IV & VI
Argo-Rowley Terrace	475	II & VI
Mermaid Reef	740	IA
Kimberley	880	VI
Jurien	955	II & VI
Two Rocks	1105	VI
Perth Canyon	1120	II, IV & VI
Geographe	1310	VI
South-west Corner	1320	II & VI
Ashmore Reef	1385	IA & II
State Marine Parks and Nature Reserves		
Marine Parks		
Ningaloo	26	IA, II & IV
Barrow Island	145	IA
Barrow Island Nature Reserve	152	IA
Montebello Islands	170	IA, II, IV & VI
Lowendal Islands Nature Reserve	183	IA
Shark Bay	420	IA & II
Rowley Shoals	650	IA, II & IV
Abrolhos Islands Nature Reserve	763	IA
Jurien Bay	945	IA, II & VI
Ngari Capes	1325	VI
Marine Management Areas		
Muiron Islands	28	1A & VI
Barrow Island	135	IV & VI
World Heritage Areas		
The Ningaloo Coast	17	N/A

	Distance from Operational Area to Values / Sensitivity boundaries (km)	International Union for the Conservatoin of Nature (IUCN) Protected Area Category
Shark Bay, Western Australia	355	N/A
Key Ecological Features		
Continental Slope Demersal Fish Communities	Overlaps Operational Area	N/A
Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula	Overlaps Operational Area	N/A
Commonwealth waters adjacent to Ningaloo Reef	17	N/A
Ancient coastline at 125 m depth contour	17	N/A
Exmouth Plateau	65	N/A
Glomar Shoals	325	N/A
Western demersal slope and associated fish communities	465	N/A
Wallaby Saddle	480	N/A
Mermaid Reef and Commonwealth waters surrounding Rowley Shoals	645	N/A
Western rock lobster	680	N/A
Ancient coastline at 90-120 m depth	680	N/A
Perth Canyon and adjacent shelf break, and other west coast canyons	700	N/A
Commonwealth marine environment surrounding the Houtman Abrolhos Islands	720	N/A
Commonwealth marine environment within and adjacent to the west coast inshore lagoons	720	N/A
Canyons linking the Argo Abyssal Plain with the Scott Plateau	955	N/A
Seringapatam Reef and Commonwealth waters in the Scott Reef Complex	1135	N/A
Commonwealth marine environment within and adjacent to Geographe Bay	1310	N/A
Cape Mentelle upwelling	1325	N/A
Ashmore Reef and Cartier Island and surrounding Commonwealth waters	1385	N/A

**Conservation objectives for IUCN categories 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

5. ENVIRONMENTAL IMPACTS AND RISKS

5.1 Risk Identification and Evaluation

Woodside undertook an environmental risk assessment to identify the potential environmental impacts and risks associated with the Petroleum Activities Program, and the control measures to manage the identified environmental impacts and risks to ALARP and an acceptable level. This risk assessment and evaluation was undertaken using Woodside's Risk Management Framework.

The key steps of Woodside's Risk Management Framework are shown in **Figure 5-1**. A summary of each step and how it is applied to the Petroleum Activities Program is provided below.

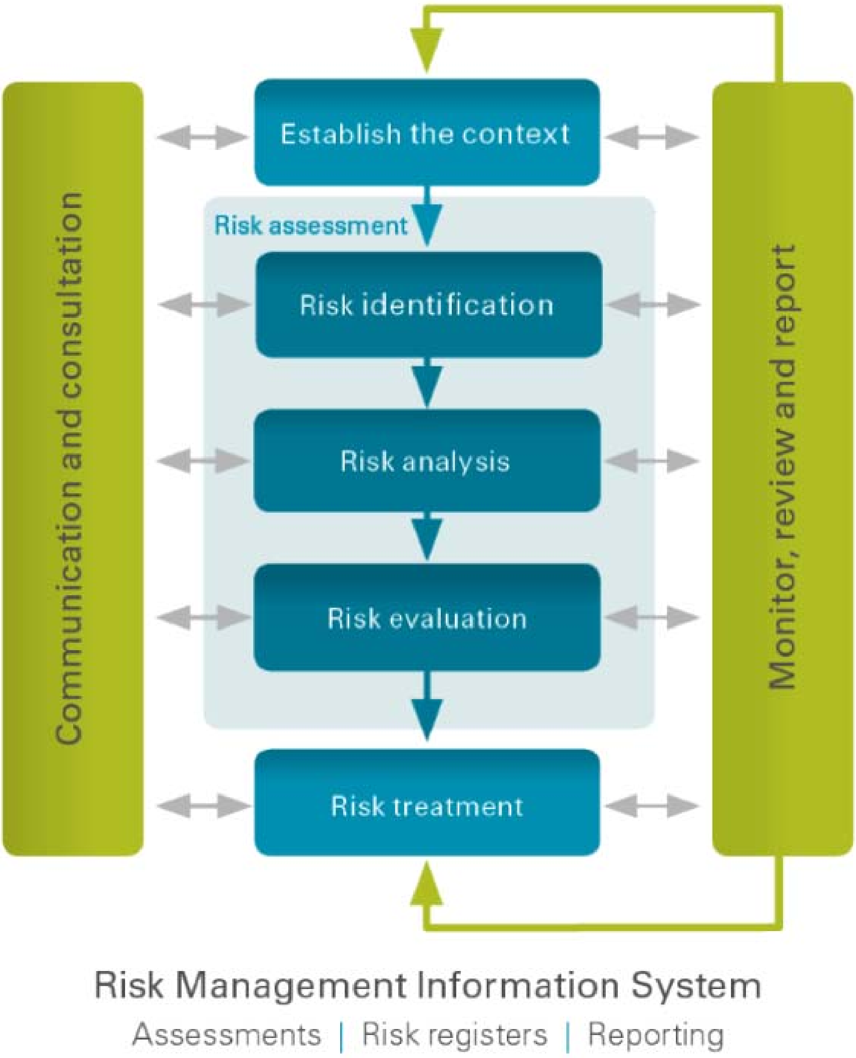

Figure 5-1: Woodside's risk management framework

Establish the Context

The objective of a risk assessment is to assess identified risks and apply appropriate control measures to eliminate, control or mitigate the risk to ALARP and to determine if the risk is acceptable.

Hazard identification workshops aligned with NOPSEMA's Hazard Identification Guidance Note were undertaken by multidisciplinary teams made up of relevant personnel with sufficient breadth of knowledge, training and experience to reasonably assure that risks and associated impacts were identified and assessed.

Risk Identification

The risk assessment workshop for the Petroleum Activities Program was used to identify risks with the potential to harm the environment. Risks were identified for both planned (routine and non-routine) and unplanned (accidents/incidents) activities.

Risk Analysis (Decision Support Framework)

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, review of past performance, external stakeholder consultation feedback and review of the existing environment.

The following key steps were undertaken for each identified risk during the risk assessment and are described in the following sections:

- identification of decision type in accordance with the decision support framework;
- identification of appropriate control measures (preventative and mitigation) aligned with the decision type; and
- calculation of the current risk rating.

To support the risk assessment process, Woodside applied the Guidance on Risk Related Decision Making during the workshops to determine the level of supporting evidence that may be required to draw sound conclusions regarding risk level and whether the risk is acceptable and ALARP.

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; and
- appropriate effort is applied to the management of risks based on the uncertainty of the risk, the complexity and risk rating.

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 it is agreed by environmental hazard identification (ENVID) workshop participants and documented in ENVID worksheets.

Identification of Control Measures

Woodside applies a hierarchy of control measures when considering Good Practice and Professional Judgement. The hierarchy of control is applied in order of importance as follows; elimination, substitution, engineering control measures, administrative control measures and mitigation of consequences/impacts.

Risk Rating Process

The current risk rating process is undertaken to assign a level of risk to each impact measured in terms of consequence and likelihood. The assigned risk level is the current risk (i.e. risk with controls in place) and is therefore determined following the identification of the decision type and appropriate control measures.

The risk rating process considers the environmental impacts and where applicable, the reputational and brand, legal/compliance and social and cultural impacts of the risk. The risk ratings are assigned using the Woodside Risk Matrix (refer to **Figure 5-2**).

Consequence

	Health & Safety	Environment	Financial	Reputation & Brand	Legal & Compliance	Social & Cultural
A	> 30 fatalities and / or permanent total disabilities	Catastropic, long-term impact (> 50 years) on highly valued ecosystems, species, habitat or physical or biological attributes	> $5B	Catastrophic, long term impact (> 20 years) to reputation and brand. International concern and / or persistent national concern in significant area of operation. Company operations, major ventures, significant or multiple asset operations severely restricted or terminated, and may extend to company at stake	Loss of licence to operate. Potential jail terms for executives, directors or officers. Prolonged litigation / prosecution. Fines (> $100M) and / or civil liability (> $1B)	Catastrophic, long-term impact (> 20 years) to a community, social infrastructure or highly valued areas / items of international cultural significance
B	Multiple fatalities and / or permanent total disabilities	Major, long-term impact (10-50 years) on highly valued ecosystems, species, habitat or physical or biological attributes	> $500M - $5B	National concern and / or international interest. Medium to long-term impact (5-20 years) to reputation and brand. Venture and / or asset operations restricted	Significant restriction on licence to operate. Prolonged litigation / prosecution. Fines (< $100M) and / or civil liability (< $1B)	Major, long-term impact (5-20 years) to a community, social infrastructure or highly valued areas / items of national cultural significance
C	Single fatality and / or permanent total disability	Moderate, medium-term impact (2-10 years) on ecosystems, species, habitat or physical or biological attributes	> $50M - $500M	National concern. Moderate, medium-term impact (2-5 years) to reputation and brand. Venture and / or asset operations restricted or curtailed	Material breach of legislation, regulation, contract or licence condition. Major litigation / prosecution. Fines (< $15M) and / or civil liability (< $150M)	Moderate, medium-term impact (2-5 years) to a community, social infrastructure or highly valued areas / items of national cultural significance
D	Major injury or occupational illness or permanent partial disability	Minor, short-term impact (1-2 years) on species, habitat (but not affecting ecosystems function), physical or biological attributes	> $5M - $50M	Minor, short-term impact (1-2 years) to reputation and brand. Close scrutiny of asset level operations or future proposals	Breach of legislation, regulation, contract or licence condition with investigation and / or report to authority. Litigation / prosecution. Fines (< $5M) and / or civil liability (< $50M)	Minor, short-term impact (1-2 years) to a community or highly valued areas / items of cultural significance
E	Moderate injury or occupational illness or temporary partial disability	Slight, short-term impact (< 1 year) on species, habitat (but not affecting ecosystems function), physical or biological attributes	> $500K - $5M	Slight, short-term local impact (< 1 year) to reputation and brand. Some impact on asset level non-production activities	Breach of legislation, regulation, contract or licence condition. Regulatory action and / or sanction	Slight, short-term impact (< 1 year) to a community or areas / items of cultural significance
F	Minor injury or occupational illness	No lasting effect (< 1 month). Localised impact not significant to environmental receptors	≤ $500K	No lasting effect (< 1 month). Isolated and short-term local concern	Breach of internal standard	No lasting effect (< 1 month). Localised impact not significant to areas / items of cultural significance

Likelihood

	Remote	Highly Unlikely	Unlikely	Possible	Likely	Highly Likely
Experience	Unheard of in the industry	Has occurred once or twice in the industry	Has occurred many times in the industry but not at Woodside	Has occurred once or twice in Woodside or may possibly occur	Has occurred frequently at Woodside or is likely to occur	Has occurred frequently at the location or is expected to occur
Frequency	1 in 100,000 - 1,000,000 years	1 in 10,000 - 100,000 years	1 in 1,000 - 10,000 years	1 in 100 - 1,000 years	1 in 10 - 100 years	> 1 in 10 years
Modelled distribution %* (Probability of event occurrence)	< 1%	1% - 5%	6% - 20%	21% – 50%	51% - 80%	> 80%
LEVEL	0	1	2	3	4	5

** Not to be used for operational Health & Safety or Environment risk assessments.*

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

Risk endorsement table

Current Risk

SEVERE	Risk at this level requires **Immediate (no more than 12 hours)** communication to the **CEO & divisional EVP / SVP** via VP Risk & Compliance
VERY HIGH	Risk at this level requires **Immediate (no more than 12 hours)** communication to **divisional EVP / SVP** with concurrent communication to VP Risk & Compliance
HIGH	Risk at this level requires timely communication to **SVP / VP of business unit or function**
MODERATE	Risk at this level requires timely communication to **line manager** (i.e. relevant Asset or Project Manager)
LOW	Risk at this level requires timely communication to the relevant **line manager**

Note: All currency stated in $US. The consequence and likelihood categories are not necessarily equal to each other. For example, the financial column is not equal to the remediation costs or consequences described in other columns.

Figure 5-2: Woodside risk matrix

The ENVID (undertaken in accordance with the methodology described above) identified 19 sources of environmental risk, comprising nine planned, which are all assessed as having a low current risk rating, and ten 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. Control measures have been presented in **Appendix A**.

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.

Risk Evaluation

Environmental risks, as opposed to safety risks, cover a wider range of issues, differing species, persistence, reversibility, resilience, cumulative effects and variability in severity. The degree of environmental risk and the corresponding threshold for whether a risk/impact has been reduced to ALARP and is acceptable (refer to **Figure 5-2**) has been adapted to include principles of ecological sustainability (given as an objective in the Environment Regulations and defined in the EPBC Act), the Precautionary Principle and the corresponding environmental risk threshold decision-making principles used to determine acceptability.

With regard to assigned consequence and likelihood as per the Woodside Risk Matrix (**Figure 5-2**), it should be noted that the application of a consequence can relate to both an impact and/or a risk. In respect of impacts (e.g. laying of a pipeline) this consideration includes both the physical impact from the presence of the pipeline being laid on the seabed and the impacts associated from the installation activity (e.g. turbidity). For the presence of the line an 'F' consequence is appropriate as it recognises a planned low level of impact will occur, although with minimal physical impact on the seabed deemed not to be significant (i.e. "Localised impacts not significant to environment receptors"). For the installation activity (turbidity generation) the "no lasting effect" description applies as any turbidity plume generated will be minimal and dissipate rapidly. When considering likelihood for planned impacts, the likelihood level assigned relates to the risk that the impact could exceed that of the defined impact (for example, could laying of a pipeline impact a greater area than planned). In the case of this example it is deemed highly unlikely (likelihood of '1') based on knowledge of the activity and receiving environment, while the consequence remains an 'F' as the impact is still localised.

Demonstration of ALARP

In accordance with Regulation 10A(b) of the Environment Regulations, Woodside demonstrates risks are reduced to ALARP where:

The current risk is Low or Moderate:

- good industry practice or comparable standards have been applied to control the risk, because any further effort towards risk reduction is not reasonably practicable without sacrifices grossly disproportionate to the benefit gained.

The current risk is High, Very High or Severe:

- good industry practice is applied for the situation/risk;
- alternatives have been identified and the control measures selected reduce the risks and impacts to ALARP. This may require assessment of Woodside and industry benchmarking, review of local and international codes and standards, consultation with stakeholders etc.

In addition when a current risk is at a high level is it communicated to the Senior Vice President (SVP) / Vice President (VP) of the business unit or function, and a current risk level of very high or severe communication to the divisional Executive Vice President /SVP with concurrent communication to the VP of Risk and Compliance.

Demonstration of Acceptability

In accordance with Regulation 10A(c) of the Environmental Regulations, Woodside applies the following process to demonstrate acceptability:

- Low and Moderate current risks are 'Broadly Acceptable', if they meet legislative requirements, industry codes and standards, regulator expectations, Woodside Standards and industry guidelines.
- High to Severe risks are 'Acceptable' if ALARP can be demonstrated using good industry practice and risk based analysis (RBA), 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 following criteria:
  - principles of Ecologically Sustainable Development (ESD) as defined under the EPBC Act;
  - internal context – the proposed controls and current risk level are consistent with Woodside policies, procedures and standards;
  - external context – consideration of the environment consequence and stakeholder acceptability; and
  - other requirements – the proposed controls and current risk level are consistent with national and international standards, laws and policies.
- Very high and severe current risks require further investigation and mitigation to reduce the risk to a lower and more acceptable level. If after further investigation the risk remains in the severe category, the risk requires appropriate business sign-off to accept the risk.

5.2 Hydrocarbon Spill Risk Assessment Methodology

Quantitative hydrocarbon spill modelling was undertaken using a three-dimensional hydrocarbon spill trajectory and weathering model which is designed to simulate the transport, spreading and weathering of specific hydrocarbon types under the influence of changing meteorological and oceanographic forces.

ZoC 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, solely in terms of delineating which areas of the marine environment could be exposed to hydrocarbon levels exceeding hydrocarbon threshold concentrations. All areas where hydrocarbon levels are exceeded are evaluated in the impact assessment. As the weathering of different fates of hydrocarbons (surface, accumulated, entrained and dissolved) differs due to the influence of the metocean mechanism of transportation, the locations potentially affected by each fate will different.

The summary of all the locations where hydrocarbon thresholds could be exceeded by any of the simulations modelled is defined as the ZoC. A stochastic modelling approach was applied to the quantitative hydrocarbon spill modelling. Stochastic modelling is the combination of a number of individual spill trajectory simulations, modelled under a range of historical metocean data considered seasonally and geographically representative for the scenario modelled. The stochastic results indicate the probability of where hydrocarbon might travel and the time take by the hydrocarbon to reach a given sensitive receptor for all modelled simulations. When considering the ZoC, it is important to understand that the ZoC does not represent the extent of any single spill event, which would be significantly smaller in spatial extent than a ZoC presenting stochastic modelling probabilities.

Surface fate and shoreline accumulation concentrations are expressed as grams per square metre (g/m^2), with entrained and dissolved aromatic hydrocarbon concentrations expressed as parts per billion (ppb). Hydrocarbon thresholds are presented in the table below (**Table 5-1**) and described in the following subsections.

Table 5-1: Summary of thresholds applied to the quantitative hydrocarbon spill risk modelling results

Surface Hydrocarbon (g/m^2)	Entrained hydrocarbon (ppb)	Dissolved aromatic hydrocarbon (ppb)	Accumulated Hydrocarbon (g/m2)
10	500	500	100

Surface Hydrocarbon Threshold Concentrations

The spill modelling outputs defined for surface hydrocarbon spills (contact on surface waters) using the ≥10 g/m^2 (dull metallic colours) based on the relationship between film thickness and appearance. 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.

Dissolved Aromatic Hydrocarbon Threshold Concentrations

The threshold concentration value for dissolved aromatic hydrocarbons has been set with reference to results from ecotoxicity tests. Ecotox data from a surrogate hydrocarbon that is considered to be representative of hydrocarbon that may be encountered during the Petroleum Activities Program is used to determine thresholds where data is not available for the exact resource location. 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.

Based on these ecotoxicology tests, a dissolved aromatic hydrocarbon threshold of 500 ppb has been adopted. This 500 ppb threshold is significantly less than the lowest no observable effect concentration (NOEC) for the most sensitive organism tested. Therefore, it is considered that the 500 ppb dissolved aromatic threshold is a conservative threshold to apply to condensate that may be encountered during the Petroleum Activities Program.

Entrained Hydrocarbon Threshold Concentrations

The threshold concentration of entrained hydrocarbons that could result in a biological impact cannot be determined directly using available ecotoxicity data for water accommodated fraction (WAF) of hydrocarbons. However, it is likely these data specific to dissolved hydrocarbon represents a worst-case scenario. This is owing to the fact that entrained hydrocarbons are less biologically available to organisms through absorption into their tissues than dissolved hydrocarbons. It is therefore expected that the entrained threshold concentration of 500 ppb will represent a potential impact substantially lower than the NOEC concentrations.

Accumulated Hydrocarbon Threshold Concentrations

Published data define accumulated hydrocarbon <100 g/m^2 to have an appearance of a stain on shorelines, with an accumulated hydrocarbons ≥100 g/m^2 considered to be the threshold that could impact the survival and reproductive capacity of benthic epifaunal invertebrates living in intertidal habitat.

6. ENVIRONMENTAL RISKS AND IMPACTS SUMMARY

Table 6-1 presents a summary of the sources of risk, analysis and evaluation for the Petroleum Activities program, using the methodology described above in **Section 5** of this EP Summary. There are two types of environmental risk sources identified for the Petroleum Activities Program which relate to activities which are planned and either undertaken on a routine or non-routine basis or which may occur from unplanned activities were also identified. These sources of risk range from small scale chemical spills with a low environmental consequence to hydrocarbon spill events with high environmental consequence.

A detailed description of environmental risks and potential impacts together with a summary of control measures have been presented in **Appendix A**.

Table 6-1: Environmental Risk and Impacts Register Summary

Source of Risk	Areas of Impact / Environmental Impacts	Residual Risk Rating			
		Consequence	Potential Consequence level of impact	Likelihood	Residual Risk
Planned Activities (Routine and Non-routine)					
Displacement of other users - proximity of MODU, ISVs and activity support vessels causing interference with or displacement to third party vessels (commercial fishing, recreational fishing and commercial shipping).	Isolated social impact potentially resulting from interference with other sea users (e.g. commercial and recreational fishing, and shipping)	F	Reputation/brand – No lasting effect. Isolated and short-term local concern.	1	L
Disturbance to seabed from project activities including drilling operations, MODU mooring, flowline installation, installation of subsea infrastructure and ROV operations.	Localised impacts to benthic habitats from anchoring, placement of flowline and subsea equipment including stabilisation materials.	F	Environment – No lasting effect (< 1 month). Localised impact not significant to environmental receptors.	2	L
Generation of noise from; • MODU, ISVs and activity support vessels • subsea piling • subsea survey and positioning equipment • helicopter transfers.	Temporary and minor disruption (e.g. avoidance or attraction) to fauna, including protected species.	E	Environment – Slight, short-term local impact (< 1 year) on species, habitats (but not affecting ecosystems function), physical or biological attributes	1	L
Discharge from MODU, ISVs and activity support vessels of: • sewage • grey water • putrescible waste • bilge water • deck drainage • cooling water and brine	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.	2	L

Source of Risk	Areas of Impact / Environmental Impacts	Residual Risk Rating			
		Consequence	Potential Consequence level of impact	Likelihood	Residual Risk
Routine and non-routine discharge of drill cuttings and drilling fluids (WBM and NWBM)	Localised burial and smothering of benthic habitats. Localised and temporary minor effects to water quality and sediments (e.g. turbidity increase) and marine biota in offshore waters	E	Environment – Slight, short-term local impact (< 1 year) on species, habitats (but not affecting ecosystems function), physical or biological attributes	1	L
Routine and non-routine discharges of subsea installation and commissioning 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.	2	L
Routine discharge of drilling and completions fluids	Localised burial and smothering of benthic habitats. Localised and temporary minor effects to water quality (e.g. turbidity increase) and marine biota in offshore waters	F	Environment – No lasting effect (< 1 month). Localised impact not significant to environmental receptors.	1	L
Atmospheric emissions from fuel combustion, flaring and incineration.	Reduced local air quality from atmospheric emissions	F	Environment – No lasting effect (< 1 month). Localised impact not significant to environmental receptors	1	L
External Lighting on MODU and activity support vessels	Disturbance to marine fauna, particularly seabirds, marine turtles and fish.	F	Environment – No lasting effect (< 1 month). Localised impact not significant to environmental receptors	1	L
Unplanned Activities (Accidents / Incidents)					
Loss of well containment	Short to medium term impacts to the offshore marine environment. Long-term impacts to sensitive nearshore areas of offshore islands (e.g. the Muiron Islands, Montebello/Barrow/Lowendal Island Group) and 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).	A	Environment – Catastrophic, long term impact (>50 years) on highly valued ecosystem, species, habitat, physical or biological attributes Reputation/brand Catastrophic, long term impact (> 20 years) to reputation and brand. International concern and/or persistent national concern in significant area of operation. Company operations, major ventures, significant or multiple asset operations severely restricted or terminated, and may extend to company at stake.	1	H

Source of Risk	Areas of Impact / Environmental Impacts	Residual Risk Rating			
		Consequence	Potential Consequence level of impact	Likelihood	Residual Risk
Subsea loss of containment including: Loss of containment from subsea infrastructure as a result of: • dropped object from the MODU, ISVs or activity support vessels • MODU anchor drag over live infrastructure during drilling	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
Subsea release as a result of encountering a shallow gas hazard during drilling	Reduced local air quality from atmospheric emissions	F	Environment – No lasting effect (< 1 month). Localised impact not significant to environmental receptors	2	L
Vessel collision	Minor and temporary disruption to marine fauna, including protected species. Minor and/or temporary impacts to water quality.	D	Environment – Minor, short term impact (1-2 years) on species, habitat (but not affecting ecosystems function), physical or biological attributes	1	M
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
Deck and subsea spills	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.	1	L
Loss of hazardous and non-hazardous waste	Minor and/or temporary impacts to water quality.	F	Environment – No lasting effect (< 1 month). Localised impact not significant to environmental receptors	2	L
Drilling fluids	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	1	L

Source of Risk	Areas of Impact / Environmental Impacts	Residual Risk Rating			
		Consequence	Potential Consequence level of impact	Likelihood	Residual Risk
			attributes.		
Venting of gas (well kick)	Localised and temporary reduction in air quality as the gas vents to the atmosphere.	F	Environment – No lasting effect (< 1 month). Localised impact not significant to environmental receptors.	2	L
Vessel collision with marine fauna	Fatality of an individual or a number of individuals with no threat to overall population viability.	F	Environment - No lasting effect (< 1 month). Localised impact not significant to environmental receptors.	2	L
Disturbance to seabed as a result of: • dropped objects from a MODU, PIVs or activity support vessels • loss of MODU mooring integrity resulting in anchor drag (moored MODU only)	Localised short-term damage of benthic subsea habitats in the immediate location of the dropped object or anchor drag scour.	E	Environment – Slight, short term impact (< 1 year) on species, habitat (but not affecting ecosystems function), physical or biological attributes.	1	L
Introduction of invasive marine species	Introduction of invasive marine species possibly resulting in an alteration of the localised environment or quarantine of nearby infrastructure/FPSO.	D	Reputation & Brand – Minor, short –term impact (1-2 years) to reputation and brand. Close scrutiny of asset level operations or future proposals.	0	L

7. ONGOING MONITORING OF ENVIRONMENTAL PERFORMANCE

The Petroleum Activities Program will be managed in compliance with the Greater Enfield Tieback EP accepted by NOPSEMA under the Environment Regulations, other relevant environmental legislation and Woodside's Management System (e.g. Woodside Environment Policy).

The objective of the Greater Enfield Tieback EP is to identify, mitigate and manage potentially adverse environmental impacts associated with the Petroleum Activities Program, during both planned and unplanned operations, to ALARP and an acceptable level.

For each environmental aspect (risk) and associated environmental impacts (identified and assessed in the Environmental Risk Assessment of the EP) specific environmental performance outcomes, controls, environmental performance standards and measurement criteria have been developed. The control measures (available in **Appendix A**) will be implemented in accordance with the relevant environmental performance standards to achieve the environmental performance outcomes. The specific measurement criteria provide the evidence base to demonstrate that the environmental performance standards and outcomes are achieved.

The implementation strategy detailed in the Greater Enfield Tieback EP identifies the roles/responsibilities and training/competency requirements for all personnel (Woodside and its contractors) in relation to implementing controls, managing non-conformance, emergency response and meeting monitoring, auditing, and reporting requirements during the activity.

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 until activity completion. This information is collected using appropriate tools and systems, based on the environmental performance outcomes, performance standards and measurement criteria in the Greater Enfield Tieback EP.

The tools and systems collect, as a minimum, the data (evidence) referred to in the measurement criteria. The collection of this data (and assessment against the measurement criteria) forms part of the permanent record of compliance maintained by Woodside and the basis for demonstrating that the environmental performance outcomes and standards are met, which is then summarised in a series of routine reporting documents.

Monitoring of environmental performance is undertaken as part of the following:

- Environmental Performance Report will be submitted to NOPSEMA within twelve months of commencement of the activity to assess and confirm compliance with the accepted environmental performance objectives, standards and measurement criteria outlined in the Greater Enfield Tieback EP;
- Activity-based inspections undertaken to review compliance against the Greater Enfield Tieback EP, verify effectiveness of the implementation strategy and to review environmental performance;
- Environmental performance is also monitored daily via daily progress reports during operations; and
- Senior management regularly monitors and reviews environmental performance via a monthly report which details environmental performance and compliance with Woodside standards.

Woodside employees and contractors are required to report all environmental incidents and non-conformance with environmental performance outcomes and standards in the Greater Enfield Tieback EP. Incidents will be reported using an Incident and Hazard Report Form, which includes details of the event, immediate actions taken to control the situation, and corrective actions to prevent reoccurrence. An internal computerised database is used for the recording and reporting of these incidents. Incident corrective actions are monitored to ensure they are closed out in a timely manner.

The Greater Enfield Tieback EP is supported by an assessment of the environmental impacts and risks associated with potential hydrocarbon spill scenarios and hydrocarbon spill preparedness and response measures in relation to the risk assessment and the identified hydrocarbon spill scenarios. A summary of Woodside's response arrangements in the Oil Pollution Emergency Plan (OPEP) is provided in **Section 8**.

7.1 Environment Plan Revisions and Management of Change

Revision of the Greater Enfield Tieback EP will be undertaken in accordance with the requirements outlined in Regulations 17, Regulation 18 and Regulation 19 of the Environment Regulations. Woodside will submit a revision to the EP due to all or any of the following:

- at least 14 days before the end of each period of 5 years commencing on the day on which the original and subsequent revisions of the EP is accepted under Regulation 11 of the Environment Regulations; and
- as requested by NOPSEMA.

Management of changes relevant to the Greater Enfield Tieback EP, concerning the scope of the activity description 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 on species protected under EPBC Act and current requirements for Commonwealth Marine Reserves and potential new advice from external stakeholders will be managed in accordance with internal procedures for management of change. These provide guidance on the Environment Regulations that may trigger a Revision 1nd resubmission of the EP to NOPSEMA. They also provide guidance on what constitutes a significant new risk or increase in risk. A risk assessment will be conducted in accordance with Woodside's Environmental Risk Management Methodology to determine the significance of any potential new environmental impacts or risks not provided for in the Greater Enfield Tieback 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 the Greater Enfield Tieback 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 and administrative changes as defined above will be made to the Greater Enfield Tieback EP using Woodside's document control process. Minor revisions will be tracked and incorporated during scheduled internal reviews.

8. OIL POLLUTION EMERGENCY RESPONSE ARRANGEMENTS

Woodside's OPEP for the Petroleum Activities Program has the following components:

- Oil Pollution Emergency Arrangements (Australia);
- Greater Enfield Tieback Oil Pollution First Strike Plan; and
- Oil Spill Preparedness and Response Mitigation Assessment for Greater Enfield Tieback Drilling Campaign.

8.1 Woodside Oil Pollution Emergency Arrangements (Australia)

This document outlines the emergency and crisis management incident command structure (ICS) and Woodside's response arrangements to competently respond to and escalate a hydrocarbon spill event. The document interfaces externally with Commonwealth, State and industry response plans and internally with Woodside's ICS.

Woodside's Oil Pollution Emergency Arrangements (Australia) details the following support arrangements:

- Access to MODU to drill intervention well via Memorandum of Understanding (MoU) with other industry participants;
- Master services agreement with Australian Marine Oil Spill Centre (AMOSC) for the supply of experienced personnel and equipment;
- Access to Wild Well Control's capping stack, subsea first response toolkit (SFRT) equipment and experienced personnel for the rapid deployment and installation of a capping stack, where feasible (may require well intervention prior to deployment);
- Other support services such as 24/7 hydrocarbon spill trajectory modelling and satellite monitoring services as well as 'on-call' aerial, marine, logistics and waste management support; and
- Mutual Aid Agreements with other oil and gas operators in the region for the provision of assistance in a hydrocarbon spill response.

8.2 GED Exploration Drilling Oil Pollution First Strike Plan

The Greater Enfield Tieback Oil Pollution First Strike Plan is an activity specific document which provides details on the tasks required to mobilise a first strike response for the first 24 hours of a hydrocarbon spill event. These tasks include key response actions and regulatory notifications. The intent of the document is to provide immediate oil spill response guidance to the Incident Management Team until a full Incident Action Plan specific to the oil spill event is developed.

The activity vessels will have Ship Oil Pollution Emergency Plans (SOPEPs) in accordance with the requirements of International Convention for the Prevention of Pollution from Ships (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 Greater Enfield Tieback Oil Pollution First Strike Plan is intended to work in conjunction with the SOPEPs.

Woodside's oil spill arrangements are tested by conducting periodic exercises. These exercises are conducted to test the response arrangements outlined in the Greater Enfield Tieback Oil Pollution First Strike Plan and to ensure that personnel are familiar with spill response procedures, in particular, individual roles and responsibilities and reporting requirements.

8.3 Oil Spill Preparedness and Response Mitigation Assessment

Woodside has developed an oil spill preparedness and response position in order to demonstrate that risks and impacts associated with loss of hydrocarbons from the Petroleum Activities Program would be mitigated and managed to ALARP and would be of an acceptable level.

The following oil spill response strategies were evaluated and subsequently pre-selected for a significant oil spill event (level 2 or 3 under the National Plan) from the Petroleum Activities Program:

- Monitor and Evaluate (Operational Monitoring) – Operational Monitoring commences immediately following a spill and includes the gathering and evaluation of data to inform the oil spill response planning and operations. It includes fate and trajectory modelling, spill tracking, weather updates and field observations. Woodside would implement the following operational monitoring plans to satisfy the requirements of this strategy. The following operational monitoring programs are available for implementation:
    - Predictive modelling of hydrocarbons to assess resources at risk;
    - Surveillance and reconnaissance to detect hydrocarbons and resources at risk;
    - Monitoring of hydrocarbon presence, properties, behaviour and weathering in water;
    - Pre-emptive assessment of sensitive receptors at risk; and
    - Monitoring of contaminated resources and the effectiveness of response and clean-up operations.
- Response Strategies based on identified Response Protection Areas (RPAs). The following response strategies may be applied based on the outcomes of implemented Operational Monitoring programs and identified RPAs from deterministic modelling:
    - Surface dispersant application - Surface dispersant application may reduce surface hydrocarbons and therefore prevent, or reduce the scale of, shoreline contact. Priority would be placed on treating high volume surface hydrocarbons closest to the release location as this is where they are expected to achieve the greatest environmental benefit.
    - Containment and recovery - The aim of this response strategy is to reduce damage to sensitive resources by the physical containment and mechanical removal of hydrocarbons from the marine environment.
    - Subsea dispersant injection - Subsea dispersant injection involves the deployment of a subsea dispersant manifold with associated equipment to inject chemical dispersant directly into the oil plume in the event of a loss of well control. As it may take some time to mobilise subsea dispersant equipment, surface dispersants are generally used in the interim to treat oil that makes it to the surface. The use of subsea dispersants has similar benefits to surface dispersant application including a potential reduction in the volume of hydrocarbons that reach the shoreline thereby reducing impacts to sensitive receptors. In addition to these benefits, subsea dispersant application may greatly reduce volatile organic compound (VOC) levels during surface response operations, reducing risks and hazards to responders.
    - Source control - A loss of well control is the identified worst case spill scenario. Woodside's primary mitigation strategy is to minimise the volume of hydrocarbons released. Woodside plans to deploy the following response options specific to a loss of well control event:

        - Well intervention - BOP intervention / ROV survey, Top kill / mud kill;
        - Subsea first response toolkit (SFRT) - Debris clearance/removal, Subsea dispersant injection;
        - Capping stack deployment; and/or
        - Relief well drilling.
- Shoreline protection and deflection - The placement of containment, protection or deflection booms on and near a shoreline is a response strategy to reduce the potential volume of hydrocarbons contacting or spreading along shorelines, which may reduce the scale of shoreline clean-up. Hydrocarbons contained by the booms would be collected where practicable. Shorelines would be protected where accessible via vessel or shore. Where hydrocarbon contact has already occurred, there may still be value in deploying protection equipment to limit further accumulations and preventing remobilisation of deposited hydrocarbons.
- Shoreline clean-up - Shoreline clean-up is undertaken when residual hydrocarbons not collected through previously described response strategies make contact with shorelines. The timing, location, and extent of shoreline clean-up can vary from one scenario to another, depending on the hydrocarbon type, shoreline type and access, degree of oiling and area oiled. A shoreline clean-up can limit injury to wildlife, prevent or reduce remobilisation of hydrocarbons in the tidal zone, facilitate habitat recovery and meet societal expectations.
- Wildlife response - An oiled wildlife response would be undertaken in accordance with Woodside's Health, Safety, Environment and Quality Policy and values and recognition of societal expectations. The response would involve reconnaissance from vessels, aircraft and shoreline surveys, the capture, transport, rehabilitation and release of oiled wildlife.
- Scientific monitoring - A scientific monitoring program (SMP) would be activated following a Level 2 or 3 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 ZoC and in particular, the identified Pre-emptive Baseline Areas (PBAs) in the event of a loss of well control from the PAP drilling activities (refer to response planning assumptions). The SMP would be informed by the operational monitoring programs, but differs from the operational monitoring program in being a long-term program independent of, and not directing, the operational oil spill response. Key objectives of the Woodside oil spill scientific monitoring program are:
    - Assess the extent, severity and persistence of the environmental impacts from the spill event; and
    - Monitor subsequent recovery of impacted key species, habitats and ecosystems.
- Waste management - Waste management is considered a support strategy to the response strategies examined above.

9. CONSULTATION

In support of the Greater Enfield Tieback EP, Woodside conducted a stakeholder assessment and engaged with relevant stakeholders to inform decision-making and planning for continued production activities in accordance with the requirements of Regulation 11A and 14(9) of the Environment Regulations.

Woodside conducted a stakeholder assessment based on the activity location, timing and potential impacts. A consultation fact sheet was sent electronically to all stakeholders identified through the stakeholder assessment process prior to lodgement of the Greater Enfield Tieback EP with NOPSEMA for assessment and acceptance. Woodside provided information about the Petroleum Activities Program to the relevant stakeholders listed in **Table 9-1**. Woodside considers relevant stakeholders for routine operations as those that undertake normal business or lifestyle activities in the vicinity of the existing facility (or their nominated representative) or have a State or Commonwealth regulatory role.

Table 9-1: Relevant stakeholders identified for the Petroleum Activities Program

Stakeholder	Relevance
Department of Industry Innovation and Science	Department of relevant Commonwealth Minister
Department of Mines and Petroleum	Department of relevant State Minister
Australian Maritime Safety Authority	Maritime safety
Department of Defence	Helicopter movements
Australian Hydrographic Service	Maritime safety
Pearl Producers Association	Commercial fishery management
Department of Primary Industries and Regional Development (formally known as Department of Fisheries)	Commercial fishery management
Commonwealth fisheries	Commercial fisheries – Commonwealth • Western Skipjack Fishery • Western Tuna and Billfish Fishery • North-West Slope Trawl Fishery • Southern Bluefin Tuna Fishery • Western Deepwater Trawl Fishery
Western Australian Fisheries	Commercial fishery – State • Mackerel Fishery • Pilbara Trawl Fishery • Pilbara Trap Fishery • Gascoyne Demersal Scalefish Fishery • Specimen Shell Fishery • Marine Aquarium Fishery • Exmouth Gulf Prawn Fishery (M G Kailis)
Australian Maritime Safety Authority	Oil spill preparedness (Australian waters) Maritime safety
Department of Transport	Oil spill preparedness (Western Australian waters)
Western Australian Fishing Industry Council	Commercial fishery – State

(WAFIC)	
Exmouth Community Reference Group	Government, industry and community groups
Exmouth Fishing Charter Operators	Vessel activities
Quadrant Energy and BHP Billiton Petroleum Australia	Nearby titleholders

Woodside also made available advice about the Petroleum Activities Program to other stakeholders who may be interested in the activity or who have previously expressed an interest in being kept informed about Woodside's activities in the region. The following are stakeholders that have been identified as 'interested' in the Petroleum Activities Program:

- Australian Maritime Safety Authority (marine pollution);
- Department of Biodiversity, Conservation and Attractions (Formally known as Department of Parks and Wildlife);
- Australian Customs Service – Border Protection Command;
- Commonwealth Fisheries Association;
- Recfishwest;
- World Wildlife Fund (WWF);
- Australian Conservation Foundation;
- Wilderness Society;
- International Fund for Animal Welfare;
- APPEA; and
- AMOSC.

Woodside received feedback on the Petroleum Activities Program from a range of stakeholders, including government agencies and commercial fishing organisations. Issues of interest or concern included the location of the activities across commercial fishing areas. Woodside considered this feedback in its development of control measures specific to the Petroleum Activities Program. A summary of feedback and Woodside's response is presented in **Appendix C.**

9.1 Ongoing Consultation

Consultation activities for the Petroleum Activities Program build upon Woodside's extensive and ongoing stakeholder consultation for offshore petroleum activities in this area.

Feedback received through community engagement and consultation will be captured in Woodside's stakeholder database and actioned where appropriate through the Petroleum Activities Program Project Manager. Implementation of ongoing engagement and consultation activities for the Petroleum Activities Program will be undertaken by Woodside Corporate Affairs consistent with Woodside's External Stakeholder Engagement Operating Standard.

Woodside will continue to accept feedback from all stakeholders throughout the duration of the accepted Greater Enfield Tieback EP. Stakeholder feedback should be made to the nominated liaison person, identified in **Section 10** of this EP Summary.

10. TITLEHOLDER NOMINATED LIAISON PERSON

For further information on this Petroleum Activities Program, please contact:

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11. ABBREVIATIONS AND ACRONYMS

Term	Description / Definition
Abbreviations	
µm	Micrometer
AHS	Australian Hydrographic Service
AHV	Anchor Handling Vehicle
ALARP	As Low As Reasonably Practicable
AMOSC	Australian Maritime Oil Spill Centre
AMSA	Australian Maritime Safety Authority
API	American Petroleum Institute
APPEA	Australian Petroleum Production and Exploration Association
AUV	Autonomous underwater vehicle
BIA	Biologically Important Area
BOP	Blow-out Preventer
CBL	Cement Bog Log
CCL	Casing Collar Locator
CEFAS	Centre for Environment Fisheries and Aquaculture Science
CIM	Cimatti
CMR	Commonwealth Marine Reserve
COT	Casing Orientation Tool
DGPS	Differential Global Surface Position System
DP	Dynamically Positioned
DSV	Diving Support Vessel
EDS	Emergency Disconnect Sequence
EHU	Electrical Hydraulic Umbilical System
ENVID	Environmental hazard Identification
Environment Regulations	Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009
EP	Environment Plan
ESD	Ecological Sustainable Development
EPBC Act	*Environment Protection and Biodiversity Conservation Act, 1999*.
FCGT	Flood, Clean and Gauge testing
FEWD	Formation Evaluation While Drilling
FLET	Flowline End Termination
FPSO	Floating Production, Storage and Offloading vessel
FSB	Flow Support Base
g/m^2	Grams per square metre

GR	Gamma Ray
HXT	Horizontal Xmas Tree
ICS	incident command structure
ILI	In-line inspection
ILT	Inline tees
ILTA	Inline tee Assembly
ISV	Installation Support Vessel
ITF	Indonesian Through Flow
IUCN	International Union for Conservation of Nature
KEF	Key Ecological Feature
km	Kilometre
L	Litres
LARS	Launch and Recovery System
LAO	Linear Alpha Olefin
LAV	Laverda Canyon
LBL	Long base line
LNG	Liquefied Natural Gas
MARPOL	International Convention for the Prevention of Pollution from Ships
MEG	Monoethylene Glycol
MNES	Matters of National Environmental Significance
MODU	Mobile Offshore Drilling Unit
MoU	Memorandum of Understanding
MPA	Marine Protected Areas
MPP	Multiphase Pump
MWD	Measurement-while-drilling
NDT	Non Destructive Testing
nm	Nautical mile (1,852 m) a unit of distance on the sea
NOEC	No-observed-effect concentration
NOL	Norton-Over-Laverda
NOPSEMA	National Offshore Petroleum Safety and Environmental Management Authority
NTU	Nephelometric turbidity units
NWBM	Non Water Based Mud
NWMR	North west marine region
NWS	Northwest Shelf
NY	Ngujima Yin
OCNS	Offshore Chemical Notification Scheme
OPEP	Oil Pollution Emergency Plan
PBAs	Pre-emptive Baseline Areas

PHG	Pre-hydrated Gum
ppb	Parts Per Billion
ppm	Parts Per Million
PTW	Permit To Work
RBA	Risk Based Analysis
ROV	Remotely Operated Vehicle
SCE	Solids Control Equipment
SIMOPS	Simultaneous Operations
SMP	Scientific monitoring program
SOPEP	Ship Oil Pollution Emergency Plan
SVP	Senior Vice President
TD	Total Depth
TMS	Tether Management System
TSS	Total Suspended Solids
SFRT	subsea first response toolkit
USBL	Ultra Short Baseline
USIT	Ultrasonic Imaging Tool
UTA	Umbilical Termination Assembly
VLS	Vertical Lay System
VP	Vice President
WA	Western Australia
WAF	Water Accommodated Fractions
WAFIC	Western Australian Fishing Industry Council
WBM	Water Based Mud
WHA	World Heritage Area
WOMP	Well Operation Management Plan
Woodside	Woodside Energy Ltd
WWF	World Wildlife Fund
ZoC	Zone of Consequence

APPENDIX A: DETAILED ENVIRONMENTAL IMPACTS AND RISKS

PLANNED ACTIVITIES (ROUTINE AND NON-ROUTINE)

Physical Presence: Displacement of Other Users

Source of Risk	Environmental Value Potentially Impacted							Evaluation		
	Soil and Groundwater	Marine Sediment	Water Quality	Air Quality (incl. odour)	Ecosystems / Habitats	Species	Socio-economic	Consequence	Likelihood	Residual Risk
Proximity of Project Vessels causing interference with or displacement to third party vessels (commercial fishing, recreational fishing and commercial shipping).							X	F	1	L
Proximity of helicopters causing interference with other aerial operations.							X	F	1	L

Description of Source of Risk

Project Vessels

A MODU will be present for approximately two and a half years, including mobilisation, demobilisation and allowances, depending on operational requirements.

The ISVs and activity support vessels will also be present over a two to two and a half year period to complete subsea installation activities (various vessels at various times as per project schedule). These activities will run concurrently with the drilling campaign.

Activity support vessels will be used to support the MODU and ISVs and will transit in and out of the Operational Area, as required. The support vessels will make approximately two to four trips per week and will standby at the MODU and ISV vessels, as required. During flowline installation, pipe supply vessels may be present daily in the Operational Area alongside the ISV.

Helicopters

During the Petroleum Activities Program, crew changes will be undertaken using helicopters as required.

Potential Environmental Impacts

Value	Description of Potential Environmental Impact
Socio-economic values	***Displacement of Commercial Fishing Activities*** A number of Commonwealth and State managed fisheries occur in the region. The Operational Area overlaps the fisheries management areas of five Commonwealth and four State-managed fisheries. Historical fisheries data indicates that commercial fishing is unlikely to be significantly affected by the presence of project vessels, as there is very little or no activity associated with these fisheries within the Operational Area. The potential impact to commercial fishers as a result of project vessels is therefore considered to be minor, and may result in minor interference (e.g. navigational hazard) and localised displacement/avoidance by commercial fishing vessels within the immediate vicinity. The potential impacts are considered minor and temporary. The presence of permanent subsea infrastructure could present a hazard to bottom trawl fisheries due to risk of equipment entanglement and subsequent equipment damage/ loss. However, stakeholder engagement indicates that trawl fishers are not expected in the Operational Area and therefore, any risk of interference with or impact to fishers is considered minor. ***Displacement of Recreational Fishing*** Woodside's operational experience gained from the operation of the Nganhurra (NGA) and Ngujima-Yin (NY) FPSOs has shown that very little recreational (including charter) fishing takes place in the vicinity of the Operational Area. This is supported through stakeholder consultation. In addition, given the lack of reef habitat and relatively deep water depth, any recreational fishing

	would likely be targeting pelagic species targeted at shallower depth such as mackerel or marlin. Recreational fishing in the region is concentrated around the coastal waters and islands of the NWS such as the Muiron Islands (approximately 35 km from the Operational Area). Due to the distance offshore and water depths, recreational fishing is unlikely to occur in the Operational Area. In the event that recreational fishing effort occurred within the Operational Area, displacement as a result of the Petroleum Activities Program would be minor, resulting in minor interference or displacement/avoidance. Therefore, the potential impact is considered to be minor and temporary. ***Displacement to Commercial Shipping*** The presence of project vessels could potentially cause temporary disruption to commercial shipping. The Operational Area is subjected to a reasonable amount of vessel traffic that is likely to be associated with oil and gas support infrastructure. No recognised shipping lanes overlap or occur in the vicinity of the Operational Area. Most vessel activity in the vicinity of the Operational Area is associated with nodes such as offshore facilities (e.g. FPSOs) and ports; no such nodes occur within the Operational Area. Additionally, the NY FPSO has been operational since 2008 and is marked on nautical charts, surrounded by a 500 m petroleum safety zone. A cautionary zone of 2.5 nautical miles (4.6 km) applies around the FPSO.The potential impacts associated with this Petroleum Activities Program include short-term displacement of vessels as they make slight course alteration to avoid the Operational Area. Therefore, the potential impact is considered to be minor and temporary. ***Interference with Existing Oil and Gas Infrastructure*** The NY FPSO is located within the northern section of the Operational Area, and the Operational Area also overlaps BHP Billiton permit (WA-32-L) and Quadrant permit (WA-35-L) areas. The Woodside operated Nganhurra FPSO (WA-28-L) is also located within close proximity to the Operational Area. Vessel based activities in the vicinity of the NY FPSO (e.g. Petroleum Safety Zone) or relevant subsea infrastructure, and where interaction between Greater Enfield specific activity scopes occur, will be managed by the SIMOPS plan and under the direction of the OIM/designated person if applicable. The Ningaloo Vision FPSO, operated by Quadrant, lies within the boundary of the Operational Area, however, no planned activities will take place within the 500 m Petroleum Safety Zone established around the Ningaloo Vision. At its closest point, the proposed Greater Enfield flowline (the closest infrastructure) is approximately 2.5km from the Ningaloo Vision FPSO and 1.2km from the nearest subsea infrastructure (umbilical). The BHP operated Stybarrow FPSO has ceased production and is no longer on station. The subsea infrastructure remains (wells shut in and flowlines flushed), and the proposed Greater Enfield flowline is at least 2km from this infrastructure. These distances are deemed sufficient such that any SIMOPS specific management as a result of Greater Enfield and Quadrant and BHP's existing activities is not required. Woodside routinely consults with other operators, including Quadrant; and no issues in relation to interference with existing oil and gas infrastructure from the Petroleum Activities Program have been identified in the consultation undertaken in support of this EP. No impacts are expected where the Operational Area overlaps parts of the BHP and Quadrant permits as there are no assets or infrastructure in close proximity to planned activities. ***Cumulative Impacts*** Given the Operational Area's distance offshore, distance from the nearest AMSA shipping fairway (approximately 50 km) and lack of commercial fishing activity within the Operational Area, cumulative impacts to commercial and recreational fishing and commercial shipping from the presence of project vessels are not expected. In addition, the AMSA 2016 Automatic Identification System (AIS) shipping density in the Operational Area suggests only minor shipping activity over the Operational Area. This is supported through consultation with AMSA. Vessel-based activities for the Petroleum Activities Program will lead to an increase in the overall vessel traffic in the Operational Area; with much of the existing traffic relating to vessels undertaking support activities for nearby petroleum activities. Given the controlled access of vessels to the area surrounding these facilities, the proposed controls and the relatively short duration of vessel-based activities for the Petroleum Activities Program, no significant cumulative impacts from the interference with or displacement of third party vessels are expected. ***Interference with other aerial operations*** The Petroleum Activity 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. 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. No concerns were raised during the consultation process.

Summary	Given the adopted controls, it is considered that physical presence of MODU, ISVs, activity support vessel and helicopters 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.

Summary of Control Measures

- Marine Orders 30 (Prevention of Collisions) 2009
- Marine Order 21 (Safety of navigation and emergency procedures) 2012
- Establishment of a 500 m safety exclusion zone around MODU and communicated to marine users
- Have an activity support vessel on standby during drilling activities to communicate with third-party vessels and assist in maintaining the petroleum safety zone
- The activity support vessel will undertake surveillance/watch actions to prevent unplanned interactions
- AHS of relevant activities
- Notify relevant State and Commonwealth fisheries of activities
- Notify AMSA Joint Rescue Coordination Centre (JRCC) of relevant activities
- Communicate any navigational hazards associated with the activity on completion
- Notify quadrant four weeks prior to vessels entering their permit.
- Notify BHP if anchors are to be used within the permit.

Physical Presence: Disturbance to Seabed

Source of Risk	Environmental Value Potentially Impacted							Evaluation		
	Soil and Groundwater	Marine Sediment	Water Quality	Air Quality (incl. odour)	Ecosystems / Habitats	Species	Socio-economic	Consequence	Likelihood	Residual Risk
Disturbance to seabed from activities including: • Drilling and completion activities • Seabed transponders (DP MODU) or MODU mooring, including anchor holding testing (Moored MODU only) • Flowline installation activities • Installation of subsea infrastructure • ROV operation (including localised sediment relocation from jetting activities).					X			F	2	L

Description of Source of Risk

Drilling

The drilling and completion activities will result in direct seabed disturbance of up to 100 m radius around each well location due to the installation of the BOP and conductor. Once drilling is complete, well infrastructure will remain in place until field abandonment at which stage risks associated with well infrastructure will be re-examined. The generation and discharge of cuttings and drilling fluids are not considered in this section; refer to detailed risk assessment for drill cuttings and drilling fluids for an assessment of drill cuttings and drilling fluids.

DP MODU Transponders

Dynamic positioning of the MODU uses satellite navigation and radio transponders in conjunction with thrusters to maintain the position of the MODU at the required location. Information relating to the position of the MODU is provided via a number of seabed transponders, which are replaced on the seabed and emit signals that are detected by receivers on the MODU 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 the drilling at each well and at the end are recovered, generally by remotely operated vehicle (ROV). Clump weights are recovered if practicable to do so or may be left in situ on the seafloor. Clump weights generally consist of a clumped group of four 20 kg weights covering an area less than 1m^2.

MODU Anchoring and Anchor Holding Testing

If a moored MODU is used, seabed disturbance will result from the anchor holding testing and MODU anchor mooring system, including placement of anchors and chain/wire on the seabed, potential dragging during tensioning and recovery of anchors. Overall, the mooring of the MODU and anchor holding testing activities will result in localised, small scale seabed disturbance in relation to the spatial extent of the benthic habitats. Mooring is likely to require a 12 point pre-laid mooring system at each well location. There are 12 well locations for the Petroleum Activities Program equating to the need for approximately 124 anchor installations.

Flowline Installation Activities and Presence

Commencement of flowline installation may require the deployment of an initiation anchor/deadman anchor or suction pile. If required, a typical initiation anchor will weigh approximately 15t and will be similar to a delta-flipper type anchor with approximately 1100 m of 7 cm diameter wire to initiate the pipe-lay. The flukes of this type of anchor are able to flip over depending on which way it lands on the seabed, consequently, it is anticipated that there will be no need to reset the anchor. A suction pile would involve the installation of a pile, typically two metres in diameter and 30 m in length, and will protrude approximately one metre above the seafloor when installed. Either option will result in impact to a small area of seabed.

Walking structures may be required to prevent axial movement of the flowline. If required, installation will include the placement of pile templates on the seafloor, suction or driven pile/e in the template, two tether chains between the pile templates and anchor connection on the flowline and one flowline anchor connection. Pile templates are likely to be similar in dimension to the concrete mattresses discussed below. The dimensions of the suction or driven piles are typically two metres in diameter and 30 m in length, and will protrude approximately one metre above the seafloor when installed. Therefore, seabed disturbance from walking anchor installation is expected to be restricted locally in relation to the benthic habitats.

An array of Long Baseline (LBL) and acoustic survey transponders attached to concrete clump weights will be placed on the seafloor and are critical for the accurate positioning of flowline infrastructure. At the completion of installation, the transponders will be recovered via an acoustic release mechanism, leaving only the concrete clump weight on the seafloor. Clump weights generally consist of a clumped group of four 20 kg weights. Steel chains are used as they rust and gradually degrade in seawater over time.

Prior to flowline installation, span rectification may be required using concrete mattresses positioned at identified free span locations by the use of ROV. The number of pre-lay span rectification is currently unknown. The dimensions for each concrete mattress are expected to be 12 m by 3 m. Prior to the commencement of flowline installation, buckle initiators and Flowline End Terminations (FLETs) (two) will also be installed as required along the flowline route. Post-lay span rectification may also be required and will involve the placement of grout bags on the seabed, with the extent of any impact limited to the footprint of the installed flowline. Concrete mattresses may also be used for post-lay span rectification, similar to pre-lay span rectification described above.

A flexible water injection flowline will traverse the Enfield Canyon. Current installation methodology has determined that the flowline will be installed using an installation method similar to that of a flexible riser. The flowline would be anchored on either side of the canyon by anchors, with the flowline (or umbilical) raised off the seabed by floatation devices similar in nature to external buoyancy modules. Therefore, seabed disturbance will not occur within the canyon and is restricted to the installation of the permanent gravity anchors on either side, and will be highly localised.

Once laid and operational the physical presence of the rigid flowlines and associated umbilicals will be limited to the width of the flowline corridor for the length of the line (~32km). The flowline corridor incorporating the rigid production and water injection flowlines along with associated umbilicals will vary along the route, but current design has the corridor at approximately 170 m wide. It should be noted however that this incorporates planned distances between each line when laid and does not represent a total area which will be impacted. Actual impact will be much less and limited to temporary disturbance when the lines are laid and touch down on the seabed (sediment disturbance and localised turbidity) and subsequent physical impact from the presence of the lines on the seabed. The latter physical impact will likely be limited to the width of the lines along the route (i.e. 16" and 10" rigid lines and small 7" diameter umbilicals) and conservatively 5m either side allowing for some minor movement/settling.

The flexible flowlines and jumpers will be laid as per the layout**.** Similar to the rigid line the laying of these lines will have minor temper seabed disturbance. The physical impact of these lines is deemed negligible given their small diameter (6") and the type of benthic habitats present.

Installation tolerances for the rigid and flexible flowlines and umbilicals is ±10m laterally of the defined installation location.

Given the benthic habitats described for the region of the pipeline corridor and well locations the impact of the installation and physical presence is deemed to be negligible.

Subsea Infrastructure

The installation of subsea infrastructure required for the project (FLET, wellheads, MPPs, jumpers, manifolds, skids, buckle initiator structures, concrete mattresses) may also result in localised disturbance to benthic habitats in the form of generation of minor turbidity when placed on the seafloor, physical impact to the extent of the infrastructure footprint and a scour around the subsea infrastructure during the lifespan of the equipment.

Seabed footprint of the installed infrastructure will vary however is minimal given the spatial extent of the project area and benthic habitats present. The most significant equipment by footprint size relates to the subsea structures. Installation tolerances is ±13m laterally and ±13m longitudinally for the Umbilical termination Assembly (UTA) and ±18m laterally ±24m longitudinally for the other key infrastructure.

ROV

The use of the ROV during Petroleum Program Activities 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 ROV is approximately 2.5 m x 1.7 m. Additionally, the ROV may be used to relocate small amounts of sediment material (known as jetting) to create a stable, level surface and reduce the potential for scouring for subsea equipment (e.g. manifolds).

Decommissioning Considerations

EPBC 2005/2110 Condition 1b(i) requires consideration that design and construction allow for the decommissioning of all structures and components above the seafloor. Whilst a decommissioning plan is a requirement of a separate condition and the subject of future consideration, the Basis of Design for Greater Enfield addresses this condition by including the functional requirement that all subsea equipment, including xmas trees and wellheads, shall be capable of being

removed.	
Potential Environmental Impacts	
Value	**Description of Potential Environmental Impact**
Ecosystems / Habitats	**Deepwater Habitats** 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. Drilling activities may result in localised sedimentation in the immediate vicinity of the well site. Surveys (BMT Oceanica 2016) indicate the sediments within the Operational Area were characterised primarily by soft, fine unconsolidated sediments, with few areas of hard substrate noted. Anchors will be installed at each well location prior to drilling, and removed following completion of the well. Anchor placement results in a highly localised, physical presence on the soft sediment seabed and temporary disturbance when placed and removed. Such disturbance can alter the physical seabed habitat conditions resulting in community changes in epifauna and infauna. Following recovery of the anchors, impacts from the disturbance are expected to be localised and short-term (<4 years), with the underlying conditions present to support re-colonisation and recovery after the activity has been completed (Ingole et al. 2013 and Bluhm 2001). As such the anchor disturbance to the seabed is determined to be minor and temporary. Flowline installation and subsea infrastructure installation (including FLETs, manifolds, concrete mattresses, wet buckle initiators, piling, initiation anchors and gravity anchors) are likely to result in localised sedimentation and permanent modification of seabed habitat in the vicinity of the infrastructure. Similarly, ROV activities near the seafloor and small amounts of sediment relocation may result in minor and short-term impacts to deepwater biota as a result of elevated turbidity and the clogging of respiratory and feeding parts of filter feeding organisms. Due to the nature of the activity, elevated turbidity is expected to be localised, short-term and temporary, potentially affecting sessile epifauna, however, it is not expected to have any material or measurable impact on sessile benthic habitats within the context of the wider distribution of these habitats within the Operational Area and more broadly. As outlined within Section 4.5.1, the seabed within the Operational Area is characterised by featureless flat unconsolidated sediment seabed and occasional isolated hard substrate areas (e.g. outcrops or boulders) with sparsely distributed epifauna representative of the broader Operational Area (Section 4.5.1). The likely impacts and sensitivity of benthic habitats will depend upon the suspended sediment concentrations and the period of exposure. The predicted turbidity generating activities are expected to be restricted in scale (in the context of the wider Operational Area) and short-term and therefore impacts to deepwater habitats and associated benthic biota are considered to be minor (i.e. localised physical impacts) and temporary (i.e. short-term turbidity and sedimentation impacts). **Demersal Fish Communities** Impacts from drilling activities, including conductor installation, anchor drag and other subsea installation activities are expected to be limited to the potential displacement of demersal fish communities. However, given the localised nature of the seabed disturbance, sparsely distributed benthic habitats and relatively low levels of fish abundance within the proposed disturbance areas, potential impacts to demersal fish communities from the Petroleum Activities Program are considered to be minor and temporary in nature. **Infauna Communities** Impacts from drilling activities, including conductor installation and anchor drag, are expected to be confined to sediment burrowing infauna and surface epifauna invertebrates inhabiting the seabed around the well location, typically within 100 m of the well. Flowline installation and subsea infrastructure installation will result in the displacement and/or permanent loss of some benthic infauna in the vicinity of the flowline route and infrastructure footprint. Free span rectification, if required, is expected to result in similar impacts. ROV operation, particularly sediment relocation, may cause minor and temporary impacts to a minor portion of the benthic infauna. Given the widespread representation of the infauna communities within the Operational Area and the broader NWMR region, impacts are expected to be restricted to a very localised proportion of infauna communities and are therefore considered to be low. **Canyons KEF** No drilling activities will occur within the Enfield Canyon, and subsea structures or anchors will not be deployed within the canyon. Therefore, impacts to benthic habitats within the canyon are not expected. Although the flowline will traverse the Enfield Canyon, the installation methodology is such that the

	flowline will be fixed to the seabed adjacent to the canyon area with the flowline suspended above the canyon seafloor, therefore also eliminating the need for associated infrastructure such as concrete mattresses within the canyon. As such, no impacts to the Enfield Canyon are expected from flowline installation or subsea installation activities. The habitats of the canyon within the Operational Area have been observed to be relatively low in biodiversity and representative of the broader NWMR, containing filter feeder and infauna assemblages similar to other 'non-canyon areas within the Operational Area. Therefore, it is unlikely that there will be impacts to the Canyons KEF as a result of drilling activities, flowline and subsea infrastructure installation or ROV activities associated with the Petroleum Activities Program. **Continental Slope Demersal Fish Communities KEF** This KEF overlaps with the Operational Area and wells and subsea infrastructure may be installed over the KEF. Therefore, impacts to the KEF may range from localised short-term disturbance of the seabed (e.g. MODU mooring line and anchor deployment and retrieval) to localised permanent loss of benthic habitat associated with subsea infrastructure installation. However, only a relatively small portion of this broad scale seabed feature overlaps the Operational Area, and the environmental values and sensitivities associated with the KEF are not known to occur in the Operational Area. Therefore, seabed disturbance impacts to the Continental Slope Demersal Fish Communities KEF will be localised and minor, and will not impact the values and sensitivities of the KEF. **Cumulative Impacts** Seabed disturbance associated with the Petroleum Activities Program (e.g. flowline and subsea installation) may result in permanent loss of benthic habitat. However, cumulative impacts are expected to be minimal. No significant escarpments or hard substrates, or other environmental values associated with the Canyons KEF or the Continental Slope Demersal Fish Communities KEF are known to occur with the Operational Area. The ecological consequences identified may result in a minor loss of benthic habitat that is well represented throughout the Operational Area and the wider NWMR. Therefore, cumulative impacts associated with seabed disturbance when considered with other operator's subsea infrastructure are not expected to significantly increase the risk to biota.
Summary	Given the adopted controls, seabed disturbance will result in localised and short-term impacts to benthic habitat and communities.

Summary of Control Measures

- Anchors installed as per mooring design analysis to ensure adequate MODU station holding capacity.
- Woodside Well Location and Site Appraisal Data Sheet (WLSADS) include environmental sensitivity and seabed topography to inform the selection of the MODU mooring locations.
- No infrastructure installed within the Enfield Canyon.
- All vessels used for flowline and subsea installation activities will be DP capable.
- Buckle initiators and FLETs (and other subsea infrastructure as required) will be positioned on the seabed within the required location accuracy to reduce seabed disturbance.
- No wet storage on the seabed.
- Monitoring of infrastructure post installation to confirm adherence to installation design parameters

Routine Acoustic Emissions: Noise from the MODU, ISVs and Activity Support Vessels, subsea piling, survey, positioning equipment and Helicopter transfers

Source of Risk	Environmental Value Potentially Impacted							Evaluation		
	Soil and Groundwater	Marine Sediment	Water Quality	Air Quality (incl. odour)	Ecosystems / Habitats	Species	Socio-economic	Consequence	Likelihood	Residual Risk
Generation of underwater noise from Project Vessels during normal operations.						X		F	2	L
Generation of underwater noise from subsea piling driving activities.						X		E	1	L
Generation of underwater noise from survey and positioning equipment						X		F	1	L
Generation of atmospheric noise from helicopter transfers						X		F	1	L

Description of Source of Risk

Generation of underwater noise from MODU, ISVs and activity support vessels

The MODU, ISVs and activity support vessels will generate underwater noise due to the operation of thrusters, engines, propeller movement, drilling operations and subsea installation activities etc. These noises will contribute to and can exceed ambient noise levels which range from around 90 dB re 1 µPa (root mean square sound pressure level (RMS SPL)) under very calm, low wind conditions, to 120 dB re 1µPa (RMS SPL) under windy conditions.

MODU Noise

Noise associated with a moored MODU will be restricted to drilling activities, such as drill pipe operations and on board machinery. 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 drilling activities. A DP MODU will typically produce low intensity but continuous sound. A range of broadband values (59 to 185 dB re 1 µPa at 1 m (RMS SPL)) have been quoted for various MODUs where noise is likely to be between 100 to 190 dB re 1 µPa at 1 m (RMS SPL) during drilling and between 85 to 135 dB re 1 µPa at 1 m (RMS SPL) when not actively drilling.

DP MODU underwater noise measurements were taken for the MAERSK Discoverer drill rig used on the North West Shelf (Woodside, 2011) and showed the system emitted tonal signals between 200 hertz (Hz) and 1.2 kilohertz (kHz), which is within the auditory bandwidth for cetaceans. The measured source level was between 176 and 185 dB re 1µPa at 1 m. A noise assessment for the Deepwater Millennium (McPherson et al., 2013) DP drillship undertaking drilling off the Northwest Cape estimated the broadband source level for drilling operations at 196 dB re 1µPa at 1 m, with all six thrusters working at 100%, which is a worst case scenario as standard operation uses thrusters at 60% capacity or less depending on weather conditions.

Underwater noise generated by the *Atwood Condor* MODU for this activity has been determined as analogous to the above mentioned noise measurements. The Condor has eight thrusters compared to six for the Deepwater Millennium, however the Condor's thrusters have a lower power rating (3,800 KW versus 4,000 KW). In addition, the power requirements for the Condor's thrusters to maintain positioning for drilling under environmental conditions representative of the area is estimated at 25% or less of the total power output of each thruster. Therefore the modelling undertaken for the Deepwater Millennium is considered to remain conservative and not be representative of noise generated for the majority of the time, and only during short periods where weather conditions require increased thruster output.

Activity Support Vessel Noise

The main source of underwater noise for a DP vessel (such as ISVs) relates to the use of DP thrusters. There is no applicable sound data available for a typical DP ISV; however, frequencies and sound levels are expected to be similar to those for DP drill ships. DP thruster noise measurements used on the North West Shelf showed the system emitted tonal signals between 200 Hz and 1.2 kHz, which is within the auditory bandwidth of cetaceans. The measured source level was between 176 and 185 dB re 1µPa at 1 m (SPL). A noise assessment for the Deepwater Millennium working at 100%, estimated the broadband source level for drilling operations at 196 dB re 1µPa at 1 m. However, this is considered to be a worst case scenario as the ISVs are not expected to operate on 100% DP capacity on a continual basis.

Activity support vessels will maintain DP for shorter durations while the vessel is beginning approach to an ISV/MODU or maintaining position as part of loading and unloading activities. McCauley (1998) measured underwater broadband noise equivalent to approximately 182 dB re 1µPa at 1 m (SPL) from a support vessel holding station in the Timor Sea.

Note that all activity support vessels are required to comply with EPBC Regulation 2000 – Part 8 Interacting with Cetaceans to reduce the likelihood of collisions with cetaceans. Implementing this control may incidentally reduce the noise generated by vessels in proximity to cetaceans as vessels will be travelling slower; Slower vessel speeds may reduce underwater noise from machinery noise (main engines) and propeller cavitation.

Generation of underwater noise from subsea piling activities

Driven underwater piling using an impact hammer may be required for subsea installation activities (e.g. flowline walking piles).

Subsea piling will generate underwater noise, due to hydraulically activated hammering. These noises will contribute to, and may in some cases, exceed existing ambient underwater noise levels. Ambient noise levels can be caused by wind and wave action, as well as biological noise and range from around 90 dB re 1µPa under very calm, low wind conditions, to 120 dB re 1µPa under windy conditions.

It is anticipated that a combination of suction and driven piles may be required. In respect of noise generation, only driven piles would create a potential noise source of concern. The number of piles is yet to be determined but for the purposes of impact assessment it has been estimated that 12 driven piles may be required. Each pile is likely to be approximately 1.3-1.5 m in diameter and required to be driven to approximately 30 m. Based on recent experience with similar pile driving activities and an analysis of substrate infrastructure in the activity area, pile driving time is expected to be approximately 30-60 minutes per pile. The actual piling time is subject to increase depending on the substrate type encountered but not expected to vary considerably. There will not be any concurrent piling during this activity, and all piles will be driven consecutively and therefore there will be a break between each active piling period of approximately 12-24 hours. The pile hammer is expected to have a maximum impact frequency of 38 blows per minute with an impact energy of 280 kJ, however is not expected to operate at this rate given expected conditions of the area.

Pile Driving Noise Source Levels

Pile driving will generate impulsive sounds. The noise emanating from a pile during pile-driving is a function of its material type, its size, the force applied to it and the characteristics of the substrate into which it is being driven. The frequency bandwidth for most of the energy in pile driving sounds is typically below 1,000 Hz and overlaps the same hearing bandwidth of marine fauna, particularly,. When compared to other impulsive sources such as seismic surveys, pile driving source levels are significantly lower in volume (211 dB @ 1m for a 83 tonne pile hammer compared to approximately 240-265 dB @ 1 m for a 4000 in^3 seismic source array (McCauley and Kent, 2008)

To inform the risk assessment for underwater noise associated with piling, an underwater acoustic modelling study of pile driving noise was previously commissioned by Woodside for piling activities on the Northwest Shelf. This study considered two pile diameters (2.18 m and 1.98 m) and two hammer energies (600 kJ/64 tonne hammer and 1200 kJ/140 tonne hammer) and calculated a maximum source SEL of 210.3 dB re 1 μPa^2 s @ 1 m (1200 kJ hammer, 2.18m diameter pile). This modelling study is considered a conservative representation of the piling activities associated with this Petroleum Activities Program due to:

- the proposed pile diameter is significantly less (1.3 -1.5 m) than modelled (2.18m),
- the proposed hammer energy (280 KJ) is significantly less than modelled 1200 kJ); and
- Individual pile duration (approximately 30 -60 minutes) is less than modelled (1.17 – 2 hours).

For example, source modelling of a 235 kJ hammer and 1.45m diameter pile has been calculated to be 205.8 dB re 1 μPa^2 s @ 1 m, which is 5 dB lower than the source level adopted in this impact assessment.

Generation of underwater noise from survey and positioning equipment

The pre-lay survey utilises a side scan sonar fish towed behind a project supply vessel, or a multi-beam echo sounder (MBES). The survey methods are non-intrusive and the equipment, under normal operation, will not disturb the seabed. The towfish side scan sonar system is a compact high definition side scan sonar system designed for a wide range of seabed survey and inspection duties. The towfish sonar is designed to tow cleanly and with stability behind a vessel. Most modern MBES systems work by transmitting a broad acoustic pulse from a hull or pole mounted transducer. Transponders will be placed on the seabed to assist in correct flowline placement, acoustic metrology and LBL/ Ultra Short Baseline (USBL).

Generation of noise from helicopter transfers	
Helicopter engines and rotor blades are recognised as a source of noise emissions, which may constitute a source of environmental risk resulting in behavioural disturbance to marine fauna. Activities relevant to the Operational Area will relate to the landing and take-off of helicopters on the MODU or vessel 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 heli-decks, which constitutes a relatively short phase of routine flight operations.	
Potential Environmental Impacts	
Value	**Description of Potential Environmental Impact**
Species	***Underwater Noise*** The Operational Area of the Petroleum Activities Program is located in waters approximately 350 - 850 m deep. The fauna associated with this area will be predominantly pelagic species of fish, with migratory species such as turtles, whale sharks and cetaceans present in the area seasonally[1]. Elevated underwater noise can affect marine fauna, including cetaceans, fish, turtles, sharks and rays in three main ways (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 potential impacts of anthropogenic noise on marine mammals have been the subject of considerable research. Southall *et al.* (2007), Finneran and Jenkins (2012) Wood *et al*. (2012) reviewed available literature to determine exposure criterion for injury referred to as the onset of non-recoverable permanent hearing loss (PTS) and temporary hearing threshold shift (TTS) in cetaceans. To assess the potential impacts to cetaceans from underwater noise, a group of experts (Southall et al. 2007) introduced dual criteria consisting of both peak pressure level) thresholds, expressed in dB re 1 µPa, and cumulative sound exposure level (cSEL) thresholds, expressed in dB re 1 µPa2·s. A received sound exposure is assumed to cause PTS, if it exceeds the peak SPL criterion, the SEL criterion, or both. It is difficult to accurately quantify the cumulative exposure of a moving marine mammal around a point source. Variables such as representative exposure time are largely not known, particularly if there are no known critical habitats (breeding/feeding) where marine mammals are expected to be present in proximity to the activity. In the event species are transiting through the area, their duration of exposure is expected to be significantly reduced. Additionally it is expected that most species, including humpbacks and pygmy blue whales, would exhibit avoidance behaviour at a specific range from the noise source and therefore, their noise exposure time would be very limited. For continuous sound, the relevant criteria proposed by Southall *et al.* (2007) are an un-weighted peak pressure level of 230 dB re 1 µPa and an M-weighted SEL of 215 dB re 1 μPa^2s for all cetaceans. It is important to note that the above criteria were developed using a precautionary approach, meaning that: • The criteria do not take into account the potential for recovery in hearing between subsequent pulses or days of exposure, and are therefore likely to overestimate hearing damage caused by time varying exposure; • The M-weighting curves are heavily generalised, in that they emphasise the frequency range at which each hearing classification is deemed to be most sensitive. In reality, the hearing threshold audiograms for individual mammal species will not adhere to this shape, but will instead comprise a much narrower “trough” shape, showing peak sensitivity somewhere in the range identified by the hearing group classification and decreasing sensitivity with increasing and decreasing frequency about this “trough”; and

[1] Potential impacts on dugongs have not been considered further as part of this impact assessment given their unlikely presence within the deep offshore waters surrounding the petroleum activities program. In addition, the closest BIAs for dugongs are 25 km away within the Ningaloo Marine Park, well outside the ranges at which behavioural or physiological impacts on individuals would be anticipated.

- The peak pressure difference between TTS and PTS was arbitrarily taken to be 6 dB for pulsed sound, compared to 15 dB for continuous sound, meaning that the pulsed sound criteria are potentially very precautionary.

The criteria for use in assessing the likelihood of injury as a result of the proposed campaign are summarised in **Table A- 1.**

Table A- 1: Marine mammal criteria for onset of PTS injury (per 24 hr period)

Marine Mammal Group	Type of Sound	Injury Criteria		
		Peak pressure, dB re 1 µPa	SEL, dB re 1 µPa^{2}s (M-weighted) Southal et al 2007	SEL, dB re 1 µPa^{2}s (M-weighted) Wood et al 2012
Low-frequency cetaceans	Single or multiple pulses	230	198	198
	Non-pulses (e.g. continuous sound)	230	215	-
Mid-frequency cetaceans	Single or multiple pulses	230	192	192
	Non-pulses (e.g. continuous sound)	230	215	-
High-frequency cetaceans	Single or multiple pulses	230	192	-
	Non-pulses (e.g. continuous sound)	230	215	-

Beyond the area in which injury may occur, the impact on marine mammal behaviour is the most important measure of a potential impact of underwater noise.

Behavioural reactions to acoustic exposure are generally more variable, context-dependent, and less predictable than the effects of noise exposure on hearing or physiology. This is because behavioural responses to anthropogenic sound are dependent upon operational and environmental variables, and on the physiological, sensory, and psychological characteristics of exposed animals. It is important to note that the animal variables may differ (greatly in some cases) among individuals, of a species and even within individuals depending on various factors (e.g. sex, age, previous history of exposure, season, and animal activity). However, within certain similar conditions, there appears to be some relationship between the exposure Received Level (RL) and the magnitude of behavioural response. Southall *et al*. (2007) graded the severity of context-specific behavioural responses to noise exposure, as follows (refer to **Table A- 2** for detailed description):

- Relatively minor and/or brief, score 0-3;
- A higher potential to affect feeding, reproduction, or survival, score 4-6; and
- Considered likely to affect these life functions, score 7-9.

Table A- 2: Southall *et al*. (2007) Behavioural disturbance scale

Response Score	Corresponding Behaviours in Free-ranging Subjects
0	• No observable response.
1	• Brief orientation response (investigation / visual orientation).
2	• Moderate or multiple orientation behaviours; • Brief or minor cessation/modification of vocal behaviour;

	• Brief or minor change in respiration rates.
3	• Prolonged orientation behaviour; • Individual alert behaviour; • Minor changes in locomotion speed, direction, and/or dive profile but no avoidance of sound source; • Moderate change in respiration rate; • Minor cessation or modification of vocal behaviour (duration < Duration of source operation).
4	• Moderate changes in locomotion speed, direction, and/or dive profile but no avoidance of sound source; • Brief, minor shift in group distribution; • Moderate cessation or modification of vocal behaviour (duration more or less equal to the duration of source operation).
5	• Extensive or prolonged changes in locomotion speed, direction, and/or dive profile but no avoidance of sound source; • Moderate shift in group distribution; • Change in inter-animal distance and/or group size (aggregation or separation); • Prolonged cessation or modification of vocal behaviour (duration > duration of source operation).
6	• Minor or moderate individual and/or group avoidance of sound source; • Brief or minor separation of females and dependent offspring; • Aggressive behaviour related to sound exposure (e.g. Tail/flipper slapping, fluke display, jaw clapping/gnashing teeth, abrupt directed movement, bubble clouds); • Extended cessation or modification of vocal behaviour; • Visible startle response; • Brief cessation of reproductive behaviour.
7	• Extensive or prolonged aggressive behaviour; • Moderate separation of females and dependent offspring; • Clear anti-predator response; • Severe and/or sustained avoidance of sound source; • Moderate cessation of reproductive behaviour.
8	• Obvious aversion and/or progressive sensitisation; • Prolonged or significant separation of females and dependent offspring with disruption of acoustic reunion mechanisms; • Long-term avoidance of area (> source operation); • Prolonged cessation of reproductive behaviour.
9	• Outright panic, flight, stampede, attack of conspecifics, or stranding events; • Avoidance behaviour related to predator detection.

The more severe the response on the scale, the lower the amount of time that the animals will tolerate it before there could be significant negative effects on life functions, which would constitute a disturbance under the relevant regulations.

The United States (US) National Marine Fisheries Service guidance sets the Level B harassment threshold for marine mammals at 160 dB re 1 μPa (rms) for impulsive noise and 120 dB re 1 μPa (rms) for continuous noise. The value for impulsive sound sits in the upper-mid range for disturbance impacts identified in Southall et al. (2007) and consequently this criterion has been used (in lieu of more suitable up to date criteria) for assessing onset of potentially strong behavioural reaction in this assessment, although it should be borne in mind that this value is possibly over-pessimistic. The value for continuous sound sits roughly mid-way between the range of values identified in Southall et al. (2007) but is lower than the value at which the majority of mammals responded at a response score of 6 (i.e. once the received rms sound pressure level is greater than 140 dB re 1 μPa). Taking into account the paucity and high level of variation of data relating to onset of behavioural impacts due to continuous sound, it is recommended that any ranges predicted using this number are viewed as probabilistic and possibly over-precautionary.

Therefore the behavioural threshold criteria used in this assessment for the differing noise is:

- Impulsive noise (VSP) - 160 dB re 1 μPa rms; and
- Continuous noise (vessels, MODU DP and drilling) - 120 and 140 dB re 1 μPa rms.

DP Thruster noise

A detailed modelling assessment of underwater noise from the operation of a DP MODU (Deepwater Millennium) at a location approximately 30 km south and at similar depth to the Greater Enfield operational area was conducted. Underwater noise generated by the *Atwood Condor* MODU for this activity has been determined as analogous to the DP MODU modelled. The modelling demonstrated that at an offshore distance of approximately 15 km from the source, the majority of noise within the water column will attenuate below 120 dB re 1 μPa (rms SPL).

The modelling also demonstrated that the majority of received noise within the water column will attenuate below 120 dB re 1 μPa (rms SPL) in the nearshore direction within 7 km. It must be noted as indicated above that this assessment is based on operation of all thrusters at 100% and assumes the lowest behavioural threshold of 120 dB re 1 μPa (rms SPL). Regional modelling has shown that the cumulative received levels from the existing regional sources in proximity to the Greater Enfield location are approximately 26 dB re 1 μPa above the expected ambient environment (Mcpherson et al. 2013).

Impact to EPBC Listed Species

Southall et al., (2007) predicted that injury to cetaceans would occur at 230 dB re 1 μPa (peak pressure level) or 215 dB re 1 μPa2s (sound exposure level). Potential injury to sea turtles as referenced in Popper et. al. (2014) has been anticipated at 210 dB re 1 μPa.s2. which is considerably higher that source levels produced from DP thrusters in the modelled scenario. Given the DP MODU and support vessel noise does not exceed either of these levels, no injury on protected species is anticipated. In addition, whale sharks do not have swim bladders they are categorised as a fish that is less sensitive to noise (Type 1 Fish Without Swim Bladder) and therefore unlikely to be impacted by DP thruster noise (Popper et al. 2014) It should be noted that the thrusters are estimated to run at 25% less than total power therefore it is expected these distances will be much smaller during the majority of operations.

Given noise from DP thruster from the MODU is anticipated through the life of the project the activity will overlap with the migration seasons for humpback whales or pygmy blue whales which occur at various times during the year. The following BIAs for these species overlap 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))

In addition to the BIAs overlapping the Operational Area, the following BIAs for fauna that may be impacted by underwater noise occur in the vicinity of the Operational Area:

- flatback turtle inter-nesting buffer (approximately 3 km east of the Operational Area) which may contain seasonally high (summer months) number of flatback turtles; and
- whale shark foraging BIA (approximately 5 km east of the Operational Area) which may contain seasonally (July to November) high numbers of whale sharks moving to and from their annual aggregation off Ningaloo Reef.

It is likely that there may be increased numbers of individuals of these species within these BIAs 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 DP thruster noise from the MODU. It is reasonable to expect that fauna may demonstrate avoidance or attraction behaviour to the noise generated by the Petroleum Activities Program. For example, when transiting through the area, cetaceans and whale sharks 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 the MODU and project vessels are not considered to be ecologically significant at a population level.

Piling Noise

An underwater acoustic modelling study of pile driving noise was commissioned by Jasco Applied Sciences. This study considered two pile diameters (2.18 m and 1.98 m) and two hammer energies (600 kJ/64 tonne hammer and 1200 kJ/140 tonne hammer) and calculated a maximum source SEL of 210.3 dB re 1 μPa^2 s @ 1 m (1200 kJ hammer, 2.18m diameter pile). This modelling study is considered a conservative representation of the piling activities associated with the Petroleum Activities Program due to the planned pile diameter being significantly less (1.3 -1.5 m), in addition to a decreased expected hammer energy (280 KJ). For example, source modelling of a 235 kJ hammer and 1.45m diameter pile has been calculated to be 205.8 dB re 1 μPa^2 s @ 1 m, which is 5 dB lower than the source level adopted in this impact assessment.

Impact to EPBC Listed Species

Cetaceans

The potential impacts of anthropogenic noise on marine mammals have been the subject of considerable research; reviews are provided by Richardson *et al.* (1995), Nowacek *et al.* (2007), Southall *et al.* (2007), Weilgart (2007) and Wright *et al.* (2007).

Southall *et al.* (2007), Finneran and Jenkins (2012) Wood *et al*. (2012), and more recently reviewed available literature to determine exposure criterion for injury referred to as the onset of non-recoverable permanent hearing loss (PTS) and temporary hearing threshold shift (TTS) in cetaceans. In addition behavioural thresholds were taken from the US's National Fisheries Marine Services (NFMS). These thresholds are outlined in **Table A- 3** along with their modelled ensonification ranges during piling which are considered highly conservative representation of the proposed piling activity.

Table A- 3: Thresholds and ranges at which physiological and behavioural impacts are anticipated in cetaceans from GEP piling.

Reference	Impact Type	Minimum Threshold			
		SPL (all cetaceans)	Modelled SPL Range (km)	M-weighted cSEL (Wood et al. 2012)	Modelled cSEL Max Range (24 hour exposure)
Southhall et al 2007 and Wood et al 2012	PTS	230 dB re 1 μPa (peak)	Unlikely to be reached	198 dB re 1 μPa (low frequency cetaceans	0.110 m
				192 dB re 1 μPa (medium frequency cetaceans)	0.825 - 1.1 km
	TTS	224 dB re 1 μPa (peak)	Unlikely to be reached	-	
NMFS 2013	Injury (All Cetaceans)	180 dB re 1 μPa (rms)	0.519 -1.08	-	
NMFS 2014 and Southal et al 2007	Behavioural Response Adults (Cetaceans)	160 dB re 1 μPa (rms)	3.25 – 4.67	-	

If required, piling may occur during any season but will be a short duration activity. It is therefore, possible that activity will overlap with the migration seasons for humpback whales or pygmy blue whales which occur at various times during the year. The following BIAs for these species overlap 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))

There is the potential that there will be increased numbers of individuals transiting the Operational Area during these months, however, even with an increased likelihood of interaction, the potential impacts are considered to be minor, due to the mitigation measures applied throughout the year (i.e. dedicated marine fauna observer, pre-start observations, soft starts and shutdowns within exclusion zone). Impact is also limited by temporal exposure of the activities, the extended period in-between piling activity such as pile deployment and setup and transiting to next location (approximately 12-24 hours). The migratory corridor of both species around the Operational Area is not constricted or narrow when compared to their migratory pathway along other areas of the West Australian coastline. Humpbacks on their southern migration are also known to stay closer to the coastline as mothers and calves migrate from calving areas in Camden sound.

Anthropogenic noise in cetacean BIAs will be managed such that acoustic injury and hearing impairment to whales in the vicinity of piling operations will be minimised. The Operational Area does not lie within foraging area BIA's, and additional mitigation measures have been applied during the peak humpback and pygmy blue whale migratory period as a precautionary measure to reduce the potential for impact to these species. The use of soft-start (or ramp-up) procedures will act to prevent the situation where the pile driving could be suddenly started up at full power with cetaceans nearby. Additionally, given the piling noise source is stationary, individuals would be expected to implement avoidance measures. In the unlikely event cetaceans are sighted within 1000 m of the piling location a shutdown zone of 1000 m will be implemented by a trained marine fauna observer to prevent potential impacts to cetaceans.

Given the credible source levels emitted during piling activities is conservatively represented by the modelling presented in, behavioural or injury to cetaceans is unlikely, with these impacts are not expected to occur during the Petroleum Activities Program. It is reasonable to expect that cetaceans may demonstrate avoidance or attraction behaviour to the noise generated by piling, and when migrating through the area cetaceans may deviate from the migration corridor, but continue on their migration pathway and any avoidance or attraction behaviours displayed are expected to be localised and temporary. This is based on the short exposure of piling activities. Predicted noise levels are not considered to be ecologically significant at a population level.

Fish

Underwater impulsive sound such as pile driving may have negative impacts on fish species ranging from behavioural disturbance to physical injury/mortality. The hearing system of most fishes is sensitive to sound pressures between 50 hertz and 500 hertz, which overlaps the predominant frequency ranges of pile driving activities.

Sound is perceived by fish through the ears and the lateral line which are sensitive to vibration. Some species of teleost or bony fish (e.g. herring) have a structure linking the gas filled swim bladder and ear and these species usually have increased hearing sensitivity. These species are considered to be more sensitive to anthropogenic underwater noise sources than species such as cod (*Gadus* sp.) which do not possess a structure linking the swim bladder and inner ear. Fish species that either do not have a swim bladder (e.g. elasmobranchs and scombrid fish (sharks, mackerel and tunas) or have a much reduced swim bladder (e.g. flat fish) tend to have a relatively low auditory sensitivity. Considering these differences in fish physiology, Popper *et al*. (2014) developed sound exposure guidelines for fish and these are presented in **Table A- 4** and have been applied to assess potential impacts on fish during piling activities.

Table A- 4: Threshold for pile driving and impulsive exposure to fish (Popper et al. 2014)

Type of Fish	Mortality and potential mortal injury	Impairment	
		Recoverable Injury (PTS)	Temporary Threshold Shift (TTS)
Type 1 – no swim	>219 dB re 1 µPa² s	>216 dB re 1 µPa² s	> 186 dB re 1 µPa² s

bladder (particle motion detector)	(cSEL) Or > 207 dB re 1μPa (SPL peak)	(cSEL) Or > 213 dB re 1μPa (SPL peak)	(cSEL)
Type 2 – Swim bladder is not involved in hearing (particle motion detector)	>210 dB re 1 μPa^2 s (cSEL) Or > 207 dB re 1μPa (SPL peak)	>207 dB re 1 μPa^2 s (cSEL) Or > 203 dB re 1μPa (SPL peak)	> 186 dB re 1 μPa^2 s (cSEL)
Type 3 – Swim bladder involved in hearing (primary pressure detection)	>207 dB re 1 μPa^2 s (cSEL) Or > 207 dB re 1μPa (SPL peak)	>207 dB re 1 μPa^2 s (cSEL) Or > 203 dB re 1μPa (SPL peak)	> 186 dB re 1 μPa^2 s (cSEL)

Using thresholds displayed in **Table A- 4** against results from the JASCO 2015 piling study displays maximum mortality and potential injury within 0.075 km if piling activity, recoverable injury/PTS within 0.108 km and Temporary Threshold Shift (TTS) within 2.10 km. These values are associated with the most sensitive fish species (Type 3) and the modelling is considered an extremely conservative representation of the impacts of piling associated with this petroleum activities program.

Most pelagic and open water fish species (including whale sharks) are expected to swim away when impulsive noise, such as pile driving, reaches levels at which it might cause physiological effects. BPM (2008) recorded no exposure mortality from the Woodside Maxima 3D Marine Seismic Survey (MSS) Phase I and Phase II survey of fish species such as mackerel (*Decapterus macarellus*), barracuda (*Sphyraena barracuda*), large billfish (sailfish or marlin), schooling bait fish and a number of species of rays and sharks.

The Scombroid fishes such as tuna, billfish and marlin are considered hearing generalists with poor hearing sensitivity based on physiological structure of the inner structure (as documented for the bluefin tuna, Song *et al.* 2006). It is considered extremely unlikely that scombroid fishes in the vicinity of piling activities will stay within the area long enough to experience sound exposure levels that will cause either high-level behavioural effects (fright/flight) or physiological effect such as hair cell damage. It is estimated that low-level behavioural effects (avoidance) may take place within a few kilometres from the piling activities. This spatial 'footprint' of potential effect is extremely small when compared to the wider open water area which scombroid fishes utilise. Any further potential effects are further mitigated by the fact that the zone of effect is confined spatially and temporally given the short duration of exposure at each piling location with no concurrent piling during this activity, and all piles will be driven consecutively and therefore there will be a break between each active piling period of approximately 12-24 hours.

Pelagic finfish species, which are not hearing specialists, inhabit seabed areas and can exhibit avoidance behaviour in the unlikely event of experiencing impulsive noise levels that lead to low-level behavioural effects. Based on a review of the available literature and the relatively short temporal and spatial extent of the proposed piling activities, the proposed piling activities are not likely to have a significant impact on pelagic fish populations. Nonetheless, mitigation measures including 'soft starts' which have been included to minimise the potential impacts on cetaceans, whale sharks and turtles and will also help minimise impacts to fish species.

Impacts to demersal fish species, including those associated with the Continental Slope Demersal Fish Communities KEF and the Canyons KEF are expected to be minor. With the exception of a few isolated boulders within the Enfield Canyon, there are no known habitats within the Operational Area that support site attached species. Any non-site attached demersal species would be expected to swim away if exposed to impulsive noise associated with piling activities.

Demersal species that may be site attached to the isolated boulders within the Enfield Canyon are unlikely to move away from the impulsive noise. Noise impact studies at Scott Reef considering site attached species, included exposure of a reef fish hearing specialist (*Pinecone Soldierfish*) to cumulative SEL of 190 dB re: 1 uPa2.s without resulting in any detectable temporary threshold shift. Furthermore, noise exposure studies conducted by Australian Institute of Marine Science (AIMS) at Scott Reef demonstrated that there was no physical or long-term behavioural effects on site attached fish (based on species richness or abundance) during the Maxima 3D Marine Seismic Survey. Although the noise source for these studies was a seismic source array, noise exposure thresholds adopted for seismic surveys are commonly applied for pile driving activities as the acoustics of the impulsive sounds generated by impact pile driving and seismic array pulses are similar (Popper et al. 2014).

As described above for pelagic fish, assuming a conservative maximum zone of effect of 1 km radius around the piling location, the spatial ‘footprint’ of potential effect is extremely small when compared to the wider open area which demersal fishes may utilise. Any further potential effects would be further mitigated by the fact that the zone of effect is confined spatially and temporally given the short duration of exposure at each piling location extended period of no acoustic exposure in-between piling activities (approximately 21 hours). Therefore, only minor impacts to demersal fish species associated with the KEFs are expected.

Whale Sharks

It is expected that the potential effects to whale sharks (*Rhincodon typus*) associated with pile driving noise will be the same as for other fish. Given whale sharks do not have swim bladders they are categorised as a fish that is less sensitive to noise (Type 1 Fish Without Swim Bladder) and therefore, unlikely to be impacted by piling noise unless at close distances to the piling location (Popper *et al*. 2014). For example, based on the threshold of Popper et al. (2014) a whale shark would need to be within less than 40 m from the piling hammer for a single pulse exposure before the onset of injury PTS (**Table A- 4**). Soft start procedures and piling shutdown exclusion zones of 200 m will also be implemented for whale sharks as a precautionary measure to reduce any potential risk of injury associated with noise exposure.

Whale sharks may transit within the Operational Area during their migrations to and from Ningaloo Reef. It is expected that whale shark presence within the Operational Area may occur within and either side of the main aggregation period at Ningaloo (April – July), particularly as there is a BIA within close proximity to the Operational Area that is associated with whale sharks foraging during northward travel from July to November. Given the whale sharks are transiting between main aggregations sites near coastal waters (Ningaloo and Indonesia) the presence within the Operational Area will be short in duration. Additionally, piling activities, if undertaken, will be of short duration. As such, the potential for any impacts beyond avoidance during piling activities on whale sharks is considered unlikely.

Turtles

Electro-physical studies have indicated that the best hearing range for marine turtles is in the 100-700 Hz range, which is similar to the predominant energy of pile impact impulse frequencies (<100 Hz) (Popper *et al*. 2014). Because of their rigid external anatomy, it is possible that sea turtles are highly protected from impulsive sound effects like pile driving, however, reference behavioural exposure thresholds for impulsive noise sources on caged green and loggerhead turtles and turtle injury thresholds specific to pile driving (**Table A- 5**).

Table A- 5: Impulsive noise Exposure for Marine Turtles

Species	Received Level			Effect
	dB re 1 µPa RMS	dB re 1 µPa pk	cSEL dB re 1 µPa.s^2	
Sea Turtles	-	> 07	210	Injury
Loggerhead turtle	175-176	-	-	Avoidance response
One green and one loggerhead turtle	166	-	-	Noticeable increase in swimming behaviour, presumed avoidance response
One green and one loggerhead turtle	175	-	-	Behaviour becomes increasingly erratic, presumed alarm response

Based on the results of piling noise modelling, distances of behavioural effects (166 dB re 1 µPa RMS) are expected to be limited to within 4 km from the piling impact location and assumed injury (207 dB re 1 µPa pk or 210 cSEL dB re 1 µPa.s2) within less than 60 metres.

The use of soft-start (or ramp-up) procedures will act to prevent the situation where the pile driving could be suddenly started up at full power with turtles nearby. Additionally, given the piling noise source is stationary, individuals would be expected to implement avoidance measures. In the unlikely event turtles are sighted within 200 m of the piling location a shutdown zone of 200 m will

	be implemented by trained marine fauna observers as a precautionary measure to prevent potential injury impacts to turtles. The 200 m shutdown zone will also be applied to marine turtles during pre-observation watch and also during soft starts.

There is an inter-nesting flatback BIA approximately 3 km east of the Operational Area, which may have relatively high abundance of flatback turtles during their summer nesting period. Assuming behavioural responses of turtles may occur up to 4 km from the source (as estimated from piling noise modelling), underwater noise generated from piling may occur above impact thresholds in a small portion of the inter-nesting BIA (approximately 18 km^2, or <0.1% of the BIA area). Given the area of the BIA potentially affected represents the western extremity of the BIA and is not known to contain foraging habitat, significant behavioural impacts to inter-nesting flatbacks due to underwater noise are considered to be highly unlikely.

The nearest turtle nesting habitat (Ningaloo Coast) is approximately 33 km from the Operational Area. Given piling may occur during any season, there is the potential piling may occur during peak turtle nesting (November to April). Turtle inter-nesting distance for flatback and green turtles have been recorded up to 26 km and 10 km, respectively from nesting beaches at the Lacepede Islands and distances up to 62.1 km from Barrow Island, however, Barrow Island inter-nesting distances were exclusively towards the Australian mainland coast and not further offshore. The Operational Area is in close proximity to the flatback turtle 80 km inter-nesting buffer. Given the limited exposure time of piling activities and that the nearest turtle nesting location is approximately 33 km from the nearest piling location leading to the unlikely occurrence of internesting turtles within the Operational Area it is unlikely there will be significant impact to marine turtles during the piling campaign.

Turtles

Electro-physical studies have indicated that the best hearing range for marine turtles is in the 100-700 Hz range (Popper *et al*. 2014). Because of their rigid external anatomy, it is possible that sea turtles are less sensitive to impulsive sound like pile driving (Popper *et al*. 2014). McCauley *et al*. (2003), Popper *et al*. (2014) and O'Hara and Wilcox (1990), reference behavioural exposure thresholds for underwater noise sources on caged green and loggerhead turtles and turtle injury thresholds specific to pile driving (**Table A- 6**).

Table A- 6: Noise exposure thresholds for marine turtles

Species	**Received Level**			**Effect**
	(dB re 1 µPa RMS)	**(dB re 1 µPa pk)**	**(cSEL (dB re 1 µPa.s^2)**	
Sea Turtles	-	>207	210	Injury
Loggerhead turtle	175-176	-	-	Avoidance response
One green and one loggerhead turtle	166	-	-	Noticeable increase in swimming behaviour, presumed avoidance response
One green and one loggerhead turtle	175	-	-	Behaviour becomes increasingly erratic, presumed alarm response

Survey and Positioning Equipment Noise

The survey equipment uses high frequencies (120 – 410 kHz) which, unlike low frequencies (<1 kHz), attenuate rapidly through water and have limited range. Marine species that may be sensitive to these high frequencies are limited to toothed whale species. The EPBC Act Protected Matters Search Tool identified two species, killer whales and sperm whales, that may occur in the Operational Area. However, based on these species habitat preferences their presence is likely to be remote and limited to infrequent transiting of the Operational Area. Additionally, studies have determined that for a unit emitting a source volume of 212 dB re 1µPa between frequencies of 110 to 125 kHz the received levels had attenuated to 190 dB re 1µPa within 22 m of the source, and to 180 dB re 1µPa within 47 m of the source. This suggests that a cetacean would have to be within 50 m of the source for behavioural impacts to occur. The noise source levels are below known injury thresholds for marine mammals. Given the short period of time it is proposed for use, the

	spatial location and water depth impacts from use of the side-scan sonar or the multi-beam echo sounder are not expected. Due to the short duration chirps and higher frequencies involved, the acoustic noise from the transponders is unlikely to have an effect on the behavioural patterns of marine mammals. Therefore, no impacts are anticipated from positioning transponders. **Helicopter Noise** 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, with noise received at the sea surface decreasing with increasing distance from the aircraft. 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 are not considered to be credible. Note that helicopter noise during approach, landing and take-off is more likely to propagate through the sea surface due to the reduced air speed and lower altitude. However, helicopter noise during approach, landing and take-off will be mingled with underwater noise generated by the facility hosting the helipad (e.g. thruster noise from vessels, machinery noise from MODU etc.). Additionally, approach, landing and take-off are relatively short phases of the flight, resulting in little opportunity for underwater noise to be generated. Woodside is not aware of any studies specifically examining behavioural responses of cetaceans when exposed to helicopter noise expected to occur within the Operational Area (e.g. humpback and pygmy blue whales), however, helicopters have been used as a platform for cetacean surveys. 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. Responses included raising flukes, increasing swimming speed and changes in swimming direction. Blue whale behavioural responses to helicopter flights maintaining vertical and horizontal separation of >457 m and >0.5-1 km respectively were not noted during extensive aerial surveys off California. Studies of bowhead whales exposed to helicopter noise indicated behavioural responses in 14% of whales observed, typically when separation from the helicopter was ≤150 m vertically and ≤250 m laterally. 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. Turtles may be present in low numbers within the Operational Area, and may be exposed to helicopter noise when on the sea surface (e.g. when basking or breathing). Hearing in marine turtles is adapted for the perception of sound underwater, where they spend the majority of their time. As such, turtles are not expected to perceive noise levels from helicopters that may result in PTS or TTS; impacts may consist of “startle” responses such as diving, which are exhibited when turtles are exposed to other disturbances such as the passage of vessels. Typical startle responses occur at relatively short ranges (10’s of metres) and as such, startle responses during typical helicopter flight profiles are considered to be remote. In the event of a behavioural response to the presence of a helicopter, turtles are expected to exhibit diving behaviour, which is of no lasting effect. Seabirds with the Operational Area may avoid helicopter flights. The Operational Area overlaps a foraging BIA for wedge-tailed shearwaters. Studies of impacts to seabirds from helicopter flights has typically been focussed on aggregations of breeding sites; impacts at these locations may result in reduced breeding success and hence, be a threatening process at a population level. Note that no emergent land, and hence, seabird breeding colonies, occurs within the Operational Area;

the nearest landfall is approximately 33 km from the Operational Area. Seabirds may exhibit a range of response behaviours when exposed to noise; greater than 20% of crested terns within a colony exhibited behavioural responses such as scanning (>65 dB), alert (>65 dB), startle (>95 dB) and escape (>100 dB) when exposed to simulated aircraft noise (Brown 1990). Seabirds exposed to noise from helicopter flights within the Operational Area may exhibit behavioural responses such as alert and escape behaviours; such behaviour is expected to cease once the helicopter has passed. Given the expected low density of seabirds within the Operational Area, the relative infrequency of helicopter flights and lack of lasting effect of potential behavioural responses to helicopter noise, the likelihood and consequence of subsequent impacts are considered to be highly unlikely and result in no lasting effect, respectively.

Cumulative Impacts

In order to assess the cumulative underwater noise impacts associated with the Petroleum Activities Program, a desktop modelling exercise was undertaken. Transmission loss was estimated keeping within scientific literature such as the approach used to create a regional sound map of shipping off the coast of British Columbia. This method provides a precautionary estimate of received levels in generalized shallow to medium depth environments. High frequency noise (>1 kHz) associated with survey and positioning equipment was not included in the cumulative assessment due to the source frequency being well outside the dominant range of vessel, FPSO and MODU noise and therefore expected to attenuate over significantly shorter distances. Additionally noise from short term piling activities was not included within the cumulative assessment as piling noise is an impulsive source and cannot be compared directly with continuous noise sources such as vessel, FPSO and MODUs. Underwater noise from helicopters has not been included within this assessment as levels are considered negligible.

Transects for sound propagation from all potential vessels, FPSO and MODU sources within the operational area were modelled to a central location within the Petroleum Activities Program, located at a central point between petroleum licences WA-28L and WA-59L. The modelled received level location is also on the eastern border of the humpback migratory BIA. Modelling was calculated using a geometric spreading model that accounts for spherical spreading out to the maximum depth of the transect and cylindrical spreading for the remainder of the transect. The calculations do not consider transmission loss associated with frequency dependant absorption or the influence of seabed or surface attenuation and are therefore considered a precautionary and conservative estimation

The assessment included the following sound sources; one MODU and three drilling activity support vessels (or light construction vessel) and an ISV/DSV and two subsea activity support vessels, three of the seven vessels were assumed to be operating on DP. Representative source levels for FSPO's were taken from Erbe et. al (2013) a publication based upon measurements by JASCO and CMST of the FPSO's from Exmouth to the North West Shelf, with the 5th percentile broadband source level measured back to 188 dB re 1 uPa @ 1m. The source levels for vessels were taken from McCauley 2011 and Woodside Energy Limited 2011, shipping fairway levels were taken from Erbe et al 2012.

The cumulative (aggregate) received levels were calculated by adding all the received levels in linear pressure units.

Table A- 7: Cumulative Desktop Underwater Noise Modelling Results

Source Type	Source Level	Distance away	Max Transect Depth	Transmission Loss	Received Level
	dB re 1 lPa @ 1 m	m	m	dB re 1 uPa	dB re 1 iPa @ 1 m
MODU DP Full Power (WA-28L)	195	13000	825	70.3	124.7
Vessel 1 (WA-59L)	175	6200	733	66.6	108.4
Vessel 2 (WA-59L)	175	14000	900	71.0	104.0
Vessel 3 (DP) (WA-59L)	182	12100	860	70.2	111.8
Vessel 4 (DP) (WA-59L)	182	12000	860	70.1	111.9

Vessel 5 (WA-28L)	175	8000	650	67.2	107.8
Vessel 6 (WA-28L)	175	11,350	650	68.7	106.3
Vessel 7 (DP) (WA-28L)	182	11,300	650	68.7	113.3
Nganhurra	188	8300	650	67.3	120.7
Ngujima-Yin	188	14000	650	69.6	118.4
Ningaloo Vision	188	16000	650	70.2	117.8
Shipping Fairway	190	38000	1100	76.2	**113.8**
Received Level of Existing Sources within Operational Area					**124.3 dB**
Received Level including Petroleum Activities Program within Operational Area					**128.1 dB**

The desktop modelling has shown that the cumulative received levels from the existing regional sources within the operational area are relatively high in comparison to the additional noise sources associated with this Petroleum Activities Program. Additional noise sources from the Petroleum Activities Program are expected to increase the existing ambient noise levels by only 3.8 dB. These received levels are below all known injury and TTS levels for all marine fauna and below published behavioural thresholds for fish and turtles. The estimated existing ambient noise level (124.3 dB re 1 uPa) is actually already above the most conservative behavioural threshold 120 dB re 1 uPa for whales.

The Operational Area therefore already experiences exposure to anthropogenic levels substantially greater than the predicted ambient environment, and above the most conservative threshold for potential behaviour effects to whales. Given the length of time that these sources have been present, the ambient environment is therefore influenced by them, and it expected that they have become part of the background soundscape experience by marine mammals that would regularly transit this region.

The significance of the existing noise sources need to be considered in combination with the Petroleum Activities Program. The introduction of the additional sound sources associated with the Petroleum Activities Program only slightly increase the level of aggregate noise in the region (3.8 dB); this will have the primary result of marginally expanding the geographical area ensonified above the 120 dB re 1 uPa behavioural threshold of interest. There is currently no adopted published threshold for masking effects however it could also be assumed that the 3.8 dB increase in noise within the Operational Area will have some influence on increasing the ensonifed area of masking effects associated with anthropogenic noise. It should be noted the modelled levels presented here represent worst case scenarios for each source type and propagation and therefore should be considered precautionary with respect to determining extent of potential behavioural and masking impacts. Based on this assessment, cumulative noise levels associated with the Petroleum Activities Program are not expected to have a significant impact on marine fauna within or adjacent to the Operational Area.

Summary	It is considered that noise generated by the MODU, ISVs and activity support vessels, underwater piling, survey and positioning equipment will not result in a potential impact greater than slight and temporary disruption to a small proportion of the populations of marine fauna associated with the Operational Area.

Summary of Control Measures

- If undertaking impact piling a dedicated Marine Fauna Observer (MFO) will be used on the relevant activity vessel.
- If undertaking impact piling – Application of a soft start procedure at commencement of piling.
- If undertaking impact piling - during night/ low visibility period, passive acoustic monitoring (PAM) will be used.
- If undertaking impact piling – Application of a 1km shutdown distance when whales are sighted.
- If undertaking impact piling – Application of a 200m shutdown distance when turtles or whale sharks are sighted.

Routine and Non-routine Discharges: Project Vessels and MODU

Source of Risk	Environmental Value Potentially Impacted							Evaluation		
	Soil and Groundwater	Marine Sediment	Water Quality	Air Quality (incl. odour)	Ecosystems / Habitats	Species	Socio-economic	Consequence	Likelihood	Residual Risk
Routine discharge of sewage, grey water and putrescible wastes to marine environment from Project Vessels			X					F	2	L
Routine discharge of deck, bilge and drain water to marine environment from Project Vessels			X					F	1	L
Routine discharge of cooling water or brine to the marine environment from Project Vessels			X					F	2	L

Description of Source of Risk

Project Vessels routinely generate/discharge:

- small volumes (impacts assessed based on an approximate discharge of 250 m^3 per vessel per day) of treated sewage and putrescible wastes to the marine environment
- routine/periodic discharge of relatively small volumes of bilge water. Bilge tanks 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 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

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 detailed risk assessment for Unplanned Discharges to the Marine Environment – Loss of Hazardous/Non-hazardous Waste.

Potential Environmental Impacts

Value	Description of Potential Environmental Impact
Water Quality	No significant impacts from the planned (routine and non-routine) discharges to the marine environment 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) 2009 and Marine Order 95 (Marine pollution prevention – garbage) 2013. This is supported by monitoring of sewage discharges, which has demonstrated that a 10 m3 sewage discharge reduced to approximately 1% of its original concentration within 50 m of the discharge location (Woodside, 2008). In addition to this, monitoring at distances 50, 100 and 200m 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. TN, total phosphorous and selected metals) were recorded above background levels at any station. **Cumulative Impacts** It is possible that multiple vessels will be present at various locations within the Operational Area throughout the project, potentially discharging multiple, but low volume, waste streams. However,

	cumulative impacts from multiple vessels within the Operational Area are unlikely, given that discharges are small, with a localised mixing zone, and are expected to dilute readily within the offshore marine environment. Additionally, whilst the Petroleum Activities Program may extend for up to two and a half years, vessels will not be continuously in the Operational Area nor continuously discharging at one given location for an extended period of time. Rather, these routine and non-routine discharges are expected to be intermittent in nature for the duration of the Petroleum Activities Program and occurring with sufficient temporal and spatial separation such that when considering mixing and dilution characteristics, potential for cumulative impacts to water quality within the Operational Area is considered negligible. It is possible that marine fauna transiting the localised area may come into contact with these discharges (e.g. humpback whales and pygmy blue whales as they traverse the Operational Area during their seasonal migrations, however, given the localised extent of cumulative impacts from multiple vessel discharges within the Operational Area, and the very short exposure period which would be experienced, potential impacts to marine fauna are considered low. As the discharges are small, intermittent and highly localised, no cumulative impacts associated with other discharges from vessels outside the Operational Area are expected.
Summary	Given the adopted controls, it is considered that the discharges described will not result in a potential impact greater than localised contamination above background levels, water quality standards, or known effect concentrations.

Summary of Control Measures

- Marine Orders 95 – pollution prevention – Garbage (as appropriate to vessel class).
- Marine Orders 96 - pollution prevention – sewage (as appropriate to vessel class).
- Woodside Engineering Standard for Rig Equipment which specifies requirements for deck drainage and management of oily water for MODU.
- Marine Orders 91 – oil (as relevant to vessel class).

Routine and Non-routine Discharges: Drill Cuttings and Drilling Fluids

Source of Risk	Environmental Value Potentially Impacted							Evaluation		
	Soil and Groundwater	Marine Sediment	Water Quality	Air Quality (incl. odour)	Ecosystems / Habitats	Species	Socio-economic	Consequence	Likelihood	Residual Risk
Routine discharge of drill cuttings (WBM) to the marine environment at the seabed and sea surface		X	X		X			E	1	L
Routine discharge of drill cuttings (NWBM) to the marine environment at the sea surface		X	X		X			E	1	L
Routine discharge of drilling muds (WBM) to the seabed and the sea surface		X	X		X			E	1	L
Non-routine discharge of wash water from mud pits and skimmer tank		X	X		X			E	1	L

Description of Source of Risk

Drilling Program

The proposed Petroleum Activities Program includes the drilling of six production wells and, six water injection wells in water depths ranging from 530 to 850 m at the proposed well locations. The following describes the source of risk with respect to drill cuttings, drill fluids and muds only. The base case (e.g. typical drilling operations) for the management of cuttings is to discharge into the marine environment along with WBM drilling muds used to transport the cuttings out of the well.

For the purposes of this risk assessment, the indicative dimensions, discharge locations and approximate cuttings volumes provided in **Table A- 8** represent the worst case wells from the three main drill locations to be drilled during the Petroleum Activities Program.

Wells will be drilled as a series of sections, as detailed in **Table A- 8.** The top hole sections of each well will be drilled without a riser in place (i.e. riserless drilling). Upon drilling of the top hole sections, casings will be cemented in place, a BOP installed and a riser put in place between the BOP and the MODU. The riser remains in place during drilling of the bottom hole sections and facilitates the circulation of drilling fluids and cuttings between the well bore and the MODU.

Table A- 8: Indicative discharges of cuttings and drilling fluids for wells during the Petroleum Activities Program

Well	Section	Section widths (inches)	Discharge point	~ Cuttings discharged (m^3) plus washout (10%)	~ Fluids discharged (m^3)	~ Solids discharged (within fluid) (m^3)	Indicative discharge duration (days)
NOLB	Top hole	42”	Seabed	82	376	38	0.4
		17.5”		141	1030	103	2.1
	Bottom hole	12.25”	Surface	48	959	96	2.1
		8.5”		181	1852	185	42.6
NOLB total				**451**	**4217**	**422**	**47.2**
LAVD	Top hole	42”	Seabed	82	377	38	.5
		17.5”		121	614	61	1.9
	Bottom hole	12.25”	Surface	56	133*	13*	3.6
		8.5”		90	1973	197	7.8

LAVD total				**259**	**3097**	**309**	**13.8**
CIMC W1	Top Hole	42”	Seabed	142	441	44	0.4
		26”		281	640	64	2.0
	Bottom Hole	17.5”	Surface	228	894	89	4.0
		12.25”		66	1137	114	3.8
		8.5”		22	833	83	5.5
CIMCW1 total				**739**	**3945**	**394**	**15.7**

* NWBM planned – Drilling fluids will not be operationally discharged.

Drill Cuttings

Indicative total drill cuttings discharged for the three worst case Greater Enfield wells (highest cuttings volume) are provided in **Table A- 8**.

Drill cuttings generated from the well are expected to range from very fine to very coarse (<1 cm) particle/sediment sizes. Drill cuttings generated while drilling the top hole sections (WBM only) will be discharged at the seabed around the well, along with WBM drilling fluids.The bottom hole sections will be drilled with a marine riser that enables cuttings and drilling fluid to be circulated back to the MODU, where the cuttings are separated from the drilling fluids by the Solid Control Equipment (SCE). The SCE uses shale shakers to remove coarse cuttings from the drilling fluids. After processing by the shale shakers, the recovered fluids from the cuttings may be directed to centrifuges, which are used to remove fine solids (~4.5 to 6 µm). The cuttings with retained fluids are discharged below the water line and the mud is recirculated into the fluid system.

Where NWBM is needed to drill a well section, the cuttings from the NWBM drilling fluid system will also pass through a cuttings dryer to reduce the average residual oil on cuttings for the well (only sections using NWBM) to 8% wt/wt or less on wet cuttings, prior to discharge. The estimated volume of cuttings discharged with residual NWBM is shown in **Table A- 8** for the LAVD well (refer 12.25” section = 56m^3). This represents a worst case scenario per well for the wells where NWBM is planned. Therefore, conservatively, 280m^3 of cuttings with residual NWBM will be discharged (56m^3 x 5 wells).

Drilling Fluids

The Petroleum Activities Program will predominantly use a WBM drilling fluid system. WBM will be operationally discharged to the marine environment at the location of the well being drilled (refer **Table A- 8**) during the Petroleum Activities Program under the following scenarios:

1. at the seabed when drilling the top hole (riser less) sections (bentonite and guar gum)
2. below the sea surface as fluid retained on drill cuttings, after passing through the SCE (bottom hole sections, drilled with riser in place)
3. from the mud pits via a pipe discharged below the sea surface at the MODU location when WBM cannot be re-circulated/ re-used (due to deterioration/ contamination) or stored. Discharges will occur between each section of every well except for CIM where the 17 ½” section mud is planned to be reused on the 12 1/4” sections on each CIM well. Estimated discharge volumes are listed in **Table A- 8**, ‘fluids discharged’ column. Not all wells are listed, however it is conservatively assumed that these volumes will occur for each well (noting those shown are the worst case for each reservoir area). There is an over estimation on the CIM wells as mud is planned to be reused between the 17 ½” and 12 1/4” hole sections.

A NWBM drilling fluid system is planned to be used for the 12-1/4” hole sections of the five LAV wells. Its usage has been minimised as much as possible for the Project and justified in accordance with the Woodside Drilling and Completions Functional Division (D&C) Operations Manual – Drilling and Completions Fluids Procedure. This considers technical factors relevant to wellbore conditions, such as well temperature, well shape and depth, reactivity of the formation to water and well friction and consideration of environment, health, safety and waste management.

The requirement to use NWBM has been based on offset history, geohazards assessment and borehole stability studies. NWBM has been selected primarily to cater to kick tolerance margin whilst balancing borehole stability requirements in the highly deviated Laverda 12-1/4” sections. Offset well data showed that a high performance WBM would likely not be able to successfully drill the Laverda 12-1/4” sections.

Although not planned, there is a contingency to change from WBM to NWBM for some hole sections of the NOL and CIM wells in the event of unplanned technical difficulties which compromise well objectives on initial wells in these fields. The applicable hole sections for this contingency are the 12-1/4” hole sections of the NOL wells (though highly unlikely) and the 17-1/2” and 12-1/4” sections of the CIM wells. A change from WBM to NWBM for the above sections will result in an incremental increase in the discharge of cuttings with residual NWBM (<8%) only (noting bulk discharge of NWBM will not occur). The volumes of cuttings in these events are as per the estimates provided for the representative worst case

NOL and CIM well (relevant sections) shown in **Table A- 8,** multiplied by the number of wells where this contingency may be required (conservatively noting worst case wells are shown). NWBM discharged will be 8% or less of this volume as per SCE performance criteria. The use of NWBM under these contingent scenarios will also require justification as per the abovementioned procedure.

NWBMs will primarily be mixed onshore and transported to the MODU via a support vessel. Should a NWBM system be used, the NWBM drill cuttings and fluid are returned through the riser to the MODU and processed through the SCE to separate the majority of drilling fluids from cuttings. Cuttings are then processed through dryers to further reduce the per well average oil on cuttings to 8% or less by wet weight prior to the discharge of cuttings to the marine environment, below the waterline. NWBM drilling fluid is only operationally discharged as oil on cuttings associated with drill cuttings from sections of the well where NWBM drilling fluid system has been used.

Both WBM and NWBM drilling fluids are contained within the drilling fluids circulation system. Mud pits (tanks) within this system provide capacity for the storage of drilling fluids. The mud pits are cleaned out when fluids are changed or at the completion of drilling operations. Mud pit residue may be discharged to the sea where the residue contains <1% oil volume. Where the mud pit residue exceeds 1% by volume, the residue will either be retained and disposed of onshore or treated onboard until <1% oil volume is reached. Chemicals used in WBM and NWBM are assessed in accordance with Woodside Chemical Selection and Assessment Environment Guideline.

Contingent Activities

Consideration of activities which are not planned but are possible if certain conditions or events dictate, including potential likelihood and estimated associated discharge volumes, are provided below.

Respud

The requirement to respud a well is overall a low likelihood event. If required, the most likely scenario is that the decision to respud is made during drilling of the top hole section of a well, and therefore the incremental increase in cuttings and mud discharges are associated with the repeat drilling of the same top hole sections for the respuded well with the same associated discharges (as summarised in **Table A- 8**). A respud once drilling of the bottom hole sections has commenced is far less likely given the time and effort already committed to the well. However, if this was to occur the associated discharges would also be a repeat of the discharges as per **Table A- 8** to re-drill the same sections of the respuded well. In respect of the likelihood of a respud, Woodside's recent experience for an 8 well development drilling program on the NWS (GWF2 Project) required no respuds. For the previous 5 well drilling program for GWF1, one respud was required, but for the conductor (top hole) section only.

Well flowback

All well cleanup activities are planned to be done via the FPSO and as such well flowback to the MODU is only considered in the EP as a contingent activity. It will only be required in the unlikely occurrence of injectivity issues on the water injection wells. If this occurs it will result in hydrocarbon flow to the rig and associated flaring for a period of 24 hours.

Workover and well intervention

There is a low likelihood that a well workover or intervention is required given completion activities focus on ensuring the well is completed appropriately and ready for start-up. Workovers or well interventions typically occur later in field life or if operational issues are identified with the well and would result in discharges similar to the completions activities described and risk assessed in this EP.

Sidetrack

There is a varying likelihood a sidetrack will be required, depending on the scenario. **Table A- 9** has been developed to provide an overview of potential sidetrack scenarios across the project and the associated discharges if these scenarios eventuate.

Table A- 9: Estimated likelihood and discharge volumes from well sidetrack contingencies

Scenario	Likelihood	Potential # over Project	Fluid	Section (inches)	~ Cuttings discharged (m^3) plus washout (10%)	~ Fluids discharged (m^3)	~ Solids discharged (within fluid) (m^3)	Indicative discharge duration (days)
12-1/4" Open Hole sidetrack	Medium		WBM	12.25	29	295	29	1.5
	Medium	5	NWBM	12.25	29	0	0	1.5
8-1/2" Cased hole whipstock	Low	1	WBM	8.5	14	107	11	1.5
8-1/2" Open Hole sidetrack	High	13	WBM	8.5	8	61	6	1.0
12-1/4" Cased Hole whipstock	Low		WBM	12.25	50	506	51	3.0
	Low	1	NWBM	12.25	50	0	0	3.0

Potential Environmental Impacts	
Value	**Description of Potential Environmental Impact**
Water Quality, Marine Sediment and Ecosystems/ Habitats	The identified potential impacts associated with the discharge of drill cuttings and fluids include a localised reduction in water and seabed sediment quality, and detrimental but localised changes to benthic biota (habitats and communities). A number of direct and indirect ecological impact pathways are identified for drill cuttings and drilling fluids as follows: • Temporary increase in total suspended solids (TSS) in the water column; • Attenuation of light penetration as an indirect consequence of the elevation of TSS and the rate of sedimentation; • Sediment deposition to the seabed leading to the alteration of the physico-chemical composition of sediments, and burial and potential smothering effects to sessile benthic biota; and • Potential contamination and toxicity effects to benthic and in-water biota from drilling fluids. The top hole sections drilled (riser-less) have drill cuttings and unrecoverable fluids discharged at the seabed at the well site and typically result in a localised area of sediment deposition (known as a cuttings pile) in close proximity to the well site. Depending on seabed current regimes, a greater spread of cuttings and WBMs may occur downstream from the well site. The bottom hole sections are drilled after the riser is fitted. Cuttings with unrecoverable fluids are discharged below the water line at the MODU site, resulting in drill cuttings and drilling fluids (WBMs or NWBMs) rapidly diluting, which disperse and settle through the water column. The dispersion and fate of the cuttings is determined by particle size and density of the unrecoverable fluids, therefore, the sediment particles will primarily settle in proximity to the well site with potential for localised spread downstream (depending on currents and their speed throughout the water column and seabed). Potential impacts from the discharge of cuttings range from the complete burial of benthic biota in the immediate vicinity of the well site due to sediment deposition, smothering effects from raised sedimentation concentrations as a result of elevated Total Suspended Solids (TSS), changes to the physico-chemical properties of the seabed sediments (particle size distribution and potential for reduction in oxygen levels within the surface sediments due to organic matter degradation by aerobic bacteria) and subsequent changes to the composition of infauna communities to minor sediment loading above background and no associated ecological effects. Predicted impacts are generally confined to within a few hundred metres of the discharge point (International Association of Oil and Gas Producers 2016). The proposed well locations are situated in areas of relatively flat, featureless seabed comprised of relatively fine (silt and sand) unconsolidated sediment. Benthic environmental surveys within and around the Operational Area have shown such substrates are very well represented in the region and hosts sparse assemblages of widely distributed filter feeder invertebrate species. Two KEFs, the Canyons KEF and the Continental Slope Demersal Fish Communities KEF, overlap the Operational Area. The Continental Slope Demersal Fish Communities KEF extends along the majority of the continental slope of the North West Shelf, with a small portion overlapping the Operational Area. Fish assemblages associated with this KEF are widely distributed throughout continental slope habitat in the region; the Operational Area does not constitute an area of particular sensitivity. The portion of the Canyons KEF within the Operational Area consists of the Enfield canyon. This canyon is considered to be a blind canyon, and a tributary of the larger Cape Range Canyon, resulting from slumping of sediments down the continental slope, and may not provide the ecological functions associated with the Canyons KEF, and larger scale submarine canyons (for example Cape Range Canyon), more broadly. The majority of the Canyons KEF lies beyond the Operational Area, extending to the south. Seabed surveys in the area, including the Enfield Canyon within the Canyons KEF, have shown the Operational Area is characterised by fine, unconsolidated sediments, with sparse deepwater invertebrate fauna (e.g. filter feeders: sea pens (Cnidaria), deposit feeders: sea cucumbers (echinoderms) and scavengers; shrimps and crabs (crustacea) and infauna communities. Hard substrates, which generally host more abundant and diverse sessile filter feeding biota, are uncommon. Some instances of hard substrate were noted during the geophysical and environmental surveys and were associated with isolated rock outcroppings and on large boulders in the area where the canyon interfaces with the continental slope. The water column in the Operational Area is typical of continental slope waters in the region, with pelagic fauna expected to be broadly distributed.

	Modelling Studies Woodside commissioned a modelling study to predict the fate of drill cuttings and drilling fluids discharged during the Petroleum Activities Program. The study was undertaken by RPS APAPSA (2016), and modelled discharges from the worst case well (greatest cuttings and fluids produced) from each of the three drilling locations – Cimatti, Laverda and Norton over Laverda. The study included numerical modelling techniques to predict total suspended sediments (TSS), sedimentation rate (concentration, g/m^2) and sediment deposition on the seabed (thickness, mm). The study used cuttings and fluid volumes as presented in **Table A- 8** and calculated particle size distributions and associated settling velocities for each well section based on cuttings data from previous offshore wells and empirical data, respectively. A regional hydrodynamic model that considered mesoscale, tidal and wind generated currents was created for the dispersion model. A worst-case scenario approach to the modelling study is adopted to represent the extremes of potential transportation of sediment particles using a 10 year modelled data set as the basis for the cuttings discharge study. The worst-case metocean periods (i.e. when currents were most likely to advect cuttings towards the canyons KEF) were based on the estimated durations for each well and consisted of the following: • LAV04: 19 December 2005 to 9 January 2006 • CIM04W1: 17 February 1998 to 12 March 1998 • NOL02: 8 April 2004 – 1 June 2004. Modelling studies did not indicate that cuttings/drilling fluids would be deposited above the detection threshold within the Ningaloo WHA, Ningaloo CMR or Ningaloo Marine Park, which are the closest protected areas to the Operational Area. **Water Quality** The discharge of drill cuttings and unrecoverable fluids from the MODU is expected to increase turbidity and TSS levels in the water column, leading to an increased sedimentation rate above ambient levels associated with the settlement of suspended sediment particles in close proximity to the seabed or below sea surface, depending on location of discharge. Cuttings with retained (unrecoverable) drilling fluids are discharged below the water line at the MODU location, resulting in drill cuttings and drilling fluids rapidly diluting, as they disperse and settle through the water column. The dispersion and fate of the cuttings is determined by particle size and density of the retained (unrecoverable) drilling fluids, therefore, the sediment particles will primarily settle in proximity to the well locations with potential for localised spread downstream (depending on the speed of currents throughout the water column and seabed). The finer particles will remain in suspension and will be transported further before settling on the seabed. Modelling results indicating that the TSS plume of suspended cuttings will typically disperse to the south-west while oscillating with the tide and diminish rapidly with increasing distance from the well locations (**Figure A- 1, Figure A- 2** and **Figure A- 3**). Maximum TSS concentrations predicted for 100 m; 250 m and 1 km distances from the wellsite were 7, 5 and 1 mg/L, respectively (**Figure A- 1, Figure A- 2** and **Figure A- 3**). Furthermore, water column concentrations below 10 mg/L remain within 235 m of the discharge location for each modelled well (the modelled CIMCW1 scenario presented in Figure A- 2 predicted the largest distribution). For all well discharge locations (outside of direct discharge sites), TSS concentration did not exceed 10 mg/l. Nelson et al. (2016) identified <10 mg/L as a no effect or sub-lethal minimal effect concentration. The 2015 Oceanica offshore canyon survey indicates habitats within the TSS discharge zone for all proposed well locations for concentrations between 1 mg/L and 10 mg/L consist of flat to moderate relief slopes with sand/mud habitats with associated sparse biota (**Figure A- 1, Figure A- 2** and **Figure A- 3)**. The habitat and bathymetry suggests TSS discharge remains outside the canyon (**Figure A- 2** and **Figure A- 3**), even though these sites are within the Canyon KEF. Given the generally low concentration of TSS (due to rapid dispersion from the discharge location), the offshore open ocean location with discharge modelling indicated outside the canyon KEF in conjunction with rapid dispersion of sediment and the intermittent discharge, the plume is not expected to have more than a very highly localised potential area of ecological impact and it is not predicted to impact productivity of the water column. Furthermore, there are no likely impacts expected for pelagic fauna. While very high concentrations of suspended sediments have been shown to result in mortality of pelagic animals (>1830 mg/L), such concentrations do not occur as a result of drill cuttings discharges. In addition, fish are likely to move away when elevated TSS concentrations are detected, while air breathing megafauna such as cetaceans and turtles are not expected to be in direct contact with TSS plume given its proximity to the MODU. Any potential contact would be of a short duration given the rapid dispersion of the plume and the expected transient movement of megafauna in this offshore area. With the lack of complex habitat within the modelled TSS plume (**Figure A- 1, Figure A- 2** and **Figure A- 3)**, in combination with the absence

	of light dependent benthic primary producer habitats located with the Operational Area or the wider area of potential influence the impact to habitats is expected to be minimal.

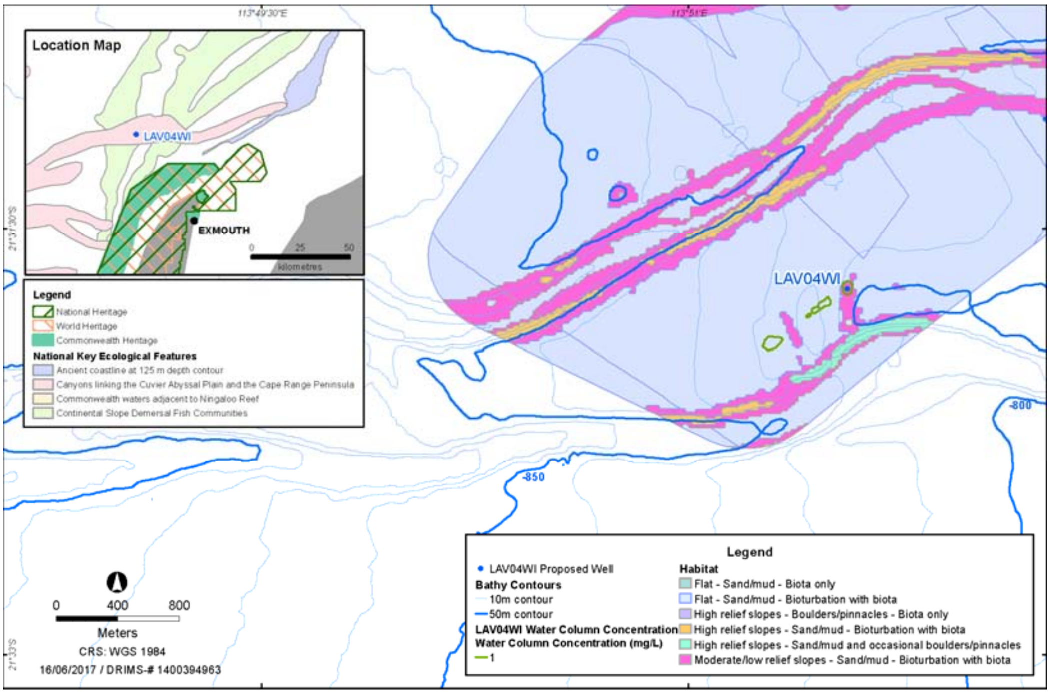

Figure A- 1: Contours of the modelled water column concentration (TSS) predicted for a release of cuttings and fluids for the discharge at LAV04WI proposed well location.

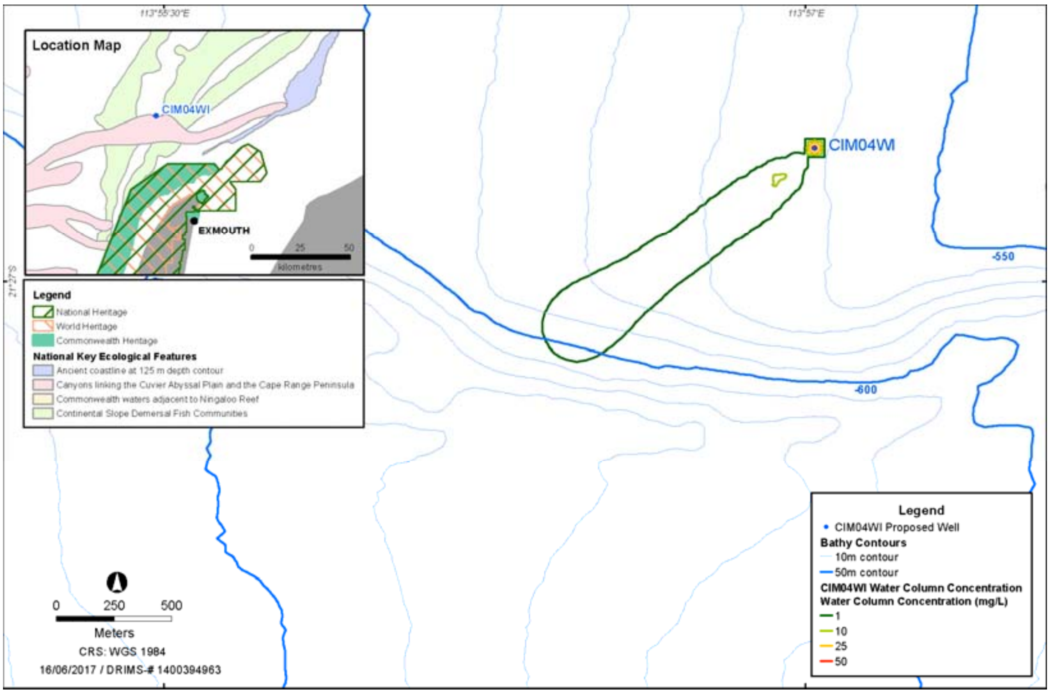

Figure A- 2: Contours of the modelled water column concentration (TSS) predicted for a release of cuttings and fluids for a discharge at CIM04WI proposed well location.

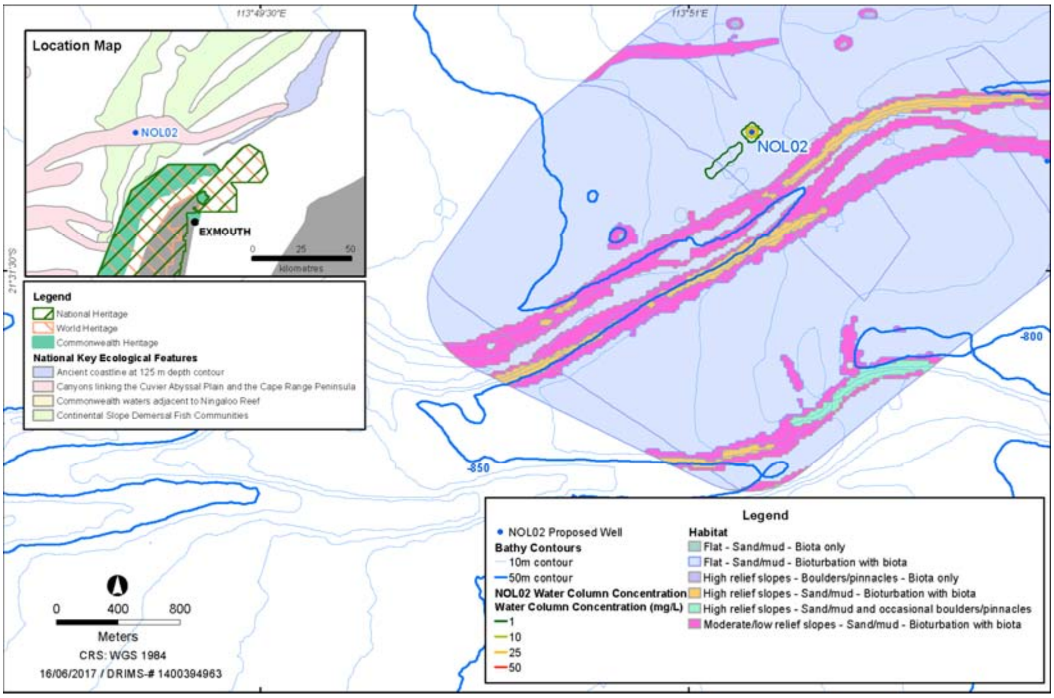

Figure A- 3: Contours of the modelled water column concentration (TSS) predicted for a release of cuttings and fluids for a discharge at NOL02 proposed well location.

Sediment Deposition

Cuttings discharged at the seabed during drilling of the top hole sections will result in localised cuttings piles on the seabed surrounding the well head, with top hole section volumes for indicative wells at each drilling centre provided in **Table A- 8.** Benthic organisms below this cuttings pile will be smothered, however, the cuttings piles from top hole sections are expected to be recolonised over time. Drilling fluids used for the top hole sections consist entirely of WBM. Mobile benthic fauna, such as demersal fish, may be temporarily displaced from areas where cuttings discharges accumulate.

Potential impacts are expected to be confined to sessile biota such as sediment burrowing infauna and epifauna where present in or on the seabed in immediate proximity to the well location. Ecological impacts to such biota are predicted when sediment deposition is equal to or greater than 6.5 mm (in thickness). Modelling indicated that such deposition to a distance of within 170 m from the well locations (in a south-westerly direction) would potentially occur (**Figure A- 4**, **Figure A- 5** and **Figure A- 6**). Results also indicated that maximum deposition at 250 m from the well locations would be less than 2 mm reduced to less than 0.1 mm at 1 km distance from the modelled wells (**Figure A- 4**, **Figure A- 5** and **Figure A- 6**). It should also be noted that Woodside's modelled wells are considered to be representative of all wells that may be drilled during the Petroleum Activities Program. Results indicated that accumulation of sediment to a thickness of 1 mm or more is expected to disperse to within ~350 m distance from the well locations for an individual well (350 m distance represented in Figure A- 5 for discharge location CIM04).

The 2015 Oceanica offshore canyon survey indicates habitats within a sediment thickness zone between 1 and 30 mm for all proposed well locations consist of flat to moderate relief slopes with sand/mud habitats with associated sparse biota (**Figure A- 4**, **Figure A- 5** and **Figure A- 6**). Bathymetry combined with the 2015 Oceanica canyon survey data indicates these sediment thickness zones (1- 30 mm) are not within the canyons (**Figure A- 4**, **Figure A- 5** and **Figure A- 6**). The sediment thickness zone of 0.1 mm extends slightly further into higher relief zone, with bathymetry suggesting presence at 0.1 mm into the canyon for the modelled scenario at LAV04WI and the NOL02 (**Figure A- 4** and **Figure A- 6**). Furthermore, levels of sediment deposition away from the immediate area of the well locations will represent a thin layer of settled drill cuttings which will likely be naturally reworked into surface sediment layers through bioturbation. Additionally, the sediment thickness of 0.1 is likely undetectable and will not be of a significant impact potential.

Furthermore, ecological impacts are not expected for mobile benthic fauna such as crabs and shrimps or pelagic and demersal fish given their mobility (IOGP 2016). It is also noted that NWBM cuttings tend to clump and settle to the seabed rapidly adding to the cuttings pile around each well site. Balcom *et al*. (2012) concluded that impacts to deepwater benthic infauna and sessile epifauna associated with the discharge of cuttings and synthetic based fluid (NWBMs) are highly localised to the area of the discharge, with recovery anticipated post disturbance (Gates and Jones 2012, Jones et al. 2012 and Balcom et al. 2012). Organic enrichment can occur leading to anoxic conditions in the surface sediments and a loss of infauna species that have a low tolerance to low oxygen concentrations, and to a lesser extent chemical toxicity near the well location. These impacts are highly localised with recovery anticipated which may include changes in community composition with the replacement of infauna species that are hypoxia-tolerant (IOGP 2016). Recovery of affected benthic infauna, epifauna and demersal fish communities is expected to occur post disturbance (Gates and Jones 2012 and Jones et al. 2012), given the short duration and localised nature of sediment deposition and expected changes to a localised seabed area. The seabed area and associated biota anticipated to be impacted by sediment deposition represents a small proportion of the broader benthic habitat within the Operational Area.

Modelling indicates that settlement of cuttings from all well locations modelled is expected to overlap the Continental Slope Demersal Fish Communities KEF and the Canyons KEF. However, these areas are well represented in the region, and potential impacts are expected to be localised to the areas south-west of the wells.

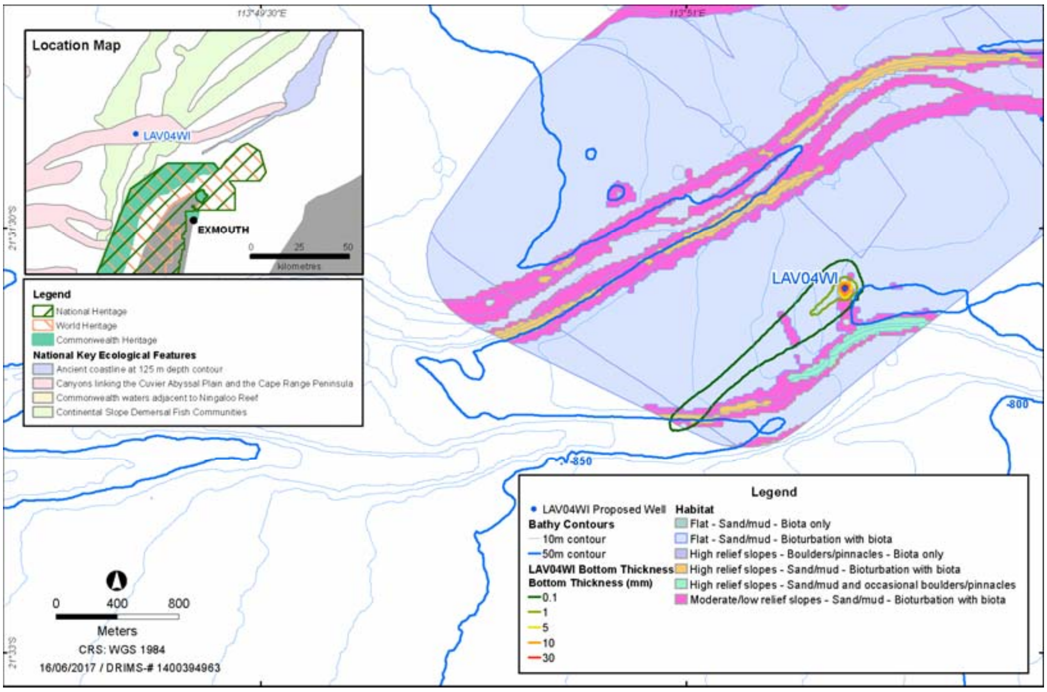

Figure A- 4: Contours of bottom thickness predicted for the release of cuttings and fluid for a discharge at the LAV04WI location.

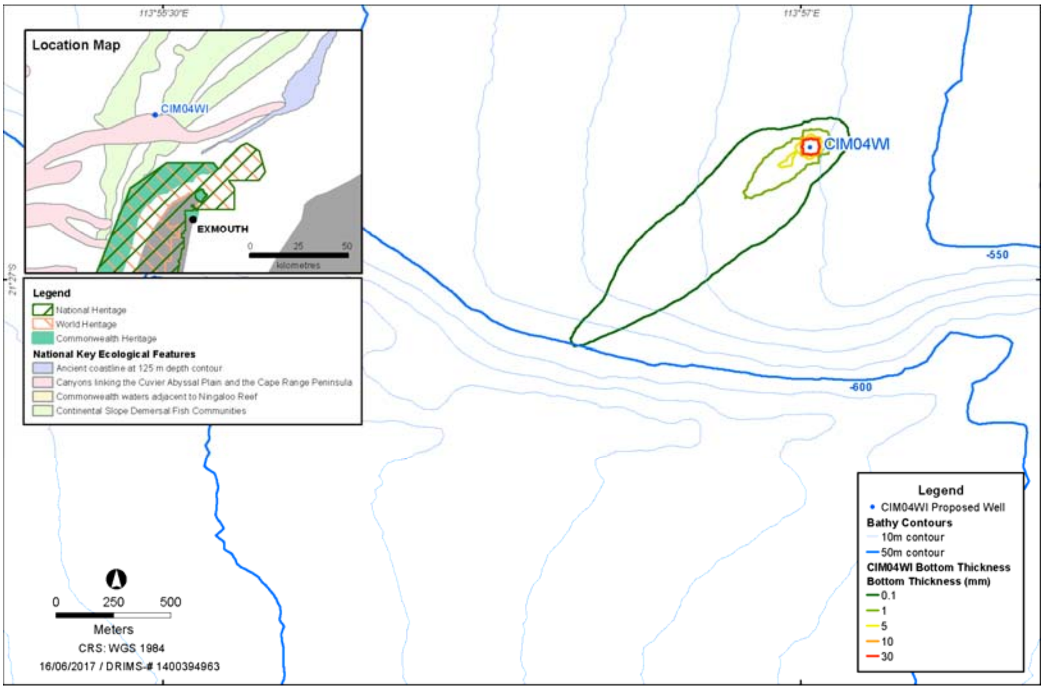

Figure A- 5: Contours of bottom thickness predicted for the release of cuttings and fluid for a discharge at the CIM04 location.

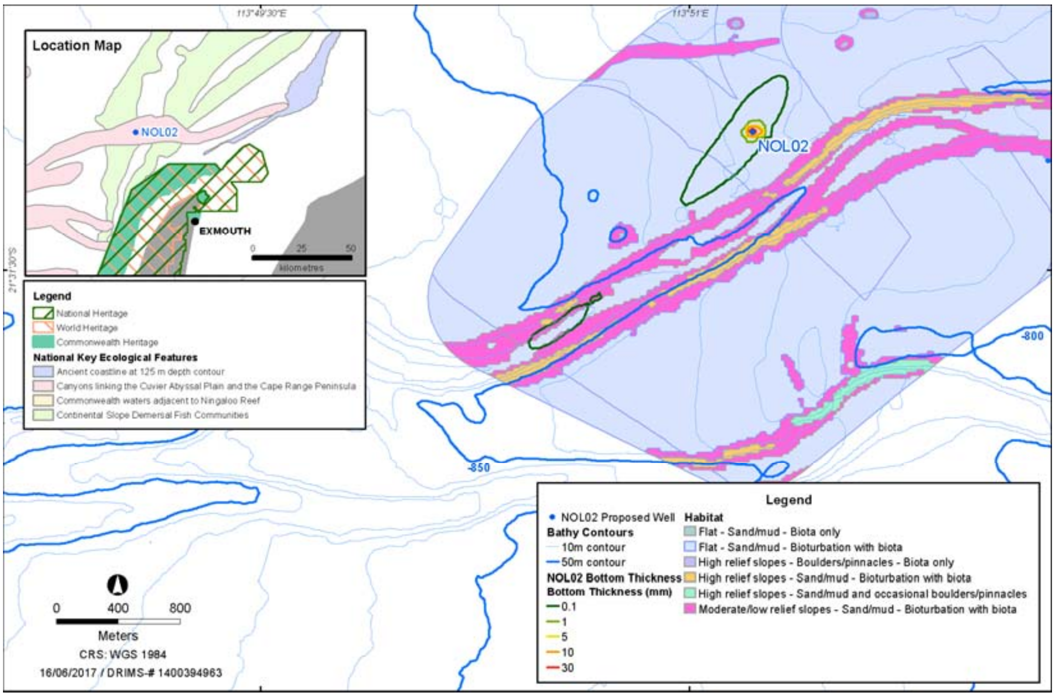

Figure A- 6: Contours of bottom thickness predicted for the release of cuttings and fluid for a discharge at the NOL02 location.

Drilling Fluids

Indicative components of the WBM system are 'non-toxic' or 'almost non-toxic'. Bentonite and guar gum are listed as 'E' category fluids under the OCNS and considered to 'pose little or no risk to the environment' (PLONOR). These metals are present primarily as insoluble mineralised salts and consequently are not released in significant amounts to the pore water of marine sediments and have low bioavailability to those benthic fauna which may come into contact with the discharged barite.

For NWBM, small discharges of residual oil on cuttings will be released to the environment, which may result in elevated hydrocarbons in sediments. The potential impacts to benthic communities

	are discussed below. The guar gum and bentonite sweeps have very low toxicities and are considered by Oslo and Paris Commission for the Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR) to be PLONOR to the environment. They may; however, cause physical damage to benthic organisms by abrasion or clogging, or through changes in sediment texture that can inhibit the settlement of planktonic polychaete and mollusc larvae. However, these impacts are not expected to be significant due to the rapid biodegradation and dispersion of WBM drilling fluids. The dilution of solid elements of the WBM into substrate largely depends on the energy level of the local environment and the 'mixing' that takes place, but is expected to occur rapidly following release (especially with WBM). The low sensitivity of the benthic communities/habitats combined with the low toxicity of WBM and low physical impacts affirm that any significant impact is considered unlikely. Base fluids for NWBM are designed to be biodegradable in offshore marine sediments. Biodegradation can result in a low oxygen (anoxic) environment resulting in changes in benthic community structure. However, this is dependent on the bioavailability of the base fluid. Species sensitive to anoxic environments are eliminated and replaced by tolerant and opportunistic species, resulting in decreased species diversity, but the number of individuals often increases. NWBM are designed to be low in toxicity and are not readily bioavailable, based on their physical/chemical properties, for bioaccumulation to infauna and epifauna. Furthermore, the combination of low toxicity and rapid dilution of unrecoverable NWBMs discharged in association with drill cuttings are of little risk of direct toxicity to water-column biota. A small quantity of WBM and NWBM residue may be discharged at the sea surface during cleaning of mud pit (<1%), typically at the conclusion of drilling activities. This discharge is expected to dilute rapidly, with potential impacts to the environment considered to be a local, temporary decrease in water quality. Balcom *et al*. (2012) concluded that impacts to deepwater benthic infauna and sessile epifauna associated with the discharge of cuttings and synthetic based fluid (NWBMs) are highly localised to the area of the discharge, with recovery of such deepwater communities post disturbance likey to occur (Gates and Jones 2012, Jones *et al*. 2012 and Balcom *et al*. 2012). Therefore, due to the low density and broad representation of the observed benthic communities in the vicinity of the well locations and Operational Area, impacts on the ecosystem function of such deepwater communities are considered to be minor, given the anticipated duration of the recovery of such communities post disturbance. . **Cumulative Impacts** Given the number of wells planned to be drilled during the Petroleum Activities Program, there is the potential for cumulative disturbance to marine sediment quality and benthic communities to occur. The cuttings and drilling fluids discharges from each of the wells will accumulate within the receiving environment. Given that wells will not be drilled concurrently, the TSS plume modelling results presented are considered to provide a representative worst case scenario, with cumulative impacts to water quality not expected to occur, given that discharged sediments are predicted to settle in between the drilling activities for each well. In addition, when considering deposition of sediments from each drilling activity, deposition at a thickness of greater than 6mm is limited to within a distance of 170 m from each well location. With the exception of the Cimatti water injection wells which are located within 25 m for each other, all other wells associated with the Petroleum Activities Program are beyond this distance. Cumulative impacts from the Cimatti wells are anticipated to be minimal, considering the observed lack of benthic biota within the area adjacent to the well locations and the prevailing metocean conditions (ie South Westerly direction), which run perpendicular to the well orientation. Therefore, a thickness of greater than 6 mm limited to a distance of within 170 m from the well locations is still considered a representative worst case scenario. **Summary** Conclusion for potential impacts of drill cuttings and drilling fluids: • area of influence measured by thresholds may extend between 1-2 kilometers from the well locations, however, the extremely low levels of sedimentation and TSS indicate negligible impacts to the wider water column and seabed area including KEFs. • no contact by drill cuttings, WBMs drilling fluids and retained NWBMs on drill cuttings to the Ningaloo WHA is predicted. The low density and broad representation of deepwater benthic communities/habitats within the vicinity of the well locations and Operational Area, combined with the low toxicity of WBM and NWBMs, no bulk discharges of NWBM and the highly localised nature and scale of predicted physical impacts to seabed biota, indicates that while impacts are predicted, they are likely to be

	highly localised in the context of the wider Operational Area and regional deepwater areas and temporary given the anticipated recovery.
Summary	Given the adopted controls, it is considered that the drill cutting and drilling muds discharges described will not result in a potential impact greater than localised burial and smothering of benthic habitats and temporary minor effects to water quality (e.g. turbidity increase).

Summary of Control Measures

- Woodside's Chemical Selection and Assessment Environment Guideline for drilling, completions, cementing and sub-sea control fluids and additives.
- Written NWBM justification process followed.
- Environmental Performance Standards Procedure which restricts overboard bulk discharge of NWBM.
- Bulk operational discharges conducted under MODU's permit to Work (PTW) system (to operate discharge valves/pumps).
- Mud pit wash residue will only be discharged if less than 1% by volume is oil content.
- WBM Drill cuttings returned to the MODU will be processed using SCE equipment allowing reuse of mud prior to discharge.
- All drilling with riser in place will be undertaken using SCE to limit discharge of mud on cuttings.
- Discharge of cuttings below the water line in accordance with the Woodside Engineering Standard – Rig Equipment.
- Solids Control Equipment (SCE) (augers and cuttings dryers) used to treat NWBM cuttings and reduce the average oil on cuttings for the entire well (12-1/4" sections using NWBM) to 8% or less by wet weight prior to discharge.

Routine and Non-routine Discharges: Subsea Installation and Commissioning Activities

Source of Risk	Environmental Value Potentially Impacted							Evaluation		
	Soil and Groundwater	Marine Sediment	Water Quality	Air Quality (incl. odour)	Ecosystems / Habitats	Species	Socio-economic	Consequence	Likelihood	Residual Risk
Discharge of flowline, subsea installation fluids and discharges from the Submerged Turret Production (STP) to the marine environment		X	X		X	X		F	2	L
Description of Source of Risk										

The following activities will result in the discharge of flowline and subsea installation preservation and pre-commissioning fluids and other subsea activity related discharges as listed below. Key discharges and:

- Flood, Clean and Gauge Testing (FCGT) to clean and preserve the flowline
- hydrotesting to check system integrity
- non-routine dewatering – contingency dewatering may be required when the FPSO is off station or a contingency event occurs (e.g. wet buckle)
- small leaks from subsea infrastructure hydrotesting
- small discharges associated with hookup to the STP
- discharges of grout when flushing downlines during span rectification activities.

Rigid Flowlines

Water used for the FCGT activities of the production and water injection rigid flowlines will be chemically treated and filtered sea water, with sufficient chemical concentration to provide a minimum protection period of two years. The chemicals will be continuously injected into the flowline at a rate producing the correct concentration within the flowline (400-550 ppm of hydrosure and 50 ppm of dye). Injection rates will be continuously monitored and automatically adjusted as necessary to compensate for varying fill rates. These discharges may occur at either end of the flowlines and discharges will equate to ~121% of the volume of the production and water injection flowlines.

Following FCGT the line will be left in a preservation state with inhibited seawater and MEG mix until the time of hydrocarbon commissioning. At this time the line will need to be dewatered when hydrocarbons are introduced, however this is planned to be done via the FPSO and therefore does not form part of the scope of this EP. Various dewatering contingencies are required should the line require dewatering sooner (and when the FPSO is not available) or due to an installation event. The worst case scenario is full dewatering of the line, which will result in the discharge of 110% (treated seater/MEG) - 120% (treated seawater) of the flowline volume as described above. .

It is highly unlikely that the line would need to be dewatered post FCGT activities once preserved. The only scenario which would require this activity is that preservation of the internals of the line are compromised creating a serious integrity risk. If this occurs, a risk assessment would be performed as part of the decision to dewater the line and replace with new preservation fluid.

Contingency activities during construction (e.g. wet buckle) are more likely but remain low. The requirement for these activities relate to technical design specifications and performance criteria of the line. Should these be compromised (i.e. failed welding joint) various repair strategies will be assessed and a decision made should the contingency be required.

Flexible flowlines and infrastructure

The connection of infrastructure and flexibles and associated leak tests of all infrastrcutres (rigids, flexibles and equipment) will result in discharges of MEG and hydrotest fluid in small quantities at the locality of the subsea infrastructure.

All subsea chemicals will be selected, assessed and approved in accordance with the *Woodside Environment Procedure for Offshore Chemical Selection and Assessment*. This procedure is used to demonstrate that the potential impacts of the chemicals selected are acceptable and ALARP (subject to technical and economic constraints).

De-ballasting from the STP

Prior to tie-in and hook-up of installed risers to the STP, the STP will require de-ballasting. There is approximately 243 tonnes of ballast water in the central ballast compartment of the STP, of which approximately 131 tonnes is required to be removed to allow installation of the new risers. The ballast water medium is seawater sourced from the STP location and is believed to have originally been dosed with a chemical inhibitor for corrosion protection. Testing of this water will occur before deballasting takes place if it is to be discharged to the marine environment. The water will be assessed against ANZECC/ARMCANZ (2000) marine water quality criteria for physico-chemical parameters and heavy metals (95% species protection) and deemed acceptable for discharge if these criteria are met.

Marine growth removal from the STP 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 (sulphamic acid) or sand are likely from marine growth removal activities.

Grout discharges

Following grouting activities at each span site, the downline and pump will need to be purged using seawater. This results in an amount of grout, approximately equivalent to the downline volume, being discharged to the ocean.

Potential Environmental Impacts

Value	Description of Potential Environmental Impact
Water Quality, Marine Sediment, Ecosystems/ Habitats, and Species	*Flowline Fluids* The worst case dewatering discharge of 3,630 m^3 (121% line volume) associated with FCGT activities will contain approximately 1.5 m^3 of treatment chemicals (e.g. hydrosure and fluorescein dye). Treated water will be discharged between and after pig runs resulting in an average discharge rate of approximately 4m3 per minute over a 17-24 hour maximum period. The worst case discharge is therefore expected to result in a localised plume leading to localised and temporary reduction in water quality. Woodside has previously commissioned discharge modelling for a volume of 1,449 m^3 of treated seawater containing similar treatment chemicals at the same concentration ratio. Although this modelling was for a smaller volume over a five hour period and a location shallower than the Operational Area, the average discharge flowrate modelled was 4.83m^3 per minute, which is similar to that proposed for this project. Therefore, the likelihood for localised and temporary impacts remains applicable, due to the following findings: • The modelled flowrate is similar to that proposed for the project which is a key driver for dilution and dispersion; • Based on an LC_{50} of 1-10ppm (over 96 hours), it was predicted that the plume would dilute to below 10ppm within close proximity (~ 10 m) to the discharge location for the 95%ile exceedance (slow currents, low dilution scenario – e.g. worst case). • Whilst the volume proposed for Greater Enfield is larger to the volume modelled, given the similar discharge rate, it is expected that the plume dynamics would behave similarly, however, the plume may persist for longer in the environment owing to the greater discharge volume and duration. • While Greater Enfield has larger volumes it is predicted that it would result in a similar spatial extent of the plume but the dosage (duration) would increase. However, the LC_{50} is based on 96 hours while the maximum duration for any of the planned discharges is 17-24 hours. Therefore the likelihood of fish or pelagic invertebrates being exposed to concentrations at these levels for greater than 96 hours is negligible.Furthermore, it is expected that motile fish and other marine fauna will adapt their behaviour and move away from the discharge, if exposed. Impact on the surrounding seabed at the location of the discharge is expected to be minimal and localised to a small area around the pipeline discharge outlet location. Modelling (as referenced above) indicates the plume is initially a thin horizontal jet due to its large initial momentum, and then the plume begins a gradual rise/fall due to slight positive/negative buoyancy ending at a trapping depth or the seabed after it reaches neutral buoyancy. This suggest the plume may contact the seabed if it is more negatively buoyant, however predictions suggest this would conservatively occur up to a distance of 200m long and 50m wide. Whilst contact may occur, the rapid dilution of the plume indicates the concentration of the plume upon contact will have minimal impact. Furthermore, the habitats in the vicinity of the proposed release location are mostly composed of benthic communities typical of the NWMR and the seabed is expected to be flat and featureless and no hard substrate habitat is expected at the release location at either end of the flowline. Impacts on benthic communities are predicted to be negligible due to the relatively low biological abundance and wide distribution of similar community types throughout the region. In the

	event of lethal/sub-lethal stress to infauna the ecological consequences may include temporary and localised impact to infauna populations with a temporary decline in abundance in the immediate area of the discharge, however, populations would recover rapidly by recolonisation by surrounding populations. Potential impacts to marine fauna such as pelagic fish species and marine mammals are expected to be limited to avoidance of the plume in a localised area. Plankton populations may be affected in the immediate discharge plume; however, given the fast population turn-over of open water plankton populations, the potential ecological impacts are considered very minor. Therefore, localised, short term and negligible impacts are predicted. Potential impacts to the continental slope demersal fish communities KEF are expected to be negligible, with no overall impact on the environmental values and sensitivities associated with the KEF. No impacts to the environmental sensitivities or values of Canyons KEF are expected; given its distance from the discharge locations (i.e. either ends of the flowline). ***Subsea Installation Fluids*** Given the low volume of MEG and hydrotest discharged during testing, any impact on the marine environment is expected to be highly localised and negligible. Potential impacts to benthic habitats and pelagic fauna are discussed above. ***Discharges from the STP*** Minor discharges associated with STP deballasting and marine growth removal are expected to dilute readily in the open offshore environment of the Operational Area. No significant impacts 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. Impacts on the seabed are not predicted given the discharge will be released at or near the surface in ~350m water depth in an offshore location. ***Discharges of grout*** Grout discharges are expected to rapidly disperse in the water column. Any impact of grout discharge at the seabed will be limited to affecting sediment quality and any surrounding benthic and/or infauna communities, in a small localised area immediately around the discharge location. **Cumulative Impacts** Given that impacts on water quality and marine biota from routine and non-routine discharge are predicted to be localised, short term and negligible, cumulative impacts on such environmental values are considered unlikely, particularly, due to the lack of environmental sensitivities within the vicinity of the proposed discharge locations. The largest subsea discharge will be associated with flowline dewatering activities. Whilst multiple discharge events may occur from the discharge location, they will not be undertaken without sufficient time between discharge events, therefore allowing suitable dispersion and dilution of the discharge between events such that any potential for cumulative impact risk is negligible. Similarly, discharges associated with hydrotest fluid and grout will be of low volumes and occur at the specific location of the infrastructure/activity and at different times when the specific infrastructure is tested or activity undertaken. Therefore the discharges will be at different locations suitably spread out over the whole field with sufficient temporal separation which mitigates any potential cumulative impact risk. Discharges from the STP buoy will be a one off event, occurring at or near the surface at the location of the buoy. The FPSO will not be on station during this time and therefore no discharges associated with the operation of the FPSO will be occurring. Minor discharges may occur from the vessel supporting the operation. However given the nature of de-ballasting discharge, location and deep open ocean conditions, the risk of any cumulative impacts is negligible. In addition, although dewatering discharge may occur at either end of the flowline (including the end nearest to the NY and Nganhurra FPSOs), this discharge is considered unlikely to mix with any operational discharge streams from these facilities (e.g. cooling water) as one is a subsea and the other a surface discharge, in over 300m water depth and therefore no cumulative impacts to water quality or biota are anticipated. Overall, the planned discharges from the Petroleum Activity Program will occur at varying times in the campaign and given the low exposure time predicted from each discharge, high dilution and dispersion given the open ocean conditions and lack of sensitive species or habitats present, potential cumulative impacts are considered unlikely and of a low consequence.
Summary	Given the adopted controls, it is considered that the discharges described will not result in a potential impact greater than minor and/or short-term contamination above background levels, water quality standards, or known effect concentrations, and localised and temporary impacts to marine fauna.

Summary of Control Measures
• All hydrotest, dewatering and leak testing discharge volumes are monitored. • Woodside's Chemical Selection and Assessment Environment Guideline. • Selection of chemicals and treatment methodology will preserve and prepare subsea infrastructure for commissioning, whilst meeting Woodside's environmental outcomes. • Leak test procedure: Inspection/monitoring during hydrotest. • Woodside Standard Specification for Flooding, Cleaning, Gauging and Hydrotesting of Offshore Pipelines. • Prior to hook-up of new risers seawater contained in the STP will be tested against ANZECC/ARMCANZ (2000) water quality criteria. If the water meets relevant contaminant criteria (95% species protection) it will be deemed acceptable for discharge. • If STP ballast water does not meet discharge limits STP ballast water will be treated offshore before discharge or ship onshore for disposal.

Routine and Non-routine Discharges: Drilling and Completions Fluids

Source of Risk	Environmental Value Potentially Impacted							Evaluation		
	Soil and Groundwater	Marine Sediment	Water Quality	Air Quality (incl. odour)	Ecosystems / Habitats	Species	Socio-economic	Consequence	Likelihood	Residual Risk
Routine use and discharge of project fluids to the marine environment including: • Cement and cementing fluids discharged during drilling activities or if drill and grout technique is used for piling • Discharge of well intervention/workover fluids including brine and suspension fluids • BOP control fluids • Completions fluids.		X	X		X			F	1	L

Description of Source of Risk

Cementing Fluids and Cement

Cementing fluids are not routinely discharged to the marine environment. However, when cementing the conductor and surface casings after top-hole sections of the well have been drilled, cement must be circulated to the seabed to ensure structural integrity of the well. Excess cement is pumped to ensure structural integrity is achieved.

If the hole is completely in-gauge and there are no downhole losses while running the cement, a maximum average volume of 113m^3 per well is estimated to be circulated to the seafloor at the well location, which forms a thin concrete film on the seabed in close proximity to the well.

After each cement job, left-over cement slurry in the cement pump unit and the surface lines is flushed and discharged to the sea to prevent clogging of lines and equipment. This is estimated at approximately 2m^3 per well (Based on 3-4 cement jobs per well x 3bbls discharged per job).

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 fluorescein dye. The dye is used to provide a pre-indicator of cement overflow to the seabed surface, to ensure adequate cement height.

If the drill and grout technique is used to install piles, small volumes of grout may also be unavoidably released. However, any release is likely to be less than when installing the well conductor casing described above (15 m3), given the smaller grout volume require for pile installation.

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 drilling program or if these options aren't practicable discharged to the marine environment as a slurry

Well Intervention and Workover Fluids

If the well has been flowed previously, or if down-hole hydrocarbons remain in the well (e.g. reservoir fluid or if base oil has been left in the well) there is potential the intervention/workover fluids will be contaminated with hydrocarbons. If hydrocarbon contamination of the intervention/workover fluids has occurred, treatment of the fluid will occur to ensure hydrocarbon content prior to discharge is 1% or less by volume, or returned to shore if treatment is not possible.

BOP Control Fluids

The BOP is required to be regularly function tested when subsea, as defined by legislative requirements. The BOP is function tested during assembly and maintenance and during operation on the seabed. As part of this testing, small volumes of BOP control fluid (generally consisting of water mixed with a glycol based detergent or equivalent water based anti-corrosive additive) is released to the marine environment. The hydraulic control fluid used for the operation of the BOP rams is water mixed with a control fluid additive, likely to be similar to Stack-Magic (commercial name), which is biodegradable. The contracted rig's BOP is a 6 cavity stack and will be function tested every 7 days and pressure tested a minimum every 21 days as per API 53 (approximately 78 releases over the total project period).This will result in the following discharges associated with these safety and environment critical tests:

- Function test volume (7 days) = 2200 lt @ 3% conc = 66 lt stack magic

- Tests on shear rams (21 days) = 2000 lt @ 3% conc = 60 lt stack magic

Completion and Well Bore Clean-Out Fluids

Prior to installing the upper completion, wells will generally be displaced from the drilling fluid system to completion brine. A chemical cleanout fluids train will be circulated between the two fluids, then seawater or brine circulated until operational cleanliness specifications are met. This will be in line with Woodside's Reservoir, Drilling and Completions Fluids Guideline. For completion brine, this will typically be filtered brine with <70NTU and/or <0.05% TSS. This results in a brine and seawater discharge after this operation. In the reference case, there is no plan to have brine contaminated with NWBM as the reservoir section will be drilled with WBM. However, should there be residual completion/clean-up brine contaminated with NWBM drilling fluid or base oil, it will be captured and stored on the MODU for treatment prior to discharge or returned to shore if treatment is not possible. For initial clean-up fluids (usually returned to the rig within the first few hours of circulation) which are predominantly drilling mud (concentration of mud compared to brine is a higher percentage of mud); NWBM will be retained and returned to shore and WBM will be discharged as per requirements in this EP.

Potential Environmental Impacts	
Value	**Description of Potential Environmental Impact**
Water Quality, Marine Sediment and Ecosystems / Habitats	Pelagic and benthic habitats in the Operational Area are considered to be of low sensitivity (no known significant benthic habitat or infauna habitat. Although the Canyons KEF and Continental Slope Demersal Fish Communities KEF overlap with the Operational Area, the values and sensitivities of these KEFs occur on a broad scale outside the Operational Area. Coupled with the low toxicity of the fluids to be used for the Petroleum Activities Program, the likelihood of any significant impact to marine biota, water quality and sediments is considered to be low. **Cement and Grout Discharges** Cement and grout discharges are not expected to widely disperse and may settle on the seabed. 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 and likely within the area previously impacted by drill cuttings. **Cementing and Grouting Fluids (slurry), Well Intervention/Workover Fluids, BOP Control Fluids and Completions Fluids** All chemicals that may be operationally released or discharged to the marine environment are required to be selected and approved as per *Woodside Environment Procedure - Drilling and Completions Chemical Approval, Review and Improvement* (DC0000PH9668367). Therefore, any chemicals selected and potentially released are expected to be of low toxicity and biodegradable. Additionally, where operational discharges are undertaken for fluids which have been mixed in excess and therefore, cannot be reused or returned to shore; these will be either turned into a slurry (in the case of cement) or diluted prior to discharge. As chemicals have initially been chosen based on the environmental performance, further dilution prior to discharge will further reduce any impact to water quality, sediment quality and benthic and/or infauna communities. Given the small quantities and short durations of the low toxicity discharges, along with the high dispersion rates predicted in the open, potential impacts on the marine environment are expected to be minor and localised Cumulative Impacts Given the highly localised nature of these discharges and potential impacts, the dispersion characteristics of the open ocean environment, and the fact they will occur at different locations (i.e. well location) and different time periods over the project, cumulative impacts to marine biota, water quality and sediments are expected to be low. As per consideration of drill cuttings on sediments, there is a potential for a low level of cumulative impact to occur from cement and grout discharges for wells that are located in close proximity to each other. This is however only considered a potential for the Cimatti water injection wells which are within 25m of each other. Cumulative impacts from the Cimatti wells are anticipated to be minimal, considering the observed lack of benthic biota within the area adjacent to the well locations (Section 4.5.1) and the prevailing metocean conditions (i.e. South Westerly direction), which run perpendicular to the well orientation. The other wells are considered to have sufficient distance that any potential for cumulative impact is low.
Summary	Given the adopted controls, it is considered that routine cement and cementing fluid and subsea control fluid discharges described will not result in a potential impact greater than minor and short term impacts to infauna and benthic communities and minor and/or temporary contamination of water and marine sediment above background levels and/or national/international quality standards and/or known biological effect concentrations.

Summary of Control Measures
• Woodside's Chemical Selection and Assessment Environment Guideline for drilling, completions, fluids. • Bulk operational discharges conducted under MODU's permit to Work (PTW) system (to operate discharge valves/pumps). • Intervention/workover fluids or suspension brine which may have come into contact with reservoir hydrocarbons will be treated prior to discharge • Use excess dry bulk cements and grout on subsequent wells, or pass to subsequent operators, when deemed necessary on a case by case basis.

Routine Atmospheric Emissions: Fuel Combustion, Flaring and incineration

Source of Risk	Environmental Value Potentially Impacted							Evaluation		
	Soil and Groundwater	Marine Sediment	Water Quality	Air Quality (incl. odour)	Ecosystems / Habitats	Species	Socio-economic	Consequence	Likelihood	Residual Risk
Internal and combustion engines and waste incinerators on Project Vessels				X				F	1	L
Contingency flaring during well unloading/testing (including hydrocarbon dropout to atmosphere or marine environment)			X	X				F	1	L

Description of Source of Risk

Atmospheric emissions will be generated by the Project Vessels from internal combustion engines (including all equipment and generators) and incineration activities (including onboard incinerator) during the Petroleum Activities Program. Emissions will include SO_2, NO_x, ozone depleting substances, CO_2, particulates and Volatile Organic Compounds (VOCs).

Whilst not planned, flaring of base oil will occur if well testing/unloading is required, which has the potential to increase the volumes of greenhouse gas emissions. Incomplete combustion under certain scenarios may also generate other air pollutants and dark smoke. During flaring, combustion mainly generates water vapour and CO_2.

If the flare is extinguished, venting of hydrocarbons will occur in small volumes, and small volumes of unburnt hydrocarbons could be discharged to the marine environment. Flare extinguishment may occur due to changes in weather (particularly wind speed and direction) and liquid slugs. If the flare is unlit for approximately one minute (a credible timeframe based on how long it takes effluent to dissipate), up to 2 bbl (0.23 m3) of hydrocarbon may be lost to the atmosphere and the marine environment.

Potential Environmental Impacts

Value	Description of Potential Environmental Impact
Air Quality and Water Quality	Fuel combustion, flaring and incineration have 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 the MODU, ISVs and activity support vessels (which will lead to the rapid dispersion of the low volumes of atmospheric emissions), the potential impacts are expected to be minor, with no cumulative impacts when considered in the context of existing or future oil and gas operations in the region. The discharge of small volumes of hydrocarbons would result in localised reduction in water quality and toxic effects on in-water biota such as plankton. Impacts to marine megafauna are unlikely, given the small volumes and localised extent associated with hydrocarbon dropout. However, given the offshore, open water location, receptors such as marine mammals, marine reptiles and seabirds may be affected if they come in direct contact with the hydrocarbon (i.e. by traversing the immediate spill area).
Summary	Given the adopted controls, it is considered that fuel combustion and flaring emissions will not result in a potential impact greater than a localised and short-term decrease in local air and/or water quality standards.

Summary of Control Measures

- Marine Order 97 (Marine Pollution Prevention – Air Pollution).
- Maintain flare to maximise efficiency of combustion and minimise venting.

Routine Light Emissions: External Lighting on MODU and Activity support vessels

Source of Risk	Environmental Value Potentially Impacted							Evaluation		
	Soil and Groundwater	Marine Sediment	Water Quality	Air Quality (incl. odour)	Ecosystems / Habitats	Species	Socio-economic	Consequence	Likelihood	Residual Risk
External light emissions onboard MODU, ISVs and activity support vessels						X		F	1	L

Description of Source of Risk

The MODU, ISVs and activity support vessels will routinely have external lighting to facilitate navigation and safe operations at night throughout the Petroleum Activities Program. External light emissions are typically managed to maintain good night vision for crew members.

Lighting is used to allow safe operations during night hours, as well as to communicate the vessel's presence and activities to other marine users (i.e. navigation lights). Lighting is required for the safe operation and cannot reasonably be eliminated.

External lighting is located over the entire MODU/vessel, with most external lighting directed towards working areas such as the main deck, pipe rack and drill floor. These areas are typically lower than 20 m above sea level. The highest point for a light source is likely to be the MODU at top of the derrick, 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. Using this formula, the approximate distances at which various MODU components (and associated light sources) will be visible at sea level are:

- main deck (~20 m above sea level): approximately 16 km from MODU
- derrick top (~50 m above sea level): approximately 25 km from MODU

Potential Environmental Impacts

Value	Description of Potential Environmental Impact
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 nighttime 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 large whales transiting through the Area. Additionally, there is no known critical habitat within the Operational Area for EPBC listed species, although there are BIAs that overlap the Operational Area. Given the fauna expected to occur within the Operational Area, impacts from light emissions are considered to be highly unlikely. **Marine Turtles - Hatchlings** Light emissions reaching turtle nesting beaches is widely considered detrimental owing to interference with important nocturnal activities including choice of nesting sites and orientation/navigation to the sea by post-nesting females and hatchlings. 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. Artificial light from coastal developments has been identified as potentially misorientating 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 misorientated 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. Hatchling and adult turtles may also use the Earth's magnetic field for larger scale navigation. As such, hatchling turtles are only likely to be misorientated by artificial light between leaving the nest and reaching the sea. The nearest potential nesting site in relation to the Operational Area is Ningaloo Coast (North West Cape) approximately 33 km from the Operational Area. The Muiron Islands, approximately 35 km from the Operational Area are also known to host significant turtle nesting beaches. Given the nature of the light emitted from the MODU and the distance to the nearest landfall (and nearest significant rookeries), artificial light from the MODU is not expected to be directly visible to hatchling turtles. Misorientation of hatchling turtles in response to MODU lighting is considered to be a remote possibility. In the event that hatchling turtles were attracted to light from the MODU 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. As such, the potential for hatchling turtles to become misorientated by artificial lighting onboard the MODU, ISV's, or activity support vessels is considered to be remote. In the event such misorientation occurred, the potential impacts are considered to be negligible. **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. 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 (Ningaloo Coast) is located approximately 33 km from Operational Area). It is acknowledged that marine turtles may be present transiting the Operational Area in low densities; given the water depth (approximately 350 to 850 m) turtles are unlikely to be foraging within the Operational Area. Given the distance between the Operational Area and the nearest landfall, light from the MODU, ISVs and activity support vessels is unlikely 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 the there is no critical habitat for these species within the Operational Area and slow moving speeds associated with MODU, ISVs and activity support vessels. There is a foraging BIA for the wedge-tailed shearwater overlapping the Operational Area; as such wedge-tailed shearwaters may occur within the Operational Area. Foraging wedge-tailed shearwaters may be attracted to sources of light emission to feed upon fish drawn to the light, however, the species feeds predominantly during the day in association with pelagic predators. The majority of foraging trips are short, with single day foraging trips significantly more common than any other length trip, with birds returning to nesting / roosting sites between trips. As such, the numbers of wedge-tailed shearwaters present in the Operational Area at night is expected to be low relative to daylight hours, and any potential changes to behaviour would only affect a relatively low number of birds. Given the species' global distribution and primarily diurnal foraging behaviour, impacts to wedge-tailed shearwaters from artificial lighting are considered to be highly unlikely. Demersal fish communities of Continental Slope Demersal Fish Communities KEF and Canyons KEF (both within the operational area), are highly unlikely to be affected by MODU, ISV or activity support vessel lighting given the water depth. Lighting from the presence of a activity support vessel may result in the localised aggregation of fish below the vessel. These aggregations of fish are considered localised and temporary and any long term changes to fish species composition or abundance is considered highly unlikely.
Summary	Light emissions from the MODU, ISVs and activity support vessels will not result in an impact greater than a slight and temporary disturbance to fauna in the vicinity of the Operational Area.

Summary of Control Measures
• The potential impacts and risks from routine light emissions are deemed to be ALARP in its current risk state. No reasonable additional/alternative controls were identified that would further reduce the impacts and risks

without grossly disproportionate sacrifice.

UNPLANNED ACTIVITIES (ACCIDENTS / INCIDENTS / EMERGENCY SITUATIONS)

Accidental Hydrocarbon Release: Well Loss of Containment

Source of Risk	Environmental Value Potentially Impacted							Evaluation		
	Soil and Groundwater	Marine Sediment	Water Quality	Air Quality (incl. odour)	Ecosystems / Habitats	Species	Socio-economic	Consequence	Likelihood	Residual Risk
Loss of hydrocarbons to the marine environment due to a well loss of containment.		X	X	X	X	X	X	A	1	H

Description of Source of Risk

Background

A loss of well control can lead to an uncontrolled well loss of containment of reservoir hydrocarbons or other well fluids to the surface, resulting from an over-pressured reservoir (well blowout). Woodside has identified a well blowout as the scenario with the worst case credible environmental outcome as a result of a well loss of containment. A well blowout could occur due to:

- failure of all the predefined technical well barriers (e.g. the BOP) during drilling and completion of a well
- damage to a completed Greater Enfield Tieback well (non-operational), for example damage to a completed subsea wellhead as a result of a dropped object or other physical damage from an associate Greater Enfield Tieback activity.

In the unlikely event that a dropped object or other physical impact occurred on a completed well head, any release would likely be restricted to a small volume of fluid present between the last proven isolation in the well casing (Subsurface safety valve - which will be proven and closed) and the well head. All well heads will be installed and have isolations proven as per the Woodside Engineering Standard – Subsea Isolation and Woodside Engineering Standard – Well Barriers. The maximum credible release from this scenario is 5 m^3 of well fluid. This scenario is therefore assessed in detailed risk assessment for Unplanned Hydrocarbon Release – Subsea Loss of Containment.

Therefore, a blowout resulting from the failure of all technical barriers during drilling and completion activities is considered the worst case credible well blowout scenario (as detailed below).

Credible Scenario – well blowout

The Petroleum Activities Program consists of the drilling of six production wells and six water injection wells. A loss of well containment could result in a well blowout and hydrocarbon loss of containment at any of these 12 locations. Whilst the Water Injection wells penetrate the reservoir and therefore still present a hydrocarbon loss of containment risk, the significance of the event compared to a production well would be much less, as the positioning of the wells is to avoid key hydrocarbon areas with the purpose of sweeping oil (via water injection) to the production wells.

Woodside identified the worst case credible spill scenario for a well blowout to be an uncontrolled surface release from a production well for five days, when the MODU would provide a conduit to the surface for the uncontrolled flow, followed by a 72 day uncontrolled seabed release when the MODU would no longer be present to provide a conduit.

The MODU would no longer be present after five days for the following reasons:

- in a non-explosion scenario, the MODU will have initiated its emergency disconnect process and moved off location to a safe position as soon as is practicable to prevent escalation and further harm to personnel. In this scenario, and in the case of a DP MODU, five days is considered highly conservative given the rig is not moored to the seabed and constrained by mooring lines and anchors, and is therefore likely to move off station much quicker (e.g. three days or even less).
- in an explosion scenario, the MODU is expected to sink due to an anticipated compromise in structural integrity and stability after a period of time. The most recent example of a similar scenario is the Deepwater Horizon incident, when the semi-submersible MODU sank after 36 hours following the uncontrolled loss of well control in the Gulf of Mexico in April 2010.

This scenario assumes the well has been drilled to its maximum depth, with the entire reservoir open to flow. The 77 day (11 weeks) duration represents the estimated time to drill a relief well under the Mutual Aid Memorandum of

Understanding (MoU).

Woodside has determined that the worst case credible release for a well blowout associated with the Petroleum Activities Program is 384,611 m^3 from a NOL production well based on the reference case well design and reservoir modelling. The blowout event represents the worst case scenario across all Greater Enfield Tieback wells, as it is based on a production well with the highest reservoir flow and assumes blowout of all three well laterals (not all Greater Enfield wells are trilateral wells) with no restrictions (e.g. no drill pipe in hole). Therefore, whilst deemed credible for the purpose of impact assessment, this scenario and associated loss of containment volumes represents the most unlikely and worst case scenario for all wells associated with the Petroleum Activities Program.

Event likelihood (Industry Experience and Frequency)

Woodside has a good history of implementing industry standard practice in well design and construction. In the company's 60 year history, it has not experienced any well integrity events that have resulted in significant releases or significant environmental impacts.

In accordance with the Woodside Risk Matrix, a blowout event from a Greater Enfield well has been defined as a 'highly unlikely' event as it 'has occurred once or twice in the industry' (experience based likelihood) and aligns with a frequency of a '1 in 10,000 to 1 in 100,000 year' event. Information to support this likelihood determination is outlined below.

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.
- blow-out probability for a production development well was estimated to be 3.34 x 10-5 per well. This is based on data from the Gulf of Mexico, United Kingdom and Norway from 1980, including wells that had BOPs installed.
- probability of a blow-out during completions activities was estimated to be 8.72 x 10-5 (SINTEF 2013).

Further to the above published data, an internal peer review was conducted by Woodside as part of its risk assessment process to interrogate well blowout frequency data (given multiple wells are to be drilled in a year) and ensure the appropriate likelihood (as per Woodside risk matrix) is applied to the Greater Enfield well blowout scenario. This review noted the following key elements supporting the 'highly unlikely' determination for a Greater Enfield well blowout.

- The SINTEF dataset does not account for Woodside and Industry Process Safety Improvements post the Gulf of Mexico (GOM) Macondo event. The SINTEF data set is January 1991 – December 2010, whilst the Macondo blowout occurred in April 2010. Therefore it is likely that this data may now hold some conservatism as it does not account for improvements currently implemented by the industry with potential to reduce the likelihood of an event.
- Significant strengthening of barriers is now in place post the data set period, such as but not limited to:
  - Revised and more stringent API 53 Subsea BOP requirements in force.
  - Competency assessments of offshore personnel is now more stringent for both Woodside and drilling contractors, for example through implementation of improvements to well control training as recommended by IOGP and requirements for Woodside personnel in safety critical roles to complete the Process Safety Management training requirements.
  - Revision to Woodside barrier installation and verification process, including acceptance criteria and change control management.
- The SINTEF blowout data recorded 17 production development well blowouts in the period January 1991 – December 2010 in the North Sea and GOM, however all of these blowouts occurred in the GOM and none occurred in the North Sea. The SINTEF report mentions the GOM lower 'standard of operation' as a possible reason for more blowouts. Of the 17 blowout events, two are evaluated as "Not North Sea standard", two are evaluated as "Sometimes North Sea standard" and three are evaluated as "Unknown whether North Sea standard". The standard of operation for the remaining ten incidents was "North Sea Standard". It is known that Woodside's Wells Management System and the Australian Safety Case regime is similar to 'North Sea Standards', compared to the GOM standards. Therefore the SINTEF blowout data of 3.34 x 10-5 per well may hold some conservatism, as all these blowouts occurred under the GOM regulatory regime.
- The Greater Enfield fields are well appraised as a result of detailed seismic surveys and the drilling of numerous exploration wells. They are also known to have normally pressured reservoirs. This reduces the likelihood of an influx due to an unexpected overpressured sand. This is believed another area of conservatism in the SINTEF likelihood data when applied to Greater Enfield.
- When considering likelihood from an 'Experience' perspective, the review also concluded:
  - a ranking of 'Has occurred many times in the industry…' was too high when assessing the worst credible event of blowout with no pipe in hole, and no significant bridging or flow restriction through the BOP or other means. This is supported by SINTEF data, showing that none of the 17 blowouts analysed were open hole with no pipe

in hole, whilst 28% had an annulus 'full flow' but the flow area is unknown (though it is unlikely to be as large as the open hole, no pipe in hole case).

- When considering likelihood of the environmental consequence of the blowout event, historic blowouts that have had catastrophic impact to the environment ('A' consequence rating) have not occurred many times in the industry. This also further supports the likelihood ranking of 'Highly Unlikely.

Quantitative Spill Risk Assessment – well blowout

Spill modelling was undertaken by RPS Asia Pacific Applied Science Associates (APASA), on behalf of Woodside, over a 105 day simulation length to determine the fate of hydrocarbon released for the 11 week blowout scenario at the NOL well location, based on the assumptions in **Table A- 10.** Modelling was undertaken over all seasons to address year-round operations. This is considered to provide a conservative estimate of the ZoC and the potential impacts from the identified worst-case credible release volume of 384,611 m^3.

Table A- 10: Summary of modelled credible scenario – well blowout

	Loss of well containment
Total discharge[2] at surface	5 days 65,987 m^3
Total discharge at seabed	72 days 318,624 m^3
Total Discharge (surface and seabed)	384,611 m^3 (77 days)
Water Depth	825 m
Fluid	Norton-1 crude

Hydrocarbon Characteristics

Norton-1 Crude (API 19.4) contains a high proportion (approximately 48%) of hydrocarbon compounds that will not evaporate at atmospheric temperatures (Boiling Point >380 °C). These compounds will persist in the marine environment. The oil is composed of hydrocarbons with a wide range of boiling points and volatilities at atmospheric temperatures. The characteristics of Norton-1 crude are provided in **Table A- 11.**

Weathering processes under realistic variable wind conditions are illustrated in the example mass balance weathering graph for a discrete spill of 50 m^3 of Norton-1 crude released at the surface, which is considered informative for this scenario (**Figure A- 7**). The graph demonstrates that approximately 15% of the released hydrocarbon would be expected to evaporate within the first 24 hours, increasing to approximately 20% after seven days. Approximately 60% of the released hydrocarbon is predicted to remain on the surface after seven days and is expected to undergo a long weathering duration. Only minor rates of entrainment and dissolution are expected, depending on the prevailing conditions.

The most probable cause of a stable emulsions to form, and the stability across time, is the asphaltene content. Although Asphaltenes are considered the prime source of crude oil emulsion stability in seawater, generally an asphaltene content of 0.5% or less is considered to have a lower tendency to form a stable water-in-oil emulsion. Norton-1 crude has a low asphaltene content (<0.02%) indicating a low propensity for the mixture to take up water to form water-in-oil emulsion over the weathering cycle.

[2] 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.

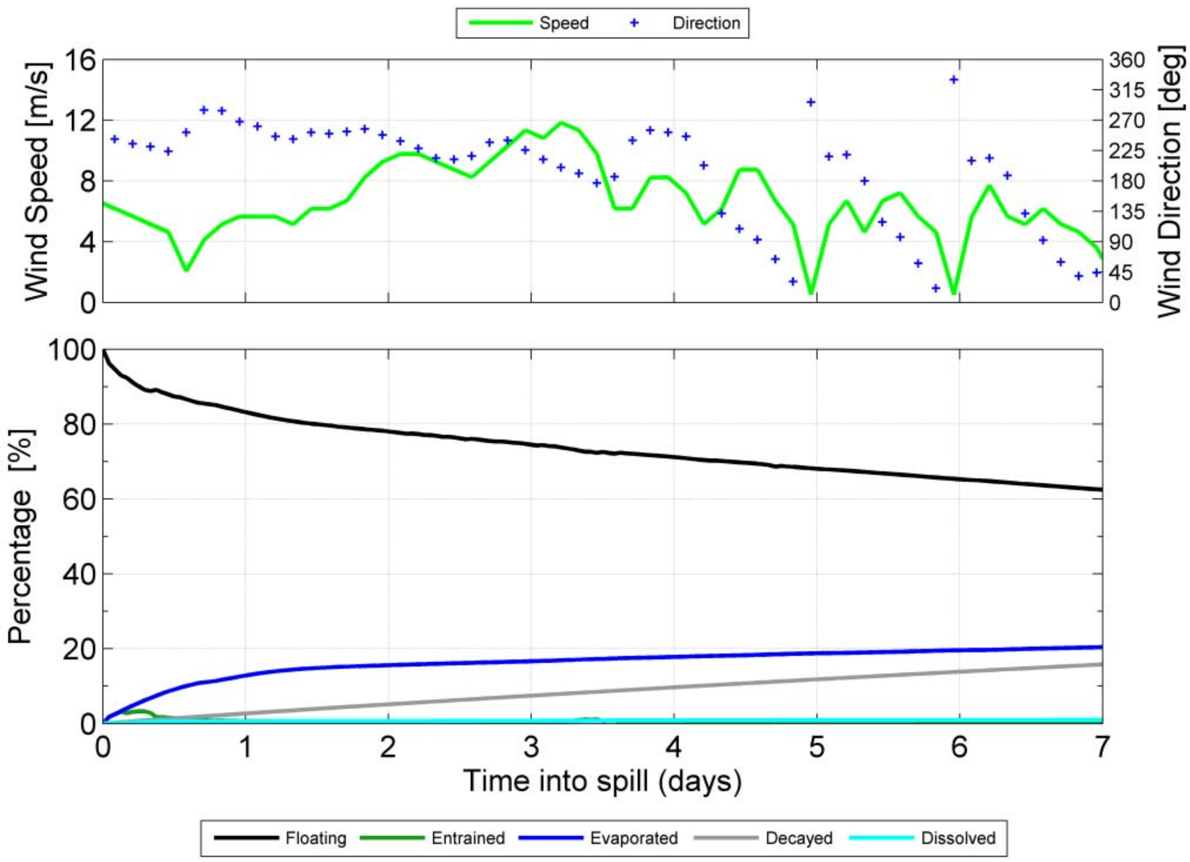

Figure A- 7: Proportional mass balance plot representing the weathering of 50m³ from a surface spill of Norton-1 Crude

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 A- 12** shows a summary of the results of the OILMAP Deep modelling for the well blowout.

Table A- 11: Range of assumed inputs and range of calculated outputs, by OILMAP-Deep model for the surface/subsea well loss of containment

	Variable	Norton-1 crude
Assumed discharge	Release Depth (m)	Surface (initial) 825 m (seabed release phase)
	Oil temp (C°)	43°C
	Gas:oil ratio (scf/bbl)	~4,093
	Oil flow rate (bbl/day)	27,834
	Diameter of exit hole (m)	0.244 m
Calculated gas plume dynamics	Plume diameter (m)	69.7 m
	Plume Trapping height (m ASB)	336 m
Calculated droplet size distribution	droplets of size 121.4 µm	16.5%
	droplets of size 242.7 µm	26.0%
	droplets of size 364.1 µm	23.6%
	droplets of size 485.4 µm	17.2%
	droplets of size 606.8 µm	10.7%
	droplets of size 728.1 µm	6.0%

For a pressurised discharge of hydrocarbons and gas at the seabed (depth of 825 m), the blowout model (OILMAP-Deep) calculated that at the outset, the discharge would generate relatively large hydrocarbon droplets (121.4 to 728.1 µm) and entrained by the rising plume. The droplets will be mixed by turbulence generated by the lateral displacement of the rising water and droplets. The droplets are predicted to reach the surface and expected to form floating slicks dependent on prevailing conditions.
Potential Environmental Impacts
Description of Potential Environmental Impact
ZoC **Surface Hydrocarbons**: Quantitative hydrocarbon spill modelling result outputs for surface hydrocarbons provides a summary of all the locations where the surface hydrocarbon impact threshold (10 g/m^2) could be exceeded by any of the simulations modelled (ie down to 1% probability). In the event that this scenario occurred, a surface hydrocarbon slick would drift in all directions from the well site with the trajectory dependent on prevailing wind and current conditions at the time. Within this probability range is there potential to contact a number of emergent receptors at varying probabilities, including Ningaloo Coast, the Muiron Islands, the Montebello/Barrow/Lowendal Island group, the Pilbara Northern and Southern Island Groups, Scott Reef, Seringapatam Reef, Shark Bay and the Abrolhos Islands. The modelling indicates the ZoC has a high probability (>80%) of contacting open ocean for approximately 150 km to the north west of the well site, with a very low probability (<1%) of extending up to 2,000 km from the well site (as far south as the Perth Canyon CMR and as far north as Indonesia (Lesser Sunda Ecoregion and Java)). **Entrained Hydrocarbons**: In the event of the loss of well containment scenario occurring, entrained hydrocarbons are forecast to potentially drift in all directions with the most likely directions of travel being to the south-west of the release site, due to the influence of the NWS seasonal currents. The modelling indicated that the entrained hydrocarbon ZoC above the 500ppb threshold concentrations could potentially contact the Ningaloo Coast, Muiron Islands, the Montebello/Barrow/Lowendal Islands Group, Rankin Bank, the Pilbara Southern and Northern Island Groups, Shark Bay (open ocean cost), the Abrolhos Islands and the Argo- Rowley Terrace CMR, with the potential to extend as far south as the Ngari Capes Marine Park. **Table A- 12** indicates entrained threshold concentrations contact locations for receptors as identified by the modelling. The entrained ZoC may extend up to approximately 1,500 km south of the release site (<1% probability). **Dissolved Aromatic Hydrocarbons**: In the event of the loss of well containment scenario occurring, a plume of dissolved hydrocarbons would potentially drift in all directions with the most likely directions of travel being to the south-west of the release site, due to the influence of the NWS seasonal currents. The modelling indicated that the dissolved hydrocarbon ZoC may contact and reach thresholds concentrations at the Ningaloo Coast, Muiron Islands, the Montebello/Barrow/Lowendal Islands Group, the Pilbara Southern Islands Group and Shark Bay. **Table 5-17** indicates the dissolved threshold contractions contact locations for receptors, as identified by the modelling. The dissolved aromatic ZoC may extend up to approximately 750 km from the release site (<1% probability). **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, Exmouth Gulf (west), Muiron Islands, Montebello/Barrow/Lowendal Islands Group, Pilbara Southern Island Group, Shark Bay (including the WHA and State Marine Park), Abrolhos Islands, Kimberley Coast (Lacepede Islands, Adele Island, Dampier Peninsula, Buccaneer and Bonaparte Archipelagos) and Indonesia (Lesser Sunda Ecoregion and Java). **Summary of Potential Impacts** **Table A- 12** presents the full extent of the ZoC, i.e. the sensitive receptors and their locations that may be exposed to hydrocarbons (surface, entrained, dissolved and accumulated) at or above the set threshold concentrations in the unlikely event of a major hydrocarbon release from a loss of well containment during the Petroleum Activities Program. 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 A- 12: ZoC – Key receptor locations and sensitivities with summary hydrocarbon spill contact for a 77 day blowout of Norton-1 crude (5 day surface spill followed by a 72 day subsea release)

Environmental setting	Location / name	Environmental, Social, Cultural, Heritage and Economic Aspects presented as per the Environmental Risk Definitions (Woodside's Risk Management Procedure (WM0000PG10055394))																													Hydrocarbon contact and fate (Condensate/Crude/marine diesel)			
		Physical		Biological																						Socio-economic and Cultural								
		Water Quality	Sediment Quality	Marine Primary Producers			Other Communities / Habitats								Protected Species									Other Species										
		Openwater – (pristine)	Marine Sediment - (pristine)	Coral reef	Seagrass beds / Macroalgae	Mangroves	Spawning/nursery areas	Openwater – Productivity/upwelling	Non biogenic coral reefs	Offshore filter feeders and/or deepwater benthic communities	Nearshore filter feeders	Sandy shores	Estuaries / tributaries / creeks / lagoons (including mudflats)	Rocky shores	Cetaceans – migratory whales	Cetaceans – dolphins and porpoises	Dugongs	Pinnipeds (sea lions and fur seals)	Marine turtles (including foraging and internesting areas and significant nesting beaches)	Seasnakes	Whale sharks	Sharks and rays	Sea birds and/or migratory shorebirds	Pelagic fish populations	Resident /Demersal Fish	Fisheries – commercial	Fisheries – traditional	Tourism and Recreation	Protected Areas / Heritage – European and Indigenous / Shipwrecks	Offshore Oil & Gas Infrastructure (topside and subsea)	Surface hydrocarbon (≥10 g/m²)	Entrained hydrocarbon (≥500 ppb)	Dissolved aromatic hydrocarbon (≥500 ppb)	Accumulated hydrocarbons (>100 g/m²)
Offshore[3]	Commonwealth waters	✓	✓					✓		✓					✓	✓				✓	✓	✓	✓	✓		✓		✓		✓	X	X	X	
	Kimberley CMR	✓	✓	✓	✓		✓	✓		✓					✓	✓	✓		✓	✓		✓	✓	✓	✓			✓	✓		X			
	Agro-Rowley Terrace CMR	✓						✓							✓	✓			✓			✓	✓	✓		✓			✓		X	X		
	Montebello CMR	✓	✓	✓			✓	✓							✓	✓			✓	✓	✓	✓	✓	✓	✓	✓		✓	✓		X	X	X	
	Dampier CMR	✓	✓					✓		✓					✓	✓			✓	✓		✓	✓	✓	✓	✓			✓		X			
	Carnarvon Canyon CMR	✓	✓					✓		✓														✓	✓	✓			✓		X	X	X	
	Ningaloo CMR	✓						✓		✓					✓	✓			✓		✓	✓	✓	✓	✓	✓		✓	✓		X	X	X	
	Gascoyne CMR	✓	✓												✓	✓			✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	X	X	X	
	Shark Bay Open Ocean (including CMR)	✓	✓					✓							✓	✓	✓		✓	✓		✓	✓	✓	✓	✓		✓	✓		X	X	X	
	Abrolhos CMR	✓	✓					✓							✓	✓		✓		✓		✓	✓	✓	✓	✓			✓		X	X		
	Jurien CMR	✓	✓		✓		✓				✓				✓			✓				✓	✓	✓	✓	✓		✓	✓			X		
	Two Rocks CMR	✓	✓					✓					✓		✓			✓					✓	✓	✓	✓			✓			X		
	Perth Canyon CMR	✓						✓							✓	✓							✓	✓	✓				✓			X		
	Geographe CMR	✓						✓		✓					✓	✓						✓	✓	✓	✓			✓	✓			X		
	South-west Corner CMR	✓						✓		✓					✓	✓		✓				✓	✓	✓	✓			✓	✓			X		

[3] Note: hydrocarbons cannot accumulate on open ocean, submerged receptors, or receptors not fully emergent

Environmental setting	Location / name	Environmental, Social, Cultural, Heritage and Economic Aspects presented as per the Environmental Risk Definitions (Woodside's Risk Management Procedure (WM0000PG10055394))																													Hydrocarbon contact and fate (Condensate/Crude/marine diesel)			
		Physical		Biological																						Socio-economic and Cultural								
		Water Quality	Sediment Quality	Marine Primary Producers			Other Communities / Habitats								Protected Species									Other Species										
		Openwater – (pristine)	Marine Sediment - (pristine)	Coral reef	Seagrass beds / Macroalgae	Mangroves	Spawning/nursery areas	Openwater – Productivity/upwelling	Non biogenic coral reefs	Offshore filter feeders and/or deepwater benthic communities	Nearshore filter feeders	Sandy shores	Estuaries / tributaries / creeks / lagoons (including mudflats)	Rocky shores	Cetaceans – migratory whales	Cetaceans – dolphins and porpoises	Dugongs	Pinnipeds (sea lions and fur seals)	Marine turtles (including foraging and internesting areas and significant nesting beaches)	Seasnakes	Whale sharks	Sharks and rays	Sea birds and/or migratory shorebirds	Pelagic fish populations	Resident /Demersal Fish	Fisheries – commercial	Fisheries – traditional	Tourism and Recreation	Protected Areas / Heritage – European and Indigenous / Shipwrecks	Offshore Oil & Gas Infrastructure (topside and subsea)	Surface hydrocarbon (≥10 g/m²)	Entrained hydrocarbon (≥500 ppb)	Dissolved aromatic hydrocarbon (≥500 ppb)	Accumulated hydrocarbons (>100 g/m²)
Oceanic Reefs and Offshore Islands	Ashmore Reef and CMR	✓	✓	✓	✓		✓	✓				✓				✓	✓		✓	✓		✓	✓	✓	✓		✓	✓	✓		X			
	Seringapatam Reef	✓	✓	✓	✓		✓	✓		✓		✓				✓			✓	✓		✓	✓	✓	✓		✓	✓	✓		X			
	Scott Reef (North and South)	✓	✓	✓	✓		✓	✓		✓		✓			✓	✓			✓	✓	✓	✓	✓	✓	✓		✓	✓	✓		X			
	Mermaid Reef and CMR	✓	✓	✓			✓	✓		✓						✓			✓	✓		✓	✓	✓	✓			✓	✓		X			
	Clerke Reef and State Marine Park	✓	✓	✓			✓	✓		✓						✓			✓	✓		✓	✓	✓	✓			✓	✓		X			
	Imperieuse Reef and State Marine Park	✓	✓	✓			✓	✓		✓						✓			✓	✓		✓	✓	✓	✓			✓	✓		X			
Submerged Shoals and banks	Rankin Bank	✓	✓	✓			✓	✓		✓						✓				✓		✓		✓	✓	✓		✓			X	X		
	Glomar Shoals	✓	✓	✓			✓	✓		✓						✓				✓		✓		✓	✓	✓		✓			X			
	Rowley Shoals (including Sate Maine Park)	✓	✓	✓			✓	✓		✓						✓				✓		✓		✓	✓	✓		✓			X			
	Fantome Shoals	✓	✓	✓			✓	✓		✓						✓				✓		✓		✓	✓	✓					X			
Islands	Adele Island	✓	✓	✓								✓											✓	✓	✓									X
	Lacepede Islands	✓	✓	✓	✓		✓					✓		✓	✓	✓			✓	✓		✓	✓	✓	✓		✓		✓					X
	Montebello Islands (including State Marine Park)	✓	✓	✓	✓	✓	✓	✓				✓		✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓		✓	✓		X	X		X

Environmental setting	Location / name	Environmental, Social, Cultural, Heritage and Economic Aspects presented as per the Environmental Risk Definitions (Woodside's Risk Management Procedure (WM0000PG10055394))																													Hydrocarbon contact and fate (Condensate/Crude/marine diesel)			
		Physical		Biological																						Socio-economic and Cultural								
		Water Quality	Sediment Quality	Marine Primary Producers			Other Communities / Habitats								Protected Species									Other Species										
		Openwater – (pristine)	Marine Sediment - (pristine)	Coral reef	Seagrass beds / Macroalgae	Mangroves	Spawning/nursery areas	Openwater – Productivity/upwelling	Non biogenic coral reefs	Offshore filter feeders and/or deepwater benthic communities	Nearshore filter feeders	Sandy shores	Estuaries / tributaries / creeks / lagoons (including mudflats)	Rocky shores	Cetaceans – migratory whales	Cetaceans – dolphins and porpoises	Dugongs	Pinnipeds (sea lions and fur seals)	Marine turtles (including foraging and internesting areas and significant nesting beaches)	Seasnakes	Whale sharks	Sharks and rays	Sea birds and/or migratory shorebirds	Pelagic fish populations	Resident /Demersal Fish	Fisheries – commercial	Fisheries – traditional	Tourism and Recreation	Protected Areas / Heritage – European and Indigenous / Shipwrecks	Offshore Oil & Gas Infrastructure (topside and subsea)	Surface hydrocarbon (≥10 g/m²)	Entrained hydrocarbon (≥500 ppb)	Dissolved aromatic hydrocarbon (≥500 ppb)	Accumulated hydrocarbons (>100 g/m²)
	Lowendal Islands (including State Nature Reserve)	✓	✓	✓	✓		✓	✓				✓		✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓		✓	✓		X	X		X
	Barrow Island (including State Nature Reserves, State Marine Park and Marine Management Area)	✓	✓	✓	✓		✓	✓				✓		✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	X	X		X
	Muiron Islands (WHA, State Marine Park)	✓	✓	✓	✓		✓	✓		✓		✓		✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓			✓	✓		X	X	X	X
	Pilbara Islands – Southern Island Group (Serrurier, Thevenard and Bessieres Islands – State Nature Reserves)	✓	✓		✓		✓		✓			✓		✓		✓	✓		✓	✓		✓	✓	✓	✓	✓		✓	✓		X	X	X	X
	Pilbara Islands – Northern Island Group (Sandy Island Passage Islands – State nature reserves)	✓	✓		✓		✓		✓			✓		✓		✓	✓		✓	✓		✓	✓	✓	✓	✓		✓	✓			X		
	Abrolhos Islands	✓	✓	✓	✓	✓	✓	✓				✓		✓	✓	✓		✓	✓	✓		✓	✓	✓	✓	✓		✓	✓		X	X		X
Mainland (nearshore waters)	Kimberley Coast	✓	✓	✓	✓	✓	✓				✓	✓	✓	✓	✓	✓	✓		✓	✓		✓	✓	✓		✓		✓	✓					X
	Dampier Peninsula	✓	✓	✓	✓	✓	✓					✓	✓	✓	✓	✓	✓		✓	✓		✓	✓	✓	✓	✓		✓	✓					X
	Northern Pilbara Shoreline	✓	✓	✓	✓	✓	✓				✓	✓	✓	✓		✓	✓		✓	✓		✓	✓	✓	✓	✓		✓				X		
	Ningaloo Coast (North/North West Cape, Middle and South) (WHA, and State Marine Park)	✓	✓	✓	✓	✓	✓	✓		✓		✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓		✓	✓		X	X	X	X

Environmental setting	Location / name	Environmental, Social, Cultural, Heritage and Economic Aspects presented as per the Environmental Risk Definitions (Woodside's Risk Management Procedure (WM0000PG10055394))																													Hydrocarbon contact and fate (Condensate/Crude/marine diesel)			
		Physical		Biological																							Socio-economic and Cultural							
		Water Quality	Sediment Quality	Marine Primary Producers			Other Communities / Habitats								Protected Species										Other Species									
		Openwater – (pristine)	Marine Sediment - (pristine)	Coral reef	Seagrass beds / Macroalgae	Mangroves	Spawning/nursery areas	Openwater – Productivity/upwelling	Non biogenic coral reefs	Offshore filter feeders and/or deepwater benthic communities	Nearshore filter feeders	Sandy shores	Estuaries / tributaries / creeks / lagoons (including mudflats)	Rocky shores	Cetaceans – migratory whales	Cetaceans – dolphins and porpoises	Dugongs	Pinnipeds (sea lions and fur seals)	Marine turtles (including foraging and internesting areas and significant nesting beaches)	Seasnakes	Whale sharks	Sharks and rays	Sea birds and/or migratory shorebirds	Pelagic fish populations	Resident /Demersal Fish	Fisheries – commercial	Fisheries – traditional	Tourism and Recreation	Protected Areas / Heritage – European and Indigenous / Shipwrecks	Offshore Oil & Gas Infrastructure (topside and subsea)	Surface hydrocarbon (≥10 g/m²)	Entrained hydrocarbon (≥500 ppb)	Dissolved aromatic hydrocarbon (≥500 ppb)	Accumulated hydrocarbons (>100 g/m²)
	Shark Bay – Open Ocean Coast	✓	✓	✓	✓		✓	✓		✓	✓	✓		✓		✓	✓		✓	✓		✓	✓	✓	✓	✓		✓	✓		X	X	X	X
	Shark Bay WHA	✓	✓	✓	✓	✓	✓					✓		✓	✓	✓	✓		✓	✓		✓	✓	✓	✓	✓	✓	✓	✓		X	X	X	X
	Ngari Capes State Marine Park	✓	✓		✓						✓	✓	✓	✓	✓	✓		✓				✓	✓	✓	✓	✓		✓	✓			X		
Indonesia	Lesser Sunda Ecoregion	✓	✓	✓	✓	✓	✓				✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓		✓	✓	✓		X			X
	Java	✓	✓	✓	✓	✓	✓				✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓		✓	✓	✓		X			X

Summary of Potential Impacts to Environmental Values	
Summary of Potential Impacts to Protected Species	
Setting	**Receptor Group**
Offshore	**Cetaceans**: Marine mammals that have direct physical contact with surface, entrained or dissolved aromatic 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. If prey (fish and plankton) are contaminated, this can result in the absorption of toxic components of the hydrocarbons (PAHs). In a review of cetacean observations in relation to a number of large scale hydrocarbon spills, found little evidence of mortality associated with hydrocarbon spills, however, behavioural disturbance (i.e. avoiding spilled hydrocarbons) was observed in some instances for several species of cetacean. This suggests that cetaceans have the ability to detect and avoid surface slicks. In the event of a loss of well containment resulting in a well blowout, surface, entrained and dissolved hydrocarbons exceeding threshold concentrations may drift across the migratory routes and BIAs of EPBC Act listed whale species, including humpback whales and pygmy blue whales (north- and southbound migrations). Pygmy blue whales and humpback whales are known to migrate seasonally through the potential spill affected area for surface, dissolved and entrained hydrocarbons. However, feeding during migrations is low level and opportunistic. As such, the opportunity for ingestion of hydrocarbons is low. Migrations of both pygmy blue whales and humpback whales are protracted through time and space (i.e. the whole population will not be within the ZoC), and as such, a spill from the loss of well containment is unlikely to affect an entire population. Cetacean populations that are resident within the potential ZoC may be susceptible to impacts from spilled hydrocarbons if they interact with an area affected by a spill. Such species are more likely to occupy coastal waters (refer to the mainland and islands section below for additional information). Suitable habitat for oceanic toothed whales (e.g. sperm whales) and dolphins (e.g. spinner dolphin) is broadly distributed throughout the region and as such, impacts are unlikely to affect an entire population. These species are expected to detect and avoid entrained spills. Other species identified may also have possible transient interactions with the ZoC. Given cetaceans are smooth skinned and hydrocarbons would not tend to adhere to body surfaces, the biological consequences of physical contact with hydrocarbons is likely to be in the form of irritation and sub-lethal stress. A major spill in July to December would coincide with humpback whale migration through the waters off the Pilbara, North West Cape (Ningaloo) and Shark Bay (open ocean). A major spill in April to August or October to December would coincide with pygmy blue whale migration. Double *et al*. (2014) suggest that pygmy blue whales migrate in offshore waters to the west and north of the Operational Area in approximately 200–1000 m of water. The Operational Area overlaps the humpback whale migration BIA, however, the humpback whale resting area in Exmouth Gulf and the calving area in Camden Sound are not predicted to be contacted by surface, entrained or dissolved hydrocarbons above threshold concentrations. The pygmy blue whale BIA also overlaps the Operational Area. The ZoC has limited potential to extend to the Perth Canyon (approximately 1,120 km to the south of the Operational Area), thought to be a seasonal aggregation area for pygmy blue whales and a migratory area for humpback whales. A loss of well containment resulting in a well blowout could result in a disruption to a significant portion of a cetacean population, particularly 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 ZoC.
	Marine Turtles: Adult sea turtles exhibit no avoidance behaviour when they encounter hydrocarbon spills. Contact with surface slicks, or entrained hydrocarbon, can therefore, result in hydrocarbon adherence to body surfaces causing irritation of mucous membranes in the nose, throat and eyes leading to inflammation and infection. Oiling can also irritate and injure skin which is most evident on pliable areas such as the neck and flippers. 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. 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. This can lead to lung damage and congestion, interstitial emphysema, inhalant

	pneumonia and neurological impairment. Contact with entrained hydrocarbons can result in hydrocarbon adherence to body surfaces causing irritation of mucous membranes in the nose, throat and eyes leading to inflammation and infection. Due to the absence of potential nesting habitat and location offshore, the Operational Area is unlikely to represent important habitat for marine turtles (approximately 17 km to the Ningaloo CMR/WHA area and water depths of approximately 350 - 850 m deep). It is, however, acknowledged that foraging marine turtles may be present foraging within the ZoC, and the ZoC would overlap with the BIA's identified in the EP, in particular the internesting BIAs for flatback turtles which extend for ~80 km from known nesting locations. However, it is noted by Woodside that the Petroleum Activities Program may coincide with nesting season for marine turtles in the region. In the event of a well blowout, there is potential that surface, entrained and dissolved hydrocarbons exceeding threshold concentrations will be present in offshore waters extending up to 2,000 km, 1,500 km and 750 km, respectively, from the release site. Therefore, a hydrocarbon spill may have a minor disruption to a portion of the population; however, there is no threat to overall population viability. Potential impacts to internesting marine turtles are discussed in the *Mainland and Islands (nearshore)* impacts discussion.
	Seasnakes: Impacts to seasnakes from direct contact with hydrocarbons are likely to result in similar physical effects to those recorded for marine turtles and may include potential damage to the dermis and irritation to mucus membranes of the eyes, nose and throat. 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). It is acknowledged that seasnakes will be present in the Operational Area and wider ZoC; however, their abundance is not expected to be high in the deep water and offshore environment. 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 (see Mainland and Islands (nearshore waters) below). Whale sharks may also carry out opportunistic feeding in offshore waters and the Operational Area. The ZoC overlaps the whale shark migration BIA identified in this EP, within which whale sharks are seasonally present between April and October, and the wider ZoC overlaps an aggregation area at Ningaloo. 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.
	Seabirds and/or Migratory Shorebirds: Offshore waters are potential foraging grounds for seabirds associated with the coastal roosting and nesting habitat (e.g. Ningaloo, Muiron Islands and the Barrow/Montebello/Lowendal Island Group). There are confirmed foraging grounds off Ningaloo and the Barrow/Montebello/Lowendal Island Group and a BIA for the wedge-tailed shearwater (peak use August-April) overlaps with the Operational Area. There are also a number of BIAs for seabirds and migratory shorebirds that overlap with the wider ZoC. 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 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. Therefore, a hydrocarbon spill may result in surface slicks disrupting a significant portion of the foraging habitat for seabirds, including BIAs identified for foraging birds which are generally associated with breeding habitat and seabirds foraging in waters in proximity to these sites. This may lead to impacts upon foraging seabirds in the offshore

	environment; however, this is not expected to result in a threat to the overall population viability, given the relatively broad distributions of the seabird species. Seabird distributions are typically concentrated around islands and as such, hydrocarbons in proximity to nesting / roosting areas may result in increased numbers of seabirds being impacted, with many species of seabirds such as the wedge-tailed shearwater and species of terns forage relatively close to breeding islands/colonies.
Submerged shoals	**Marine Turtles:** There is the potential for marine turtles to be present at submerged shoals such as Rankin Bank, Glomar Shoals and Rowley Shoals. These shoals and banks may, at times, be foraging habitat for marine turtles, given the coral and filter feeding biota associated with these areas. However, these areas are not known foraging locations and satellite tracking of individual green turtles in the nearshore environment of the NWS did not indicate any overlap of the tracked post-nesting migratory routes and the Operational Area. It is, however, acknowledged that individual marine turtles may be present at Glomar Shoals, Rankin Bank, Rowley Shoals and the surrounding areas. Therefore, a hydrocarbon spill may have a minor disruption to a portion of the population (see offshore description above); however, there is no threat to overall population viability.
	Seasnakes: There is the potential for seasnakes to be present at submerged shoals such as Glomar Shoals, Rankin Bank and Rowley Shoals. The potential impacts of exposure are as discussed previously in Offshore – Seasnakes. A hydrocarbon spill may have a minor disruption to a portion of the population but there is no threat to overall population viability. Seasnake species in Australia generally show strong habitat preferences; species that have preferred habitats associated with submerged shoals and oceanic atolls may be disproportionately affected by a hydrocarbon spill affecting such habitat.
	Sharks (including whale sharks) and Rays: There is the potential for resident shark and ray populations to be impacted directly from hydrocarbon contact or indirectly through contaminated prey or loss of habitat. Spill model results indicate potential impacts to the benthic communities of Rankin Bank (Glomar Shoals and Rowley Shoals are not predicted to be contacted by entrained or dissolved hydrocarbons above threshold concentrations). Pelagic sharks and rays are expected to move away from areas affected by spilled hydrocarbons. Impacts to such species are expected to be limited to behavioural responses/displacement. Shark and ray species that have associations with submerged shoals and oceanic atolls may not move in response to such habitat being contacted by spilled hydrocarbons. Such species may be more susceptible to a reduction in habitat quality resulting from a hydrocarbon spill. Impacts to sharks and rays at Rankin Bank are likely to be localised as they are comparable to other Australian reefs and the NWMR submerged shoals and banks. It is expected that there will be no impacts at the population level.
Mainland and islands (nearshore waters)	**Cetaceans and Dugongs:** In addition to a number of whale species that may occur in nearshore waters, coastal populations of small cetaceans and dugongs are known to reside or frequent nearshore waters, including the Ningaloo Coast, Muiron Islands, Montebello/Barrow/Lowendal Islands Group, Pilbara Southern and Northern Island Groups, Shark Bay, and a number of other nearshore and coastal locations including coastal areas of the Indonesian archipelago (see **Table A- 12**) which may be potentially impacted by surface, entrained and dissolved hydrocarbons exceeding threshold concentrations in the event of a loss of well containment. The predicted ZoC for surface, entrained and dissolved hydrocarbons extends past Exmouth Gulf and Shark Bay. These areas are known humpback whale aggregation areas during their annual southern migration (September to December) and therefore, humpbacks moving into these aggregations areas may be exposed to hydrocarbons above thresholds levels. However, surface, entrained and dissolved hydrocarbons concentrations above thresholds are not expected within Exmouth Gulf itself. No hydrocarbon contact at or above threshold concentrations is expected for Camden Sound, an important calving area for humpback whales. The potential impacts of exposure are as discussed previously in Offshore – Cetaceans. However, nearshore populations of cetaceans and dugongs are known to exhibit site fidelity and are often resident populations. Therefore, 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 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 significant portion of the local population but it is not predicted to result in impacts on overall population viability of either dugongs or coastal cetaceans.

	Pinnipeds: Australian sea lions are found in the Houtman Abrolhos Islands Nature Reserve and Ngari Capes Marine Park, distant from the Operational Area but within the wider ZoC (**Table A-12**). Given the considerable distance from the Operational Area to these receptors and the lengthy time for surface and entrained hydrocarbons to contact (minimum 39 days for the Abrolhos Islands), surface or entrained hydrocarbons that do reach this area are likely to be heavily weathered and are expected to have minor or no impacts on sea lions.
	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, Muiron Islands, Montebello/Barrow/Lowendal Islands group, Pilbara Islands (Northern and Southern Island Groups), Shark Bay, Scott Reef, Ashmore Reef and the Kimberley Coast (including Adele and Lacepede Islands and the Buccaneer and Bonaparte Archipelagos) and the southern Indonesian archipelago (Bali and East Java). There are distinct breeding seasons for marine turtles. The nearshore waters of these turtle habitat areas may be exposed to surface, entrained or 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). 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. In the event that accumulated hydrocarbons or entrained hydrocarbons reach the shoreline or internesting coastal waters (refer to **Table A- 12** for receptor locations) , there is the potential for impacts to turtles utilising the affected area. During the breeding season, turtle aggregations near nesting beaches within the wider ZoC are most vulnerable due to greater turtle densities and potential impacts may occur at the population level and may impact on overall population viability of some marine turtle species.
	Seasnakes: Impacts to sea snakes for the mainland and island nearshore waters from direct contact with hydrocarbons may occur, and may include potential damage to the dermis and irritation to mucous membranes of the eyes, nose and throat. Refer to **Table A- 12** for relevant receptor locations for seasnakes predicted to be contacted by hydrocarbons above threshold concentrations.
	Sharks (including whale sharks) and Rays: Whale sharks and manta rays, known to frequent the Ningaloo Reef system and the Muiron Islands (forming feeding aggregations in late summer/autumn). The Indonesian islands of Komodo and Nusa Penida, Bali are also known to host significant Manta Ray populations. Whale sharks and Manta rays generally transit along the nearshore coastline and are vulnerable to surface, entrained and dissolved aromatic hydrocarbon spill impacts, with both taxa having similar modes of feeding. Whale sharks are versatile feeders, filtering large amounts of water over their gills, catching planktonic and nektonic organisms. Whale sharks at Ningaloo Reef have been observed using two different feeding strategies, including passive sub-surface ram-feeding and active surface feeding. 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. These feeding methods would result in the potential for individuals that are present in worse affected spill areas to ingest potentially toxic amounts of surface, entrained or dissolved aromatic hydrocarbons into their body. Large amounts of ingested hydrocarbons may affect their endocrine and immune system in the longer term. The presence of hydrocarbons may 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 surface, entrained or dissolved aromatic hydrocarbons through the contamination of their prey. The preferred food of whale sharks are fish eggs and phytoplankton which are abundant in the coastal waters of Ningaloo Reef in late summer/autumn, driving the annual arrival and aggregation of whale sharks in this area. If the spill event were to occur during the spawning season, this important food supply (in worse spill affected areas of the reef) may be diminished or contaminated. The contamination of their food supply and the subsequent ingestion of this prey by the whale shark may also result in long term impacts as a result of bioaccumulation. There is the potential for other resident shark and ray (e.g. sawfish species) 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. **Table**

	A- 12 indicates the receptor locations predicted to be impacted from entrained and/or dissolved aromatic hydrocarbons to the benthic communities of nearshore, subtidal communities, and it is considered that there is the potential for habitat loss to occur. Shark populations displaced or no longer supported due to habitat loss would be expected to redistribute to other locations. Therefore, the consequences to resident shark and ray populations (if present) from loss of habitat, may result in a disruption to a significant portion of the population however it is not expected to impact on the overall viability of the population.
	Seabirds and/or Migratory Shorebirds: In the unlikely event of a major spill, there is the potential for seabirds, and resident and non-breeding overwintering shorebirds that use the nearshore waters for foraging and resting, to be exposed to surface,entrained and dissolved hydrocarbons. This could result in lethal or sublethal 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 sublethal 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. Important areas for foraging seabirds and migratory shorebirds are identified in this EP. Refer to **Table A- 12** for locations within the predicted extent of the ZoC 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 ZoC. Of note are important nesting and resting areas, including: • Muiron Islands; • Ningaloo Coast; • North West Cape; • Montebello/Barrow/Lowendal Islands group (including known nesting habitats on Boodie, Double and Middle Islands); • Pilbara Islands North and South Island Group; • Shark Bay; • Abrolhos Islands; • Ashmore Reef; and • Adele Island. Therefore, a hydrocarbon spill may result in impacts on key feeding habitat and a disruption to a significant portion of the habitat however this is not expected to result in a threat to the overall population viability of seabirds or shorebirds.
Indonesia	**Cetaceans and Dugongs:** Hydrocarbon spill modelling indicates that surface hydrocarbons exceeding threshold concentrations may extend into the Lesser Sunda and Southern Java ecoregions of Indonesia, potentially exposing migratory and resident cetaceans and dugongs. The potential impacts from exposure to surface slicks are discussed above in Offshore - Cetaceans and Mainland and Islands (nearshore waters) – Cetaceans. A hydrocarbon spill may result in a disruption to a portion of a migratory cetacean population in Indonesian waters, including blue whale and sperm 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 migratory cetaceans within Indonesian waters. Resident cetacean populations (e.g. numerous dolphin species) known to inhabit nearshore waters with the ZoC for surface hydrocarbons, such as the Laut Sawu Marine National Park may experience impacts on feeding habitats that could result in a disruption to a portion of the local population but is not predicted to result in impacts on overall population viability of either dugongs or resident/coastal cetaceans.

	Marine Turtles: The islands within the Lesser Sunda and Southern Java Ecoregions provide habitat for marine turtles, with the Laut Sawu Marine National Park, in particular, identified as providing habitat for five species of marine turtles – green, leatherback, olive ridley, loggerhead and flat back turtles. The potential impacts to marine turtles in Indonesian waters contacted by the surface hydrocarbon ZoC and those contacted by accumulated hydrocarbons on shorelines are likely to be similar to those described above for Offshore – Marine Turtles and Mainland and Islands (nearshore waters) – Marine Turtles.
	Seasnakes: There is little publically available information concerning the status of seasnakes in Indonesian waters. However, in the event of surface hydrocarbons at or above threshold levels contacting Indonesian waters, the potential impacts to seasnakes would be similar to those described above for Offshore – Seasnakes.
	Sharks (including whale sharks) and Rays: The potential impacts to sharks and rays in Indonesian waters contacted by surface hydrocarbons at or above threshold concentrations are likely to be limited to indirect impacts associated with consumption of contaminated prey or reduction in abundance of prey, and are unlikely to result in any significant impacts to a population. The potential impacts to sharks and rays are discussed above for Offshore - Sharks (including whale sharks) and Rays, and Mainland and Islands (nearshore waters) – Sharks (including whale sharks) and Rays.
	Seabirds and/or Migratory Shorebirds: Whilst there is little publically information on the status of seabirds and migratory shorebirds in Indonesia, the Lesser Sunda and Southern Java ecoregions are within the East Asian Flyway for migratory shorebirds, and the two ecoregions support habitat for seabirds. The potential impacts from surface hydrocarbons above threshold levels to seabirds and migratory shorebirds are discussed above for Mainland and Islands (nearshore waters) – Seabirds and/or Migratory Shorebirds. Whilst a spill resulting in the surface ZoC reaching Indonesian waters may result in impacts feeding habitat and a disruption to a portion of the habitat, it is not expected to result in a threat to the overall population viability of seabirds or shorebirds.
Summary of Potential Impacts to Other Species	
Setting	**Receptor Group**
Offshore	**Pelagic Fish Populations:** Fish mortalities are rarely observed to occur as a result of hydrocarbon spills. Scholz *et al*., (1992) concluded that fish do not generally experience acute mortality due to hydrocarbon spills, and that it is rare to find fish kills after a spill, especially in open water environments. This has generally been attributed to the possibility that pelagic fish are able to detect and avoid surface waters underneath hydrocarbon spills by swimming into deeper water or away from the affected areas. Fish that have been exposed to dissolved aromatic hydrocarbons are capable of eliminating the toxicants once placed in clean water, hence individuals exposed to a spill are likely to recover. Where fish mortalities have been recorded, the spills (resulting from the groundings of the tankers Amoco Cadiz in 1978 and the Florida in 1969) have occurred in sheltered bays. A spill of crude due to a loss of well containment associated with the Petroleum Activities Program is therefore, unlikely to cause a major impact on short-term survival of open water pelagic fish but may result in a level of sub-lethal stress on fish. The potential impacts to fish populations in open waters are considered to be minor and localised.
	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 well blow out and within the ZoC for entrained/dissolved aromatic hydrocarbons (≥500 ppb). Additionally, if prey (infauna and epifauna) surrounding the well location and within the ZoC 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.
Submerged shoals and Oceanic Atolls	**Pelagic Fish Populations**: Detection and avoidance predicted for pelagic fish populations (see offshore description above).
	Demersal Fish: Mortality and sub lethal effects may impact populations within the ZoC for entrained and dissolved hydrocarbons (≥500 ppb). Additionally, if prey (infauna and epifauna) within the ZoC 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 effects on demersal fish habitat, e.g. seafloor.

	Resident Fish: Site-attached fish (for example coral reef fish), 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 fish populations will be entirely dependent on actual hydrocarbon concentration, duration of exposure and water depth of the affected communities. It is also noted that the early life stages (larval and fingerling) of resident fish populations are particularly sensitive to hydrocarbon exposure.
Mainland and islands (nearshore waters)	**Pelagic Fish Populations:** Detection and avoidance predicted for pelagic fish populations (see offshore description above).
	Demersal Fish (including site attached fish): Lethal and sublethal impact may occur for demersal fish populations (see offshore description above) may result in located medium/long term impacts.
	Resident Fish: Site-attached fish (for example coral reef fish), are at higher risk from hydrocarbon exposure than non-resident, more wide-ranging fish species (see submerged shoal description above).
Indonesia	**Pelagic Fish Populations:** Detection and avoidance predicted for pelagic fish populations (see offshore description above). Adult pelagic fish are less likely to be impacted by surface slicks. However, nursery areas such as intertidal seagrass and mangrove areas may be impacted (e.g. smothering and dieback) by surface hydrocarbons exceeding threshold levels, leading to potential indirect impacts to the juvenile stages of pelagic fish.
	Demersal Fish (including site attached fish): Lethal and sublethal impact may occur for demersal fish populations (see offshore description above) and may result in located medium/long term impacts. Potential indirect impacts to juvenile stages are possible, if surface hydrocarbons exceeding threshold levels impact intertidal nursery areas; as discussed above for pelagic fish populations.
	Resident Fish: Site-attached fish (for example coral reef fish), are at higher risk from hydrocarbon exposure than non-resident, more wide-ranging fish species (see submerged shoal description above). Potential indirect impacts to juvenile stages are possible if surface hydrocarbons exceeding threshold levels impact intertidal nursery areas, as discussed above for pelagic fish populations.
Summary of Potential Impacts to Marine Primary Producers	
Setting	**Receptor Group**
Submerged Shoals	The waters overlying the submerged Rankin Bank have the potential to be exposed to entrained hydrocarbons above threshold concentrations (at or greater than 500 ppb). This permanently submerged habitat represents sensitive open water benthic community receptors, extending from deep depths to relatively shallow water. Given the depth of Rankin Bank, it is likely the potential for biological impact is significantly reduced when compared to the upper water column layers. However, potential biological impacts could include sub-lethal stress and in some instances total or partial mortality of sensitive benthic organisms such as corals and the early life stages of resident fish and invertebrate species. Other submerged shoals and banks within the wider ZoC (e.g. Glomar Shoals and Rowley Shoals) are not predicted to be exposed to entrained or dissolved hydrocarbons above threshold concentrations. Although the waters above these shoals may be contacted by surface slicks, any entrainment of surface hydrocarbons is likely to be restricted to the first few meters of the water column and is considered to pose limited potential for impact to marine primary producer habitats at these locations.
Mainland and Islands (nearshore waters)	**Coral Reef**: The quantitative spill risk assessment and ZoC indicate there would be potential for coral reef habitat to be exposed to surface, dissolved and entrained hydrocarbons. There would be potential for surface, entrained and dissolved hydrocarbons above threshold concentrations to reach reef habitat along the Ningaloo coast and at identified offshore islands and coastline (see **Table A- 12**) such as the Muiron Islands, Montebello/Barrow/Lowendal Islands Group, Pilbara Southern Islands Group, Shark Bay, Abrolhos Islands, Mermaid Reef, Scott Reef, Ashmore Reef, Seringapatam Reef, the Kimberley Coast (including Adele and Lacepede Islands) and southern Indonesian islands (Bali, Lombok, Sumba, Sumbawa, Flores, Java, Savu and Pulau Roti). The shallow coral habitats are most vulnerable to hydrocarbon coating by direct contact with surface slicks during periods when corals are tidally-exposed at spring low tides. Water soluble hydrocarbon fractions associated with surface slicks are also known to cause high coral mortality via direct physical contact of hydrocarbon droplets to sensitive coral species (such as the branching coral species). The duration of surface slick contact with the reef flat may be reduced as the slick will likely be lifted off the reef by the flooding tide, however, exposure will be prolonged

	where hydrocarbons adhere. There is significant potential for lethal impacts due to the physical hydrocarbon coating of sessile benthos, with likely significant mortality of corals (adults, juveniles and established recruits) at the small spill affected areas. This particularly applies to branching corals which are reported to be more sensitive than massive corals. Exposure to entrained hydrocarbons/dissolved aromatic hydrocarbons (≥500 ppb) has the potential to result in lethal or sublethal 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. Sublethal 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. This could result in impacts to the shallow water fringing coral communities/reefs of the offshore islands (e.g. Muiron Islands, Barrow/Montebello/Lowendal Islands, Pilbara Southern and Northern Island Groups and Abrolhos Islands) and also the mainland coast (e.g. Ningaloo Coast and Shark Bay). With reference to Ningaloo Reef, wave-induced water circulation flushes the lagoon and may promote removal of entrained and dissolved hydrocarbons from this particular reef habitat. Under typical conditions, breaking waves on the reef crest induce a rise in water level in the lagoon creating a pressure gradient that drives water in a strong outward flow through channels. These reef incises are across as much as 15% of the length of Ningaloo Reef. 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 the 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 typically 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 with the supply of larvae from locations within Ningaloo Reef of critical importance to the healthy maintenance of the coral communities. Recovery at other coral reef areas, including Scott Reef, may not be aided by a large supply of larvae from other reefs, with levels of recruits after a disturbance event only returning to previous levels after the numbers of reproductive corals had also recovered. Therefore, a hydrocarbon spill may result in large-scale impacts to coral reefs, particularly Ningaloo Reef, with long-term effects (recovery >10 years) likely.
	Seagrass Beds / Macroalgae and Mangroves: Spill modelling has predicted surface, entrained and dissolved hydrocarbons above threshold concentrations 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. Depending on the trajectory of the surface and entrained/dissolved plume, macroalgal/seagrass communities including the Ningaloo Coast (patchy and low cover associated with the shallow limestone lagoonal platforms), Muiron Islands (associated with limestone pavements), the Barrow/Montebello/ Lowendal Islands, Shark Bay, the Pilbara Southern Island Group (documented as low and patchy cover), the Northern Island Group, the Abrolhos Islands, the Kimberley Coast, Ashmore Reef and southern Indonesian islands (Bali, Lombok, Sumba, Sumbawa, Flores, Java, Savu and Pulau Roti) have the potential to be exposed (see **Table A- 12** for a full list of receptors within the ZoC). Seagrass in the subtidal and intertidal zones have different degrees of exposure to hydrocarbon spills. Subtidal seagrass is generally considered much less vulnerable to surface oil spills than intertidal seagrass, primarily because freshly spilled hydrocarbons, including crude oil, float under most circumstances. Dean et al. (1998) found that oil mainly affects flowering, therefore, species that are able to spread through apical meristem growth are not as affected (such as *Zostera*,

	Halodule and *Halophila* species). Seagrass in the intertidal zone is particularly vulnerable as it may come into direct contact with surface hydrocarbons, as well as entrained components, which can smother and kill seagrasses, if it coats their leaves and stems (Taylor & Rasheed, 2011). This conclusion is supported by Howard et al. (1989) who noted that surface hydrocarbon spills which become stranded on the seagrass and smother it during the rise and fall of the tide can result in reduced growth rates, blackened leaves and mortality. Wilson & Ralph (2010) concluded that long-term impacts to seagrass are unlikely unless hydrocarbon is retained within the seagrass meadow for a sustained duration. Toxicity effects can also occur due to absorption of soluble fractions of hydrocarbons into tissues. 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. Impacts on seagrass and macroalgal communities are likely to occur in areas where hydrocarbon threshold concentrations are exceeded. Mangrove habitat and associated mud flats and salt marsh at Ningaloo Coast (small habitat areas), the Pilbara islands and the Montebello Islands, southern Indonesian islands (Bali, Lombok, Sumba, Sumbawa, Flores, Java, Savu and Pulau Roti), and the Kimberley Coast (shoreline accumulation only) have the potential to be exposed (see **Table A- 12** 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. The hydrocarbon comprises a proportion of persistent residual fractions (Norton-1 crude comprises of 48% of persistent fractions) and therefore deposited hydrocarbons are likely to persist in the sediment potentially causing chronic sub-lethal toxicity impacts beyond immediate physical and acute effects which may delay recover in an affected area. Recovery of mangroves from oil spills can take 20-30 years therefore recovery from any impacts would be long-term (>10 years). 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 sublethal in-water toxic effects. This may result in mortality or impairment of growth, survival and reproduction. 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.
Indonesia	**Coral Reef**: The fringing coral reefs of the islands of the Lesser Sunda and Southern Java ecoregions, including Bali, Lombok, Sumba, Sumbawa, Flores, Savu and Pulau Roti, may be impacted by surface hydrocarbons at or above threshold levels in the event of loss of well containment. The potential impacts on shallow water coral reef systems are discussed above for Mainlands and Islands (nearshore waters) - Coral Reef. There is the potential for lethal impacts due to the physical hydrocarbon coating of coral reef systems, with likely mortality of corals (adults, juveniles and established recruits) at areas contacted by surface hydrocarbons above threshold concentrations.
	Seagrass Beds / Macroalgae and Mangroves: Seagrass meadows, macroalgae and mangroves in the intertidal and subtidal habitats of the islands of the Lesser Sunda and Southern Java ecoregions all have the potential to be contacted by surface hydrocarbons exceeding threshold levels in the unlikely event of a loss of well containment. The potential impacts on these habitats and communities are discussed above for Mainland and Islands (nearshore waters).
Summary of Potential Impacts to Ecosystems/Habitats	
Setting	**Receptor group**
Offshore	**Benthic Fauna Communities**: In the event of a major release at the seabed, the stochastic spill model predicted hydrocarbons droplets would be entrained, rapidly transporting them to the sea surface. As a result, the low sensitivity benthic communities associated with the unconsolidated, soft sediment habitat and any epifauna (filter feeders) associated with the Enfield Canyon (part of the Canyons KEF, and the Continental Slope Demersal Fish Communities KEF within and outside the Operational Area are not expected to have widespread exposure to released hydrocarbons.

	Impacts are expected to be restricted to a localised area relating to the hydrocarbon plume at the point of release, which would result in a small area of seabed and associated epifauna and infauna exposed to hydrocarbons. Potential impacts to KEFs occurring within the wider ZoC are discussed below Heterotrophic, filter feeding organisms such as sponges and gorgonians have been identified as potentially occurring in the canyon features located within the wider ZoC, however, hydrocarbon exposure to these deepwater filter-feeding communities is unlikely and exposure at concentrations of ecological consequence is not expected to occur at depths where these heterotrophic communities exist. Evidence from the Deepwater Horizon (DWH) 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. 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. The location of the petroleum activity and the ZoC 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.
	Open Water – Productivity/Upwelling: Primary production by plankton (triggered by sporadic upwelling events in the offshore waters) 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. Phytoplankton may also experience decreased rates of photosynthesis. 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. Therefore, any impacts are likely to be on exposed planktonic communities present in the ZoC and short-term.
	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 ZoC.
Submerged shoals	**Open Water – Productivity/Upwelling**: The submerged shoals of Rankin Bank and Glomar Shoals are areas associated with sporadic upwelling and associated primary productivity events. Spill model results predict entrained hydrocarbons(at or above the 500 ppb threshold) may reach Rankin Bank. Therefore, impacts to plankton communities may result in short-term changes in plankton community composition but recovery would occur (see offshore description above). Hydrocarbon contact during the spawning seasons for resident shoal community benthos and fish (meroplankton), particularly exposure to in-water toxicity effects to biota, may result in the loss of a discrete cohort population but would not affect the longer-term viability of resident populations. Therefore, any impacts to resident shoal community benthos and fish (meroplankton) are likely to be localised at the shoals and temporary.
	Filter Feeders: Hydrocarbon exposure to offshore filter-feeding communities (e.g. communities around Rankin Bank in water depths between 80–100 m or on hard substrate associated with the Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula KEF and Continental Slope Demersal Fish Communities KEF or other locations as identified in **Table A- 12**) may occur depending on the depth of the entrained/dissolved hydrocarbons. Exposure to entrained hydrocarbons/dissolved aromatic hydrocarbons (≥500 ppb) has potential to result in lethal or sub-lethal toxic effects. Sub-lethal impacts, including mucus production and polyp retraction, have been recorded for gorgonians exposed to hydrocarbon. Any impacts may result in localised long-term effects to community structure and habitat.

Mainland and Islands (Nearshore Waters)	**Open Water – Productivity/Upwelling:** Nearshore waters and adjacent offshore waters surrounding the offshore islands (e.g. Muiron Islands, Montebello/Barrow/Lowendal Islands Group) 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 ZoC and temporary.
	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). 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 or dissolved hydrocarbons to occur in the surface water layers above threshold concentrations in nearshore waters including, but not limited to, Ningaloo Coast, the Muiron Islands, Montebello/Barrow/Lowendal Islands Group, Pilbara Southern and Northern Islands Groups, Shark Bay and the Abrolhos Islands. This, and the potential for possible lower concentration exposure for dissolved aromatic hydrocarbons, have the potential to result in lethal and sublethal 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 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. 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 Pilbara region (e.g. the Southern Island Group) may be exposed to surface or entrained hydrocarbons (at or above threshold concentrations) 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 or dissolved hydrocarbons, impacts are expected to result in localised long-term effects.
	Offshore Filter Feeders: Hydrocarbon exposure to offshore, filter-feeding communities (e.g. deepwater communities of Ningaloo coast and the Muiron Islands in 20–200 m) may occur depending on the depth of the entrained and dissolved aromatic hydrocarbons. See discussion above on potential impacts.
	Nearshore Filter Feeders: Nearshore filter feeders that are present in shallower water <20 m may potentially be impacted by entrained hydrocarbon and be impacted through lethal/sub-lethal effects (see discussion for offshore filter feeders). Nearshore filter feeder communities identified within the Jurien CMR (approximately 955 km from the Operational Area) may be exposed to hydrocarbons; however, any impacts will depend on concentration, duration of exposure and the inherent toxicity of the hydrocarbons. Such impacts may result in localised, long term effects to community structure and habitat.
	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 oil. Potential impacts may occur due to surface hydrocarbon contact with intertidal areas, including sandy shores, mudflats and rocky shores, listed in **Table A- 12.** Hydrocarbons at sandy shores are incorporated into fine sediments through mixing in the surface layers from wave energy, penetration down worm burrows and root pores. Hydrocarbons in the intertidal zone can adhere to sand particles however high tide may remove some or most of the hydrocarbons back out of the

	sediments. Typically hydrocarbons are only incorporated into the surface layers to a maximum of 10 cm. It is predicted that a number of sandy shores along the coastline may have accumulation of hydrocarbons ≥ 100 g/m^2 (see **Table A- 12**). As described earlier, accumulated hydrocarbons ≥ 100 g/m^2 could impact the survival and reproductive capacity of benthic epifaunal invertebrates living in intertidal habitat. The persistent of the hydrocarbons will be dependent on the wave exposure but can be months to years. The impact of oil 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 oil. 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. The location of rocky shores where impacts are predicted are listed in **Table A- 12**. Intertidal mudflats are susceptible to potential impacts from hydrocarbons as they are typically low energy environments and therefore trap oils. Intertidal mudflat have been identified in the ZoC along the Ningaloo coast, Pilbara coastline and as far north as Indonesia (see **Table A- 12**). 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 oil will penetrate the water-saturated sediments. However, oil can penetrate find 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. The toxicity of stranded surface hydrocarbons and the in-water toxicity of the entrained or dissolved hydrocarbons reaching the shorelines identified in **Table A- 12** will determine impacts to the marine biotaorganisms such as sessile barnacle species and/or mobile gastropods and crustaceans such as amphipods. Lethal and sublethal impacts may be expected where the entrained or dissolved hydrocarbon concentration threshold is > 500 ppb. Impacts may result in localised changes to the community structure of these shoreline habitats which would be expected to recover in the medium term (2-5 years).
Indonesia	**Open Water – Productivity/Upwelling:** The Lesser Sunda and Southern Java ecoregions of Indonesia experience seasonal upwellings that support megafauna such as migratory cetacean species. The potential impacts to cetaceans from surface hydrocarbons are discussed above in Offshore – Cetaceans and Mainland and Islands (nearshore waters) – Cetaceans. Megafauna attracted to seasonal upwellings may experience indirect impacts if the spill was to coincide with a seasonal event such as plankton aggregations. However, surface slicks that have not entered the water column by entrainment or dissolution are unlikely to have a significant impact on plankton populations, as only a small proportion of the population will be close to the surface. The main pathways for direct exposure and contamination of plankton are digestion and transport of hydrocarbon particles through the gut, and exposure to oil in water emulsions which adhere to the external body wall or gills. Both these pathways are unlikely to result from surface hydrocarbons, particularly Greater Enfield crude which demonstrates little potential for entrainment or dissolution. Therefore, significant impacts on open water productivity and upwelling in Indonesian waters are unlikely.
	Spawning/Nursery Areas: As discussed for Indonesia – Pelagic Fish, there is the potential for intertidal nursery areas such as mangroves and seagrass meadows to be contacted by surface hydrocarbons at or above threshold concentrations, potentially leading to impacts such as smothering and dieback, and consequently indirect impacts to early life stages of marine fauna species (such as fish species targeted by local fishers) utilising these habitats. Therefore, 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).
	Nearshore Filter Feeders: Potential impacts to nearshore filter feeders in Indonesian waters are unlikely, given the lack of entrain or dissolved hydrocarbons, and the limited potential for surface slicks of Greater Enfield crude to entrain into the water column.
	Sandy Shores/Estuaries/Tributaries/Creeks (Including Mudflats)/Rocky Shores: The islands of the Lesser Sunda and Southern Java ecoregions have the potential to be contacted by surface hydrocarbons and accumulated hydrocarbons above threshold levels. The potential impacts to shoreline habitats are discussed above for Mainland and Islands (nearshore waters) – sandy Shores/Estuaries/Tributaries/Creeks (including mudflats)/Rock Shores. Prolonged stranding of surface hydrocarbons, particularly for low energy environments such as

<table>
<tr><td></td><td>mudflats may lead to localised changes to the community structure of these shoreline habitats which would be expected to recover in the medium term (2-5 years).</td></tr>
<tr><td>Key Ecological Features</td><td>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;
Western rock lobster;
Ancient coastline at 90-120 m depth;
Perth Canyon and adjacent shelf break, and other west coast canyons;
Commonwealth marine environment surrounding the Houtman Abrolhos Islands;
Commonwealth marine environment within and adjacent to the west coast inshore lagoons;
Canyons linking the Argo Abyssal Plain with the Scott Plateau;
Seringapatam Reef and Commonwealth waters in the Scott Reef Complex;
Commonwealth marine environment within and adjacent to Geographe Bay;
Cape Mentelle upwelling; and
Ashmore Reef and Cartier Island and surrounding Commonwealth waters.
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 event are predicted to result in moderate impacts with values of the KEFs affected. 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 ZoC have relatively broad-scale distributions and are unlikely to be significantly impacted.</td></tr>
<tr><td colspan="2">Summary of Potential Impacts to Water Quality</td></tr>
<tr><td>Setting</td><td>Receptor group</td></tr>
<tr><td>Offshore</td><td>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 ZoC descriptions for each o surface, entrained and dissolved hydrocarbon fates and their predicted extent (refer to Table A- 12). 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.</td></tr>
<tr><td>Submerged Shoals</td><td>Open Water – Water Quality: Water quality would be reduced due to hydrocarbon contamination that is predicted to be at or above biological effect concentrations for the surrounding marine waters over Rankin Bank, Glomar Shoals and Rowley Shoals. The surface waters overlying the submerged banks and shoals have the potential to be exposed to entrained hydrocarbons/dissolved aromatic hydrocarbons (at or greater than 500 ppb, note not contact by entrained or dissolved hydrocarbons > 500 ppb predicted for Rowley Shoals). The waters surrounding these permanently submerged habitats, would show a reduction in quality due to hydrocarbon contamination above background and/or national/international quality standards.</td></tr>
</table>

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 A- 12**). 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.
Indonesia	**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 surface hydrocarbons in nearshore waters of the Lesser Sunda and Southern Java ecoregions. Such reduction in water quality is predicted to have minor long term or significant short term hydrocarbon contamination above background and/or national/international quality standards.
Summary of Potential Impacts to Marine Sediment Quality	
Setting	**Receptor Group**
Offshore	**Marine Sediment Quality**: In the event of a major hydrocarbon release at the seabed, modelling indicates that a pressurised release of the hydrocarbon would atomise into droplets that would be rapidly transported into the water column to the surface. As a result the extent of potential impacts to the seabed area at and surrounding the release site would be confined to a localised footprint. Marine sediment quality would be reduced (contamination above national/international quality standards) as a consequence of hydrocarbon contamination for a small area within the immediate release site for a long to medium term.
Submerged Shoals	**Marine Sediment Quality:** There is potential for the reduction of marine sediment quality due to contact and adherence of entrained hydrocarbons with seabed sediments of the submerged shoals. If this was to occur, marine sediment quality would be reduced (contamination above national/international quality standards) as a consequence of hydrocarbon contamination for a small area within the immediate release site for a long to medium term.
Mainland and Islands (Nearshore waters)	**Marine Sediment Quality:** Surface, entrained and dissolved hydrocarbons (at or above the defined thresholds) are predicted to potentially contact shallow, nearshore waters of identified islands and mainland coastlines (refer to **Table A- 12**) and hydrocarbons may accumulate (at or above the ecological threshold) at a number of shorelines (refer to **Table A- 12**). Such hydrocarbon contact may lead to reduced marine sediment quality by several processes, such as adherence to sediment and deposition shores or seabed habitat. Surface slicks predicted to potentially contact areas of the Ningaloo Coast also have the potential to reduce sediment quality due hydrocarbon contamination above background and/or national/international quality standards for the medium term.
Indonesia	**Marine Sediment Quality:** Surface and accumulated hydrocarbons at or above the defined thresholds are predicted to potentially contact shallow, nearshore waters and shorelines within the Lesser Sunda and Southern Java Ecoregions. Such hydrocarbon contact may lead to reduced marine sediment quality by several processes, such as adherence to sediment and deposition on shores or seabed habitat. Surface slicks predicted to potentially contact coastal areas may also have the potential to reduce sediment quality due hydrocarbon contamination above background and/or national/international quality standards for the medium term.
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 well loss of 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 50 km away), the potential impacts are expected to be minor and temporary.	
Summary of impacts to Protected Areas	

The quantitative spill risk assessment results indicate that the open water environment protected within the Commonwealth Marine Reserves listed in **Table A- 12** 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 ZoC (refer to **Table A- 12**).

Modelling results indicate potential contact with the Ningaloo WHA (refer to **Table A- 12**), therefore objectives of the relevant management plans (Management Plan for Ningaloo Marine Park and Muiron Islands Marine Management Areas, Ningaloo Marine Park Management Plan) require considerations to Water quality, coral, shoreline and intertidal, macroalgal, seagrass, mangroves, seabirds and social and economic values. Impact on the protected area is discussed in the sections above for ecological values and sensitivities and below for socio-economic values.

There is also the potential for the following Indonesian Marine National Parks and National Parks to be contact by surface and accumulated hydrocarbons at or above threshold levels:

- Laut Sawu Marine National Park;
- Manupeu Tanadaru National Park;
- Laiwangi Wanggameti National Park; and
- Komodo National Park.

Impact on the protected areas is discussed in the sections above for ecological values and sensitivities and below for socio-economic values. Additionally, such hydrocarbon contact may alter stakeholder understanding and/or perception of the protected marine environment, given these represent areas largely unaffected by anthropogenic influences and contain biological diverse environments.

Summary of Potential Impacts to Socio-Economic Values	
Setting	**Receptor Group**
Offshore	**Fisheries - Commercial:** Spill scenarios modelled may cause significant direct impacts on the target species of Commonwealth and offshore State fisheries within the defined ZoC. Further details are provided below (impact assessment relating to spawning is discusses above under ‘Summary of potential impacts to other habitats and communities’). *Western Tuna and Billfish, Southern Bluefin Tuna, Western Skipjack Fishery and West Australian Mackerel Fisheries:* The tuna fisheries (Western Tuna and Billfish, Western Skipjack Fishery Southern Bluefin Tuna fisheries for which limited fishing activity has occurred in this area in recent years) and the Western Australian Mackerel fishery target pelagic fish species. Adult fish are highly mobile and able to move away from the spill affected area or avoid the surface waters; however, hydrocarbon concentrations in the upper water column could lead to potential exposure through direct absorption of hydrocarbons and indirectly by the consumption of contaminated prey. 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. A major loss of hydrocarbon from the Petroleum Activities Program may lead to an exclusion of fishing from the spill affected area for an extended period. *Western Deep Trawl and Northwest Slope Trawl Fisheries:* The predicted ZoC resulting from an uncontrolled loss of hydrocarbon from a well blowout may result in direct impacts on the species fished by the Northwest Slope Trawl Fishery and Western Deep Trawl Fishery. These fisheries target benthic species (demersal finfish and crustaceans) in greater than 200 m water depth. The Northwest Slope Trawl fishery targets scampi and deepwater prawns, these species are less mobile and will therefore not be able to easily move away from the location of a well blowout. Mortality/sub lethal effects may impact populations located close to the well blowout location. While the Western Deep Trawl fishery targets over 50+ demersal fish species. Mortality and sub lethal effects may impact localised populations of targeted species located close to the well blow out and within the ZoC for entrained/dissolved hydrocarbons (≥500 ppb). However, the entrained hydrocarbon is likely to be confined in the upper water column and therefore the demersal species are less likely to be exposed to hydrocarbons than pelagic species. This is particularly relevant as the majority of the fishing effort, for both these fisheries, is located distant from the location of a potential well blowout, populations in these areas are less likely to be impacted significantly as hydrocarbons at this distance are likely to be confined in the upper water column. A major loss of hydrocarbons from the Petroleum Activities Program may lead to an exclusion of fishing from the spill affected area for an extended period. *State Fisheries*: The predicted ZoC resulting from a major spill may impact on the area fished by a number of State fisheries. 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. The demersal and crustacean (prawn) fisheries are located over 20 km from the location of a potential well blowout, populations in these areas are less likely to be impacted significantly as hydrocarbons at this distance are likely to be entrained/dissolved or weathered and confined in the upper water column. A major loss of hydrocarbons from the Petroleum Activities Program may lead to an exclusion of fishing from the spill affected area for an extended period. A number of other State and Commonwealth fisheries, further afield in the ZoC, 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. 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. 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 for the Exmouth region. 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 hydrocarbons from the Petroleum Activities Program may lead to exclusion of marine nature-based tourist activities, 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 based on the perception of hydrocarbon spills and associated impacts resulting in moderate, medium term (5-10 years) impacts to community and highly valued areas.
	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 Nganhurra FPSO (operated by Woodside). Other nearby facilities include the Quadrant 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.
Submerged shoals	**Tourism and Recreation:** In the unlikely event of a major spill a temporary prohibition on charter boat recreational fishing trips and any other marine nature-based tourism trips to Rankin Bank, Glomar Shoals and Rowley Shoals may be put into effect, depending on the trajectory of the plume, resulting in a loss of revenue for operators.
Mainland and Islands (Nearshore Waters)	**Fisheries - Commercial:** *Nearshore Fisheries and Aquaculture:* In the unlikely event of a loss of well containment, there is the possibility that target species in some areas utilised by a number of state fisheries, including pearl aquaculture in the North West Cape (including Exmouth Gulf) and wild oysters in the Pearl Oyster Managed Fishery that are within the nearfield ZoC and further afield the Western Rock Lobster Fishery and a number of west coast and south coast fisheries could be affected. Targeted fish, prawn, mollusc and lobster species and pearl oysters could

	experience sub-lethal stress, or in some instances, mortality depending on the concentration and duration of hydrocarbon exposure and its inherent toxicity. In addition, there is also the potential for commercial and artisanal Indonesian fisheries and aquaculture (e.g. seaweed farming) to be impacted (see above for potential impacts to seagrasses). *Prawn Managed Fisheries:* In the event of a major spill, the modelling indicated the surface, entrained and dissolved ZoC may extend to nearshore waters closest to the mainland Pilbara and Gascoyne coasts, including the actively fished areas of the designated Onslow Prawn Managed Fishery, Exmouth Gulf Prawn managed Fishery and the Shark Bay Prawn and Scallop Managed Fishery, and managed prawn nursery areas. Note that the majority of the demarcated area for the prawn managed fishery in the Exmouth Gulf (proper) is outside the ZoC. 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. 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 Muiron Islands, Montebello Islands, Barrow Island, Lowendal Islands, Pilbara Northern and Southern Island Groups, Shark Bay, and mangrove and seagrass habitats of the Ningaloo Coast are located within the ZoC 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: The wider ZoC intersects the formally recognised MoU box covering Scott Reef and surrounds, Seringapatam Reef and Ashmore Reef. Indonesian traditional fishers target trochus, sea cucumbers (holothurians), abalone, green snail, sponges, giant clams and finfish, including sharks, are targeted by the fishers. Impacts would be similar to those identified for commercial fishing in the form of a potential exclusion zone and contamination/tainting of fish stocks.
	Tourism and Recreation: In the unlikely event of a major spill, the nearshore waters of the Ningaloo coast and shorelines further south and north (including Indonesia) could be reached by surface slicks, entrained hydrocarbons and dissolved hydrocarbons, depending on prevailing wind and current conditions. As these locations offer a number of amenities such as fishing, swimming and utilisation of beaches and surrounds, they have a recreational value for local residents and visitors (regional, national and international). If a well blowout event resulted in hydrocarbon contact, there could be restricted access to beaches for a period of days to weeks, until natural weathering, tides, currents or oil spill response (e.g. shoreline clean-up is safe to do so) remove the hydrocarbons. In the event of a well blowout event, tourists and recreational users may also avoid areas due to perceived impacts, including after the oil spill has dispersed. Typically, a hydrocarbon spill that results in visible slicks in coastal waters and on shorelines will disrupt recreational activities, particularly tourism and its supporting services. In the unlikely event of a well blowout event, hydrocarbons may accumulate on shorelines (at or above a set threshold), and there is potential for visible surface slicks (<10 g/m^2) (i.e. a rainbow sheen) to reach sensitive receptor locations, for example, key tourist areas of the Ningaloo Coast (see **Table A- 12** for the full list of receptors). As a result of surface slicks in nearshore waters and potential accumulation on beaches, it is expected that there will be a temporary cessation of all marine-based tourism activities on the spill-affected coast and wider coastal area for a period of weeks or longer until natural weathering or tides and currents remove the hydrocarbons or clean-up operations remove beached oil. There is potential for stakeholder perception that this 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.
	Cultural Heritage: A number of historic shipwrecks have been identified in the vicinity of North West Cape. The spill results do not predict surface slicks contacting the identified wrecks.

	However, shipwrecks occurring in the subtidal zone will be exposed to entrained/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). The foreshore and hinterland of North West Cape and along the coastline to Shark Bay contain numerous Indigenous sites such as burial grounds, middens and fish traps. Only sites that are located below the high water mark are expected to be impacted from a spill. This could result in hydrocarbon contamination of the site which may affect the cultural significance and traditional practices associated with the sites. Within the wider ZoC a number of places are designated on the National Heritage List. These places are also covered by other designations such as World Heritage Areas, marine parks, listed shipwrecks. Potential impacts have therefore, been discussed in the sections above.
Indonesia	**Fisheries – traditional:** The Lesser Sunda and Southern Java ecoregions of Indonesia are a productive area for Indonesian artisanal fisheries. The potential impacts to these fisheries from surface hydrocarbons at or above threshold levels would be similar to those described above for Offshore and Mainland and Islands traditional and commercial fisheries, and would be likely to include exclusion zones and the potential tainting/contamination of catch. Indirect impacts may include impacts to local economies of coastal communities.
	Aquaculture: Within the Lesser Sunda and Southern Java ecoregions, aquaculture, encompassing a variety of species and methods, contributes significantly to local employment and food production. The main species farmed are seaweed, prawns and fish. In the event that surface hydrocarbons at or above threshold levels contacted aquaculture operations, impacts are likely to include shutdown of production, contamination/tainting of product and in the case of seagrass potentially exposed at low tides, smothering and dieback. Indirect impacts are likely to include loss of income and economic impacts to coastal communities.
	Tourism and Recreation: Tourism is a major industry within the Lesser Sunda and Southern Java ecoregions, with the islands of Bali, Flores, Lombok, Komodo and the Gili Islands particularly important popular tourist destinations, with beach and coastal activities primary attractions. Contact with surface or accumulated hydrocarbons above threshold levels with these areas is likely to result in similar impacts to those described above for Mainland and Islands (nearshore waters) – Tourism and Recreation and would include restricted access to beaches for a period of days to weeks or longer and the potential for tourist perception that this environment will be contaminated over a large area and for the longer term resulting in a potential prolonged period of tourism decline. Indirect impacts are likely to include loss of income and economic disruption to a portion of the Lesser Sunda and Southern Java ecoregions.

Summary of Potential Impacts to environmental values(s)

In the unlikely event of a major hydrocarbon spill due to a well blowout the ZoC includes the areas listed in **Table A- 12**, including but not limited to, the sensitive marine environments and associated receptors of the Ningaloo Coast, Muiron Islands, Exmouth Gulf, the Pilbara Southern and Northern Island Groups, Shark Bay, Barrow/Montebello/Lowendal Islands, Abrolhos Islands, Southern Indonesian Islands and any sensitive receptors in the open waters amongst these key receptor locations. In summary, there is unlikely to be a serious (> 10 years) long-term environmental impact on the offshore deepwater environment whereas long term impacts may occur at sensitive nearshore and shoreline habitats, particularly, areas of the Ningaloo coast, as a result of a major spill of hydrocarbon from drilling activities within the Operational Area.

As per the Woodside risk matrix, the overall environmental consequence is defined as an ‘A’ - ‘Catastrophic, long term impact on highly valued ecosystem, species, habitat or physical or biological attributes’. The likelihood of the event is defined as a ‘1’ - ‘Highly Unlikely’ resulting in a risk ranking of high.

Summary of Control Measures

- Offshore Petroleum and Greenhouse Gas Storage (Resource Management and Administration) Regulations 2011: Accepted WOMP and Well Activity Notification (WAN).
- Woodside’s Well Acceptance Criteria Procedure details the as-built checks that shall be completed during well operations to establish a minimum acceptable standard of well integrity is achieved.
- Woodside Suspension and Abandonment Procedure.
- Woodside blowout contingency planning procedure details specifications for well design to assess the feasibility of performing a well kill operation.

- 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; and
    - API Standard 53 4th Edition.
- Mitigation: Oil spill response.

Unplanned Hydrocarbon Release: Subsea Loss of Containment

Source of Risk	Environmental Value Potentially Impacted							Evaluation		
	Soil and Groundwater	Marine Sediment	Water Quality	Air Quality (incl. odour)	Ecosystems / Habitats	Species	Socio-economic	Consequence	Likelihood	Residual Risk
Subsea loss of containment (hydrocarbon or preservation fluid release) as a result of a dropped object from a MODU, ISV or activity support vessel.		X	X		X	X	X	A	2	M
Subsea loss of containment (hydrocarbon or preservation fluid release) as a result of MODU anchor drag, caused by MODU mooring loss of integrity (moored MODU only).		X	X		X	X	X	A	2	M
Subsea loss of containment as a result of encountering a shallow gas hazard during drilling activities.		X	X		X	X	X	A	2	L

Description of Source of Risk

Loss of Containment from Subsea Infrastructure

During the Petroleum Activities Program, the MODU, PIVs and activity support vessels may be operating in the vicinity of subsea infrastructure. Consequently, there is the potential for a dropped object or loss of control of a suspended load (or anchor drag in the case of a moored MODU) to impact subsea infrastructure, including a loss of containment from the following:

- Completed Greater Enfield Tieback wells (including Xmas trees), resulting in a worst case release of 5 m^3 of hydrocarbons. Any release would likely be restricted to a small volume of fluid present between the last proven isolation in the well casing (SCSSSV which will be proven and closed) and the well head. All well heads will have isolations proven prior to subsea installation activities commencing as per the Woodside Engineering Standard – Subsea Isolation and Woodside Engineering Standard – Well Barriers.
- Installed Greater Enfield Tieback subsea system, including the production flowline (but only during pre-commissioning when the flowline is filled with treated seawater):
    - 3,000 m^3 of treated seawater (approximately 170 m^3 of chemicals)

The below credible subsea loss of containment scenario is assessed and managed under the existing NY FPSO Operations EP.

- Loss of containment from the Vincent Flowline (NY FPSO Operations EP).

Loss of containment of production hydrocarbons from the Greater Enfield Tieback production flowline is only applicable post hydrocarbon commissioning when it is live with hydrocarbons, and is therefore not relevant to this EP and will be the subject of a revision to the NY FPSO Operations EP.

Consequently, the controls, performance standards and measurement criteria related to the above scenarios are outside the scope of this EP. However, this EP does present controls relevant to this Petroleum Activities Program that manage the risk of a subsea loss of containment.

Shallow Gas Hazards

During drilling activities, shallow gas hazards may be encountered when drilling through the overburden layer. This has the potential to result in a release of gas to the marine environment. The worst case release volume associated with encountering shallow gas is unknown, however, a shallow gas risk study completed by Woodside for the proposed well locations indicates a low likelihood (between approximately 0.375% and 7.5%) of encountering shallow gas.

Potential Environmental Impacts

Summary of Potential Impacts to environmental values(s)

Subsea Loss of Containment – Hydrocarbon Release

The potential biological and ecological impacts associated with much larger hydrocarbon spills are presented in detailed risk assessments for Unplanned Hydrocarbon Release Well Loss of Containment and Vessel Collision. Further detail on impacts specific to a spill of Norton-1 crude as a result of an impact to an installed Greater Enfield Tieback well head, or a shallow gas release during drilling are provided below.

The biological consequences of these small volume releases 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 detailed risk assessment for an Unplanned Hydrocarbon Release from Loss of Well Containment for the detailed potential impacts; however, the extent of the ZoC associated with a loss of containment from a Greater Enfield Tieback well head will be greatly reduced in terms of spatial and temporal scales, and hence, potential impacts are considered slight and temporary.

Subsea Loss of Containment – Preservation Fluid Release

The potential biological and ecological impacts associated with a release of 3,000 m^3 of preservation fluid (approximately 170 m^3 of chemicals from a flowline impacted by MODU anchor drag are presented in detailed risk assessment for Routine and Non-routine Discharges of Subsea Installation and Commissioning Activities. It is considered that this would not result in a potential impact greater than minor and/or short-term contamination above background levels, water quality standards, or known effect concentrations, and localised and temporary impacts to marine fauna.

Subsea Loss of Containment – Hydrocarbon Gas Release

The worst case release volume associated with encountering shallow hydrocarbon gas is predicted to be small with potential impacts limited to localised reductions in air quality providing a minor contribution to greenhouse gas emissions. No impacts to marine fauna are expected beyond a localised and short term disturbance.

Summary of Control Measures

- The MODU, ISVs and activity support vessels work procedures for lifts, bulk transfers and cargo loading.
- MODU and project vessel inductions include control measures and training for crew in dropped object prevention.
- Woodside Engineering Standard – Subsea Isolation: Proven isolation in place prior to commencement of subsea installation activities.
- Anchors installed as per mooring design analysis to ensure adequate MODU station holding capacity
- Woodside Well Location and Site Appraisal Data Sheet (WLSADS) include environmental sensitivity and seabed topography to inform the selection of the MODU mooring locations.
- Woodside's Engineering Standard – Rig Equipment specifications and requirements for station keeping equipment (DP and mooring systems)
- ROV observations during drilling for shallow gas detection
- Known shallow gas hazards mapped and primary well locations and trajectories planned to avoid these locations. Shallow hazard well contingencies developed and implemented
- Offshore Petroleum and Greenhouse Gas Storage (Resource Management and Administration) Regulations 2011: Accepted WOMP.
- Woodside's Well Acceptance Criteria Procedure details the as-built checks that shall be completed during well operations to establish a minimum acceptable standard of well integrity is achieved.
- MODU to be tracked when unmanned.
- Mitigation: Oil spill response.

Accidental Hydrocarbon Release: Vessel Collision

Source of Risk	Environmental Value Potentially Impacted							Evaluation		
	Soil and Groundwater	Marine Sediment	Water Quality	Air Quality (incl. odour)	Ecosystems / Habitats	Species	Socio-economic	Consequence	Likelihood	Residual Risk
Loss of hydrocarbons to marine environment due to a vessel collision (e.g. activity support vessels or other marine users).			X		X	X	X	D	1	M

Description of Source of Risk

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 involving the ISV. The modelling assessed the extent of a marine diesel spill volume of 683 m^3 for all seasons, using an historic sample of wind and current data for the region. A total of 200 simulations for each season 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 A- 8**). 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. Up to 95% of the spill volume is expected to evaporate over time (**Figure A- 8**). The remaining 5% is persistent and will reduce in concentration through degradation and dissolution.

Given the environmental conditions experienced in the Operational Area, marine diesel is expected to undergo rapid spreading and this, together with evaporative loss, is likely to result in a rapid dissipation of the spill. Marine diesel distillates tend not to form emulsions at the temperatures found in the region. Therefore, there is limited potential for the spill to extend to sensitive shorelines or mainland receptors above threshold concentrations. The characteristics of the marine diesel used in the modelling are given in **Table A- 13.**

Table A- 13: 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	0.829	4.0	% of total	6	34.6	54.4	5

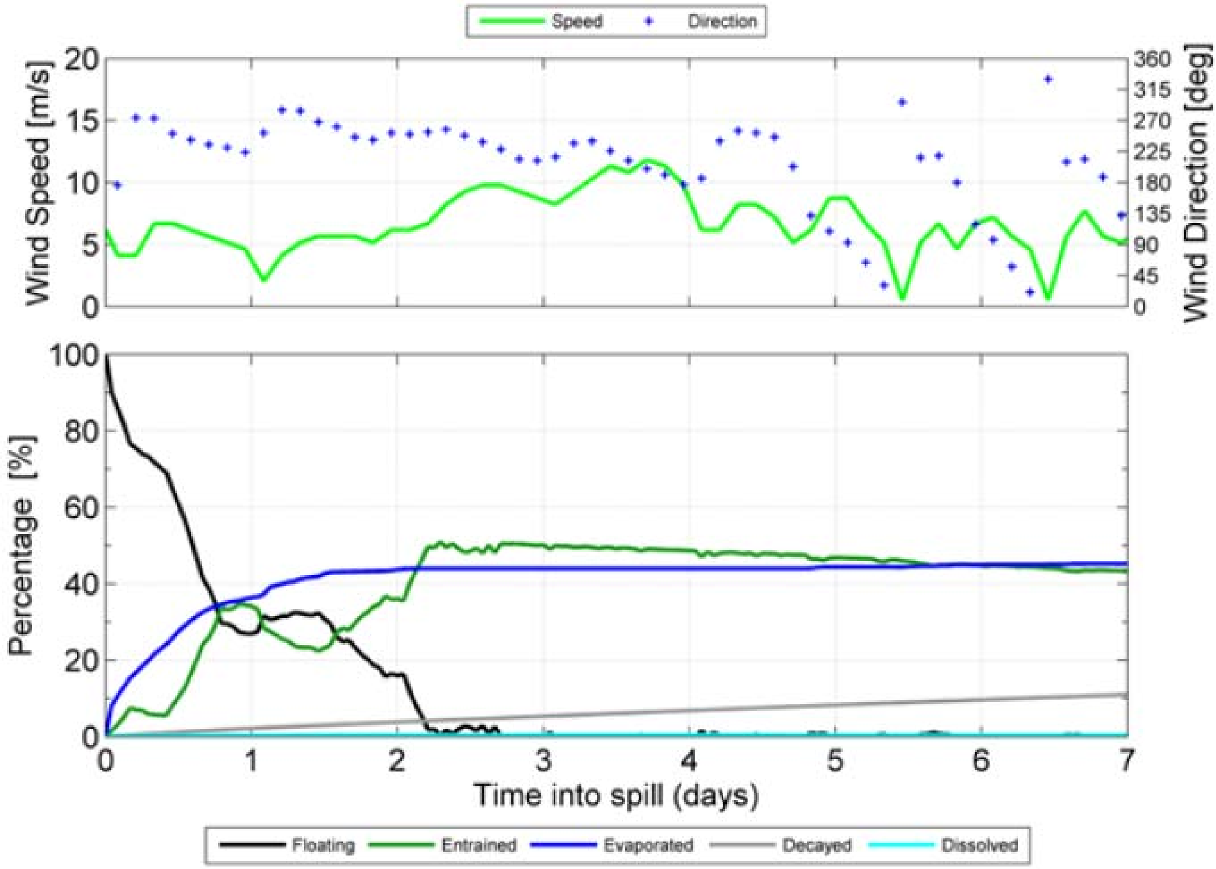

Figure A- 8: Proportional mass balance plot representing weathering of a surface spill of 50 m³ of marine diesel

Potential Environmental Impacts
Potential Impacts Overview
ZoC **Surface hydrocarbons:** 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 ZoC would extend up to approximately 150 km from the release location. No contact with sensitive shoreline receptors was predicted. **Entrained hydrocarbons:** In the event that this vessel collision scenario occurred, a plume of entrained hydrocarbons would form down current of the release location with the trajectory dependent on prevailing current conditions at the time. The modelling indicates that the ZoC may extend for up to 300 km from the release location. Ningaloo coast (the WHA and CMR) was the only sensitive receptor location predicted to be contacted by entrained hydrocarbons above threshold concentrations (500 ppb). **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, and a ZoC figure is not presented. **Accumulated hydrocarbons**: Accumulated hydrocarbons above threshold concentrations (>100 g/m²) were not predicted by the modelling to occur at any location. **Summary of potential impacts** In the unlikely event of a spill of marine diesel as a result of vessel collision, the ZoC is expected to remain primarily restricted to the open ocean only (Commonwealth waters), with only limited potential to contact the Ningaloo coast (WHA and CMR). No other sensitive receptor locations are predicted to be contacted. Consequently, a ZoC summary table is not presented.
Potential Impacts to Protected Species, Ecosystems/Habitats, Water Quality, Protected Areas and Socio-Economic Sensitivities
The potential biological and ecological impacts associated with hydrocarbon spills are presented in the detailed risk assessment for an Unplanned Hydrocarbon Release from Loss of Well Containment. 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

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 ZoC may spatially overlap with identified BIAs, it is considered that protected species that are present will be predominantly transiting through the area. Additionally, the ZoC 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 ZoC 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. With the relatively small ZoC 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 ZoC 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 ZoC 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) may be within the ZoC, 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 ZoC and the rapid dispersion of marine diesel. The potential impact is therefore expected to be low.

Protected areas

The ZoC may extend into the Ningaloo Coast WHA and CMR. In the unlikely event of a spill and 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 which overlap with the ZoC. These fisheries target demersal fish species (demersal finfish and crustaceans) that inhabit waters in the range of >60–200 m depth or pelagic species which are highly mobile. Therefore, a marine diesel spill due is expected to only result in negligible impacts, considering the relatively small area of the ZoC 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 from 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 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'.
Summary of Control Measures
• Marine Orders 30 (Prevention of Collisions) 2009. • Marine Order 21 (Safety of navigation and emergency procedures) 2012. • Establishment of a 500 m petroleum safety zone around MODU and communicated to marine users. • Activity support vessel is on standby during drilling activities to communicate with third-party vessels and assist in maintaining the petroleum safety zone. • The activity support vessel will undertake actions to prevent unplanned interactions. • AHS of relevant activities and movements • Notify relevant State and Commonwealth fisheries of activities. • Notify AMSA JRCC of relevant activities and movements. • Mitigation: Oil spill response.

Unplanned Hydrocarbon Discharges: Bunkering

Source of Risk	Environmental Value Potentially Impacted							Evaluation		
	Soil and Groundwater	Marine Sediment	Water Quality	Air Quality (incl. odour)	Ecosystems / Habitats	Species	Socio-economic	Consequence	Likelihood	Residual Risk
Loss of hydrocarbons to marine environment from bunkering.			X			X		E	3	M

Description of Source of Risk

Credible Scenario

Bunkering of marine diesel between the activity support vessel/s and the MODU or ISV will occur within the Operational Area. Additionally, refuelling of helicopters using aviation jet fuel may take place onboard the MODU, ISV and activity support vessels.

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 delay 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 substitute for aviation jet fuel for the purposes of this environmental risk assessment. Woodside has commissioned RPS APASA to model several small marine diesel spills, including surface spill volumes of 8 m^3 in the offshore waters of northwest WA. 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 ZoC for the vessel collision scenario in the detailed risk assessment for an Unplanned Hydrocarbon Release – Vessel Collision. 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 detailed risk assessment for an Unplanned Hydrocarbon Release – Vessel Collision for a description of the characteristics of marine diesel, including detail on the predicted fate and weathering of a spill to the marine environment.

Potential Environmental Impacts

Potential Impacts to Water Quality and Protected Species

Previous modelling studies for 8 m^3 marine diesel releases, spilt a 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 detailed risk assessments for Unplanned Hydrocarbon Release for Well Loss of Containment and Vessel Collision, 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 potential impacts of unplanned hydrocarbon release to the marine environment from vessel collision for the detailed potential impacts; however, the extent of the ZoC 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 slight and temporary.

Summary of Control Measures

- Marine Order 91 (Marine pollution prevention – oil) 2006.
- The Woodside Engineering Standard – Rig Equipment and Woodside Engineering Operating Standard – Standard for Construction Vessels (ISVs) details requirements for the management of bunkering equipment.
- The contractor bunkering/helicopter refuelling procedures specify control measures to be implemented during bunkering/ refuelling operations.
- Mitigation: Oil spill response

Unplanned Discharges: Deck and Subsea Spills

Source of Risk	Environmental Value Potentially Impacted							Evaluation		
	Soil and Groundwater	Marine Sediment	Water Quality	Air Quality (incl. odour)	Ecosystems / Habitats	Species	Socio-economic	Consequence	Likelihood	Residual Risk
Accidental discharge of other hydrocarbons / chemicals from MODU or project vessel deck activities and equipment (e.g. cranes) and subsea ROV hydraulic fluid leaks.			X		X	X		E	1	L

Description of Source of Risk

Deck spills can result from spills from stored hydrocarbons/chemicals or equipment. MODU, ISVs and activity support 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).

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.

- Minor leaks during wire line activities (a contingent activity) with a live well are described to include leaks such as:
- leaks from the lubricator, stuffing box and hose or fitting failure, which are expected to be less than 10 L (0.01 m^3)
- loss of containment - fluids - surface holding tanks
- backloading of raw slop fluids in an Intermediate Bulk Container/s (IBC)
- 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 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.

Potential Environmental Impacts

Potential Impacts to Water Quality, Ecosystems/Habitats and Protected Species

Accidental spills of hydrocarbons or chemicals from the MODU, ISVs and activity support 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 the detailed risk assessment for an Unplanned Hydrocarbon Release from Well Loss of Containment, 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. Refer to detailed risk assessment of an Unplanned Hydrocarbon Release from Vessel Collision for 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.
Summary of Control Measures
• Marine Order 91 (Marine pollution prevention – oil) 2006. • The Australian Government Civil Aviation Safety Authority CAAP 92-4(0) ‘Guidelines for the development and operation of off-shore helicopter landing sites, including vessels’. • Environmental Performance Procedure details chemical storage and handling requirements. • Woodside’s Engineering Standard – Rig Equipment details deck drainage system requirements. • Woodside’s Engineering Standard – Rig Equipment which includes requirements for onboard spill kits. • PIVs have self-containing hydraulic oil drip tray management system to contain any on-deck spills of hydraulic oil from ROVs. • Mitigation: Oil spill response

Unplanned Discharges: Loss of Hazardous / Non-hazardous Waste

Source of Risk	Environmental Value Potentially Impacted							Evaluation		
	Soil and Groundwater	Marine Sediment	Water Quality	Air Quality (incl. odour)	Ecosystems / Habitats	Species	Socio-economic	Consequence	Likelihood	Residual Risk
Accidental loss of hazardous or non-hazardous wastes to the marine environment (excludes sewage, grey water, putrescible waste and bilge water).			X		X	X		F	2	L

Description of Source of Risk

The MODU, ISVs and activity support 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. Woodside's Drilling function has not reported any significant loss of solid wastes to the marine environment during the past 12 months of operations. Wastes that have been recorded as being lost (primarily windblown or dropped overboard) have included the loss of a wooden crate lid. These have occurred during backloading activities, periods of adverse weather and incorrect waste storage.

Potential Environmental Impacts

Potential Impacts to Water Quality, other Habitats and Communities and Protected Species

The potential impacts of solid wastes accidentally discharged to the marine environment include direct pollution and contamination of the environment and secondary impacts relating to potential contact of marine fauna with wastes, resulting in entanglement or ingestion and leading to injury and death of individual animals. The temporary or permanent loss of waste materials into the marine environment is not likely to have a significant environmental impact, based on the location of the Operational Area, the types, size and frequency of wastes that could occur and species present.

Summary of Potential Impacts to environmental values(s)

Given the adopted controls, it is considered that the accidental discharge of solid waste described will not result in a potential impact greater than slight and temporary contamination above background levels, water quality standards, or known effect concentrations.

Summary of Control Measures

- Marine Orders 95 – pollution prevention – Garbage (as appropriate to vessel class).
- The Drilling and Completions Waste Management Plan, or equivalent subsea activity plan, which includes requirements for waste.
- Project vessel ROV or crane used to attempt recovery of solid wastes lost overboard.

Unplanned Discharges: Drilling Fluids

Source of Risk	Environmental Value Potentially Impacted							Evaluation		
	Soil and Groundwater	Marine Sediment	Water Quality	Air Quality (incl. odour)	Ecosystems / Habitats	Species	Socio-economic	Consequence	Likelihood	Residual Risk
Accidental discharge of drilling fluids (NWBM/WBM/base oil) to marine environment from MODU during bulk transfer, incorrect management or failure of deck drainage systems, failure of slip joint packers or emergency disconnect system (EDS)		X	X		X	X		E	1	L

Description of Source of Risk

Transfers

A support vessel undertakes bulk transfer of NWBM to the MODU, if and when, required. At the conclusion of the drilling sequence, any remaining NWBM is backloaded to a support vessel for transport back to the onshore mud plant for conditioning and reuse or disposal onshore. Failure of a transfer hose or fittings during a transfer or backload, as a result of an integrity or fatigue issue, could result in a spill of NWBM to either the bunded deck or into the marine environment.

Similar to a spill event during refuelling (refer to detailed risk assessment for an Unplanned Discharges from Deck and Subsea Spills), the most likely spill volume of NWBM is likely to be less than 0.2 m^3 based on the volume of the transfer hose and the immediate shutoff of the pumps by personnel involved in the bulk transfer process. However, the worst-case credible spill scenario could result in up to 8 m^3 of NWBM being discharged. This scenario represents a complete failure of the bulk transfer hose, combined with a failure to follow procedures requiring transfer activities to be monitored, coupled with a failure to immediately shut off pumps (e.g. NWBM pumped through a failed transfer hose for a period of approximately five minutes).

Slip Joint Packer Failure

The slip joint packer enables compensation for the dynamic movement of the MODU (heave) in relation to the static location of the BOP. A partial or total failure of the slip joint packer could result in a loss of NWBM to the marine environment. The likely causes of this failure include a loss of pressure in the pneumatic (primary) system combined with loss of pressure in the back up (hydraulic) system.

Catastrophic sequential failure of both slip joint packers (pneumatic and hydraulic) would trigger the alarm and result in a loss of the volume of fluid above the slip joint (conservatively 1.5 m^3), plus the volume of fluid lost in the one minute (maximum) taken to shut down the pumps. At a flow rate of 1000 gallons per minute (gpm) this volume would equate to an additional 3.8 m^3. In total, it is expected that this catastrophic failure would result in a loss of 5.2 m^3.

Failure of either of the slip joint packers at a rate not large enough to trigger the alarms could result in an undetected loss of 20 bbl (3 m^3) maximum assuming a loss rate of 10 bbl/hr for one hour and that MODU personnel would walk past the moonpool at least every two hours. The slip joint is under camera surveillance to the drillers control cabin.

Activation of the EDS

The EDS is an emergency system that provides a rapid means of shutting in the well (i.e. BOP closed) and disconnecting the MODU from the BOP. There are two main scenarios where the EDS could be activated: (1) automatic activation of the EDS due to a loss of MODU station keeping that results from a “DP drive-off” or loss of power to the DP system or loss of multiple moorings; and (2) manual activation of the EDS due an identified threat to the safety of the MODU including potential collision by a third-party vessel or loss of well containment.

The activation of the EDS can result in the release of the entire volume of the marine riser to the marine environment. When drilling, this could result in a subsurface release of a combination of NWBM and cuttings at the seabed and a release of base fluid. The volume of base fluid released depends on the water depth and hence the length of the riser (the entire riser volume would be lost). However, this is expected to be smaller than the volumes modelled for subsea loss of containment scenarios presented in detailed risk assessments for Unplanned Hydrocarbon Releases from Well Loss of Containment, Subsea Loss of Containment and Vessel Collision. The potential impacts from a hydrocarbon loss of containment are discussed in Unplanned Hydrocarbon Releases from Well Loss of Containment. It is expected the weight of NWBM would result in the majority of the release settling to the seabed and/or remaining at depth within the water column. The base oil of the NWBM would remain in an emulsion with the other components of the mud system and drill cuttings.

NWBM Drilling fluid system

The selection of a NWBM drilling fluid system is based on Woodside processes; however, for the purposes of this risk assessment, a base case of base oil (Saraline 185V) has been used. Saraline 185V is a mixture of volatile to low volatility hydrocarbons. Predicted weathering of base oil, based on typical conditions in the region, indicates that approximately 50% by mass is predicted to evaporate over the first day or two (refer to **Table A- 14**). At this time, the majority of the remainder could be entrained into the water column, in calm conditions entrained hydrocarbons are likely to resurface with up to 100% will be able to evaporate over time.

Table A- 14: Characteristics of the Non Water Based Mud base oil

Oil Type	Initial Density (kg/m³)	Viscosity (cP @ 20˚C)	Component BP (˚C)	Volatiles <180	Semi volatiles 180-265	Low Volatility (%) 265-380	Residual (%) >380	Aromatic (%) Of whole oil < 380 °C BP
				Non-Persistent			Persistent	
Base oil (Saraline 185 v)	0.7760	2.0 @ 40ºC	% of total	8.5	41.1	50.4	0	0

Potential Environmental Impacts

Potential Impacts to Water Quality, Marine Sediments and Protected Species

Indicative components of the WBM drilling fluid system are 'non-toxic' or 'almost non-toxic'. Bentonite and guar gum are listed as 'E' category fluids under the OCNS and considered to PLONOR. Barite and bentonite sweeps may also be used and may contain some heavy metal concentrations, but not in a readily bioavailable form. Both substances have very low toxicities and are considered by OSPAR to be PLONOR to the environment. They may, however, cause physical damage to benthic organisms by abrasion or clogging, or through changes in sediment texture that can inhibit the settlement of planktonic polychaete and mollusc larvae. However, these impacts are not expected to be significant due to the rapid biodegradation and dispersion of WBM drilling fluids and no significant habitats/biota are considered to be present in the Operational Area. The dilution of solid elements of the WBM into substrate largely depends on the energy level of the local environment and the 'mixing' that takes place, but is expected to occur rapidly following release (especially with WBM). The low sensitivity of the benthic communities/habitats combined with the low toxicity of WBM and low physical impacts affirm that any significant impact is considered unlikely.

Base fluids for NWBM are designed to be biodegradable in offshore marine sediments. Biodegradation can result in a low oxygen (anoxic) environment resulting in changes in benthic community structure. However, this is dependent on the bioavailability of the base fluid. Species sensitive to anoxic environments are eliminated and replaced by tolerant and opportunistic species, so species diversity decreases, but the number of individuals often increases. NWBM are designed to be low in toxicity and are not bioavailable, based on their physical/chemical properties, for bioaccumulation to infauna and epifauna.

Based on the volumes discharged (10% oil on cuttings by weight only) and dilution, concentrations of base fluid are unlikely to be high. Combined with low toxicity to water-column organisms, there is little risk of direct toxicity to water-column organisms. Marine fauna may be affected if they come in direct contact with a release (i.e. by traversing the immediate spill area), but due to the small footprint of such a spill, it is anticipated that any impacts would be negligible and temporary in nature.

The ZoC associated with the release of NWBM from the activation of the EDS would be small, and limited to deeper water seabed surrounding the well site (the release point). The environmental consequence of such NWBM release would include a highly localised area at the discharge location. Lethal impacts to the underlying infauna may occur but are considered unlikely, and recolonisation would occur over time. Elevated hydrocarbon and metal concentrations in the localised area of deposition would also occur, with reduction over time. It is likely that any impacts to water and sediment quality (including within the Canyons KEF and Continental Slope Demersal Fish Communities KEF) and low-sensitivity deeper water benthos would be short term, localised and recovery expected.

Summary of Potential Impacts to environmental values(s)

Given the adopted controls, it is considered that accidental discharge of drilling fluids will not result in a potential impact greater than localised impacts to infauna and benthic communities, minor and/or temporary contamination above background levels, water quality standards, or known effect concentrations.

Summary of Control Measures

- Woodside Engineering Standard for Rig Equipment which specifies requirements for deck drainage and management of oily water for MODU.
- Woodside Engineering Standard for Rig Equipment which specifies requirements for the MODU marine riser's telescopic joint.

- Woodside's Chemical Selection and Assessment Environment Guideline for drilling, completions, fluids.
- Woodside NWBM Start-up Checklist Parts 1 and 2.
- Environmental Performance Procedure which restricts overboard bulk discharge of NWBM.
- Mud transfers onto, around and off the MODU shall be managed using contractor procedures.

Unplanned Atmospheric Emissions: Well Kick

Source of Risk	Environmental Value Potentially Impacted							Evaluation		
	Soil and Groundwater	Marine Sediment	Water Quality	Air Quality (incl. odour)	Ecosystems / Habitats	Species	Socio-economic	Consequence	Likelihood	Residual Risk
Unplanned venting of gas during drilling (well kick).				X				F	2	L

Description of Source of Risk

During drilling of the well, a kick may occur in the reservoir. A kick is an undesirable influx of formation fluid into the wellbore. The resultant effect would be a release of a small volume of greenhouse gases via the degasser to the atmosphere during well control operations.

Potential Environmental Impacts

Potential Impacts to Protected Species

Localised and temporary reduction in air quality as the gas vents to the atmosphere, and localised and temporary contribution to greenhouse gas emissions.

There is potential for human health effects for workers in the immediate vicinity of atmospheric emissions. However, the closest sensitive residential receptor is the town of Exmouth, approximately 50 km south-west of the Operational Area; therefore, any risks associated with off-site human health effects are negligible beyond the immediate zone of release and dispersion.

Given the short duration and isolated location of the Petroleum Activities Program (which will lead to the rapid dispersion of the low volumes of atmospheric emissions) the potential impacts are expected to be minor.

Summary of Potential Impacts to environmental values(s)

Given the adopted controls, it is considered that the release of a small volume of greenhouse gases via the degasser will not result in a potential impact greater than a localised and short-term exceedance over air quality standards.

Summary of Control Measures

- Offshore Petroleum and Greenhouse Gas Storage (Resource Management and Administration) Regulations 2011: Accepted WOMP and Well Application Notification (WAN).
- Woodside's Well Acceptance Criteria Procedure details the as-built checks that shall be completed during well operations to establish a minimum acceptable standard of well integrity is achieved.
- Woodside blowout contingency planning procedure details specifications for well design to assess the feasibility of performing a well kill operation.
- Subsea BOP specification and function testing is undertaken in accordance with internal Woodside Standards and international requirements:
    - OEM Standards;
    - Woodside Engineering Standard – Rig Equipment;
    - Woodside Engineering Manual – Well Control Manual; and
    - API Standard 53 4th Edition.
- Woodside Engineering Manual – Well Control Manual specifies the process to be undertaken to calculate, update and monitor kick tolerance for use in well design and while drilling.

Physical Presence: Collision with Marine Fauna

Source of Risk	Environmental Value Potentially Impacted							Evaluation		
	Soil and Groundwater	Marine Sediment	Water Quality	Air Quality (incl. odour)	Ecosystems / Habitats	Species	Socio-economic	Consequence	Likelihood	Residual Risk
Accidental collision between project vessels and threatened and migratory whale species.						X		F	2	L

Description of Source of Risk

The MODU, ISVs and activity support 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.

Potential Environmental Impacts

Potential Impacts to Protected Species

The likelihood of vessel/whale collision being lethal is influenced by vessel speed; the greater the speed at impact, the greater the risk of mortality. 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.

The MODU, ISVs and activity support vessels within the Operational Area are likely to be travelling less than 8 knots, therefore, the chance of a vessel collision with protected species resulting in lethal outcome is reduced. No known key aggregation areas (resting, breeding or feeding) are located within or immediately adjacent to the Operational Area; however, the following BIAs for the following relevant marine megafauna overlap with the Operational Area:

- humpback whales (migration BIA): seasonally present June to September
- pygmy blue whale (migration BIA): seasonally present April to August

Additionally BIAs for internesting flatback turtles and whale sharks are within close proximity (approximately 3 km and 5 km away, respectively) of the Operational Area.

The timing of the activity could occur at any time throughout the year (all seasons), therefore, it is possible that activity will overlap with the migration seasons or seasonal presence of the species above and it is likely that there may be increased numbers of individuals of these species within the Operational Area during the seasonal periods described above.

According to the data of Vanderlaan and Taggart (2007), it is estimated that the risk of collision with whales 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 US 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.

Whale sharks are at risk from vessel strikes when feeding at the surface or in shallow waters (where there is limited option to dive). Whale sharks may traverse offshore NWS waters including the Operational Area during their migrations to and from Ningaloo Reef and a BIA for foraging whale sharks lies adjacent to the Operational Area (within 5 km). However, it is expected that whale shark presence within the Operational Area would not comprise significant numbers given there is no main aggregation area within the vicinity of the Operational Area, and their presence would be transitory and of a short duration.

Marine mammals and fish are at risk of mortality through being caught in thrusters during station keeping operations (dynamic positioning). The risk of marine life getting caught in operating thrusters is unlikely, given the low presence of individuals, combined with the avoidance behaviour commonly displayed during dynamic positioning operations.

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 350-850 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 acknowledged that there are significant nesting sites along the mainland coast and islands of the region.

It is unlikely, that vessel movement associated with the Petroleum Activities Program will have a significant impact on marine fauna populations given (1) the low presence of transiting individuals, (2) avoidance behaviour commonly displayed by whales, whale sharks and turtles and (3) low operating speed of the MODU, ISVs and 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 and temporary disruption to a small proportion of the population and no impact on critical habitat or activity.
Summary of Control Measures
• EPBC Regulations 2000 – Part 8 Division 8.1 Interacting with cetaceans, and Woodside's Marine Charterers Instructions.

Physical Presence: Seabed Disturbance

Source of Risk	Environmental Value Potentially Impacted							Evaluation		
	Soil and Groundwater	Marine Sediment	Water Quality	Air Quality (incl. odour)	Ecosystems / Habitats	Species	Socio-economic	Consequence	Likelihood	Residual Risk
Objects dropped overboard from the MODU, ISVs and activity support vessels					X			F	2	L
Loss of MODU mooring integrity leading to seabed disturbance (moored MODU only)					X			E	1	L

Description of Source of Risk

Dropped Objects

There is the potential for objects to be dropped overboard from the MODU, ISVs and activity support vessels to the marine environment. Objects that have been dropped during previous offshore projects include small numbers of personnel protective gear (e.g. glasses, gloves, hard hats), small tools (e.g. spanners), hardware fixtures (e.g. riser hose clamp) and drill equipment (e.g. drill pipe). There is also the potential that larger subsea infrastructure such as well heads, MPPs and piping could be dropped during installation The spatial extent in which dropped objects can occur is restricted to the Operational Area.

Loss of MODU Mooring Integrity (in the event Moored MODU is used)

In the event that a moored MODU is utilised, the rig will be secured on station by a number of morning lines, as dictated by the mooring analysis, which are held in place by anchors deployed to the seabed. High energy weather events such as cyclones, while the MODU is on station, can lead to excessive loads on the mooring lines resulting in failure (either anchor(s) dragging or mooring lines parting). A failure of mooring integrity may lead to the MODU losing station, which may lead to the mooring lines and anchors attached to the MODU being trailed across the seabed.

For a moored MODU, personnel on-board are typically evacuated during cyclones. Woodside and the rig contractor implement a risk-based assessment process to aid in decision making for cyclone evacuations, with the well suspended prior to MODU evacuation. Activity support vessels also demobilise from the Operational Area during the passage of a cyclone. While the MODU is temporarily abandoned, the position of the MODU is monitored remotely for any deviation. Activity support vessels and MODU personnel return to the Operational Area as soon as safe to do so following a cyclone evacuation. Operational experience indicates cyclone evacuations typically last for 7 days.

Industry statistics from the North Sea show that a single mooring line failure for MODUs is the most common failure mechanism (33 x 10-4 per line per year), followed by a double mooring line failure (11 x 10-4 per line per year). Note that single and double mooring line failures do not typically result in the loss of station keeping. In the event of partial or complete mooring failures that are sufficient to result in a loss of station keeping, industry experience indicates that MODUs may drift considerable distances from their initial position. Partial mooring failures leading to a loss of station keeping resulted in smaller MODU displacements due to the remaining anchors dragging along the seabed when compared to complete mooring failures; complete mooring failures resulted in a freely drifting MODU.

Potential Environmental Impacts

Potential Impacts to Ecosystems/Habitats

Dropped Objects

In the unlikely event of loss of equipment or materials to the marine environment, potential environmental effects would be limited to localised physical impacts on benthic communities. As a result of recovery of any dropped objects, this impact will be temporary in nature, however, if the object cannot be recovered due to health and safety, operational constraints and other factors (locating dropped objects at depth) then the impact will be long term.

The temporary or permanent loss of dropped objects into the marine environment is not likely to have a significant environmental impact, as the benthic communities associated with the Operational Area are of low sensitivity and are broadly represented throughout the NWMR. The Canyons KEF and Continental Slope Demersal Slope Fish Communities KEF (broad-scale regional features) have been identified as occurring within the Operational Area. The habitats of the within the Operational Area have been observed to be representative of the broader NWMR and contain filter feeder and infauna assemblages similar to other areas within the Operational Area. Given the extent of the Operational Area and the nature and scale of impacts and risks from dropped objects, seabed sensitivities in the broader region (e.g. the KEFs) will not be impacted. Given the types, size and frequency of dropped objects that could occur, it is unlikely that a dropped object would have a significant impact on the marine environment.

Loss of MODU Mooring Integrity

Marine Primary Producers

Given the water depth (approximately 350 - 850 m) and the bathymetry of the Operational Area, benthic primary producer habitat is not expected to be present. The nearest areas expected to host significant benthic primary producer habitat are the Ningaloo WHA and Muiron Islands (17 and 35 km from the Operational Area respectively), however, such habitat is expected to be distributed in shallow waters throughout the region.

In the event of a loss of mooring integrity with partial failure of mooring lines, the remaining intact mooring lines may result in anchors (and potentially chains) being dragged through benthic primary producer habitat distant from the Operational Area. This may result in physical damage include scarring of the seabed habitat, and damage to the sessile benthic biota such as hard and soft corals, including the breakage of corals, and indirect damage through the movement of dislodged corals colonies and shifting sediments and rubble created during the initial impact. Similar impacts would be expected in the event of the MODU grounding in shallow waters. Anticipated impacts may include localised and long term effects to corals and sensitive primary producer habitats.

Other Benthic Habitats and Communities

Benthic habitats in the Operational Area are expected to largely consist of bare unconsolidated sediments dominated by silt and clay fractions. Therefore, potential impacts that may result from a MODU breaking its mooring and dragging anchors during a cyclone are likely to be to other benthic habitats and communities in the surrounding vicinity, including:

- soft sediment
- the Canyons KEF (including the Enfield Canyon, within the Operational Area)
- the continental slope demersal fish communities KEF

In the unlikely event of a cyclone resulting in the MODU breaking its moorings the anchors could cause physical damage to the hard bottom habitats (including the KEFs) and associated benthic communities (e.g. filter feeders) identified outside of the Operational Area. This would result in localised medium-term impacts to community composition and habitat structure. However, given the broad-scale distribution of the benthic habitat types within and outside the Operational Area, the scale of impact will not be significant.

Summary of Potential Impacts to environmental values(s)

Given the adopted controls and the predicted small footprint of a dropped object, it is considered that a dropped object will not result in a potential impact greater than slight and temporary disruption to a small area of the seabed, a small proportion of the benthic population and no impact on sensitive habitat. Seabed disturbance from a loss of station keeping will result in localised effects to benthic habitat. Impacts to soft sediment benthic communities would be slight and temporary localised effect, which would be expected to recover to their pre-disturbance state in a short time.

Summary of Control Measures

- Project vessel ROV or crane used to attempt recovery of solid wastes and dropped objects lost overboard where safe and practicable.
- The MODU, ISVs and activity support vessels work procedures for lifts, bulk transfers and cargo loading.
- MODU and project vessel inductions include control measures and training for crew in dropped object prevention.
- Anchors installed as per mooring design analysis to ensure adequate MODU station holding capacity
- Woodside Well Location and Site Appraisal Data Sheet (WLSADS) include environmental sensitivity and

seabed topography to inform the selection of the MODU mooring locations.

- Woodside's Engineering Standard – Rig Equipment specifications and requirements for station keeping equipment (DP and mooring systems).
- MODU to be tracked when unmanned.

Physical Presence: Accidental Introduction of Invasive Marine Species

Source of Risk	Environmental Value Potentially Impacted							Evaluation		
	Soil and Groundwater	Marine Sediment	Water Quality	Air Quality (incl. odour)	Ecosystems / Habitats	Species	Socio-economic	Consequence	Likelihood	Residual Risk
Introduction of invasive marine species.					X	X	X	D	0	L

Description of Source of Risk
During the Petroleum Activities Program, vessels will be transiting to and from the Operational Area, including traffic coming from international ports. These vessels may include the pre-lay survey vessel, general cargo vessels, heavy lift vessels, ISV, DSV, AHVs, PSVs and an intervention support vessel or light construction vessel. The MODU will remain offshore within the Operational Area. All vessels are subject to some level of marine fouling. Organisms attach to the vessel hull, particularly in areas where organisms can find a good surface (e.g. seams, strainers and unpainted surfaces) or where turbulence is lowest (e.g. niches, sea chests etc). Organisms can also be drawn into ballast tanks during onboarding of ballast water as cargo is loaded or to balance vessels under load. During the Petroleum Activities Program, the following project vessel activities have the potential to lead to the introduction of Invasive Marine Species (IMS): • Vessel to vessel interactions within the Operational Area; • Installation of subsea infrastructure[4]; and • Vessel interactions with nearby fixed infrastructure/FPSOs.
Potential Environmental Impacts
Potential Impacts to Ecosystems/Habitats
Non-indigenous Marine Species (NIMS) have been introduced into a region beyond their natural biogeographic range and have the ability to survive, reproduce and establish founder populations. Not all NIMS introduced into an area will thrive or cause demonstrable impacts. Indeed the majority of NIMS around the world are relatively benign and few have spread widely beyond sheltered ports and harbours. Only a subset of NIMS that become abundant and impact on social/cultural, human health, economic and/or environmental values can be considered Invasive Marine Species (IMS). IMS have historically been introduced and translocated around Australia by a variety of natural and human means including biofouling and ballast water. Species of concern are those that are not native to the region; are likely to survive and establish in the region; and are able to spread by human mediated or natural means. Species of concern vary from one region to another depending on various environmental factors such as water temperature, salinity, nutrient levels and habitat type. These factors dictate their survival and invasive capabilities. Introducing invasive marine species into the local marine environment may alter the ecosystem, as invasive species have characteristics that make them superior (in a survival and/or reproductive sense) to the indigenous species. They may predate on local species (which had previously not been subject to this kind of predation and therefore not have evolved protective measures against the attack), 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. Invasive marine species 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). Introduced marine species have proven particularly difficult to eradicate from areas, once established. If the introduction is captured 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 high consequence of the establishment of a marine pest within a high value environment as a result of introduction, the deep offshore open waters of the Operational Area, away from shorelines and/or critical habitat, more

[4] Subsea infrastructure mobilised to the Operational Area for installation will be cleaned and dried at topsides and therefore, presents no risk of introduction of IMS, this aspect of the IMS introduction risk is therefore not discussed further in this EP.

than 12 nm from a shore and in waters 350 – 850 m deep are not conducive to the settlement and establishment of IMS (Geiling 2016), most likely due to the lack of light or suitable habitat to sustain growth and survival.

When examining nearby fixed infrastructure and FPSOs (ie Ningaloo Vision and Ngujima-Yin FPSOs), both within and in proximity to the operational area. Interactions with the FPSOs will be limited during the petroleum activity program, with 500m safety exclusion zones being adhered to and operations associated with the RTM occurring once the Ngujima-Yin FPSO has left the field. There is however remote potential for the transfer of marine pests to occur. If IMS were to establish this would potentially result in fouling of intakes (depending on the pest introduced), transfer of pests to other support vessels (and translocation to other marine areas) and would likely result in the quarantine of the FPSO/ Fixed Infrastructure until eradication could occur (through cleaning and treatment of infected areas), which would be costly to undertake. Such introduction would be expected to have minor impact to Woodside's reputation and brand, particularly if the introduction was to a non-Woodside operated FPSO, and close scrutiny of asset level operations or future proposals.

This risk of this occurring is however considered manageable given the implementation of ballast water and biofouling controls which will be implemented during the project.

Summary of Potential Impacts to environmental values(s)

In support of Woodside's assessment of the impacts and risks of IMS introduction associated with the petroleum activity program, Woodside conducted a risk and impact evaluation of the different aspects of a marine pest translocation. The results of this assessment are presented in the table below.

As a result of this assessment Woodside has presented the highest potential consequence as a D and likelihood as Remote (0), resulting in an overall Low risk following the implementation of identified controls.

IMS Introduction Location	**Credibility of Introduction**	**Consequence of Introduction**	**Likelihood**
Introduced to operational area and establishment on the seafloor or subsea structures	**Not Credible** The deep offshore open waters of the Operational Area, away from shorelines and/or critical habitat, more than 12 nm from a shore and in waters 350 – 850 m deep are not conducive to the settlement and establishment of IMS		
Introduced to operational area and established on FPSOs or RTM	**Credible** There is potential for the transfer of marine pests to occur	Reputation and Brand – D [5] If IMS were to establish this would potentially result in fouling of intakes (depending on the pest introduced), transfer of pests to other support vessels and would likely result in the quarantine of the FPSO/ Fixed Infrastructure until eradication could occur (through cleaning and treatment of infected areas), which would be costly to undertake. Such introduction would be expected to have minor impact to Woodside's reputation and brand, particularly if the introduction was to a non-Woodside operated FPSO, and close scrutiny of asset level operations or future proposals.	Remote (0) Interactions with the FPSOs will be limited during the petroleum activity program, with 500m safety exclusion zones being adhered to and operations associated with the RTM occurring once the Ngujima-Yin FPSO has left the field. Spread of marine pests via ballast water or spawning in these open ocean environments is considered remote.

[5] Note – the translocation of IMS from an "infected" FPSO or fixed infrastructure to shallower environments is not considered credible given the distances of infrastructure from nearshore environments (ie 12nm/50 water depth).

Transfer from project vessel to FPSO or RTM to support vessel (and by extension from support vessels to other marine environments)	**Not Credible** Risk is considered so remote that it is not credible for the purposes of the GEP. The transfer of a marine pest from a project vessel to nearby fixed infrastructure or FPSOs was already considered remote given the offshore open ocean environment. For a marine pests to then establish into a mature spawning population and then transfer to a support vessel is not considered credible (ie beyond the Woodside risk matrix). FPSO's are locates in offshore, open ocean, deep environments. Support vessels only spend short periods of time alongside FPSOs (ie during backloading or bunkering activities). There is also no direct contact (ie they are not tied up alongside) during these activities. Its' also noted that Woodside has been conducting marine vessel movements between FPSOs and ports (such as Dampier), no IMS has been detected in these ports.		

Summary of Control Measures

- All project vessels will undertake ballast water exchange or treat ballast water using an approved ballast water treatment system [6].
- Woodside's IMS risk assessment process[7] will be 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.

[6] Once the Ballast Water Management Convention enters into force for Australia on 8 September 2017, these requirements, under the *Biosecurity Act 2015*, will be updated and apply nationwide.

[7] The correct management of IMS requires careful consideration of multiple complex factors. These range from an understanding of the vectors through which IMS can be introduced and spread, the maintenance and operational history of vessels and rigs proposed to be used, climatic conditions, existing baseline data of past and proposed transit and operational areas and consideration of different regulatory frameworks.
Woodside's approach simplifies the management of IMS into a standardised toolkit that includes an IMS management plan, lists of 'species of concern', risk assessment score sheets, inspection procedures and a Contractor Information Pack to ensure the risk is managed in a simple and efficient manner. Woodside's risk-based process also delivers continued value to Woodside by reducing the risk of project delays and increased operational costs, whilst delivering excellent marine biosecurity and environmental outcomes.
Woodside's approach has been validated through a proactive program that engaged stakeholders during development of the methodology. This included Woodside personnel, scientific input and review by experienced external IMS consultants, recognised industry experts and liaison with regulatory agencies and vessel contractors. The result is a fit-for-purpose biofouling management process that is now embedded within Woodside's marine systems, procedures and contractual requirements.

APPENDIX B: CONTROL MITIGATION MEASURES FOR POTENTIAL ENVIRONMENTAL IMPACTS ASSOCIATED WITH SPILL RESPONSE ACTIVITIES

Monitor and Evaluate

Response Strategy Risk & Impact Evaluation

Description of Source of Risk

Additional risks associated with the monitor and evaluate response not included within the scope of the EP include:

Seabed disturbance that may be associated with Vessel anchoring

During the implementation of response strategies, where water depths allow, it is possible that response vessels will be required to anchor (e.g. during shoreline surveys). The use of vessel anchoring will be minimal, and likely to occur when the impacted shoreline is inaccessible via road to shoreline response teams.

Presence of personnel

During the implementation of response strategies, it is possible that personnel may have minimal, localised impacts on habitats, wildlife and coastlines.

Previously Assessed Environmental Risks

Field-based activities undertaken during the Monitor and Evaluate Response Strategy including monitoring, surveillance and reconnaissance involving vessel, aircraft operations, and shoreline surveys present risks to the environment. Several of these risks have been previously assessed within the scope of the EP (**Section 5**) including;

- *Atmospheric emissions*
- *Routine and non-routine discharges*
- *Physical presence, proximity to other vessels* (shipping and fisheries)
- *Routine acoustic emissions vessels*
- *Lighting for night work/navigational safety*
- *Collision with marine fauna*

Refer to the EP for details regarding how these risks are being managed to an ALARP and acceptable level.

**Note, any additional controls and environmental performance outcomes relating to these risks that are not presented in the EP but are specific to the monitor and evaluate response are presented below.*

Impacts and Risks Evaluation Summary

	Environmental Value Potentially Impacted						
	Soil & Groundwater	Marine Sediment Quality	Water Quality	Air Quality	Ecosystems/ Habitat	Protected Species	Socio-Economic
Standard Control Measures		X	X	X	X	X	X

Impact Assessment
Potential Impacts to marine sediments, water quality, air quality, protected species, socio-economic and protected areas
Seabed disturbance that may be associated with Vessel anchoring • Anchoring in the nearshore environment, such as the Response Protection Areas (RPAs), may impact nearshore coral reefs, seagrass beds and benthic communities in these areas. Impacts would be highly localised (restricted to the footprint of the vessel anchor) and temporary, with full recovery expected. **Presence of personnel during shoreline survey operations resulting in disturbance to wildlife and habitats. The impacts associated with human presence on shorelines during shoreline surveys include:** • Damage to vegetation/habitat to gain access to areas; • Damage or disturbance to wildlife and habitats during shoreline surveys; • Removal of surface layers of intertidal sediments (potential habitat depletion); and • Excessive removal of substrate can have erosion and instability effects.
Summary of Adopted Controls
• Woodside has arrangements through its external memberships, external arrangements, and internal arrangements to implement Monitor and Evaluate activities. • Woodside will activate and terminate Operational Monitoring plans in accordance with Woodsides Operational Monitoring Operational Plan (W0000AH932960) • The operational NEBA will assess anchoring impacts to sensitive benthic receptors. Existing mooring points will be utilised wherever possible, or alternatively anchor locations will be selected to reduce benthic disturbance. • Environmental impacts from shoreline surveys will be assessed during the Operational NEBA process. • Woodside will use shallow draft vessels for remote shoreline access including Woodsides own small vessel

Surface Dispersant Application

Description of Source of Risk
Dispersants remove hydrocarbons from surface waters (typically by surface application) or prevent hydrocarbons from reaching surface waters (subsea application), thereby reducing the risk of air breathing marine fauna (e.g. cetaceans, dugongs, marine turtles, seabirds and shorebirds) from becoming oiled and reducing/eliminating contamination of sensitive intertidal habitats such as mangroves, coral reefs, salt marshes and sandy shores (recreational and tourist areas). Chemical dispersants act to break up hydrocarbons by reducing surface tension between the oil and the surrounding water. Dispersants, whether applied on the surface or subsea, results in the breakup of hydrocarbons into micron-sized droplets, which are easier to disperse throughout the water column. In addition, these small, dispersed hydrocarbons droplets are degraded more rapidly by bacteria due to the increased surface area presented by the droplets and therefore, the application of dispersants can enhance biodegradation and dissolution. Surface application of dispersants results in the micron-sized droplets being mixed into the upper layer of the water column, usually the first 10 to 20 m, through wave action. These elevated concentrations of dispersed hydrocarbons within the upper layer of the water column are rapidly diluted through vertical and horizontal mixing The application of subsea dispersant is similar; however, the dispersed hydrocarbon droplets are trapped at depth in the water column due to their reduced buoyancy. This results in a larger entrained hydrocarbon plume, at depth near the application location. Therefore, by dispersing hydrocarbons, there is a greater risk that water column and subtidal habitats could be exposed to elevated concentrations of dispersed hydrocarbons. Note that potential impacts from the use of dispersants and increased entrainment of hydrocarbons as a result of dispersant use are discussed below.

Impacts and Risks Evaluation Summary							
Response Strategy	Environmental Value Potentially Impacted						
	Soil & Groundwater	Marine Sediment Quality	Water Quality	Air Quality	Ecosystems/ Habitat	Species	Socio-Economic

Source Control		X	X	X	X	X	X
Previously Assessed Environmental Risks							

Potential risks to the environment from activities associated with the surface dispersant response that are covered within the scope of the EP (**Section 5)**, include:

- *Atmospheric emissions*
- *Routine and non-routine discharges*
- *Physical presence, proximity to other vessels* (shipping and fisheries)
- *Routine acoustic emissions*
- *Lighting for night work/navigational safety*
- *Invasive marine species*
- *Collision with marine fauna*

Refer to the EP for details regarding how these risks are being managed to an ALARP and acceptable level.

**Note, any additional controls and environmental performance outcomes relating to these risks that are not presented in the EP but are specific to the surface dispersant response are presented below.*

Impact Assessment

Potential Impacts to marine sediments, water quality, air quality, protected species, socio-economic and protected areas

Assessment of Likely Redistribution of Hydrocarbons for this Petroleum Activities Program

An assessment of the use of dispersant (both subsea and surface application) was undertaken for a loss of well control scenario utilising dispersant modelling. The modelling was based on conservative hydrocarbon release volumes to compare the fate and trajectory of dispersed hydrocarbons compared to untreated hydrocarbons, to evaluate the use of this response strategy as appropriate to a hydrocarbon spill, as part of the Petroleum Activities Program. The results indicated:

- application of dispersant, particularly subsea dispersant, is effective in reducing the proportion of realised hydrocarbons that would reach or remain floating on the surface
- the amount of hydrocarbon predicted to be entrained in the water column increases at most receptor locations, with dispersant application from the trapping of treated entrained hydrocarbons at a lower depth (from subsea dispersant application) due to the greatly reduced droplet size and therefore reduced buoyancy
- overall, the application of dispersant reduces the maximum local concentrations and maximum accumulated volumes at receptors predicted to be contacted by floating hydrocarbons, and reduces the number of hydrocarbons reaching the shoreline. It also results in some reduction in the overall length of shorelines affected
- subsea application is the dominant factor resulting in a reduction of the overall contact with near shore or shallow receptors

The assessment has shown that the application of dispersants is likely to reduce local surface concentrations and accumulated volumes at the RPAs of the Ningaloo Coast, Montebello/Barrow Islands Group and Shark Bay, as well as sensitive areas with longer times to contact above thresholds (e.g. Murion Islands). However, it is likely that the entrained concentrations at these receptors would increase as a result. Modelling has indicated that multiple Priority Protection Areas (within the ZoC see Section 5 of the EP) are predicted to receive worst case maximum entrained hydrocarbon concentrations above the threshold level of 500 ppb from an unmitigated release. Therefore, it is considered that the application of dispersant, leading to increased concentrations of entrained hydrocarbons whilst reducing the concentrations and volumes of surface hydrocarbons will result in decreased impacts to sensitive biological receptors. Impacts to marine-based tourism (including recreational beaches) including along the Ningaloo Coast and the coastline south to Shark Bay may also be reduced.

Toxicity of Dispersant and Dispersed Hydrocarbons

The evaluation of the potential impacts to the receiving environment needs to consider not only the redistribution of hydrocarbons into the water column, but also the potential toxic nature of the dispersant applied and the toxicity effects of dispersed hydrocarbons.

The potential toxicity to the marine environment can be from the chemical/dispersant itself but also chemical dispersion of hydrocarbon can dramatically increase the concentration of toxic hydrocarbon compounds in the water column (Anderson et al 2014). Subtidal habitats and communities such as coral reefs, seagrass meadows, plankton, fish, known spawning grounds and periods of increased reproductive outputs (early life stages of fish and invertebrates i.e.

meroplankton) are highly susceptible to toxic effects of chemically dispersed hydrocarbons.

The toxicity effects of entrained hydrocarbons depend on the hydrocarbon exposure in terms of type (e.g. bioavailability of PAH components), concentration and duration. Toxicity testing has been undertaken on eight commercial dispersant types on the National Contingency Plan (NCP) Product Schedule, the United States Environmental Protection Authority (EPA) list of dispersants, that may be used to remove or control oil discharges, and results indicated that toxicity ranged from moderately toxic (LC50> 1 to 10 mg/L) to practically nontoxic (LC50>100 mg/L) (Hemmer et al 2011). However, the sensitivity of organism to dispersants and dispersed hydrocarbons is species and situation specific and will vary from near shore subtidal habitats to offshore in the water column.

It is known that redistributing surface expressions of the hydrocarbon into entrained plumes (small droplets) exposes biological sensitivities to more of the toxic compounds in the hydrocarbon source, such as PAHs, but in general, the mechanisms of dispersed hydrocarbon toxicity to marine organisms are poorly understood (NRC, 2010). The degree of dispersed hydrocarbon exposure would depend on the dilution of the dispersed hydrocarbons before they reach the subtidal environment.

Furthermore, a range of factors such as the distance from the response area (dispersant ZoA), type of dispersant, dispersant effectiveness, application methods, relative buoyancy of the dispersed oil droplets and the extent of their vertical distribution in the water column, water depth and near-shore wave energy are expected to influence exposure concentrations.

Generally, the application of dispersants is expected to result in a decrease in entrained hydrocarbons in the near shore environment away from the ZoA. However, there are instances where the use of dispersants may increase the entrained hydrocarbons at distant areas, therefore, potentially increasing the exposure of subtidal habitats, including corals, to elevated hydrocarbons over a larger area. Corals are considered more sensitive than other subtidal habitats and have therefore been used as a bioindicator for toxicity from dispersants and dispersed hydrocarbons. Both field and laboratory studies have assessed impacts on corals because of exposure to undispersed and dispersed hydrocarbons and there is evidence that the reproductive life stages including fertilisation, larval survivorship, settlement and metamorphosis are most sensitive and more likely to be impacted than adult corals. Studies have indicated significant impacts to coral early life stages which range from as low as 0.325 mg L-1 for coral fertilisation exposed to crude oil and Corexit ® 9527 (Negri and Heyward, 2000) and up to 6.9 mg L-1 for larval survivorship of 12-day old coral larvae exposed to heavy fuel oil (HFO) and Ardrox 6120 (Harrison, 1999). Therefore, the use of dispersant should be assessed through an operational NEBA during coral spawning periods. Recent Deepwater Horizon-related studies have shown the chemical dispersant Corexit® 9500 has the potential to negatively impact coral larvae settlement and survivorship with settlement failure and complete larval mortality after exposure to 50 and 100 mg L-1 (ppm) for Montastrea faveolata and 100 ppm for Porites astreoides (Goodbody-Grinley et al., 2013). Chemically-dispersed hydrocarbons also have potential to cause significant mortality to adult stages at high dispersant concentrations (Shafir et al., 2007). Adult coral findings range from increased impacts to limited differences or temporary impacts (reviewed in NAS, 2005; Le Gore et al., 1989). A field experiment in Panama showed treatment of crude oil with dispersant over corals resulted in long-term reduction in coral cover (Ward et al., 2003); however, the actual concentrations of dispersed hydrocarbons were not measured

The use of dispersants is likely to increase entrained hydrocarbons in the offshore environment in the vicinity of the dispersant ZoA, both in the upper water column (10-20 m) and at depth. Therefore, it is likely that impacts will be to pelagic organisms in the water column in the offshore environment, including plankton, invertebrates and fish. The exposure of planktonic organisms to dissolved hydrocarbon is likely to increase with the application of dispersants, thereby resulting in greater hydrocarbon exposure for planktonic organisms with a given amount of hydrocarbon in the water column when dispersant is present. This has been recorded in studies where chemically enhanced water accommodated fraction (CEWAF) had higher TPH concentrations for given nominal loads (Cohen et al 2014). A recent Deepwater Horizon-related study assessed the toxicity (LC50) of dispersed hydrocarbons (CEWAF), using Corexit®EC9500A, for Labidocera aestiva, a copepod. Acute toxicity for CEWAF was 27.5ug/L (measured in 48h LC50 tests) and acute effects on L. aestiva included impaired swimming upon CEWAF exposure (Cohen et al 2014). Another Deepwater Horizon related study looked at eight different dispersants for two aquatic species, mysid shrimp (Americamysis bahia) and inland silversides (Menidia beryllina), acute toxicity ranged from 0.39 mg/l to 9.7 mg/l and 0.64 mg/l to 13.1 mg/l, respectively. These results indicate that dispersed hydrocarbons can cause mortality and sublethal effects, dependent on concentration, on planktonic organisms within the water column (Hemmer et al 2011).

Summary of Adopted Controls

- Woodside has arrangements through its external memberships, external arrangements, and internal arrangements to implement a Surface Dispersant response.
- Woodside will activate and terminate Surface Dispersant activities in accordance with Woodsides Surface Dispersant Operational Plan (W0000AH932960)
- Dispersant will only be applied to the Zone of Application (ZoA) identified within the First Strike Plan
- Dispersant spraying equipment will be located on project support vessels and crews will be trained on dispersant spraying operations.

Containment and Recovery

Description of Source of Risk

Containment and recovery typically involves the deployment of boom and skimmers from suitable vessels, as well as the collection, transfer and disposal of oily water recovered during the response.

Additional risks associated with the containment and recovery response not included within the scope of the EP include:

Waste generation and disposal leading to secondary contamination

It is possible for an unplanned release of recovered oily water to the marine environment causing secondary contamination during transfer, decanting or transport activities that form part of a containment and recovery response.

Response equipment obstructing wildlife

Containment and recovery equipment such as booms and skimmers have the potential to act as obstacles or trap wildlife.

Impacts and Risks Evaluation Summary

Response Strategy	Environmental Value Potentially Impacted						
	Soil & Groundwater	Marine Sediment Quality	Water Quality	Air Quality	Ecosystems/Habitat	Species	Socio-Economic
Containment & Recovery		X	X	X	X	X	X

Previously Assessed Environmental Risks

Potential risks to the environment from activities associated with the containment and recovery response that are covered within the scope of the EP (**Section 5)**, include:

- *Atmospheric emissions*
- *Routine and non-routine discharges*
- *Physical presence, proximity to other vessels* (shipping and fisheries)
- *Routine acoustic emissions*
- *Lighting for night work/navigational safety*
- *Invasive marine species*
- *Collision with marine fauna*

Refer to the EP for details regarding how these risks are being managed to an ALARP and acceptable level.

**Note, any additional controls and environmental performance outcomes relating to these risks that are not presented in the EP but are specific to the containment and recovery response are presented below.*

Impact Assessment

Potential Impacts to marine sediments, water quality, air quality, protected species, socio-economic and protected areas

An environmental impact assessment, controls, environmental performance standards and measurement criteria for the sources of risk within the scope of the EP (as stated above) are detailed in the **Section 5** of the EP**.**

An evaluation of the impacts not within the scope of the EP are as followed:

Secondary Contamination

Secondary contamination refers to the release of hydrocarbons back to the environment during a response (potentially during containment and recovery, oiled wildlife response and shoreline clean-up). The largest volume of oily water that could be spilt is conservatively considered to be 100 m^3, i.e. the equivalent to the maximum volume stored by one CAR operation. Given the application of a conservative bulking factor of 10 when calculating the hydrocarbon content of the oily water mixture, the maximum volume of hydrocarbon that could be released is 10 m^3. The biological consequences of such a small volume spill on identified open water sensitive receptors would be expected to be similar to those associated with the unplanned release of hydrocarbons as a result of a bunkering scenario (**Section 5.7.2** of the EP), and 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. **Section 5.7.4** of the EP (potential impacts of unplanned hydrocarbon release to the marine environment from vessel collision) describes the detailed potential impacts from a hydrocarbon spill; however, the extent of the ZoC associated with a spill of recovered oily water from a containment and recovery response will be much reduced in terms of spatial and temporal scales, and hence, the potential impacts are expected to be very minor.

Waste

Implementing the selected response strategies will result in the generation of the following waste streams that will require management and disposal:

- Liquids (recovered oil/water mixture), recovered from containment and recovery operations
- Semi-solids/solids (oily solids), collected during containment and recovery operations
- Debris (e.g. seaweed, sand, woods, plastics), collected during containment and recovery operations and oiled wildlife response.

If not managed and disposed of correctly, wastes generated during the response have the potential for secondary contamination similar to that described above, impacts to wildlife through contact with or ingestion of waste materials and contamination risks if not disposed of correctly onshore. Woodside's waste management strategy to manage the potential volumes of waste generated by the selected response strategies.

Response equipment obstructing wildlife

Typical booms used in containment and recovery operations are designed to sit on the water surface, meaning that fauna capable of diving, such as cetaceans, marine turtles and seasnakes can readily avoid contact with the boom. Impacts to species that inhabit the water column such as sharks, rays and fish are not expected. Additionally, many fauna, such as cetaceans, are likely to detect and avoid the spill area, and are not expected to be present in the proximity of containment and recovery operations.

Summary of Adopted Controls

- Woodside maintains access to equipment to adequately implement and scale a containment and recovery response
- Woodside maintains access to trained personnel to adequately implement and scale a containment and recovery response
- Woodside would prioritise the use of rapid sweep and active booming systems to maximise oil encounter rates
- Woodside would use a licensed waste provider to transport, dispose and treat waste generated during containment and recovery operations to limit secondary contamination and appropriately manage any waste generated
- Containment and Recovery operations will be activated via the first strike plan (when operational monitoring identifies surface hydrocarbons are present at sufficient thicknesses) provided a net environmental benefit is identified through the Operational NEBA
- If there is a net environmental benefit, decanting of oily water will be undertaken to reduce waste volume

Subsea Dispersant Injection

Description of Source of Risk

Subsea dispersant injection is intended to prevent hydrocarbons from reaching surface waters (subsea application), thereby reducing the risk of air breathing marine fauna (e.g. cetaceans, dugongs, marine turtles, seabirds and shorebirds) from becoming oiled and reducing/eliminating contamination of sensitive intertidal habitats such as mangroves, coral reefs, salt marshes and sandy shores (recreational and tourist areas).

Chemical dispersants act to break up hydrocarbons by reducing surface tension between the oil and the surrounding water. Dispersants, whether applied on the surface or subsea, results in the breakup of hydrocarbons into micron-sized droplets, which are easier to disperse throughout the water column. In addition, these small, dispersed hydrocarbons droplets are degraded more rapidly by bacteria due to the increased surface area presented by the droplets and therefore, the application of dispersants can enhance biodegradation and dissolution. Surface application of dispersants results in the micron-sized droplets being mixed into the upper layer of the water column, usually the first 10 to 20 m, through wave action. These elevated concentrations of dispersed hydrocarbons within the upper layer of the water column are rapidly diluted through vertical and horizontal mixing

The application of subsea dispersant is similar; however, the dispersed hydrocarbon droplets are trapped at depth in the water column due to their reduced buoyancy. This results in a larger entrained hydrocarbon plume, at depth near the application location. Therefore, by dispersing hydrocarbons, there is a greater risk that water column and subtidal habitats could be exposed to elevated concentrations of dispersed hydrocarbons.

Note that potential impacts from the use of dispersants and increased entrainment of hydrocarbons as a result of dispersant use are discussed below.

Impacts and Risks Evaluation Summary

Response Strategy	**Environmental Value Potentially Impacted**						
	Soil & Groundwater	Marine Sediment Quality	Water Quality	Air Quality	Ecosystems/Habitat	Species	Socio-Economic
Source Control		X	X	X	X	X	X

Previously Assessed Environmental Risks

Potential risks to the environment from activities associated with the surface dispersant response that are covered within the scope of the EP (**Section 5)**, include:

- *Atmospheric emissions –*
- *Routine and non-routine discharges –*
- *Physical presence, proximity to other vessels* (shipping and fisheries)
- *Routine acoustic emissions*
- *Lighting for night work/navigational safety*
- *Invasive marine species*
- *Collision with marine fauna*

Refer to the EP for details regarding how these risks are being managed to an ALARP and acceptable level.

**Note, any additional controls and environmental performance outcomes relating to these risks that are not presented in the EP but are specific to the containment and recovery response are presented below.*

Impact Assessment

Potential Impacts to marine sediments, water quality, air quality, protected species, socio-economic and protected areas

Assessment of Likely Redistribution of Hydrocarbons for this Petroleum Activities Program

An assessment of the use of dispersant (both subsea and surface application) was undertaken for a loss of well control scenario utilising dispersant modelling. The modelling was based on conservative hydrocarbon release volumes to compare the fate and trajectory of dispersed hydrocarbons compared to untreated hydrocarbons, in order to evaluate the use of this response strategy as appropriate to a hydrocarbon spill, as part of the Petroleum Activities Program. The results indicated:

- application of dispersant, particularly subsea dispersant, is effective in reducing the proportion of realised hydrocarbons that would reach or remain floating on the surface
- the amount of hydrocarbon predicted to be entrained in the water column increases at most receptor locations, with dispersant application from the trapping of treated entrained hydrocarbons at a lower depth (from subsea dispersant application) due to the greatly reduced droplet size and therefore reduced buoyancy
- overall, the application of dispersant reduces the maximum local concentrations and maximum accumulated volumes at receptors predicted to be contacted by floating hydrocarbons, and reduces the amount of hydrocarbons reaching the shoreline. It also results in some reduction in the overall length of shorelines affected
- subsea application is the dominant factor resulting in a reduction of the overall contact with near shore or shallow receptors

The assessment has shown that the application of dispersants is likely to reduce local surface concentrations and accumulated volumes at the RPAs of the Ningaloo Coast, Montebello/Barrow Islands Group and Shark Bay, as well as sensitive areas with longer times to contact above thresholds (e.g. Murion Islands). However, it is likely that the entrained concentrations at these receptors would increase as a result. Modelling has indicated that multiple Priority Protection Areas (within the ZoC see Section 5 of the EP) are predicted to receive worst case maximum entrained hydrocarbon concentrations well above the threshold level of 500 ppb from an unmitigated release. Therefore, it is considered that the application of dispersant, leading to increased concentrations of entrained hydrocarbons whilst reducing the concentrations and volumes of surface hydrocarbons will result in decreased impacts to sensitive biological receptors. Impacts to marine-based tourism (including recreational beaches) including along the Ningaloo Coast and the coastline south to Shark Bay may also be reduced.

Toxicity of Dispersant and Dispersed Hydrocarbons

The evaluation of the potential impacts to the receiving environment needs to consider not only the redistribution of hydrocarbons into the water column, but also the potential toxic nature of the dispersant applied and the toxicity effects of dispersed hydrocarbons.

The potential toxicity to the marine environment can be from the chemical/dispersant itself but also chemical dispersion of hydrocarbon can dramatically increase the concentration of toxic hydrocarbon compounds in the water column (Anderson et al 2014). Subtidal habitats and communities such as coral reefs, seagrass meadows, plankton, fish, known spawning grounds and periods of increased reproductive outputs (early life stages of fish and invertebrates i.e. meroplankton) are highly susceptible to toxic effects of chemically dispersed hydrocarbons.

The toxicity effects of entrained hydrocarbons depend on the hydrocarbon exposure in terms of type (e.g. bioavailability of PAH components), concentration and duration. Toxicity testing has been undertaken on eight commercial dispersant types on the National Contingency Plan (NCP) Product Schedule, the United States Environmental Protection Authority (EPA) list of dispersants, that may be used to remove or control oil discharges, and results indicated that toxicity ranged from moderately toxic (LC50> 1 to 10 mg/L) to practically nontoxic (LC50>100 mg/L) (Hemmer et al 2011). However, the sensitivity of organism to dispersants and dispersed hydrocarbons is species and situation specific and will vary from near shore subtidal habitats to offshore in the water column.

It is known that redistributing surface expressions of the hydrocarbon into entrained plumes (small droplets) exposes biological sensitivities to more of the toxic compounds in the hydrocarbon source, such as PAHs, but in general, the mechanisms of dispersed hydrocarbon toxicity to marine organisms are poorly understood (NRC, 2010). The degree of dispersed hydrocarbon exposure would depend on the dilution of the dispersed hydrocarbons before they reach the subtidal environment.

Furthermore, a range of factors such as the distance from the response area (dispersant ZoA), type of dispersant, dispersant effectiveness, application methods, relative buoyancy of the dispersed oil droplets and the extent of their vertical distribution in the water column, water depth and near-shore wave energy are expected to influence exposure concentrations.

Generally, the application of dispersants is expected to result in a decrease in entrained hydrocarbons in the near shore environment away from the ZoA. However, there are instances where the use of dispersants may actually increase the entrained hydrocarbons at distant areas, therefore, potentially increasing the exposure of subtidal habitats, including corals, to elevated hydrocarbons over a larger area. Corals are considered more sensitive than other subtidal habitats and have therefore been used as a bioindicator for toxicity from dispersants and dispersed hydrocarbons. Both field and laboratory studies have assessed impacts on corals as a result of exposure to undispersed and dispersed hydrocarbons and there is evidence that the reproductive life stages including fertilisation, larval survivorship, settlement and metamorphosis are most sensitive and more likely to be impacted than adult corals. Studies have indicated significant impacts to coral early life stages which range from as low as 0.325 mg L-1 for coral fertilisation exposed to crude oil and Corexit ® 9527 (Negri and Heyward, 2000) and up to 6.9 mg L-1 for larval survivorship of 12-day old coral larvae exposed to heavy fuel oil (HFO) and Ardrox 6120 (Harrison, 1999). Therefore, the use of dispersant should be assessed through an operational NEBA during coral spawning periods. Recent Deepwater Horizon-related studies have shown the chemical dispersant Corexit® 9500 has the potential to negatively impact coral larvae settlement and survivorship with settlement failure and complete larval mortality after exposure to 50 and 100 mg L-1 (ppm) for Montastrea faveolata and 100 ppm for Porites astreoides (Goodbody-Grinley et al., 2013). Chemically-dispersed hydrocarbons also have potential to cause significant mortality to adult stages at high dispersant concentrations (Shafir et al., 2007). Adult coral findings

range from increased impacts to limited differences or temporary impacts (reviewed in NAS, 2005; Le Gore et al., 1989). A field experiment in Panama showed treatment of crude oil with dispersant over corals resulted in long-term reduction in coral cover (Ward et al., 2003); however, the actual concentrations of dispersed hydrocarbons were not measured The use of dispersants is likely to increase entrained hydrocarbons in the offshore environment in the vicinity of the dispersant ZoA, both in the upper water column (10-20 m) and at depth. Therefore, it is likely that impacts will be to pelagic organisms in the water column in the offshore environment, including plankton, invertebrates and fish. The exposure of planktonic organisms to dissolved hydrocarbon is likely to increase with the application of dispersants, thereby resulting in greater hydrocarbon exposure for planktonic organisms with a given amount of hydrocarbon in the water column when dispersant is present. This has been recorded in studies where chemically enhanced water accommodated fraction (CEWAF) had higher TPH concentrations for given nominal loads (Cohen et al 2014). A recent Deepwater Horizon-related study assessed the toxicity (LC50) of dispersed hydrocarbons (CEWAF), using Corexit®EC9500A, for Labidocera aestiva, a copepod. Acute toxicity for CEWAF was 27.5ug/L (measured in 48h LC50 tests) and acute effects on L. aestiva included impaired swimming upon CEWAF exposure (Cohen et al 2014). Another Deepwater Horizon related study looked at eight different dispersants for two aquatic species, mysid shrimp (Americamysis bahia) and inland silversides (Menidia beryllina), acute toxicity ranged from 0.39 mg/l to 9.7 mg/l and 0.64 mg/l to 13.1 mg/l, respectively. These results indicate that dispersed hydrocarbons can cause mortality and sublethal effects, dependent on concentration, on planktonic organisms within the water column (Hemmer et al 2011).
Summary of Adopted Controls
• Woodside maintains access to equipment to adequately implement a subsea dispersant response • Woodside maintains access to trained personnel to adequately implement a subsea dispersant response • A Subsea Dispersant response will be activated via the SFRT and Capping Stack Operational Plan (DC0000PD8782024)

Source Control

Description of Source of Risk
In the event of a worst-case loss of well control, source control would be the primary response strategy to reduce the volume of hydrocarbons released, potentially involving the following activities: • Vessel based deployment of the subsea first response toolkit (SFRT) to facilitate debris clearance by ROV • Vessel based deployment of a capping stack • Well intervention/relief well drilling.

Impacts and Risks Evaluation Summary

Response Strategy	**Environmental Value Potentially Impacted**						
	Soil & Groundwater	Marine Sediment Quality	Water Quality	Air Quality	Ecosystems/Habitat	Species	Socio-Economic
Source Control		X	X	X	X	X	X

Previously Assessed Environmental Risks
The risks and impacts of drilling a relief well are similar to those described in the EP for drilling activities. The remaining risks to the environment from vessel activities associated with the implementation of the Source control response fall within the scope of the EP (**Section 5)**, including: • *Atmospheric emissions* • *Routine and non-routine discharges* • *Physical presence, proximity to other vessels* (shipping and fisheries) • *Routine acoustic emissions* • *Lighting for night work/navigational safety* • *Collision with marine fauna-*

• *Disturbance to Seabed – **Section 5.6.2** of the EP* Refer to the EP for details regarding how these risks are being managed to an ALARP and acceptable level. **Note, any additional controls and environmental performance outcomes relating to these risks that are not presented in the EP but are specific to the source control response are presented below.*
Impact Assessment
Potential Impacts to marine sediments, water quality, air quality, protected species, socio-economic and protected areas
The risks and impacts of drilling a relief well are similar to those described in the EP for drilling activities. The remaining risks to the environment from vessel activities associated with the implementation of the Source control response fall within the scope of the EP. An environmental impact assessment, controls, environmental performance standards and measurement criteria for the sources of risk within the scope of the EP (as stated above) are detailed in Section 5 of the EP**.** Implementing a source control response strategy will not result in a potential impact greater than localised, minor and temporary contamination above background levels and/or standards with localised, minor/negligible and temporary impacts to habitats or populations.
Summary of Adopted Controls
• Woodside has arrangements through its external memberships, external arrangements and internal arrangements to implement Source Control • Woodside will activate Source Control if a net environmental benefit is identified through the operational NEBA • Selection of a dynamically positioned MODU for the activity to increase the chance of using the same MODU for any well intervention activities

Shoreline Protection and Deflection

Description of Source of Risk							
Additional risks associated with the shoreline protection and deflection response not included within the scope of the EP include: • Equipment/material/worker transport • Human Presence (boom deployment) • Waste Generation/ Disposal • Waste generation and disposal and secondary contamination							
Impacts and Risks Evaluation Summary							
Response Strategy	**Environmental Value Potentially Impacted**						
	Soil & Groundwater	Marine Sediment Quality	Water Quality	Air Quality	Ecosystems/Hab itat	Species	Socio-Economic
Shoreline Protection and Deflection	X	X	X	X	X	X	X
Previously Assessed Environmental Risks							

A number of risks assessed in Section 5 of the EP are applicable to the oil spill response strategy implementation. These are:

- Atmospheric emissions
- Routine and non-routine discharges
- Physical presence, proximity to other vessels (shipping and fisheries)-
- Routine acoustic emissions
- Routine light emissions
- Invasive marine species
- Collision with marine fauna
- Disturbance to Seabed

Refer to the EP for details regarding how these risks are being managed to an ALARP and acceptable level. The following sections address additional risks to the environment from the implementation for the oil spill response strategies not previously assessed.

Impact Assessment

Potential Impacts to marine sediments, water quality, air quality, protected species, socio-economic and protected areas

Seabed disturbance that may be associated with Vessel anchoring

- Anchoring in the nearshore environment, such as the RPAs may impact nearshore coral reefs, seagrass beds and benthic communities in these areas. Impacts would be highly localised (restricted to the footprint of the vessel anchor) and temporary, with full recovery expected.

Presence of personnel during shoreline protection and deflection operations resulting in disturbance to wildlife and habitats. The impacts associated with human presence on shorelines during shoreline surveys include:

- Damage to vegetation/habitat in order to gain access to areas;
- Damage or disturbance to wildlife and habitats during shoreline surveys;
- Removal of surface layers of intertidal sediments (potential habitat depletion); and
- Excessive removal of substrate can have erosion and instability effects.

Summary of Adopted Controls

- Woodside maintains access to equipment to adequately implement and scale a shoreline protection and deflection response
- Woodside maintains access to trained personnel to adequately implement and scale a shoreline protection and deflection response
- Shoreline Protection and Deflection operations will be activated via the first strike plan (when operational monitoring identifies there is a potential that surface hydrocarbons will contact the coastline) provided a net environmental benefit is identified through the Operational NEBA

Shoreline Cleanup

Description of Source of Risk

Shoreline clean-up consists of different manual and mechanical recovery techniques to remove hydrocarbons and contaminated debris from a shoreline to minimise ongoing environmental contamination and impact. Shoreline clean-up techniques recommended for different shoreline types and conditions that are considered to have a net environmental benefit for this Petroleum Activities Program include manual and mechanical clean-up (**Annex A**).

Additional risks associated with the shoreline clean-up response not included within the scope of the EP include:

- Human Presence (manual cleaning)
- Sediment reworking
- Vegetation cutting

Waste generation and disposal – Refer to waste generation and disposal

Impacts and Risks Evaluation Summary

<table>
<tr><th rowspan="2">Response Strategy</th><th colspan="7">Environmental Value Potentially Impacted</th></tr>
<tr><th>Soil & Groundwater</th><th>Marine Sediment Quality</th><th>Water Quality</th><th>Air Quality</th><th>Ecosystems/Hab itat</th><th>Species</th><th>Socio-Economic</th></tr>
<tr><td>Shoreline Clean-up</td><td>X</td><td>X</td><td>X</td><td>X</td><td>X</td><td>X</td><td>X</td></tr>
</table>

Previously Assessed Environmental Risks

Potential risks to the environment from activities associated with the shoreline clean up response that are covered within the scope of the EP (**Section 5**), include:

- *Atmospheric emissions*
- *Routine acoustic emissions*
- *Lighting for night work/navigational safety*

Refer to the EP for details regarding how these risks are being managed to an ALARP and acceptable level.

**Note, any additional controls and environmental performance outcomes relating to these risks that are not presented in the EP but are specific to the shoreline clean-up are presented below.*

Impact Assessment

Potential Impacts to water quality, air quality, protected species, socio-economic and protected areas

An environmental impact assessment, controls, environmental performance standards and measurement criteria for the sources of risk within the scope of the EP (as stated above) are detailed in the **Section 5.**

An evaluation of the impacts not within the scope of the EP are as followed:

- Human Presence (manual cleaning)
  - Compaction of human presence causing hydrocarbons to be buried or penetrate sediment further.
  - Damage to vegetation/habitat in order to gain access to areas
  - Removal of surface layers of intertidal sediments (potential habitat depletion).
  - Excessive removal of substrate can have erosion and instability effects.
- Sediment reworking
  - Remobilised oil could have impacts elsewhere causing secondary contamination, further covered in **Section 5.6.6** of the EP
- Vegetation cutting
  - Cutting back too much vegetation could allow more oil to penetrate substrate.
  - Removing too much vegetation or slow growing vegetation can have negative impact for wildlife (habitat loss).

Waste generation and disposal – Refer to waste generation and disposal in Section

Summary of Adopted Controls

- Woodside maintains access to equipment to adequately implement and scale a shoreline cleanup response
- Woodside maintains access to trained personnel to adequately implement and scale a shoreline cleanup response
- Shoreline cleanup operations will be activated via the first strike plan (when operational monitoring identifies there is shoreline contact at sufficient concentrations for an effective shoreline cleanup response) provided a net environmental benefit is identified through the Operational NEBA

Oiled Wildlife Response

Description of Source of Risk
An oiled wildlife response would involve reconnaissance from vessels, aircraft and shoreline surveys, the capture, transport, rehabilitation and release of oiled wildlife. Additional risks associated with the wildlife response not included within the scope of the EP include: • Capturing wildlife • Transporting wildlife • Stabilisation of wildlife • Cleaning and rinsing of oiled wildlife • Rehabilitation (e.g. diet, cage size, housing density) • Release of treated wildlife *Waste generation and disposal – Refer to waste generation*

Impacts and Risks Evaluation Summary

Response Strategy	Environmental Value Potentially Impacted						
	Soil & Groundwater	Marine Sediment Quality	Water Quality	Air Quality	Ecosystems/Habitat	Species	Socio-Economic
Oiled Wildlife	X	X	X	X	X	X	X

Previously Assessed Environmental Risks
Potential risks to the environment from activities associated with the oiled wildlife response that are covered within the scope of the EP (**Section 5**), include: • *Atmospheric emissions Routine and non-routine discharges* • *Physical presence, proximity to other vessels* (shipping and fisheries) • *Routine acoustic emissions* • *Lighting for night work/navigational safety* • *Invasive marine species* • *Collision with marine fauna-* Refer to the EP for details regarding how these risks are being managed to an ALARP and acceptable level. **Note, any additional controls and environmental performance outcomes relating to these risks that are not presented in the EP but are specific to the wildlife response are presented below.*

Impact Assessment
Potential Impacts to marine sediments, water quality, air quality, protected species, socio-economic and protected areas
An environmental impact assessment, controls, environmental performance standards and measurement criteria for the sources of risk within the scope of the EP (as stated above) are detailed in the **Section 5.** An evaluation of the impacts not within the scope of the EP are as followed: *Impacts to Wildlife* • Capturing wildlife   o Inefficient capture techniques has potential to cause undue stress, exhaustion or injury to wildlife

- Pre-emptive capture could cause undue impacts when oiling is not certain
- Transportation
  - Inefficient transport techniques have potential to cause undue injury, stress and thermoregulation pressures to wildlife.
- Stabilisation of wildlife
  - Inefficient stabilisation of wildlife techniques has potential to cause injury to wildlife and thermoregulation stress, In addition to potential for euthanasia during the triage process.
- Cleaning and rinsing of oiled wildlife
  - Inefficient cleaning and rinsing techniques has potential to cause injury and exhaustion of wildlife with potential to remove water-proofing feathers.
- Rehabilitation (e.g. diet, cage size, housing density)
  - Inefficient rehabilitation techniques has potential to cause injury and thermoregulation stress of wildlife. Additionally, inappropriate captive diet could result in further injury to wildlife.
- Release of treated wildlife
  - Potential for undue stress to wildlife if released in an unfamiliar site.
  - Potential for rehabilitated wildlife to return to the oiled area of capture.
  - Potential of stress adjusting to the release site.

Waste generation and disposal – Refer to waste generation and disposal

Summary of Adopted Controls

- Woodside maintains access to equipment to adequately implement and scale an oiled wildlife response
- Woodside maintains access to trained personnel to adequately implement and scale an oiled wildlife response
- A licensed waste service provider will be used to transport, dispose and treat waste generated during oiled wildlife operations to limit secondary contamination and appropriately manage any waste
- Oiled Wildlife operations will be activated via the first strike plan (when operational monitoring identifies there is a potential for oiled wildlife) provided a net environmental benefit is identified through the Operational NEBA
- Any deterrence/hazing/pre-emptive capture activities will require licensing authority from the DBAC and operational approval from the IC

Scientific Monitoring

Description of Source of Risk

Field-based activities undertaken during SMP implementation include vessel operations in the nearshore and offshore environments, in addition to coastal monitoring and data collection at intertidal and subtidal habitats, resulting in potential impacts to the receiving environment.

Additional risks associated with Scientific Monitoring implementation not included within the scope of the EP include:

Seabed disturbance that may be associated with Vessel anchoring

During the implementation of response strategies, where water depths allow, it is possible that response vessels will be required to anchor (e.g. during shoreline surveys). The use of vessel anchoring will be minimal, and likely to occur when the impacted shoreline is inaccessible via road to SMP teams.

Impacts and Risks Evaluation Summary

Response Strategy	Environmental Value Potentially Impacted						
	Soil & Groundwater	Marine Sediment Quality	Water Quality	Air Quality	Ecosystems/Habitat	Species	Socio-Economic
Scientific Monitoring	X	X	X	X	X	X	X

Previously Assessed Environmental Risks

Potential risks to the environment from activities associated with the SMP field activities that are covered within the scope of the EP (**Section 5)**, include: • *Atmospheric emissions* • *Routine and non-routine discharges* • *Physical presence, proximity to other vessels* (shipping and fisheries) • *Routine acoustic emissions vessels* • *Lighting for night work/navigational safety* • *Collision with marine fauna* Refer to the EP for details regarding how these risks are being managed to an ALARP and acceptable level. ***Note, any additional controls and environmental performance outcomes relating to these risks that are not presented in the EP but are specific to the SMP are presented below.**
Impact Assessment
Potential Impacts to marine sediments, water quality, air quality, protected species, socio-economic and protected areas
Seabed disturbance that may be associated with Vessel anchoring Anchoring in the nearshore environment of sensitive receptor locations will have potential to impact coral reef, seagrass beds and other benthic communities in these areas Recovery of benthic communities from anchor damage depends on the size of anchor and frequency of anchoring. Impacts would be highly localised (restricted to the footprint of the vessel anchor) and temporary, with full recovery expected.

APPENDIX C: SUMMARY OF STAKEHOLDER FEEDBACK AND WOODSIDE'S ASSESSMENTS AND REPONSES

Relevant Stakeholder feedback for the Petroleum Activities Program

Organisation	Method	Feedback	Woodside assessment	Woodside's Response
Department of Industry Innovation and Science	Email with fact sheet	**Date:** 31 October 2016 **Feedback summary:** No response at the time of submission.	Woodside will accept and assess feedback from stakeholder post EP submission to NOPSEMA.	**Response/Action:** No further action required.
Department of Mines and Petroleum	Email with fact sheet	**Date:** 31 October 2016 **Feedback summary:** No response at the time of submission.	Woodside will accept and assess feedback from stakeholder post EP submission to NOPSEMA.	**Response/Action:** No further action required.
Australian Maritime Safety Authority (marine safety)	Email with fact sheet	**Date:** 3 November 2016 **Feedback summary:** The Authority provided a traffic plot, suggesting commercial traffic is expected to be minimal. The Authority advised on the communication requirements between the MODU and support vessels with nearby commercial shipping. The Authority requested that the MODU notify AMSA's JRCC 24-48 hours before operations commence and provided the details required. The Authority advised that the Australian Hydrographic Service must be contacted no less than four weeks before operations commence to commence related Notices	Woodside acknowledges the Authority's advice regarding expected traffic in the area and its communication requirements.	**Response/Action:** Woodside to request that the MODU notify AMSA's JRCC within the outlined timeframes. Woodside to notify AHS four weeks prior to activities commencing

		To Mariners.		
Department of Defence	Email with fact sheet	**Date:** 31 October 2016 **Feedback summary:** No response at the time of submission.	The stakeholder raised no claims or objections.	**Response/Action:** No further action required
AHS	Email with fact sheet	**Date:** 1 November 2016 **Feedback summary:** AHS confirmed receipt of Woodside's advice via email.	The stakeholder raised no claims or objections.	**Response/Action:** No further action required
Department of Primary Industries and Regional Development (Western Australia)	Meeting	**Date:** 28 November 2016 **Feedback summary:** Woodside held a meeting with the Department to provide an overview of the Greater Enfield Tieback. Key advice was to use the Department's State of the Fishery Report to understand fishing methods and fishery locations in the area. The Department recommended engagement with the Exmouth Gulf Prawn fishery. The Department asked if the subsea wells would have exclusion zones in place. The Department asked how Woodside plans to continues engagement with fishers during the two-year project timeframes.	Woodside acknowledges the Department's advice to engage the Exmouth Gulf Prawn Fishery. Woodside advised that consideration was still being given for applying exclusion zones on subsea infrastructure. Woodside advised that fishers will be engaged prior to the commencement of drilling activities starting. Fishers will also receive activity dates over the two year period as work starts and stops. Woodside provided advice that the Greater Enfield canyons were surveyed to support the environment plan and engineering scope for the project.	Woodside sent a letter and fact sheet to the Exmouth Gulf Prawn Fishery. No feedback was received. If the six month validity period of the department's advice expires Woodside will notify the Department of Fisheries 3 months prior to the commencement of the Petroleum Activity Program Woodside to accept and assess the Department's formal advice once received via letter.

		The Department advised that it can assist by sending activity start dates to local fishery branches. The Department commented that Woodside had undertaken its marine baseline. The Department advised its advice would be valid for a period of six month.		
Department of Primary Industries and Regional Development (Western Australia)	Letter	**Date:** 19 January 2017 **Feedback summary:** The Department confirmed via letter that it considers itself a relevant person for the proposed activity. The Department recommends Woodside engages with WAFIC, Pearl Producers Association, Recfishwest, relevant Traditional Owner groups and fishers and charter boat operators in the area. The Department advised that its advice remains valid should the proposed activity commence within six months, otherwise advice may be updated. The Department requests to receive notification from Woodside that activities are planned to commence, no	Woodside acknowledged the Department's advice via letter on 27 February. Woodside confirmed the stakeholders that it had engaged and will continue to engage with about the proposed activity. Woodside acknowledged the timeframe that the Department's advice remains valid. Woodside confirm that the EP assesses, and applies mitigation and management measures for the potential impact to benthic organisms. Woodside confirmed that it met with WAFIC to discuss the proposed EP activities, including the installation of the 31 km pipeline. In the unlikely event of an oil spill or discharge into the	Woodside to address all relevant potential impacts to fish, invertebrates, fish habitats and fishers in the environment plan, as described in the Department's letter. Woodside to provide notice to the Department, no less than three months before activity commencement.

		less than three months before the proposed start date. The Department requested contact by phone and email in the event of a hydrocarbon spill within 24 hours of Woodside reporting the incident to the relevant Authority. The Department requested that specific strategies are developed in the EP to mitigate impacts on fish spawning. A list of fish species was provided. The Department provided advice that subsea equipment installation can result in impact to benthic organisms. The Department expects Woodside to risk assess the impacts to aquatic resources, and provide mitigation and management for the impacts. The Department advised that the 31 km pipeline will impact on fishing operations and recommended Woodside discuss these issues with potentially affected fishers and WAFIC. The Department recommended resources for Woodside to demonstrate it	environment, Woodside will notify relevant agencies and organisations as appropriate to the nature and scale of the event, as soon as practicable following the occurrence. Woodside selects oil spill response strategies based on Net Environmental Benefit Analysis (NEBA). The NEBA process takes into account potential benefits/impacts of response strategies to all environmental sensitivities. Woodside confirms that the NEBA process includes analysis of potential benefits/impacts of spawning grounds and nursery areas. Woodside ensures compliance with biosecurity requirements through its implementation of its own Invasive Marine Species Management Plan, which is supported at a Commonwealth level. This process demonstrates compliance with the *Fish Resources Management Act 1994*. Woodside strongly encourages its contractors to use the Department's Vessel Check tool to proactively manage Invasive Marine	

		has taken reasonable measures to reduce its chances of carrying out offences under the *Fish Resources Management Act 1994* and associated regulations. The Department requested that suspected or confirmed marine pest or disease is report within 24 hours. The Department requests all potential impacts and Woodside strategies to mitigate are identified in the final EP. The Department requested a written response from Woodside addressing all concerns raised in its letter.	Species risk when not on contract to the company. Woodside advised that suspected or confirmed presence of marine pest or disease will be reported to the Department within 24 hours.	
Commonwealth fisheries • Western Skipjack Fishery • Western Tuna and Billfish Fishery • North-West Slope Trawl Fishery • Southern Bluefin Tuna Fishery • Western Deepwater Trawl Fishery	Email with fact sheet and map	**Date:** 1 November 2016 **Feedback summary:** No response at the time of submission.	Woodside will accept and assess feedback from stakeholder post EP submission to NOPSEMA.	No further action required.

Western Australian Fisheries • Mackerel Fishery • Pilbara Trawl Fishery • Pilbara Trap Fishery • Gascoyne Demersal Scalefish Fishery • Specimen Shell Fishery • Marine Aquarium Fishery	Email with fact sheet and map Letter with fact sheet and map	**Date:** 1 November 2016 **Feedback summary:** No response at the time of submission.	Woodside will accept and assess feedback from stakeholder post EP submission to NOPSEMA.	No further action required.
Western Australian Fisheries • Exmouth Gulf Prawn Fishery (M G Kailis)	Letter with fact sheet and map	**Date:** 14 December 2016 **Feedback summary:** No response at the time of submission.	Woodside will accept and assess feedback from stakeholder post EP submission to NOPSEMA.	No further action required.
	Meeting	**Date:** 7 February 2017 **Feedback summary:** Woodside held a meeting with M G Kailis on 7 February 2017 to provide an overview of the project and particularly the proposed use of the Exmouth Gulf (outside the scope of the EP). No concerns were raised in relation to the EP.	The stakeholder raised no claims or objections.	No further action required.
Department of Transport	Email with fact sheet and map	**Date:** 1 November 2016 **Feedback summary:** No response at the time of submission.	Woodside will accept and assess feedback from stakeholder post EP submission to NOPSEMA.	No further action required.

	Draft First Strike Plan	**Date:** 16 March 2017 **Feedback summary:** Draft First Strike Plan provided to stakeholder on 16 March 2017. Acknowledged receipt, no response at time of submission.	Woodside will accept and assess feedback from stakeholder post EP submission to NOPSEMA	No further action required.
	Draft First Strike Plan	**Date:** 16 March 2017 **Feedback summary:** Draft First Strike Plan provided to stakeholder on 16 March 2017. Acknowledged receipt, no response at time of submission.	Woodside provided the Department with an updated version of the Greater Enfield First Strike Plan (noting that it does not reflect new arrangements under the IGN, however included an incident management structure) and a copy of current Oil Pollution Emergency Arrangements – Australia). Woodside also advised that it would send the relevant Tactical Response Plans.	No further action required.
	Email	**Date:** 20 April 2017 **Feedback summary:** The Department requested Woodside provide additional activity specific information on oil spill planning beyond first strike.	Woodside provided the Department with the Consultation Initial Information Requirements and the relevant Tactical Response Plans to be read in conjunction with the First Strike Plan and fact sheet provided previously. A copy of the Oil Pollution Emergency Arrangements (Australia) (OPEA) was also provided.	No further action required.

	Email	**Date:** 8 May 2017 **Feedback summary:** The Department provided details comments via its Oil Spill Contingency Plan Review.	Woodside responded via telephone to discuss the Department's comments. Both parties agreed to hold a meeting.	Woodside to organise a meeting with the Department to provide an overview of Woodside's OPEP and determine what information is to be provided.
	Meeting	**Date:** 2 June 2017 **Feedback summary:** Woodside provided the Department with an overview on Woodside's preparedness and response; documentation hierarchy; provision of resources to the Department; risk assessment; ENVID outputs and NEBA outputs. The Department requested updated copies of the First Strike Plan and OPEA.	Woodside acknowledged the Department's request to provide revised documentation.	Woodside to provide the Department with an update of the Greater Enfield First Strike Plan and OPEA (which includes the Department's state response arrangements). Woodside and the Department to reinstate quarterly consultation meetings.
	Email	**Date:** 20 June 2017 **Feedback summary:** The Department acknowledged that Woodside provided a copy of the Oil Pollution First Strike Plan (FSP), the OPEA and the Consultation Fact Sheet. The Department requested Woodside provide an example scenario of a Level 1 spill entering State water. The Department also requested to be informed of any prior use of dispersant in	Woodside described a Level 1 spill in State waters, as a small leak of NWS Condensate from our trunkline causing a slick that migrates into State waters. Woodside advised that the NOPSEMA-accepted First Strike Plan will be formally document controlled and provided to the Department.	Woodside to provide a copy of the final First Strike Plan to the Department post acceptance from NOPSEMA.

		State waters. The Department requested a copy of the finalised revision of the First Strike Plan.		
Department of Transport (Exmouth)	Email and meeting	**Date:** 16 November 2016 **Feedback summary:** Meeting held with the Department in Exmouth to discuss using the Exmouth Gulf as a staging area for the project. The Department advised that it needs to know the proposed location to make a proper assessment, however noted it had no real concerns. The Department requested the length of the vessels, the number that will be stationary in the Gulf and rough timeframes. The Department asked Woodside to consider what fisheries are in the Gulf.	Woodside provided advice that initial planning is still underway, but Exmouth Gulf is being considered for heavy lift equipment. Woodside provided advice on size and number of vessels and provided timeframes for use. Woodside to investigate fisheries in the location.	Woodside to send letter and fact sheet to the Exmouth Gulf Fishery. Woodside to continue engagement with the Department on its advice for using the Exmouth Gulf.

Cape Conservation Group (CCG)	Meeting	**Date:** 17 November 2016 **Feedback summary:** A meeting was held with CCG in Exmouth to discuss the environment plan submission. CCG expressed its interest in understanding the water injection flowline and proposed design. CCG asked Woodside to confirm if subsea pipelines are checked for integrity. CCG asked if chlorophyll levels were examined in canyon area, querying correlation to productivity and whale shark aggregations in the area. CCG mentioned that there is anecdotal evidence that 50-70 whalesharks were spotted a couple of years ago in the area, at the back of the Muiron Islands and are unsure if aggregation was linked to canyons or a one-off due to lack of data recorded. CCG advised that the Exmouth Gulf is an important whale calving ground and use should be avoided in October. CCG expressed concerns about Invasive Marine Species (IMS) from international shipping.	Woodside discussed the water injection design with CCG and advised that the final design is still to be confirmed. Woodside advised that the water production system will be included in the revised Operations environment plan. Woodside confirmed that subsea pipelines are monitored for integrity as part of inspection, maintenance and repair activities. Woodside advised that the Cape Range Canyon has different benthic habitats than the smaller canyons where we found the sediments to be very similar to the surrounding non-canyon areas. Woodside acknowledges CCG's advice about the whale aggregation area and area avoidance in peak periods for whale calving. Regarding whale shark aggregation information raised by the CCG, Woodside subsequently consulted with DPAW who provided further information on the reported event, including GPS coordinates, suggesting this was a one off	No further action required.

			informally recorded event which occurred some 50 km to the east of the project area in approximately 70 m of water. As a result, this event is deemed sufficiently distant from the project area to not warrant further consideration or assessment. Woodside will provide this information to the CCG as part of ongoing consultation with the group. Woodside provided advice on its standards for marine contractors to adhere to in relation to IMS.	
Department of Biodiversity, Conservation and Attractions (Exmouth)	Meeting	**Date:** 17 November 2016 **Feedback summary:** Woodside held a meeting with the Department as a follow up to the presentation provided to the Exmouth Community Reference Group (CRG). Woodside and the Department discussed the Greater Enfield canyon surveys. The Department advised that the Canyons are an area of interest but it has found limited literature to date. Woodside requested further information about the whale shark aggregation location, as referenced by the CCG. The Department advised that it visited the	The stakeholder raised no claims or objections. Woodside advised that, where possible, it aims to publish and make its data public.	No further action required.

		location at the time and believed it is likely a one-off and not a regular occurrence.		
Western Australian Fishing Industry Council (WAFIC)	Meeting	**Date:** 30 November 2016 **Feedback summary:** Woodside provided WAFIC with an overview of the environment plan in a meeting. WAFIC advised its interest in the project was in relation to impact to fisheries. WAFIC asked what congestion could fishers expect in the field. WAFIC expressed its interest in a map for oil and gas operations which shows precautionary zones. WAFIC advised that precautionary zones affect fishers ability to fish and queried if the 2.5 km precautionary zone is a Woodside request. WAFIC advised that fishers previously had issues with vessel contractors asking fishers to leave the precautionary zone. WAFIC queried if Woodside was applying an exclusion zone to the subsea infrastructure.	Woodside advised that there is one MODU for the entire drilling campaign, plus support vessels, exclusion zones and precautionary zones. Woodside advised that a safety zone is in place, however fisherman can enter and are aware that activities are occurring in the location. Woodside is to ensure vessel contractors are familiar with exclusion zones vs precautionary zones. Woodside confirmed that no exclusion zones will be applied to the Project's subsea infrastructure. Woodside to consider WAFIC's recommendation to meet with M G Kailis.	Woodside held a meeting with M G Kailis on 7 February 2017.

		WAFIC strongly recommended that Woodside consults M G Kailis to understand potential impacts for the prawn and development crab fisheries. WAFIC suggested Woodside provides advice to licence holders that the MODU will be in the same location for two years. WAFIC advised it had no concerns given the Project exists amongst existing oil and gas operations.		
Western Australian Fishing Industry Council (WAFIC)	Meeting	**Date:** 1 December 2016 **Feedback summary:** WAFIC emailed Woodside with contact details for M G Kailis. WAFIC advised that it had made contact with Kailis and recommended a meeting is held.	The stakeholder raised no claims or objections.	Woodside held a meeting with M G Kailis on 7 February 2017
Pearl Producers Association	Email with fact sheet	**Date:** 1 November 2016 **Feedback summary:** No response at the time of submission.	Woodside will accept and assess feedback from stakeholder post EP submission to NOPSEMA.	No further action required.
BHP	Email	**Date:** 18 January 2016 **Feedback summary:** BHP responded via email to advice from Woodside that the proposed flowline traverses the SE corner of the title associated with the	The stakeholder raised no claims or objections.	Woodside will re-engage BHP within the requested timeframe if anchors are to be used within their permit Note: Woodside currently has no plans to install anchors.

		Stybarrow operations. BHP requested Woodside provide six months notice of any plans to use anchors in their block.		
	Email with map Teleconference	**Date:** 23 August 2017 **Feedback summary:** Woodside phoned BHP to discuss vessel activities that will occur within BHP's permit. Woodside provided additional information and a map of the Greater Enfield Project operational area via email. Woodside asked BHP to confirm if additional information was required before the Greater Enfield Subsea tie-back EP is resubmitted to NOPSEMA. BHP advised on the telephone that it would discuss further with its operations team before responding via email.	Woodside will accept and assess feedback from stakeholder post EP submission to NOPSEMA.	Woodside to assess BHP's future correspondence.
	Email	**Date:** 30 August 2017 **Feedback summary:** Woodside sent a follow-up email asking BHP to confirm if additional information is required.	BHP may provide advice following discussion with operations team.	No further action required.

	Voicemail	**Date:** 1 September 2017 **Feedback summary:** Woodside left a voicemail asking BHP to confirm if additional information is required. No response was received at the time of re-submission.	The stakeholder raised no claims or objections.	No further action required.
Exmouth Fishing Charter Operators • Exmouth Boat Hire • On Strike Charters • Blue Horizon Charters • Peak Sportfishing Adventures • Ningaloo Pearls • Fly Fishing Frontiers Exmouth • Montebello Island Safaris • Mahi Mahi Fishing Charters • Diversity Bluewater Adventures Exmouth • Top Gun Charters • Sea Venture Charters	Email with fact sheet	**Date:** 24 May 2017 **Feedback summary:** No response at the time of re-submission.	The stakeholder raised no claims or objections.	No further action required.

Quadrant Energy	Email with fact sheet	**Date:** 24 May 2017 **Feedback summary:** The titleholder responded that it had no comments on the proposed project, which is adjacent to Quadrant permit WA-35-L.	The stakeholder raised no claims or objections.	No further action required.
	Email with map Teleconference	**Date:** 23 August 2017 **Feedback summary:** Woodside phoned Quadrant to discuss vessel activities that will occur within Quadrant's permit. Woodside confirmed that no vessel activity would occur within the 500 m petroleum safety zone of the Ningaloo Vision FPSO. Woodside provided additional information and a map of the Greater Enfield Project operational area via email. Quadrant advised via telephone that it would discuss further with its operations team before responding via email.	Quadrant may provide advice following discussion with operations team.	Woodside to assess Quadrant's future correspondence. **Attached: Appendix F**
	Email	**Date:** 29 August 2017 **Feedback summary:** Quadrant advised that it expectes to have drilling activity within its permit WA-35-L in 2018.	The stakeholder raised no claims or objections. Woodside acknowledges the stakeholders advice about exclusion zones and future drilling activities. Stakeholder requests future	Woodside to notify Quadrant four weeks prior to vessels entering their permit (section 5.6.1). **Attached: Appendix F**

		Quadrant advised that it will have ongoing consultation with Woodside regarding future activities. Quadrant advised that it expects exclusion zones for MODUs and the Ningaloo Vision FPSO to be adhered to. Quadrant requested Woodside provides notification of when vessels are expected to enter permit WA-35-L.	notification about vessels entering permit WA-35-L.	

Interested Stakeholder feedback for the Petroleum Activities Program

Organisation	Method	Feedback	Woodside assessment	Woodside's Response
Australian Maritime Safety Authority (marine pollution)	Email with fact sheet	**Date:** 1 November 2016 **Feedback summary:** No response at the time of submission.	Woodside will accept and assess feedback from stakeholder post EP submission to NOPSEMA.	No further action required.
Australian Maritime Safety Authority (marine pollution)	First Strike Plan	**Date:** 16 March 2017 **Feedback summary:** No response at the time of submission.	Woodside will accept and assess feedback from stakeholder post EP submission to NOPSEMA.	No further action required.
Department of Biodiversity, Conservation and Attractions	Email with fact sheet	**Date:** 1 November 2016 **Feedback summary:** No response at the time of submission.	Woodside will accept and assess feedback from stakeholder post EP submission to NOPSEMA.	No further action required.
Australian Customs Service – Border Protection Command	Email with fact sheet	**Date:** 1 November 2016 **Feedback summary:** No response at the time of submission.	Woodside will accept and assess feedback from stakeholder post EP submission to NOPSEMA.	No further action required.
Commonwealth Fisheries Association	Email with fact sheet	**Date:** 1 November 2016 **Feedback summary:** No response at the time of submission.	Woodside will accept and assess feedback from stakeholder post EP submission to NOPSEMA.	No further action required.
Recfishwest	Email with fact sheet	**Date:** 1 November 2016 **Feedback summary:** No response at the time of submission.	Woodside will accept and assess feedback from stakeholder post EP submission to NOPSEMA.	No further action required.

WWF	Email with fact sheet	**Date:** 1 November 2016 **Feedback summary:** No response at the time of submission.	Woodside will accept and assess feedback from stakeholder post EP submission to NOPSEMA.	No further action required.
Australian Conservation Foundation	Email with fact sheet	**Date:** 1 November 2016 **Feedback summary:** No response at the time of submission.	Woodside will accept and assess feedback from stakeholder post EP submission to NOPSEMA.	No further action required.
Wilderness Society	Email with fact sheet	**Date:** 1 November 2016 **Feedback summary:** No response at the time of submission.	Woodside will accept and assess feedback from stakeholder post EP submission to NOPSEMA.	No further action required.
International Fund for Animal Welfare	Email with fact sheet	**Date:** 1 November 2016 **Feedback summary:** No response at the time of submission.	Woodside will accept and assess feedback from stakeholder post EP submission to NOPSEMA.	No further action required.
APPEA	Email with fact sheet	**Date:** 1 November 2016 **Feedback summary:** No response at the time of submission.	Woodside will accept and assess feedback from stakeholder post EP submission to NOPSEMA.	No further action required.
AMOSC	Email with fact sheet	**Date:** 1 November 2016 **Feedback summary:** No response at the time of submission.	Woodside will accept and assess feedback from stakeholder post EP submission to NOPSEMA.	No further action required.
Exmouth Chamber of Commerce and Industry	Email with fact sheet	**Date: 5 December 2016** Feedback summary: The Chamber provided a letter to Woodside via email advising that it had received advice about the Project and shared	Woodside notes the Chamber's interest in local content and participation in relation to the project.	No further action required.

		it with its members. The Chamber advised that it had not concerns with the project, however it was interested in Woodside's local content policies and the consideration of local participation for the project. The Chamber encouraged Woodside to continue further engagement in 2017.		