Julimar Operations Environment Plan Summary

Production Environment

8 August 2016

Revision 0

TABLE OF CONTENTS

1. INTRODUCTION

In accordance with the *Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations* 2009 (Cth) (Environment Regulations), Woodside Energy Julimar Pty Ltd (Woodside) (a wholly owned subsidiary of Woodside Energy Limited), as the nominated titleholder on behalf of the Joint Venture comprising Woodside Energy Julimar Pty Ltd (65%) and KUFPEC Australia (Julimar) Pty Ltd (35%)), proposes to prepare and operate the Julimar Field Production System (herein referred to as Petroleum Activities Program).

This 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 Julimar Operations Environment Plan (the Julimar Operations EP), accepted by NOPSEMA under Regulation 10A of the Environment Regulations.

1.1 Defining the Activity

The Petroleum Activities Program to be undertaken in licence areas WA-49-L and WA-26-PL (as well as within non-Woodside production licence areas) consists of:

1. Preparation of subsea infrastructure, including:
    - leak testing of pipelines and flowlines
    - subsea dewatering
    - vessel operations.
2. Operation of the Julimar Field Production System (including routine testing of the wells and subsea infrastructure). This routine testing will be performed from the Wheatstone platform, operated by Chevron Australia Pty Ltd (hereafter Chevron). Operation of the Julimar Field Production System includes:
    - Brunello wells (up to 8 wells)
    - Brunello and Julimar production flowlines
    - Mono-ethylene glycol (MEG) pipeline
    - Electro-hydraulic umbilical
    - Brunello A (BruA) Production Manifold
    - BruA Crossover Manifold.
3. Inspection, Maintenance and Repair (IMR) during Operations
    - Use of vessels for IMR activities comprising:
        - Subsea inspections and surveys (including use of remotely operated vehicles (ROVs) and side scan sonar)
        - Seabed intervention for scour protection or stabilisation works (mattress rectification, rock placement, grout bagging activities, etc.)
        - Subsea infrastructure intervention and repair.

1.2 EPBC Act Referral 2011/5936

The Julimar project was referred under the *Environment Protection and Biodiversity Conservation Act 1999* (Cth) (EPBC Act) and subsequently released for public comment on 27 April 2011. The proposed action included incremental development and operation of 17 production wells and three production manifolds connected by flowlines to the Wheatstone platform (subject to separate assessment under EPBC 2008/4469). The proposed action was

scheduled to commence (development) in 2014 and have a commercial production life of 25 years. The assessment resulted in a decision “not a controlled action if undertaken in a particular manner”. Particular measures to be addressed within the *Julimar Operations EP* to avoid significant impacts on Matters of National Environmental Significance (MNES) are listed in **Table 1-1.**

Table 1-1: EPBC 2011/5936: Manners in which the proposed action must be taken

Item	Manner in which proposed action must be taken	EP Summary Section
1	An Oil Spill Contingency Plan and an Environment Plan as described in the referral and additional information must be approved by the relevant authority and in place prior to the proposed action commencing.	*Julimar Operations EP and associated oil spill emergency arrangements accepted by NOPSEMA on 6 July 2016. This document provides a summary of the accepted EP.*
2	Procedures and equipment systems for ensuring well control must meet best practice industry standards and must be implemented prior to the proposed action commencing. This includes the installation of a minimum of two well barriers as specified in the referral and additional information.	Appendix A
3	The oil spill preparedness and response measures and equipment described in the referral and additional information must be in place prior to the proposed action commencing.	Appendix B
4	To minimise risks of a hydrocarbon release during decommissioning, decommissioning activities must be taken into account in the Environmental Plan, as specified in the referral.	Not applicable to the scope of the *Julimar Operations EP*.

2. LOCATION OF THE ACTIVITY

The Petroleum Activities Program is located in Commonwealth waters in the Carnarvon Sub-basin, within licence areas WA-49-L and WA-26-PL. Vessel based operations may also be undertaken within non-Julimar production licence areas WA-48-L and WA-34-L.

The Operational Area (**Figure 2-1**) defines the spatial boundary of the Petroleum Activities Program. For the purposes of the Julimar Operations EP the Operational Area includes the subsea infrastructure, including wells and flowlines/pipeline, and an area within 1500 m of this infrastructure. The Operational Area is approximately 25 km long extending along the length of WA-26-PL and 3 km wide to allow for vessel movement and is located approximately 160 km north-west of Dampier and adjacent to the Wheatstone platform.

Existing facilities with infrastructure within the Julimar Operational Area include:

- Sections of the Woodside Pluto subsea infrastructure which intersects the lines (including the production flowlines and MEG pipeline), as described in the Woodside Pluto Offshore Facility Operations Environment Plan; and the
- Wheatstone platform and associated subsea infrastructure, as described in the Chevron Start-Up and Operations Environment Plan: Wheatstone Project.

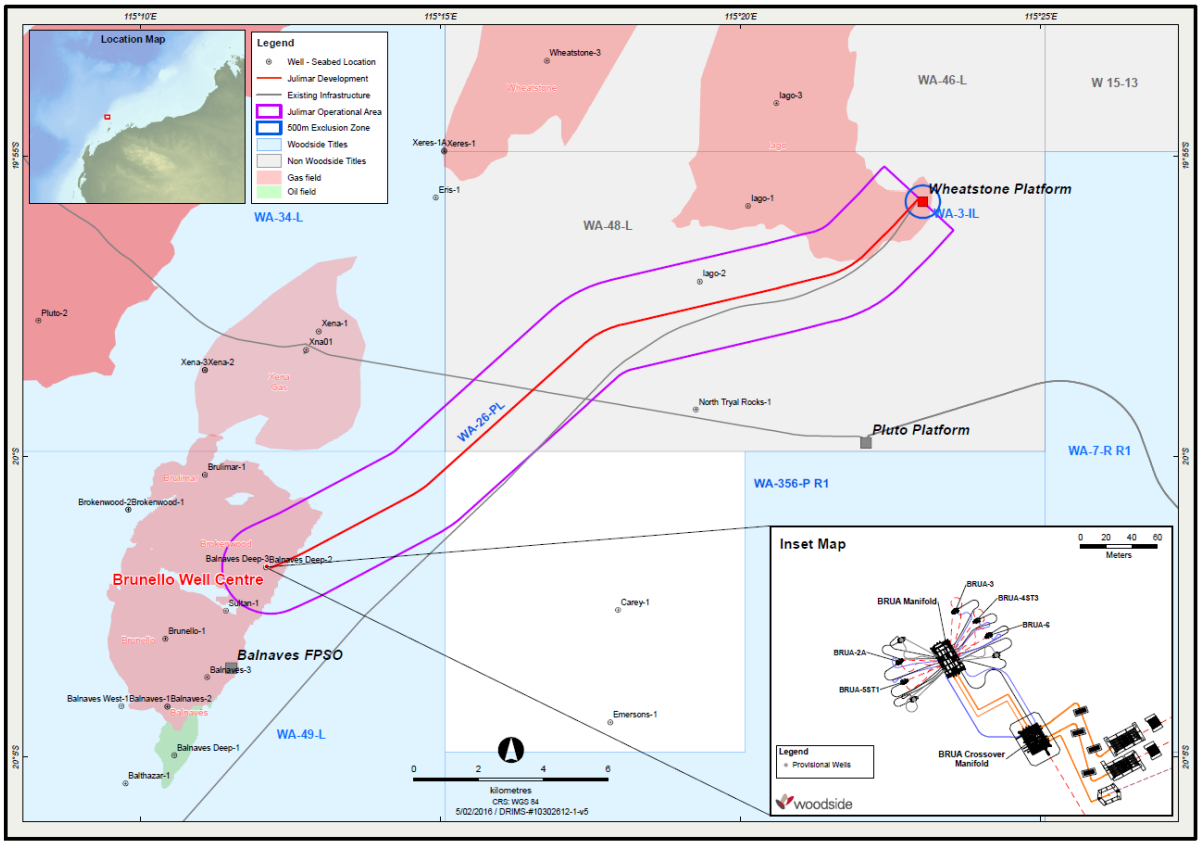


Figure 2-1: Location of the Petroleum Activities Program and Operational Area

Approximate coordinates for wells, well centres and the pipeline route are provided in **Table 2-1**. The closest landfall to the Petroleum Activities Program is the Montebello Islands, approximately 48 km south.

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

Activity	Water Depth (Approx. m LAT)	Latitude	Longitude	Production Licence
Well and well centre locations (refer to Figure 2-1)				
BRUA manifold	149	20°01’49.0788”	115°12’06.8670”	WA-49-L
BRUA Crossover manifold	149	20°01’51.1115”	115°12’09.0653”	WA-49-L
Brunello A well	149	20°01’49.1571”	115°12’05.6357”	WA-49-L
Brunello B well	149	20°01’47.8720”	115°12’07.0511”	WA-49-L
Brunello C well	149	20°01’48.1207”	115°12’07.5964”	WA-49-L
Brunello D well	149	20°01’49.6633”	115°12’05.7596”	WA-49-L
Brunello E well	149	20°01’48.4958”	115°12’07.8942”	WA-49-L
Pipeline route corridor location (refer to Figure 2-1)				
Pipeline/flowline Route – Start	148	20°01’51.7586”	115°12’11.3265”	WA-26-PL
Pipeline/flowline Route – End	71	19°55’45.776”	115°23’02.215”	WA-26-PL

3. DESCRIPTION OF THE ACTIVITY

3.1 Field Overview

The layout of the Julimar Field Production System infrastructure, including location of Brunello well centres, is shown in **Figure 3-1**. The subsea infrastructure includes:

- two 22 km, Julimar and Brunello, flowlines (18")
- 4" mono-ethylene glycol (MEG) pipeline
- horizontal spools and vertical jumpers
- up to eight wells (A-H **Figure 3-1)**
- BruA Production Manifold
- BruA Crossover Manifold
- electrical, hydraulic and optical flying leads
- electro-hydraulic umbilical
- tie-in structures and skids /pipeline end terminations
- adjustable pipe support structures
- temporary pig launchers/receivers
- Xmas trees
- flowline deflection initiators.

The pipelines, flowlines and wells are marked on nautical charts.

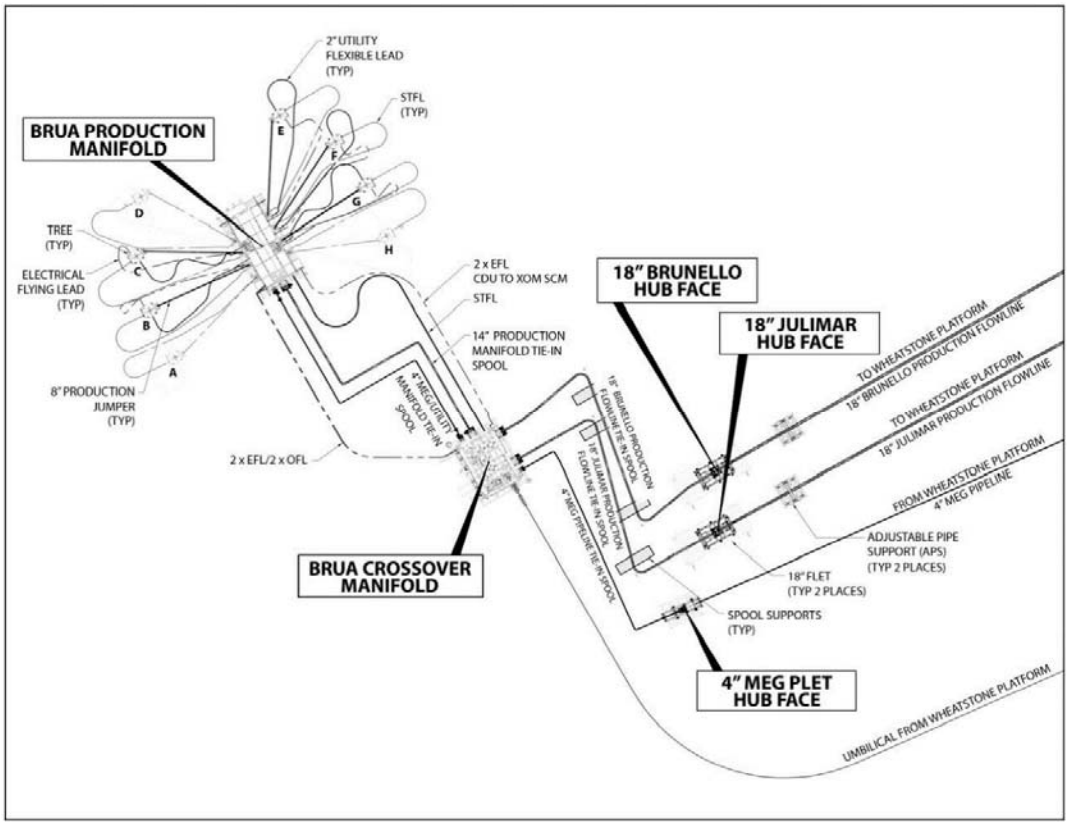


Figure 3-1: Julimar Field Production System Infrastructure Layout

3.2 Timing of the Activities

The activities associated with the Julimar Field Production System are planned to commence with dewatering in Q3 2016. Following the introduction of hydrocarbons, currently scheduled for 2017, projected field life is estimated at 25 years. All activities may be subject to rescheduling, including delay, based on operational requirements of the Wheatstone platform, vessel availability or other operational requirements and external influences such as weather. Following introduction of hydrocarbons, operations activities may occur 24 hours a day, 365 days per year.

3.3 Preparation Activities

Woodside will prepare all subsea infrastructure, which currently contains preservation fluids to prevent corrosion and/or deterioration, via pipeline pigging (referred to as dewatering). Pigging during preparation activities or re-flooding (if required) will involve discharge of treated seawater contained in the lines to the Wheatstone platform. Reflooding (where a pig train is followed with treated seawater) of pipelines/ flowlines (the lines) prior to the introduction of hydrocarbons will only be undertaken if there is an extended period prior to commissioning, or where other technical issues require it.

The lines may also be subjected to a pressure test as part of reflooding ('hydrotest' or leak test) to assess the pressure-volume relationship. Water used for hydrotesting the lines will be chemically treated, filtered seawater. Following dewatering, the lines will be dried and packed with nitrogen. They may be left in this suspended state for some time prior to well clean-up activities.

3.4 Well Clean-up

Initial well clean-up was undertaken as part of the Brunello Appraisal and Production Drilling Environment Plan, accepted by NOPSEMA in December 2014.

Following tie-in, the Brunello wells will be started in a staggered process and cleaned up to 200 MMscf/d to the Wheatstone platform. All emissions, discharges and wastes from the Wheatstone platform are associated with produced water, well solids and atmospheric emissions and will be managed under the Chevron Start-Up and Operations Environment Plan: Wheatstone Project.

3.5 Steady State Production Operations

During steady state operations, hydrocarbon gas, condensate and water are produced from five production wells from the Brunello Field into xmas trees prior to comingling into a single production header at the BruA production manifold. The Julimar Operations EP also includes provision for an additional three wells that may be tied in to the production manifold. Emissions and discharges from the Wheatstone platform, including well shut-in and start-up, are managed under the Chevron Start-Up and Operations Environment Plan: Wheatstone Project.

3.6 Inspection, Maintenance and Repair (IMR)

The Julimar subsea infrastructure is designed to not require any significant degree of intervention. Inspection and maintenance is undertaken to ensure the integrity of the infrastructure and to identify any problems before they present a risk of loss of containment. Intervention may be required to repair identified problems.

It is not possible to determine timing and frequency of IMR activities that may be undertaken prior to commencement of operations as the sequencing of routine activities and the subsequent needs for maintenance and repair relies on understanding baseline inspection data. All IMR activities are planned to be immediately adjacent to subsea infrastructure, particularly, surrounding the well centre. For non-routine activities, these activities will be undertaken as required with the frequently driven by external factors (e.g. weather events,

third party impact, reservoir behaviour) which may vary the timing with some activities expected to be undertaken. Based on experience and input from subject matter experts, the approximate frequencies of routine and non-routine IMR activities have been collated in **Table 3-1.**

Table 3-1: Approximate frequencies and potential locations of routine and non-routine IMR activities

IMR Activity	Approximate Frequency	Activity Description
Routine		
Visual inspections	Frequency will vary between every 2-4 years.	General Visual inspections and close visual inspections is undertaken using a ROV and where required side scan sonar.
Valve Leak Testing	Maybe undertaken 6 monthly.	Valve leak testing undertaken to cycle valves.
Non-Routine Activities		
Pressure and Leak Testing	Not expected to occur during field life (25 years), but if required may be undertaken once during field life.	Pressure testing is undertaken to test the integrity of subsea infrastructure, to test isolations and to identify any leaks.
Wall thickness survey	May be required once every 10 years with worst case frequency of once every 2 years for each well.	Use of ultrasonic testing to monitor the condition of subsea infrastructure
Non-destructive testing	Not expected to occur during field life (25 years), but if required may be undertaken once during field life	Evaluate the properties of material/items using electromagnetic, radio graphic, ultrasonic, or magnetic equipment
Anode sampling	Not expected to occur during field life (25 years), but if required may be undertaken once during field life	Samples taken of anode materials for testing where anode material is suspected of being out of specification.
Sampling	Not expected to occur during field life (25 years), but if required may be undertaken once during field life	• **Seabed sampling survey** (including minor grab /cores) – samples taken to identify benthic fauna, sediment, etc. • **Water sampling surveys** – samples taken of water determine water quality around the pipeline/flowline. • **Marine growth sampling** - Samples taken of marine growth for testing.
Subsea Intervention Isolations	Not expected to occur during field life (25 years), but if required may be undertaken once every 4 years for each well.	Prior to intervention activities (e.g. Hotstab) being undertaken, isolation of a particular section of subsea infrastructure is required.
Hotstab and Coldstab Intervention Operations	Not expected to occur during field life (25 years), but if required may be undertaken once every 2 years for each well.	Hotstabs/Coldstabs may be required to execute unplanned intervention and repair activities.
Marine Growth Removal	May be required once every 2 years with worst case frequency of once every 2 years.	Removal of excess marine growth prior to undertaking many subsea IMR activities. Marine growth removal is undertaken using an ROV.
Sediment Relocation	Not expected to occur during field life (25 years), but if required may be undertaken once every 4 years for each well.	Relocation of sediment build up around a pipeline/flowline or other subsea infrastructure to allow inspection/works to proceed.

IMR Activity	Approximate Frequency	Activity Description
Span Rectification, pipeline/flowline protection and stabilisation	Not expected to occur during field life (25 years), but if required may be undertaken once every 5 years for each well.	Rectification or stabilisation of components using mattresses, grout bags or rock placements for subsea components that may become unsupported by the seabed and/or become unstable.
Optical, Electrical and Steel Tube Flying Leads Replacement	Not expected to occur during field life (25 years), but if required may be undertaken once every 2 years for each well.	Replacement of o**ptical, electrical and steel tube flying leads**
Spool replacement	Not expected to occur during field life (25 years), but if required may be undertaken once during field life	Preparation, recovery, reinstallation and post repair of spool(s)
Replacement of anode skids	Not expected to occur during field life (25 years), but if required may be undertaken once during field life	Replacement of anode skid on the seafloor and reconnection to subsea component.
Flowline repairs	Not expected to occur during field life (25 years), but if required may be undertaken once during field life	Installation of a clamp around the damaged part of the flowline.

3.7 Vessel Operations

Vessels will be used for project field work such as preparation activities, subsea IMR activities and support. Typical activity vessels use a dynamic positioning (DP) system to allow manoeuvrability and to avoid anchoring when undertaking works due to the close proximity of subsea infrastructure. However, all vessels are equipped with anchors that can be deployed in the event of an emergency. Occasionally, single-use vessels may be required to deliver critical parts for field operations.

Remote Operated Vehicle (ROV) Operations

The activity vessels may be equipped with an ROV system that is maintained and operated by a specialised contractor aboard the vessel. The ROV is deployed from the vessel in a tether management system (TMS) or an umbilical that provides electrical power, data transmissions and operation transmissions to and from the ROV. 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 operations and the surrounding environment. ROV operations often require tool baskets that are temporarily placed on the seabed. These baskets typically have a mesh base with a seabed footprint of approximately 15 m^2. The baskets are recovered to the vessel at the end of the activity.

Hydraulic arms on the ROV enable the use of tools to undertake maintenance on subsea equipment. Minor hydraulic leaks (typically less than 25 L) may occasionally occur if hydraulic lines are pinched during subsea work.

Diesel Bunkering

Offshore diesel bunkering is not planned for IMR vessels that can steam back to Dampier to refuel. However, bunkering may be required during emergency response or extended periods of work such as the dewatering activity.

3.8 Helicopter Operations

Helicopters may be used to transport specialist personnel and/or urgent freight to/from the activity vessels. They may also be used as a means of evacuating personnel in the event of an emergency. Helicopter support is principally supplied from Karratha Airport. Helicopter

use for the activity will be limited to short durations and occasional periods when vessels are present within the Operational Area.

3.9 Operational Interface with the Wheatstone Platform

A contract for services has been entered into between Chevron as operator of the Wheatstone platform (WA-3-IL) and trunkline (WA-25-PL, TPL/25, PL99) and Woodside as operator of the Julimar-Brunello field (WA-49-L) and associated petroleum pipeline and flowlines (WA-26-PL) (the Julimar Field Production System). The contract regulates the operational interface between the Julimar Field Production System and the Wheatstone platform by specifying field operating services, emergency response arrangements and communication and reporting requirements between Chevron and Woodside.

Under this contract, Chevron provides field operating services from the Wheatstone platform to Woodside, which are necessary for the recovery of production fluids from the Julimar Field Production System. The field operating services include, among other matters, operation and maintenance services for the Julimar Field Production System from Wheatstone platform. This includes operation and maintenance services for all Julimar subsea field infrastructure, wells, well jumpers, subsea wellheads, subsea manifolds, umbilicals and terminations, flowlines and subsea trees upstream of the Julimar Field Production System endpoint. The contract also provides for Woodside to conduct vessel based inspection, maintenance and repair of the Julimar subsea infrastructure. Chevron services provided under the contract include, for example:

- operation of all field production system controls, valves, chokes and safety devices and monitoring of all the field production system sensors, alarm and instrument data as required by manuals provided by Woodside and consistent with general direction given by Woodside
- operation of all safety shutdown devices
- performing inspections and tests related to the field production system in accordance with applicable laws and regulations
- integrity and production testing of the Julimar Field Production System (including the subsea trees and system valves, downhole safety valves and the opening of surface controlled subsurface safety valves (SCSSV) and subsea isolation valves (SSIV), as well as the testing of SCSSVs and SSIVs and monitoring and control of the SSIVs through the Wheatstone platform facilities emergency shutdown system
- performing well tests (including pressure build-up tests and blowdown operations), monitoring well parameters and adjusting normal well parameters in accordance with Woodside's operating manuals and applicable Wheatstone platform manuals
- performing visual inspection of piping and equipment associated with the Julimar Field Production System and the route of the field production system at time intervals prescribed by applicable regulations.

Chevron will be given control of the Julimar Field Production System wells for the purpose of providing operating services. Control of specific Julimar-Brunello wells will be transferred back to Woodside during well work-overs/interventions and internal well work. Handover of control of the Julimar Field Production System or individual wells is undertaken according to a handover process between Chevron and Woodside, which involves confirming the status of the wells and infrastructure, and the transfer of relevant records and test results (with a handover certificate) to ensure system integrity is appropriately maintained.

In the addition to the above field operating services, Chevron also provides emergency response and maintenance services to Woodside and has agreed associated communication and reporting requirements. Under the contract, Woodside retains commercial responsibility

for all Julimar Field Production System operations that are not performed by Chevron from or on the Wheatstone platform or which are not included in the field operating services provided by Chevron above. These commercial arrangements do not alter the statutory obligations and responsibilities of the parties pursuant to the *Offshore Petroleum and Greenhouse Gas Storage Act 2006 (Cth)* and Environment Regulations.

3.10 Field Operations

Field operating services will be provided by Chevron from the Wheatstone platform central control room and will be in accordance with a field operating manual which applies to the Field Operator facilities, up to, and including, the Brunello well centre. The manual is developed and maintained by Woodside and the requirements executed by Chevron. It describes the requirements for operating the Julimar-Brunello field including reference to relevant operating and maintenance procedures. It also defines the relevant emergency response bridging documents and communication arrangements.

The manual does not include maintenance or specific operating procedures for the topsides equipment relevant to the Julimar-Brunello field production system, which is maintained in accordance with the requirements of the Chevron Operational Excellence Management System under the Chevron Start-Up and Operations Environment Plan: Wheatstone Project.

The Woodside Julimar Subsea Inspection, Monitoring, and Maintenance Plan describes the ongoing inspection, monitoring and maintenance requirements for the Julimar Field Production System, which may be executed either by Woodside or Chevron.

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 scenarios.

4.1 Physical

The Operational Area is located in Commonwealth waters of the North West Shelf (NWS) Province in water depths of approximately 70 to 150 m. The NWS Province is part of the wider North West Marine Region (NWMR), as defined under the Integrated Marine and Coastal Regionalisation of Australia (IMCRA v4.0). The NWS Province 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.

The climate in the region is tropical monsoon, exhibiting a hot, wet summer season from October to April and a milder, dry winter season between May and September. Rainfall in the region predominantly occurs during the wet season (summer), with highest rains occurring during late summer, often associated with the passage of tropical low pressure systems and cyclones. There are often distinct transition periods between the summer and winter regimes, which are characterised by periods of relatively low winds.

Water circulation in the NWS Province and Operational Area is primarily influenced by the Indonesian Throughflow (ITF) and the Leeuwin Current. The ITF and Leeuwin Current are strongest during later summer and winter, respectively. Flow reversals to the north-east associated with strong south-westerly winds are typically weak and short lived but can generate upwelling of cold deep water onto the shelf. Tides in the NWS Province are semi-diurnal and have a pronounced spring-neap cycle, with tidal currents flooding towards the south-east and ebbing towards the north-west.

The bathymetry of the Operational Area indicates a relatively flat and featureless seabed with increasing water depth from 70 m in the north-east end of the Operational Area to 150 m near the well centre. Seabed relief in areas of soft sediment consist mainly of ‘small ripples’ less than 0.1 m high, which is consistent with the known tidally driven bottom currents of NWS Province. A minor component of the seabed in the north-eastern end of the Operational Area consists of outcropping cemented sediments adjacent to the Wheatstone Platform and approximately 3 km along the pipeline/flowline route.

Seabed sediments within the Operational Area comprise primarily of fine to coarse sands. Sediment sampled 4 km south-west of the Operational Area in 135 m depth comprised fine silt and mud, while at the northern end of the Operational Area in 70 to 250 m water depths, sediments comprised fine to mediums sands with shell and coral fragments. In the wider NWMR, sediments are comprised of bio-clastic, calcareous and organogenic sediments. On the continental shelf, sediments are primarily sand and gravels, while the slope and deep ocean seabed are primarily mud.

4.2 Biological

Habitats

No critical habitats or threatened ecological communities (TECs), as listed under the EPBC Act, are known to occur within the Operational Area.

Benthic Habitats in the Operational Area

No seagrass beds, macroalgae, mangroves or reef building corals occur in the Operational Area. The cemented sediments observed at the Wheatstone platform (northern end of the Operational Area) support a medium density, mixed benthic invertebrate community of filter feeding biota that includes sea fans and whips, sponges, and ascidians. The Pluto pipelines,

which traverse the Operational Area, also provide hard substrate for similar filter feeding biota. The southern section of the Operational Area is unlikely to contain suitable habitat for filter feeder communities as it comprises mostly homogenous soft sediments with little or no hard substrate.

Infauna associated with soft unconsolidated sediments of the Operational Area are widespread and well represented along the continental shelf and upper slopes of the NWS Province. Benthic grab sampling in the vicinity of the Pluto platform (approximately 4 km from the Operational Area) revealed an infaunal community which was sparse in terms of abundance, of a patchy nature but comprising high species diversity represented primarily by polychaetes, nemerteans, sipunculids and crustaceans. Similarly, a benthic survey of the Balnaves Development Field, approximately 4 km south-west of the Operational Area, found sparse (less than 5% cover) of epibenthic fauna comprising occasional anemones, urchins, sea whips, sea pens, feather stars and glass sponges.

Habitats in the wider region

The wider region, including the Montebello Islands and other sensitive areas such as the submerged shoals of Rankin Bank and Glomar Shoals, comprise important benthic primary producer habitats such as coral reefs, seagrass beds and macroalgae communities, and mangroves (Montebellos, only). These benthic primary producer habitat are of high ecological value with coral reef habitats representative of high diversity communities of hard corals, associated invertebrates and fish species of both commercial and conservation importance. Seagrass beds represent a key food source for many species and provide key habitats and nursery grounds, and mangrove habitats provide complex structural habitats as well as nurseries and feeding sites for many marine species.

Rankin Bank (located approximately 30 km north-east of the Operational Area) is the nearest coral reef habitat and is composed of a number of habitat types including hard corals, mixed coral and algae and deep water filter feeders (sponges, sea fans and whips). Sampling programs to investigate the seabed biota of the wider NWMR indicate a widespread and well represented community of seabed infauna for the soft sediment habitats of the continental shelf and upper slopes, dominated by polychaetes and crustaceans

Resident/Demersal Fish Populations

Fish communities in the NWMR comprise pelagic and demersal fish species. Large pelagic fish include commercially targeted species such as mackerel, wahoo, tuna, swordfish and marlin. Large pelagic fish are typically widespread, occur in mainly offshore waters and highly mobile.

Demersal fish include commercially important species such as groper, cod and snapper. The Operational Area comprises mostly featureless, soft sediment seabed, with more complex hard substrate only occurring in the north-eastern section in water depths of 70 m to 150 m. Habitat in the north-eastern section of the Operational Area may support diverse and abundant fish communities than soft sediment and flat areas.

Species

An EPBC Act protected matters search identified a total of 57 listed marine species as potentially occurring within the Operational Area. Of those listed, 15 are threatened species and 20 migratory species under the EPBC Act.

Operational Area

Pygmy blue whales (*Balaenoptera musculus brevicauda*) may occur in the Operational Area, however, individuals generally transit the deeper offshore waters to the west of the Operational Area during their northern and southern migrations. Migrating humpback whales (*Megaptera novaeangliae*) may transit the Operational Area between June and October, during their northern and southern migrations. It is noted that the Department of Environment

(DoE) has defined a humpback whale migratory corridor Biologically Important Area (BIA) situated outside 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 (*Caretta caretta*), green turtle (C*helonia mydas*), leatherback turtle (*Dermochelys coriacea*), hawksbill turtle (*Eretmochelys imbricata*) and the flatback turtle (*Natator depressus*). The Operational Area does not contain any known critical habitat for any species of marine turtle, however, given observation of turtles in open, offshore water they may transit the Operational Area, and given the presence of suitable biota they may forage at Rankin Bank (located 30 km north-east of the Operational Area). A BIA for internesting flatback turtles overlaps with the Operational Area, however, considering the distance from known key marine turtle nesting shoreline habitats, (at least 48 km from the nearest nesting beach) and the offshore location and water depth of the activity (approximately 70 to 150 m), it is considered that the Operational Area is unlikely to represent internesting habitat for flatback turtles.

Seasnakes occur along the NWS, including at Rankin Bank and Glomar Shoals, in waters up to approximately 100 m depth and are reported to occur in offshore and nearshore waters. The short-nosed seasnake (*Aipysurus apraefrontalis*), is recorded for the region and is endemic to WA but this species prefers the reef flats and shallow waters along the outer reef edge (<10 m depth). The most commonly sighted seasnake in the region is the olive seasnake (*Aipysurus laevis*), which is generally shallow water reef environments. Large, deep water expanses create a significant barrier to seasnake movement. It is considered that seasnake presence will be infrequent and likely comprise few individuals within the Operational Area.

Whale sharks (*Rhincodon typus*) are listed as migratory and vulnerable and are likely to traverse the vicinity of the Operational Area during their migrations to and from Ningaloo Reef (where they aggregate annually between March–July). For the period 2011 to 2014, Woodside has recorded sightings of individuals within and in the vicinity of the Operational Area in April, July, August, September and October. The DoE has defined a BIA for foraging whale sharks (post aggregation at Ningaloo) centred on the 200 m isobath from July to November. This area extends northward from the Ningaloo aggregation area and overlaps with the Operational Area. Whale shark presence within the Operational Area would likely be of a relatively short duration and not of significant numbers given the main aggregations are recorded in coastal waters, particularly the Ningaloo Reef edge.

Seven other shark/ray species, including the great white shark (*Carcharodon carcharias*) (listed as vulnerable and migratory), grey nurse shark (*Carcharius taurus*) (listed as vulnerable), dwarf sawfish (*Pristis clavata*) (listed as vulnerable), green sawfish (*Pristis zijsron*) (listed as vulnerable), shortfin mako (*Isurus oxyrinchus*) (listed as migratory), longfin mako (*Isurus paucus*) (listed as migratory) and giant manta ray (*Manta birostris*) (listed as migratory) may be present within the Operational Area, for short durations when individuals transit the area.

Migratory shorebirds may be present in or fly through the Operational Area between July and December and again between March and April. A BIA defined by the DoE for the migratory wedge-tailed shearwater during its breeding period (August – April) overlaps with the Operational Area, however the wedge-tailed shearwater was not identified as potentially occurring within the Operational Area. Three species of listed birds were identified as potentially occurring within the Operational Area, including the southern giant-petrel (*Macronectes giganteus*) listed as threatened and migratory, the Australian fairy tern (*Sternula neries nereis*) listed as threatened, and the eastern osprey (*Pandion cristatus*)

listed as migratory. No critical habitat associated with these species has been identified within the Operational Area, and therefore the presence of this species within the Operational Area is likely to be infrequent as individuals traverse the area.

Wider Region

A number of additional large whales species (with seasonal presence in WA waters) and smaller cetaceans (with wider geographical distribution) may transit the Operational Area and include: the Antarctic minke whale (*Balaenoptera bonaerensis*), Bryde's whale (*Balaenoptera edeni*), sperm whale (*Physeter macrocephalus*), killer whale (*Orcinus orca) and* spotted bottlenose dolphin (*Tursiops aduncus*) and Indo-Pacific humpback dolphin (*Sousa chinensis*). Dugong occurrence within the Operational Area is considered unlikely due to their preferred nearshore distribution in areas of seagrass habitat.

Four of the EPBC Act listed turtle species (green, loggerhead, flatback and hawksbill) have significant nesting beaches along the mainland coast and islands in the region including the Montebello Islands, Barrow Island Dampier Archipelago, Muiron Islands, the North West Cape and Ningaloo coast

Whale sharks are known to aggregate annually (from March to July) in areas off Ningaloo and North West Cape and these areas are also important for manta rays in autumn and winter.

The Montebello/Barrow/Lowendal Island Groups (approximately 48 km south-east of the closest point of the Operational Area) are important seabird and shorebird nesting and foraging habitats. The Operational Area may be occasionally visited by migratory shorebirds, but it does not contain critical habitats for any species.

4.3 Socio-economic and Cultural

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

A number of Commonwealth and State fisheries are located within, adjacent to, or in the region of the Operational Area. There is no current fishing effort activities from these fisheries within the Operational Area.

Commonwealth fisheries designated management areas within or adjacent to the Operational Area include the Western Skipjack Tuna Fishery, Western Tuna and Billfish Fishery, Southern Bluefin Tuna Fishery and the North West Slope 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 Pilbara Demersal Scalefish Fisheries (Pilbara Trawl, Trap and Line) part of the North Coast Demersal Scalefish Fishery, the West Australian Mackerel Fishery, Pearl Oyster Managed Fishery (Pearl Leases), Beche de Mer Fishery, Marine Aquarium Managed Fishery, Specimen Shell Managed Fishery, and the Onslow Prawn Managed Fishery. 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.

No known tourism activities take place specifically within or adjacent to the Operational Area, however, the wider regional context includes recreational beaches and tourist nature spots. The Montebello Islands are the closest location for tourism to the Operational Area with some charter boat operators taking visitors to these remote islands. Many areas along the coast are popular and support recreational activities such as boating, diving, sightseeing, swimming, fishing and wildlife viewing. Occasional recreational fishing occurs at Rankin Bank

and Glomar Shoals (located approximately 30 km and 130 km from the Operational Area, respectively).

The region 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 in the NWS region in order 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. No shipping fairways pass through the Operational Area. Major shipping routes in the area are associated with entry to the ports of Dampier and Barrow Island.

The Operational Area is located within an area of oil and gas operations, with the Wheatstone platform also located within the Operational Area. Woodside Burrup Ltd is currently producing gas at the Pluto platform and therefore subsea infrastructure is present in the area, including subsea wellheads, subsea umbilicals and flowlines that intercept the Operational Area.

There are designated defence practice areas in the offshore marine waters off Ningaloo and the North West Cape. The Operational Area is adjacent to the northern tip of one of the defence practice areas. No objection was received from the Department of Defence in relation to the Petroleum Activities Program.

4.4 Values and Sensitivities

The offshore environment of the NWS Province contains environmental assets/receptors of high value or sensitivity, including habitats and species within Commonwealth offshore waters and coastal waters such as the Montebello/Barrow/Lowendal Island groups. Furthermore, the region is noted for its resident, temporary or migratory marine fauna, including EPBC Act listed species such as marine mammal, turtle, and bird species. The marine environment of these offshore locations is pristine and many sensitive receptor locations are protected as part of Commonwealth and State managed areas.

The closest marine reserve to the Operational Area is the boundary of the Montebello Commonwealth Marine Reserve (CMR) which is located within Operational Area (**Figure 4-1**). One key ecological feature (KEF) (the Ancient coastline at 125 m depth contour) was identified within the Operational Area. Values and sensitivities of the established marine protected areas and other sensitive areas in the wider regional setting are listed in **Table 4-1.**

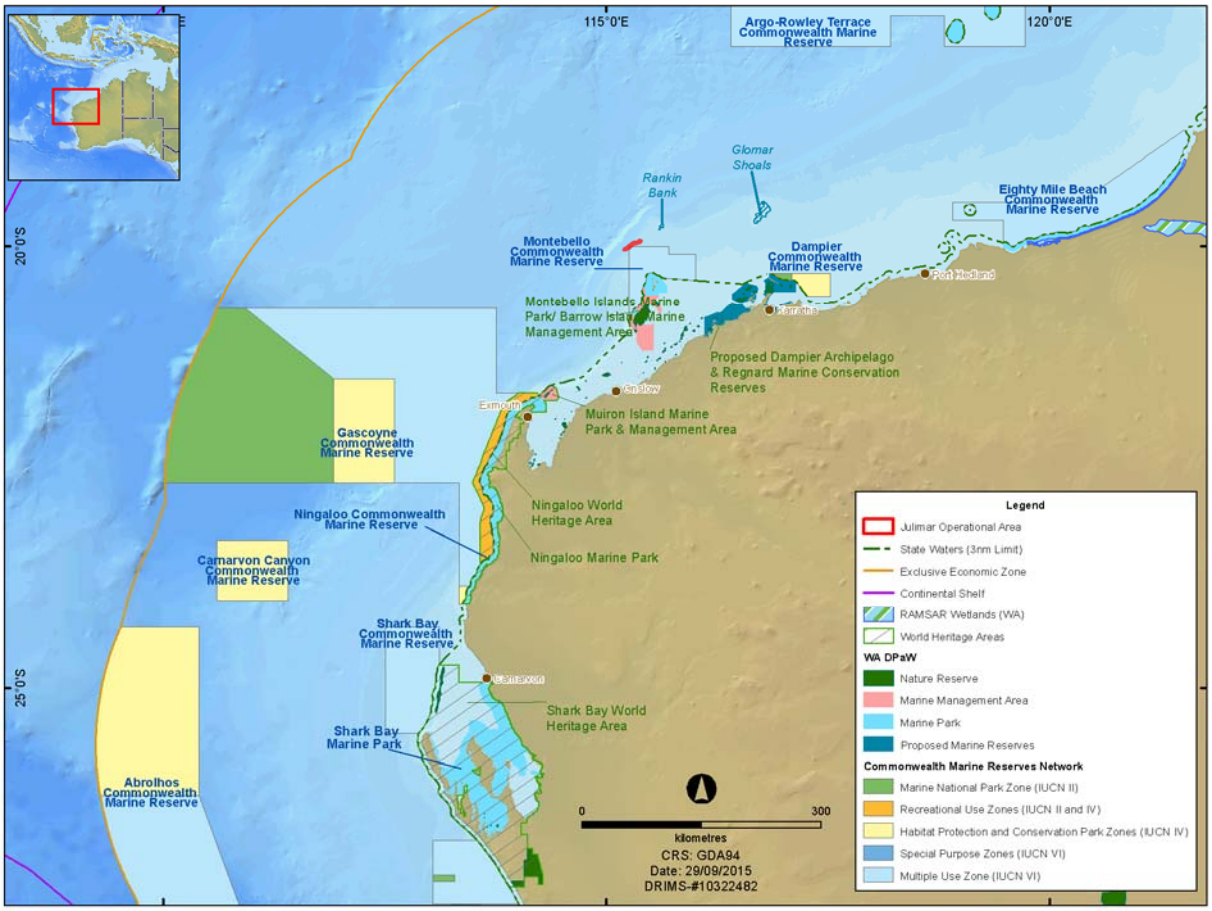


Figure 4-1: Established and Proposed Commonwealth and State Marine Protected Areas in relation to the Operational Area

Table 4-1: Summary of established Marine Protected Areas (MPAs) and other sensitive locations in the region relating to the Operational Area

	Distance from Operational Area to sensitivity boundary (km)	IUCN Protected Area Category
Nearest habitat of significant conservation value		
Montebello Commonwealth Marine Reserve	Small portion within Operational Area	VI – Multiple Use Zone
Ancient Coastline at 125 m depth contour (KEF)	Within Operational Area	N/A
Commonwealth Marine Reserves (CMR) / World Heritage Areas (WHA)		
Gascoyne Commonwealth Marine Reserve	168	II – Marine National Park Zone IV – Habitat Protection Zone VI – Multiple use Zone
Ningaloo Commonwealth Marine Reserve and WHA	212	II – Recreational Use Zone
Argo-Rowley Terrace Commonwealth Marine Reserve	264	II – Marine National Park Zone VI – Multiple use Zone
Shark Bay Commonwealth Marine Reserve	529	VI – Multiple use Zone

	Distance from Operational Area to sensitivity boundary (km)	IUCN Protected Area Category
State Marine Parks, Nature Reserves and Marine Management Areas		
Established		
Montebello Islands Marine Park/Barrow Island Marine Park/Barrow Island Marine Management Area	48	Ia – Sanctuary Zone
Lowendal Islands Nature Reserve	69	Ia – Sanctuary Zone
Barrow Island Nature Reserve (including the Boodie, Double, and Middle Islands Nature Reserve)	71	Ia – Sanctuary Zone
Pilbara Islands – Northern Island Group (Passage Islands chain including Great Sandy Islands and North Sandy Island – State Nature Reserves)	118	Ia – Sanctuary Zone
Dampier Archipelago Nature Reserves	126	Ia – Sanctuary Zone II – Marine National Park Zone
Pilbara Islands – Southern Island Group (Serrurier, Thevenard & Bessieres Islands Nature Reserves)	135	Ia – Sanctuary Zone
Ningaloo Marine Park	208	Ia – Sanctuary Zone II – Marine National Park Zone
Muiron Islands Marine Management Area	191	Ia – Sanctuary Zone (islands) II – Marine National Park Zone
Proposed		
Proposed Dampier Archipelago and Cape Preston Marine Conservation Reserves	131	N/A
World Heritage Areas		
The Ningaloo Coast WHA	212	N/A
Shark Bay WHA	571	N/A
Key Ecological Features (KEFs)		
Continental Slope Demersal Fish Communities	5	N/A
Glomar Shoals	130	N/A
Exmouth Plateau	97	N/A
Canyons Linking the Cuvier Abyssal Plain and the Cape Range Peninsula	164	N/A
Commonwealth Waters Adjacent to Ningaloo Reef	208	N/A
Other		
Rankin Bank	30	N/A

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 as low as reasonably practicable (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.

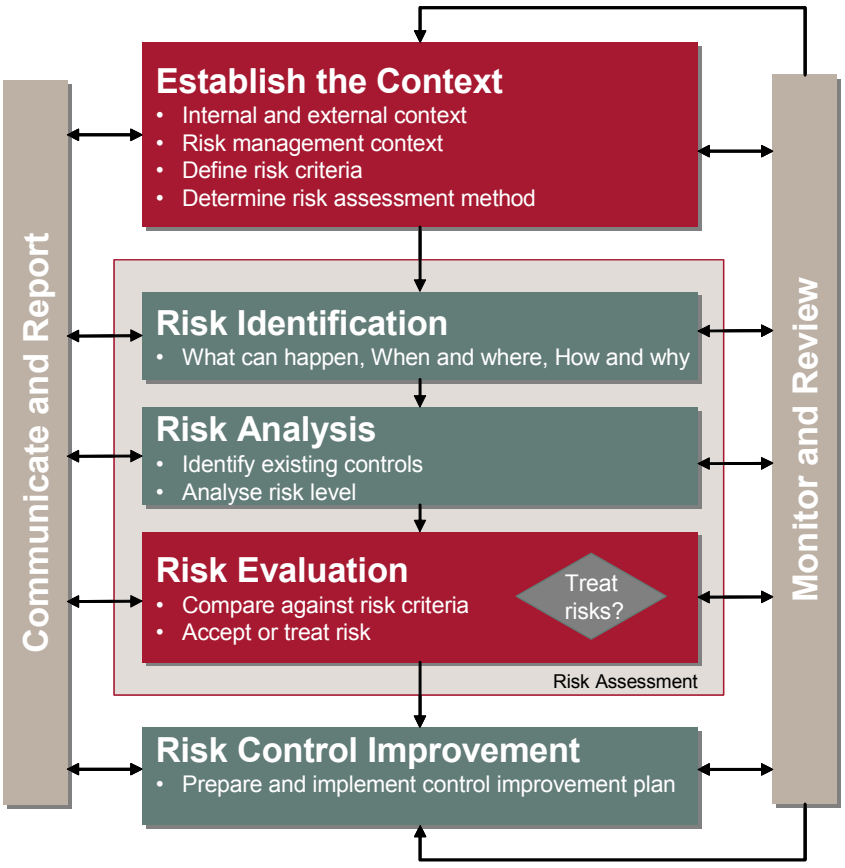


Figure 5-1: Key steps in Woodside's risk management framework

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 the appropriate controls. Risk analysis for the Petroleum Activities Program considered previous risk assessments, review of relevant studies, review of past performance, external stakeholder consultation feedback and review of the existing environment.

To support the risk assessment process, Woodside applied the United Kingdom Offshore Operators Association (1999) Industry Guidelines on a Framework for Risk Related Decision Support 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 ensure:

- Activities do not pose an unacceptable environmental risk
- Appropriate focus is placed on activities where the risk is anticipated to be tolerable and demonstrated to be ALARP
- Appropriate effort is applied to the management of risks based on the uncertainty of the risk, the complexity and risk rating.

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 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 residual risk (i.e. risk with controls in place) and is therefore undertaken following the identification of the decision type and appropriate control measures.

The Consequence Level is selected by determining the worst case credible outcomes associated with the selected event assuming some controls (prevention and mitigation) have failed (**Table 5-1**). Where more than one impact applies, the consequence level for the highest severity impact is selected. The Likelihood Level is selected by determining the description that best fits the chance of the selected consequence actually occurring, assuming reasonable effectiveness of the prevention and mitigation controls (**Table 5-2**). The consequence and likelihood levels are then used to determine the risk rating in accordance with Woodside's Operational Risk Table (**Table 5-3**).

Table 5-1: Summary of Woodside operational risk tables (consequences)

Consequence Level	Environment
A	Permanent impact. Impact on highly values ecosystems, species or habitat.
B	Serious long-term (>10 years) impact. Impact on highly valued ecosystems, species or habitat.
C	Major long-term (5-10 years) impact. Impact on ecosystems, species or habitat.
D	Moderate medium-term (2-5 years) impact but not affecting ecosystem function.
E	Minor short-term (1-2 years) impact but not affecting ecosystem function.
F	Slight and temporary (<1 year) localised effect to ecosystem, species or habitat.

Table 5-2: Summary of Woodside operational risk tables (likelihood)

Likelihood Level	Frequency	Probability	Experience
0	Once every 10,000 – 100,000 years at location.	1 in 100,000 – 1,000,000	Remote: unheard of in the industry.
1	Once every 1,000 – 10,000 years at location.	1 in 10,000 – 100,000	Highly Unlikely: Has occurred once or twice in the industry.
2	Once every 100 – 1,000 years at location.	1 in 1,000 – 10,000	Unlikely: Has occurred many times in the industry, but not in Woodside.
3	Once every 10 – 100 years at location.	1 in 100 – 1,000	Possible: Has occurred once or twice in Woodside
4	Once every 1 – 10 years at location.	1 in 10 – 100	Likely: Has occurred frequently in Woodside.
5	More than once a year at location or continuously.	>1 in 10	Highly Likely: Has occurred frequently at the location.

Table 5-3: Residual risk matrix

		Likelihood					
		0	1	2	3	4	5
Consequence	A	High	High	Severe	Severe	Severe	Severe
	B	Medium	High	High	Severe	Severe	Severe
	C	Medium	Medium	High	High	Severe	Severe
	D	Low	Medium	Medium	High	High	Severe
	E	Low	Low	Medium	Medium	High	High
	F	Low	Low	Low	Medium	Medium	High

The Environmental Hazard Identification (ENVID) for the Petroleum Activities Program identified 16 sources of environmental risk. These risks are divided into two broad categories: planned (routine and non-routine); and unplanned (accidents/incidents) activities. The 12 sources of environmental risk comprised eight planned and five unplanned sources of

risk. A summary of environmental risks is provided in **Table 6-1** and a detailed table of environmental risks, impacts and control measures have been presented in **Appendix A**.

Generally, the sources of risk from planned activities present a lower environmental consequence compared to the potential impact from unplanned accident or incident events. The Julimar Operations EP contains a variety of mitigation and control measures which ensure potential impacts and risks will be reduced to ALARP and will be 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 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 are used to determine acceptability.

Demonstration of ALARP

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

The residual risk is low:

- 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 residual risk is medium or high:

- 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.

Demonstration of acceptability

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

- Low residual risks are 'Broadly Acceptable', if they meet legislative requirements, industry codes and standards, regulator expectations, Woodside Standards and industry guidelines.
- Medium and High residual risks are ‘Acceptable’ if ALARP can be demonstrated using good industry practice and risk based analysis, if legislative requirements are met and societal concerns are accounted for and the alternative control measures are grossly disproportionate to the benefit gained.
- In undertaking this process for medium and high residual risks, Woodside evaluates the following criteria:
    - Principles of Ecological Sustainable Development (ESD) as defined under the EPBC Act
    - External context – consideration of the environment consequence and stakeholder expectations

- Internal context - the controls and residual risk level are consistent with Woodside policies, procedures and standards
- Other requirements – the controls and residual risk level are consistent with national and international standards, laws and policies.

Severe residual risks are 'Intolerable' and therefore unacceptable. These 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.

Zone of Consequence 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.

Surface fate and shoreline accumulation concentrations are expressed as grams per square metre (g/m2), with entrained and dissolved aromatic hydrocarbon concentrations expressed as parts per billion (ppb). Hydrocarbon thresholds are presented in the table below (**Table 5-4**) and described in the following subsections.

Table 5-4: 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/m2 (dull metallic colours) based on the relationship between film thickness and appearance (Bonn Agreement 2004). This threshold concentration expressed in terms of g/m2 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/m2 (NOAA 1997; French et al. 1999; Koops et al. 2004).

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. However, it is likely these data specific to dissolved oil hydrocarbon represents a worst-case scenario. This is owing to the

fact that entrained oil hydrocarbons are less biologically available to organisms through absorption into their tissues than dissolved oil hydrocarbons. A conservative entrained threshold concentration of 500 ppb has therefore been adopted.

Dissolved Aromatic Hydrocarbon Threshold Concentrations

The threshold concentration value for dissolved aromatic hydrocarbons has been set with reference to results from ecotoxicity tests. 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, the selected dissolved aromatic hydrocarbon threshold of 500 ppb has been adopted. It is considered reasonable that the 500 ppb threshold remains applicable and appropriate for delineating potential chronic and acute effects to ecosystems, with the assessment recognising the potential for impact to reproductive success and early life stages of the most sensitive species at the adopted threshold value.

Accumulated Hydrocarbon Threshold Concentrations

Owens and Sergy (1994) define accumulated hydrocarbon <100 g/m2 to have an appearance of a stain on shorelines. French Mckay (2009) defines accumulated hydrocarbons ≥100 g/m2 to be the threshold that could impact the survival and reproductive capacity of benthic epifaunal invertebrates living in intertidal habitat.

6. 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. These sources of risk include:

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)					
Proximity of activity vessels and subsea infrastructure causing interference with or displacement of third party vessels (commercial shipping, fishing and other oil and gas operations)	Minor and temporary social impact potentially resulting from interference with other sea users (e.g. commercial and recreational fishing, and shipping)	F	Reputation/brand – Isolated and short-term local concern Social and cultural – Minor, temporary impact to a community or areas/items of cultural significance	1	Low
Disturbance to seabed from dewatering and IMR activities	Temporary and localised disturbance to the seabed, largely composed of soft sediments	F	Environment – Slight and/or temporary localised effect to benthic habitats	1	Low
Generation of noise from activity vessels, helicopters, side scan sonar and mechanical equipment	Temporary and minor behavioural disturbance (e.g. avoidance or attraction) to megafauna such as migratory whale species, including protected species	F	Environment – Slight and/or temporary disruption to a small proportion of protected species	1	Low
Routine discharge of drain, deck, bilge water, grey water, sewage and putrescibles wastes from the activity vessels to the marine environment	Localised and temporary effects to water quality and marine biota, such as plankton in the water column in offshore waters	F	Environment – Slight and/or temporary decrease in water quality	1	Low
The discharge of chemicals and hydrocarbons to the marine environment as a result of planned routine and non-routine operations and activities	Localised and temporary effects to water quality and marine biota, such as plankton in the water column in offshore waters	F	Environment – Slight and/or temporary decrease in water quality	1	Low
The discharge of preservation fluid, including MEG, during dewatering or leak testing activities	Localised and temporary effects to water quality and marine biota, such as plankton in the water column in offshore waters	F	Environment – Slight and/or temporary decrease in water quality	2	Low
Internal combustion engines on activity vessels	Reduced local air quality from atmospheric emissions	F	Environment – Slight and temporary decrease in local air quality	1	Low

Source of Risk	Areas of Impact / Environmental Impacts	Residual Risk Rating			
		Consequence	Potential Consequence level of impact	Likelihood	Residual Risk
Lighting associated with the physical presence of activity vessels during IMR activities.	Minor and temporary disruption to marine fauna, including protected species	F	Environment – Slight and temporary, localised disruption to the marine environment or a small proportion of a protected species	1	Low
Unplanned Activities (Accidents / Incidents)					
Loss of well containment, arising from catastrophic damage to the Xmas Tree or similar, resulting in loss of hydrocarbons to the marine environment	Contamination of water leading to toxic effects to marine biota, particularly sessile benthos in the shallow sub-tidal and intertidal zone of the coral reefs Oiling of marine mammals, reptiles and seabirds Potential medium-term interference with or displacement of other sea users (e.g. fishing and shipping) Potential interference with activities of other regional petroleum operators	B	Environment – Large scale and long term environmental effects to sensitive biota and habitats. Recovery potentially greater than 10 years Reputation/brand – Serious national and international concern, economic impact on commercial and recreational marine-based activities.	1	High
Loss of containment of subsea infrastructure as a result of: • failure of the subsea infrastructure integrity (i.e. erosion or corrosion/mechanical) • anchor drag, or • dropped object from activity vessels onto live flowline	Contamination of water leading to localised and short/medium term impacts on other habitats and communities in the open water Oiling of marine mammals, reptiles and seabirds Potential short term interference with or displacement of other sea users (e.g. fishing and shipping) Potential interference with activities of other regional petroleum operators	E	Environment – Minor short term (1–2 years) impact but not affecting ecosystem function Reputation/brand – Short term local concern	1	Low
Loss of hydrocarbons to marine environment from a vessel collision resulting in a breach of fuel tank (Marine Gas Oil)	Minor and temporary disruption to marine fauna, including protected species Minor and/or temporary impacts to water quality	E	Environment – Minor short term, localised disruption to the marine environment or a small proportion of a protected species	1	Low

Source of Risk	Areas of Impact / Environmental Impacts	Residual Risk Rating			
		Consequence	Potential Consequence level of impact	Likelihood	Residual Risk
Loss of hydrocarbons to marine environment during bunkering activities (MGO)	Minor and temporary disruption to marine fauna, including protected species Minor and/or temporary impacts to water quality	F	Environment – Slight and temporary, localised disruption to the marine environment or a small proportion of a protected species	1	Low
Minor spills to deck from vessels in the Operational Area.	Minor and temporary disruption to marine fauna, including protected species Minor and/or temporary impacts to water quality	F	Environment – Slight and temporary, localised disruption to the marine environment or a small proportion of a protected species	1	Low
Release of chemicals and hydrocarbons to the subsea marine environment due to failure of seal or minor leaks	Minor and temporary disruption to marine fauna, including protected species Minor and/or temporary impacts to water quality	F	Environment – Slight and/or temporary decrease in water quality	2	Low
Accidental loss of solid hazardous or non-hazardous wastes to the marine environment	Pollution and contamination of the environment and secondary impacts on marine fauna (e.g. ingestion or entanglement)	F	Environment – Slight and temporary, localised disruption to the marine environment or a small proportion of a protected species	1	Low
Accidental collision between activity vessels and threatened and marine fauna	Potential injury or fatality of an individual or a number of megafauna (including listed threatened or migratory species)	F	Environment – Minor, short term disruption to a small proportion of a population protected species	1	Low

7. ONGOING MONITORING OF ENVIRONMENTAL PERFORMANCE

The Petroleum Activities Program will be managed in compliance with the *Julimar Operations* 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 Julimar Operations 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) a specific environmental performance outcome, environmental performance standards and measurement criteria have been developed. The performance standards are control measures (available in **Appendix A**) that will be implemented to achieve the environmental performance outcomes. The specific measurement criteria provide the evidence base to demonstrate that the performance standards (control measures) and outcomes are achieved.

The implementation strategy detailed in the Julimar Operations 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.

The wells and subsea infrastructure will be operated, monitored, controlled and restarted by Chevron, under the contract between the Chevron and the Woodside. IMR activities may be undertaken by Woodside or the Wheatstone platform operator, Chevron.

Under the contract, Woodside has the means to monitor the performance of Chevron, including access to real-time data and reporting, and has access rights to all facilities under the Joint Operating Agreement. Woodside will undertake an annual review to provide assurance that Chevron is complying with the requirements of the contract and, as part of that agreement, the Julimar Operations EP.

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 Julimar Operations 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 annually 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 Julimar Operations EP
- Activity based inspections undertaken by Woodside's environment function to review compliance against the Julimar Operations EP, verify effectiveness of the implementation strategy and to review environmental performance
- Environmental performance is also monitored daily via daily progress reports during operations

- 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 Julimar Operations EP. Incidents will be reported using an Incident and Hazard Report Form, which includes details of the event, immediate action 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 Julimar Operations 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 is provided in **Appendix B**.

7.1 Environment Plan Revisions and Management of Change

Revision of the Julimar Operations 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:

- When any significant modification or new stage of the activity that is not provided for in the Julimar Operations EP
- Before, or as soon as practicable after, the occurrence of any significant new or significant increase in environmental risk or impact not provided for in the Julimar Operations EP
- 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.
- As requested by NOPSEMA.

Management of changes relevant to the Julimar Operations 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 and resubmission of the environment plan 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 Julimar Operations 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 Julimar Operations 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

Julimar Operations 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 Oil Pollution Emergency Plan (OPEP) for the Petroleum Activities Program has the following components:

- Oil Pollution Emergency Arrangements (Australia)
- Julimar Operations Oil Pollution First Strike Plan
- Oil Spill Preparedness and Response Mitigation Assessment for Julimar Operations.

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:

- 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
- 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
- Mutual Aid Agreements with other oil and gas operators in the region for the provision of assistance in a hydrocarbon spill response.

8.2 Julimar Operations Oil Pollution First Strike Plan

The Julimar Operations 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.

For an oil spill incident initial actions to be undertaken by Chevron as per the Julimar Operations Oil Pollution First Strike Plan.

The activity vessels will have Ship Oil Pollution Emergency Plans (SOPEPs) in accordance with the requirements of MARPOL 73/78 Annex I. These plans outline responsibilities, specify procedures and identify resources available in the event of a hydrocarbon or chemical spill from vessel activities. The Julimar Operations 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 Julimar Operations 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** - gathering of data 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 operational monitoring plans to satisfy the requirements of this mitigation control. Further information on monitoring is provided in **Section 8.4.**
- **Source control (well control and intervention)** - Woodside's strategy is to minimise the volume of hydrocarbons released from an oil spill event. Woodside plans to deploy the following controls specific to well loss of containment scenarios, if required for the Petroleum Activities Program:
    - Subsea first response toolkit (SFRT) deployment to clear debris, assess the well at the sea bed, and if practicable, attempt to close the emergency blowout preventer
    - Source control (deployment of capping stack)
    - Well intervention (relief well drilling).
- **Open Water Containment and Recovery** – Involves the physical containment and mechanical removal of hydrocarbons from the marine environment. Suitable vessels would be drawn from Woodside's integrated fleet, other operators in the region and from the charter market. Open water containment and recovery equipment (e.g. booms and skimmers) would be sourced from Woodside's own equipment, AMSA, AMOSC and Oil Spill Response Limited (OSRL) stockpiles.
- **Oiled wildlife response** – Staging sites will be established for shoreline or vessel based oiled wildlife response teams. Once recovered to a staging site, wildlife will be transported to the designated oiled wildlife facility for stabilisation and treatment.

To support the above response strategies, Woodside has access to Veolia's waste management facilities as well as waste storage equipment from AMOSC, AMSA and OSRL.

Implementation of these response strategies would be re-assessed during a spill event, with consideration of the size of spill, weather conditions and other constraints.

A summary of potential risks; potential impacts and control measures for oil spill response during the Petroleum Activities Program is included in **Appendix B.**

8.4 Monitoring

Operational Monitoring

To gain an understanding of the spill event, its movement and to direct mitigation activities to the optimal locations, 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
- Monitoring of contaminated resources and the effectiveness of response and clean-up operations.

Scientific Monitoring

Woodside would activate its Scientific Monitoring Program (SMP) following a Level 2 or 3 hydrocarbon release, or any release event with the potential, or actual contact to sensitive environmental receptors. The nature and scale of the spill event would dictate the implementation and operational timing of the SMP. Ten targeted scientific monitoring programs may be implemented to address a range of physical-chemical (water and sediment) and biological receptors (species and habitats) including EPBC Act listed species, environmental values associated with Protected Areas and socio-economic values such as fisheries. When activated the Woodside SMP has two primary objectives as follows:

- Determine the extent, severity and persistence of the environmental impacts associated with the hydrocarbon release and the response activities
- Acquire, where practicable, the environmental baseline data required to support the Post-Response SMP in monitoring, evaluating and documenting the recovery of impacted environmental receptors.

9. CONSULTATION

In support of the Julimar Operations 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 Julimar Operations 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 stakeholder identified for the Petroleum Activities Program

Stakeholder	Relevance
Department of Industry and Science	Department of relevant Commonwealth Minister
Department of Mines and Petroleum	Department of relevant State Minister
Australian Maritime Safety Authority (maritime safety)	Maritime safety
Australian Hydrographic Office	Marine safety
Department of Fisheries (Western Australia)	Fisheries management - State
Australian Fisheries Management Authority	Fisheries management - Commonwealth
Commonwealth fisheries • Western Tuna and Billfish Fishery • North West Slope Trawl Fishery • Western Skipjack Fishery • Southern Bluefin Tuna • Western Deepwater Trawl Fishery	Commercial fishery - Commonwealth
Western Australian Fisheries • Mackerel Fishery • Pilbara Trawl Fishery • Pilbara Trap Fishery • Pilbara Line Fishery	Commercial fishery - State
Department of Defence – Defence Property Services Group	Defence estate management
Department of Transport (Western Australia)	Oil spill preparedness

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)
- Australian Customs Service – Border Protection Command
- Commonwealth Fisheries Association
- Western Australian Fishing Industry Council
- Pearl Producers Association

- Recfishwest
- World Wildlife Fund for Nature (WWF)
- Australian Conservation Foundation
- Wilderness Society
- International Fund for Animal Welfare
- Australian Petroleum Production and Exploration Association (APPEA)
- 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 Julimar Operations 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:

Kate McCallum

Corporate Affairs Adviser

240 St Georges Terrace

Perth WA 6000

feedback@woodside.com.au

Toll free: 1800 442 977

11. ABBEVIATIONS

Term	Description / Definition
Abbreviations	
AMOSC	Australian Maritime Oil Spill Centre
AMSA	Australian Maritime Safety Authority
BIA	Biological Important Area
BruA	Brunello A
Chevron	Chevron Australia Pty Ltd
DoE	Commonwealth Department of Environment
EP	Environment Plan
EPBC Act	*Environment Protection and Biodiversity Conservation Act, 1999*.
Environment Regulations	*Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations* 2009 (Cth)
ENVID	Environmental Hazard Identification
ESD	Ecological Sustainable Development
ICS	incident command structure
IMR	Inspection, Maintenance and Repair
IUCN	International Union for the Conservation of Nature
KEF	Key Ecological Feature
MARPOL	International Convention for the Prevention of Pollution from Ships, 1973
MEG	Mono-ethylene glycol
MMscf	Million Standard Cubic Feet
MNES	Matters of National Environmental Significance
NOPSEMA	National Offshore Petroleum Safety and Environmental Management Authority
NWS	North West Shelf
OPEP	Oil Pollution Emergency Plan
OSRL	Oil Spill Response Limited
Petroleum Activities Program	Comprises of activities being undertaken in licence areas WA-49-L and WA-26-PL (as well as within non-Woodside production licence areas), including preparation activities; operations; and inspection, maintenance and repair activities
ROV	Remote Operated Vehicle
SFRT	Subsea Frist Response Toolkit
SMP	Scientific Monitoring Program
SOPEP	Ship Oil Pollution Emergency Plan
SSS	Side scan sonar
Woodside	Woodside Energy Julimar Pty Ltd, a wholly owned subsidiary of Woodside Energy Limited
ZoC	Zone of Consequence

12. REFERENCES

APASA (Asia-Pacific Applied Science Associates), 2012, WEL Hydrotest Dispersion Assessment, GWF-1 Pigging Operations, Prepared for Woodside Energy Limited by APASA.

Commonwealth of Australia 2015b. Conservation Advice. Megaptera novaeangliae. Humpback Whale. Threatened Species Scientific Committee. October 2015. 14 pp.

DHI, 2014, Wheatstone Upstream Numerical Modelling, Assessment of Trunkline Treated Water Discharged at the Platform, Nearfield Assessment of Apache Flowlines, DHI Report prepared for Chevron, Project No 43801541, August 2014.

French, D.P., Schuttenberg, H.Z. and Isaji, T. 1999. Probabilities of oil exceeding thresholds of concern: examples from an evaluation for Florida power and light. In proceedings: AMOP 99 Technical Seminar, June 2-4, 1999, Calgary, Alberta, Canada, pp. 243-270.

Hartin, K.G., Bisson, L.N., Case, S.A., Ireland, D.S and Hannay, D. (eds.). 2011. Marine mammal monitoring and mitigation during site clearance and geotechnical surveys by Statoil USA E&P Inc. in the Chukchi Sea, August-October 2011: 90 –day report. LGL Rep. P1193. Rep. from LGL Alaska Research Associates Inc., LGL Ltd., and JASCO Research Ltd. For Statoil USE E&P Inc., Nat. Mar. Fish. Serv., and U.S Fish and Wild. Serv. 202 pp. plus appendices.

ITOPF. 2011. *Effects of Oil Pollution on the Marine Environment. Technical Information Paper.* Technical paper No. 13. The International Tank Owners Pollution Federation Limited.

Jensen, A.S. and Silber, G.K. 2003. *Large Whale Ship strike database*, US Department of Commerce, NOAA Technical Memorandum. NMFS-OPR-, pp 37.

Koops, W., Jak, R.G. and van der Veen, D.P.C. 2004. Use of dispersants in oil spill response to minimize environmental damage to birds and aquatic organisms, in Proceedings of Interspill 2004, Trondheim, Norway, paper no. 429.

Lutcavage, M.E., Lutz, P.L., Bossart, G.D. & Hudson, D.M. 1995. Physiologic and clinicopathological effects of crude oil on loggerhead sea turtles, *Archives of Environmental Contamination and Toxicology* (28): 417–422.

Myrberg Jr., A. A. 2001. The acoustical biology of elasmobranchs, *Environmental Biology of Fishes* 60: 31–45.

NOAA. 1997. Aerial observations of oil at sea, Modelling and Simulations Branch, Hazardous Materials Response and Assessment Division, Office of Ocean Resources Conservation and Assessment, National Oceanic and Atmospheric Administration, Seattle, Washington, USA.

Popper, A.N., Hawkins, A.D., Fay, R.R., Mann, D., Bartol, S., Carlson, T., Coombs, S., Ellison, W.T., Gentry, R., Halvorsen, M.B., Løkkeborg, S., Rogers, P., Southall, B.L., Zeddies, D., Tavolga, W.N. 2014. *Sound Exposure Guidelines for Fishes and Sea Turtles*: A Technical Report prepared by ANSI-Accredited Standards Committee S3/SC1 and registered with ANSI. ASA S3/SC1.4 TR-2014. Springer and ASA Press, Cham, Switzerland.

Southall, B.L., Bowles, A.E., Ellison, W.T., Finneran, J.J., Gentry, R.L., Green, Jr. C.R., Kastak, D., Ketten, D.R., Miller, J.H. and Nachtigall, P.E. 2007. Marine Mammal Noise Exposure Criteria: Initial Scientific Recommendations, *Aquatic Mammals* 33(4): 121 pp.

Vanderlaan, A.S.M. and Taggart, C.M. 2007. Vessel collisions with whales: The probability of lethal injury based on vessel speed, *Marine Mammal Science* 23(1):144-156.

APPENDIX A: DETAILED ENVIRONMENTAL IMPACTS AND RISKS

PLANNED ACTIVITIES (ROUTINE AND NON-ROUTINE)

Interference with or Displacement of Third Party Vessels

Source of Risk	Environmental Value Potentially Impacted									Evaluation		
	Water Quality	Marine Sediment Quality	Air Quality	Marine Primary Producers	Other Habitats & Communities	Protected Species	Soil & Groundwater	Socio-Economic	Protected Areas	Consequence	Likelihood	Residual Risk
Proximity of activity vessels and subsea infrastructure causing interference with or displacement of third party vessels (commercial shipping, fishing, other oil and gas operations).								X		F	1	L

Description of Source of Risk

Activity vessels will be present intermittently throughout the duration of the Petroleum Activities Program. The presence of activity vessels could present a navigational hazard to shipping and commercial fishing activities in the Operational Area.

Additionally, vessels associated with the Wheatstone operations, Pluto production and other oil and gas activities (including Balnaves operations cessation) may be present in the Operational Area during the course of the Petroleum Activities Program. Vessels associated with these activities may include:

- Wheatstone – inspection vessels (every 1-3 years for approximately 50 to 100 days), maintenance and repair vessels (in response to inspection findings, engineering analyses, and/or external events), major maintenance campaigns, heavy lift vessel (several weeks to remove additional living quarter modules and support vessels (servicing the platform approximately 1 to 3 times a week)
- Pluto – supply vessels (during maintenance activities) and IMR vessels along the flowlines and MEG lines (at a similar frequency to that outlined above for Wheatstone).

The presence of permanent subsea infrastructure could result in the displacement of commercial fishing, e.g. bottom trawl fisheries.

Potential Environmental Impacts

Value	Description of Potential Environmental Impact
Socio-Economic Values	***Displacement to Commercial Fishing Activities*** A number of Commonwealth and State managed fisheries occur in the region. The Operational Area overlaps the fisheries management areas of three Commonwealth and seven State-managed commercial fisheries. Historic fisheries data indicate that commercial fishing activity occurs within the Operational Area for only one fishery (Pilbara Demersal Scalefish (Pilbara Trawl, Trap and Line) Fisheries (State)), with the majority of other fishing activity targeting the shallower coastal waters outside the Operational Area. The overlap of the Operational Area with commercial fishing activity may temporarily exclude fishers from the area, resulting in a perceived loss of catch and potential loss of gear (particularly in relation to deployed traps). The potential impact to commercial fisheries in the Operational Area is considered to be minor, and may result in minor interference (navigational hazard) and localised displacement/avoidance by commercial fishing vessels within the immediate vicinity. As such, the potential impact is considered to be low. The presence of permanent subsea infrastructure over the 25 year field life could present a hazard to bottom trawl fisheries due to risk of equipment entanglement and subsequent equipment damage/loss. The only potential for contact with subsea infrastructure would potentially be with trawl fishery operations. The Existing Environment and 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 not considered credible. ***Displacement to Commercial Shipping*** The presence of activity vessels could potentially cause temporary disruption to commercial shipping. However, no AMSA shipping fairways traverse the Operational Area, though Consultation

	with AMSA did identify vessel traffic in and around the Operational Area. Vessel tracking data provided by AMSA for April to June 2015 indicates that the majority of traffic will be activity vessels associated with existing oil and gas infrastructure, which will likely decrease significantly once the Wheatstone Platform is producing and construction has ceased. However, there may be commercial vessels infrequently in the area. The use of the shipping fairways is strongly recommended by AMSA, but is not mandatory and shipping vessels still have to adhere to the International Regulations for Preventing Collisions at Sea 1972. The potential impacts associated with this Petroleum Activities Program include short-term displacement of vessels as they make slight course alteration to avoid activity vessels. Based on the nature and scale of activities in field, no long term impacts are anticipated on commercial shipping over the life of field. Therefore, the potential impact is considered to be low. ***Displacement of Recreational Fishing*** Stakeholder consultation did not identify any key recreational fishing activity within the Operational Area. Recreational fishing is concentrated around the coastal waters and islands of the NWS Province such as the Montebello Islands. Occasional recreational fishing is identified as occurring at Rankin Bank, approximately 30 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 a charter boat was fishing within the area, displacement as a result of the Petroleum Activities Program would be minimal. Therefore, the potential impact, including over the life of field, is considered to be minor. ***Interference with Existing Oil and Gas Infrastructure*** The Wheatstone Platform and associated subsea infrastructure are located at the northern end of the Operational Area. Uncontrolled access in the vicinity of this facility could increase the potential for interference with the facility and supporting vessels. Vessel based activities for the Julimar Field Production System will be managed via the Wheatstone Platform Operator Permit to Work (PTW) process, which limits the potential for any non-compatible cumulative activities. It is unlikely that multiple activities associated with this Petroleum Activities Program will be undertaken in parallel in the Operational Area. As such, the likelihood of multiple vessels being present in the Operational Area for the Petroleum Activities Program is very low.
Summary	Given the adopted controls, it is considered that physical presence of activity vessels and subsea infrastructure should not result in a potential impact greater than isolated and short term local concern to shipping and commercial/recreational fishing interests over the projected field life. Vessel-based activities for the Petroleum Activities Program will lead to a small increase in the overall vessel traffic in the Operational Area; much of the existing traffic relates to vessels undertaking similar activities for the Wheatstone development, and to a lesser extent Pluto production activities. Given the controlled access of vessels to the area surrounding the Wheatstone platform, the 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

Summary of Control Measures

- Vessels compliant with Marine Order 30 (Prevention of Collisions) 2009.
- Vessels compliant with Marine Order 21 (Safety of navigation and emergency procedures) 2012.
- Notify AHS to generate a temporary Maritime Safety Information Notifications (MSIN) and temporary Notice to Mariners (NTM) for activities where vessels will be in field >3 weeks.
- AMSA RCC is notified prior to commencement of preparation activities and at commencement of operations.
- Activities within 500 m of the Wheatstone platform completed under the Chevron's PTW system as required by the Permit to Work Manual.

Disturbance to Seabed from dewatering and IMR activities

Source of Risk	Environmental Value Potentially Impacted									Evaluation		
	Water Quality	Marine Sediment Quality	Air Quality	Marine Primary Producers	Other Habitats & Communities	Protected Species	Soil & Groundwater	Socio-Economic	Protected Areas	Consequence	Likelihood	Residual Risk
Disturbance to Seabed from Dewatering and IMR Activities	X	X			X					F	1	L

Description of Source of Risk

Some minor disturbance to the seabed may result from physical presence, subsea IMR and dewatering activities (where equipment is installed or retrieved from the seafloor) including:

- ROV activities
- clump weight installation/use
- pig launcher/receiver
- jetting or dredging
- marine growth removal
- CP survey
- installation of mattresses/ grout bags/ rocks/stabilisation of subsea infrastructure
- laydown and use of tool baskets
- jumper and umbilical replacement
- unburied infrastructure creating localised seabed disturbance (erosion and scouring)

A number of activities may result in the direct disturbance to the seabed, from installation of subsea infrastructure (e.g. mattresses) to the temporary placement of materials on the seabed during the IMR activities (e.g. ROV toolbox). The area predicted to be disturbed ranges from 0.5 m^2 (placement of transponders on the seabed) to 50 m^2 (placement of anodes on the seabed).

Use of grout and placement of small volumes of rocks or mattresses to stabilise equipment is limited to within the immediate footprint of subsea infrastructure to prevent or remediate erosion, if detected. Stabilising or other IMR activities are short duration in field (single days to weeks) rather than extended campaigns over several months. Following installation, subsea infrastructure with a profile above the seabed (i.e. not buried) such as the pipeline/flowlines and raised manifold structures may create conditions that cause localised erosion/scouring of the seabed. Physical disturbance of the seabed and associated turbidity increases in the surrounding water column are predicted to be highly localised and temporary.

During IMR or dewatering activities (during equipment installation or retrieval) additional potential seabed disturbance may also occur from dropped objects (unplanned).

Potential Environmental Impacts

Value	Description of Potential Environmental Impact
Water Quality, Marine Sediment Quality	The Operational Area is approximately 25 km long and 3 km wide in waters approximately 70–150 m deep on the middle continental shelf. The benthic habitat is predominately soft sediment with sparsely associated epifauna (RPS 2011a) with small areas of outcropping cemented sediments at the north-eastern end of Operational Area, adjacent to the base of the Wheatstone Platform (Neptune Geomatics 2010; RPS 2010a, 2011a). Benthic communities of the soft sediment seabed are characterised by burrowing infauna and outcropping hard substrate support filter feeding communities. Both soft sediment and hard substrate benthic communities are well represented within the wider region of the NWS Province. IMR activities can be categorised into two potential impacts: • direct physical disturbance of benthic habitat • indirect disturbance to benthic habitats from sedimentation Rock dumping and mattresses installation provide hard substrate, which may be colonised by sessile benthic invertebrates such as sponges or soft corals. These may

	subsequently, result in habitat creation for demersal fish populations. The potential cumulative impact of IMR activities associated with the Pluto or Wheatstone subsea infrastructure and that associated with this Petroleum Activities Program are also evaluated. *Soft Sediment Benthic Fauna Communities* The majority of the Operational Area contains soft unconsolidated sediments which are associated with benthic fauna communities (sparse epifauna and a common suite of infauna) that are broadly represented along the continental shelf and upper slopes in the NWS province. The infauna communities are representative of the NWS province being of low abundance, highly variable and diverse, dominated by polychaetes and crustaceans (RPS 2011a). Direct seabed disturbance, including permanent loss of benthic fauna communities, may result from IMR activities near or on the seabed as well as dropped objects incidents. Such impacts if they occurred, however, would disturb a very minor portion of the soft sediment habitat, which are broadly represented in the Operational Area and wider NWS province. Predicted impacts include a permanent loss of benthic fauna communities within the physical footprint of the introduced materials. The estimated overall extent of such direct seabed disturbance is extremely small in relation to the extent of the soft sediment habitats which are broadly represented within the Operational Area and the wider NWS province. Indirect seabed disturbance may include localised and temporary decline in water quality due to increased suspended sediment concentrations and increased sediment deposition caused by the placement of permanent structures, deployment/retrieval of temporary equipment, jetting/dredging and ROV activities. However, sediment loads are not expected to be significant due to the relatively small footprint for each activity. Each placement on and from the seabed will likely cause a single brief disturbance resulting in a transient small plume of suspended sediment and subsequent deposition. Such localised and short term events may affect small areas of the seabed and consequently, impact the associated sparse epifauna and burrowing infauna. However, given the extent of the soft sediment habitat within the operational area and more widely within the NWS province, anticipated recolonization of the seabed by similar benthic fauna on cessation of works such environmental impacts are considered low. Elevated turbidity plumes may be associated with erosional dynamics created by subsea infrastructure with a profile above seabed. Subsea infrastructure design together with placement of mattresses aim to limit the potential for erosion/scour of the seabed to occur. Evidence from adjacent Woodside facility surveys indicates that scour, where present, is highly localised and has been assessed as having a low likelihood of introducing an integrity issue. Where erosion/scour is identified as impacting subsea infrastructure integrity, remedial action undertaken and such events will be result in a localised, temporary disturbance to benthic biota. Additionally, the seafloor of this region is periodically strongly affected by cyclonic storms, long-period swells and routine large internal tides. Such processes lead to re-suspension and the deposition of sediment in the offshore environment of the NWS. There may be temporary and localised changes to the surficial sediment layer which will in turn lead to temporary impacts to infauna biota. In this context, any potential sedimentation impacts caused during the IMR activities are likely to be negligible. *Filter Feeders (including outcropping cemented sediments with epifauna)* Areas of cemented sediments occur approximately 3 km along the north-eastern end Operational Area (Neptune Geomatics 2010; RPS 2010a, 2011a) and support benthic invertebrate community of sessile filter feeding biota including large sea fans, sponges, soft corals, sea whips and ascidians (RPS 2010a, 2011a), likely providing habitat for demersal fish populations. The filter feeding community is considered of higher ecological value than the surrounding soft sediment habitat but only encompasses a very small proportion of the Operational Area. Activities near the seafloor may result in slight and temporary impacts to filter feeders from localised burial (sedimentation) and minor direct loss of filter feeder habitat as a result of seabed disturbance during IMR activities/initial placement of permanent solid structures (see impacts discussed in 'Soft Sediment Benthic Fauna Communities' above). Although impacts to filter feeding communities resulting from project activities may result in permanent loss, this is expected to be restricted to a small portion of filter feeder habitat as represented in the wider NWS Province. Loss of the small portion of filter feeder habitat due to this Petroleum Activity may temporarily impact demersal fish populations associated with the cemented sediment outcrops, however the ecological integrity of filter feeder communities within the region is expected to be maintained, therefore impacts are

	expected to be negligible. *Ancient Coastline at the 125 m Depth Contour KEF* No significant escarpments, species of conservation significance, emergent features or areas of high biological productivity characteristically associated with the ancient coastline at 125 m depth contour was recorded during all seabed surveys of the Operational Area. Small areas of outcropping cemented sediments are located at the north eastern extent of the Operational Area. These impacts are discussed in relation to filter feeders above. Any impacts to benthic fauna as a result of IMR activities or potential dropped objects are expected to be limited to the immediate vicinity of the footprint of the lines, which is a relatively small area compared to the regional extent of the ancient coastline KEF that extends from Exmouth to the Dampier Peninsula. Therefore, potential impacts to this regional-scale key ecological feature are expected to be negligible. Physical disturbance of the seabed resulting from the IMR activities are expected to be slight and temporary. Ecological consequences identified may result in a minor loss of the filter feeding communities associated with the consolidated sediment habitat. Any elevated turbidity associated with changes in erosional dynamics due to the raised profile of subsea infrastructure will be negligible. Given the IMR activities potential impacts are temporary, small scale and restricted to the pipeline footprint, cumulative impacts associated with physical presence of the subsea infrastructure, when considered with other operator's subsea infrastructure and IMR activities are not expected to significantly increase the risk to biota and are not considered further. No impacts on the Continental Slope Demersal Fish Communities KEF are envisaged given the distance from the Operational Area (5 km at the closest point). Montebello Commonwealth Marine Reserve A small proportion (2.7km^2) of the broader Operational Area overlaps the Montebello CMR, The CMR includes values associated with the shallow shelf environments. No regionally significant shelf/slope or pinnacle and terrace habitats were recorded during all seabed surveys of the Operational Area. As described above sessile filter feeder community is associated with the outcroppings of cemented sediments in north eastern extent of the Operational Area, outside the CMR boundary. A total of 0.4 km of the Julimar/Brunello pipeline/flowlines is present within the CMR boundary. Minor, direct loss of seabed habitat in the CMR may be possible, if IMR activities or placement of infrastructure occurs within the boundary. Indirect impacts may occur as a result of sedimentation. These direct and indirect impacts are discussed in relation to soft sediment benthic fauna communities above. Further, cumulative impacts are not predicted to occur as it is expected that any Pluto or Wheatstone subsea infrastructure IMR activities will be spatially and temporally separated. The predicted impacts of these other activities will be similar as to that described above with localised seabed impacts in the vicinity of the subsea infrastructure. **Cumulative Impacts** With respect to sources of risk from other activities, IMR activities associated with the Pluto subsea infrastructure and Wheatstone platform and associated subsea infrastructure, within or in the vicinity of the Petroleum Activities Program (approximately 100-500m) may result in localised seabed disturbance for the flowlines and pipelines. It is not expected that IMR activities will occur concurrently to those within the Operational Area. Impacts associated with Balnaves operations cessation or future decommissioning will take place over 4km from the Operational Area, within a localised disturbance footprint confined to the Balnaves Operational Area and as such, are not considered from a cumulative impact perspective. The most likely activity that could result in a larger seabed disturbance footprint is the installation of mattresses. For the purposes of the impact assessment and consideration of cumulative impacts, an average of stabilisation activities using mattresses (~18 m^2 per mattress) being undertaken every 2 years at Wheatstone and/or Pluto has been assumed. The resulting direct seabed disturbance footprint for the lifetime of the Petroleum Activities Program is approximately 4320 m2, (0.4 hectares) with additional indirect loss from sedimentation in the vicinity of the Wheatstone field and Operational Area. Whilst stabilisation activities are non-routine, if required, a lower number and frequency would be installed in practice.
Summary	In conclusion, IMR activities will have localised impacts to the benthic communities along the pipeline corridor, however, such communities are well represented in the region and

	losses are predicted to represent a small portion of their regional coverage and not affect regional ecological integrity. The loss of fauna of the effected habitats, particularly, filter feeding biota may be partially compensated by the introduction of artificial habitat and colonisation of such biota. Furthermore, introduction of artificial habitat across the Operational Area as a result of installation of hard substrate for Wheatstone, Pluto and this Petroleum Activities Program, may result in increases in demersal fish populations.
Summary of Control Measures	
• Implementation of the Julimar Subsea Inspection, Monitoring and Maintenance Plan. • Activity Vessel Safe Work Procedures developed and implemented. • Recovery of dropped objects determine safe and practicable • Subsea and Pipeline Environment Screening Questionnaire completed for all planned IMR activities.	

Acoustic Emissions

Source of Risk	Environmental Value Potentially Impacted									Evaluation		
	Water Quality	Marine Sediment Quality	Air Quality	Marine Primary Producers	Other Habitats & Communities	Protected Species	Soil & Groundwater	Socio-Economic	Protected Areas	Consequence	Likelihood	Residual Risk
Generation of noise from activity vessels and mechanical equipment during normal operations.						X				F	1	L

Description of Source of Risk

Activity vessels

The activity vessels generate noise both in the air and underwater, due to the operation of thrusters, engines, propeller movement, etc. These noises contribute to and can exceed ambient noise levels which range from around 90 dB re 1µPa rms (Sound Pressure Level, SPL) under very calm, low wind conditions, to 120 dB re 1µPa rms (SPL) under windy conditions (McCauley 2004).

Subsea activities are typically undertaken from activity vessels with DP thrusters to allow manoeuvrability and avoid anchoring when undertaking works in close proximity of subsea infrastructure. Activity vessels holding station (e.g. while using dynamic positioning (DP) systems; relying on thrusters and main propellers) are considered to be the main source of underwater noise generated during the activity. Noise generated from these activities is for discrete work packages and therefore noise generation is intermittent and of short duration. McCauley (1998) measured underwater broadband noise equivalent to approximately 182 dB re 1µPa at 1 m rms (SPL) from a support vessel holding station in the Timor Sea. It is expected that similar noise levels will be generated by activity vessels used for this Petroleum Activities Program.

Helicopters

The intensity of sound travelling from a source in the air (e.g. helicopter) to a receiver underwater is complex and depends on source altitude and lateral distance, receiver depth, water depth, and other variables. The angle at which the line from the aircraft and receiver intersects the water surface is important. In calm conditions, at angles greater than 13° from the vertical, much of the sound is reflected and does not penetrate into the water (Richardson et al, 1995). Therefore, strong underwater sounds are detectable for a period roughly corresponding to the time the helicopter is within a 26° cone above the receiver. Richardson et al, (1995) reported figures for a Bell 214 helicopter (stated to be one of the noisiest) being audible in air for four minutes before it passed over underwater hydrophones, but detectable underwater for only 38 seconds at 3 m depth and 11 seconds at 18 m depth. The maximum received level was 109 dB re 1µPa2.s.

Side scan sonar (SSS)

SSS may be required for IMR to identify buckling, movement, scour and seabed features. The towfish SSS system is a compact high-definition system designed for a wide range of seabed survey and inspection duties. Towfish sonar is designed to tow cleanly and with stability behind a vessel. The proposed side scan sonar device is a high frequency source operating at approximately 120 – 410 kHz.

Pipeline/flowline and wells

The noise produced by an operational wellhead was measured by McCauley (2002) and was very low, 113 dB re 1 µPa rms (SPL), which is only marginally above rough sea condition ambient noise. Based on the measurements of wellhead noise, the noise field produced along a pipeline/flowline may be expected to be similar to that described for wellheads, with the radiated noise field falling to ambient levels within 100 m.

Potential Environmental Impact

Value	Description of Potential Environmental Impact
Protected Species and Other Species	The Operational Area is located in water depths ranging from approximately 70 to 150 m. The fauna associated with this area is predominantly pelagic species of fish, with a low numbers of transient species such as turtles, whale sharks and large whales passing through the area while transiting between other locations. Elevated underwater noise can affect marine fauna, including cetaceans, fish, sharks and rays in three main ways (Richardson *et al*. 1995; Simmonds *et al*. 2004): 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.

Permanent injury would be expected to occur at 230 dB re 1 µPa rms (SPL) (peak) (Southall *et al.* 2007). Noise generated by the activity vessels likely to be used for this Petroleum Activities Program does not exceed that level, so permanent injury to protected species is not anticipated.

Listed threatened and listed migratory species that could be potentially impacted by noise and vibration may be present within the Operational Area and primarily include cetaceans. There are no known critical habitats (i.e. feeding, breeding, calving or constricted migratory pathways) for EPBC listed species present within the Operational Area, however, BIA's for foraging whale sharks and internesting flatback turtles overlap the Operational Area, while the migration corridor for pygmy blue whales is ~5 km North of the Operational Area. It is acknowledged that individual whale sharks and pygmy blue whales may be encountered transiting the operational area during migration seasons. However, even with an increased likelihood of interaction, the potential impacts are considered to be minor. Scientific literature and expert opinion on the flatback internesting range and patterns show that it is highly unlikely for flatbacks to be encountered within the offshore Operational Area, and therefore, the potential for noise emissions exposure and subsequent impacts to flatback turtles is extremely low to negligible.

<u>Cetaceans</u>

The thresholds of recommended rms SPL that could result in behavioural response for cetaceans is expected to be 120 dB rms SPL for continuous noise sources and 160 rms SPL for impulsive noise sources (Southall *et al*, 2007). Therefore based on the expected noise levels, 182 dB re 1µPa at 1 m rms (SPL), it is reasonable to expect that individuals may demonstrate avoidance or attraction behaviour to the noise generated in the immediate vicinity of the vessels. For example, when transiting through the area, cetaceans (e.g. humpback whales) may deviate their route within the migration corridor.

Migrating Blue Whales may transit the Operational Area during both their northern and southern migrations. It is expected that noise associated with DP vessel operations may result in temporary behavioural disturbance to some individuals, however the noise levels associated with DP vessel operations is well below published thresholds associated with potential for injury or physiological impacts to marine mammals, referred to as permanent threshold shift in hearing (PTS) and temporary threshold shift in hearing (TTS) (Southall et al. 2007). There are no known key aggregation areas (resting, breeding or feeding) located within or immediately adjacent to the Operational Area.

Migrating humpbacks may transit the Operational Area between June and October, during both their northern and southern migrations). It is expected that noise associated with DP vessel operations may result in temporary behavioural disturbance to some individuals, however the noise levels associated with DP vessel operations is well below published thresholds associated with potential for injury or physiological impacts to marine mammals, referred to as permanent threshold shift in hearing (PTS) and temporary threshold shift in hearing (TTS) (Southall et al. 2007). Satellite tracking studies indicate humpback whales may be present in the Operational Area, however, the activities will take place outside the identified DoE humpback whale migratory BIA and given the offshore open water location of the activity there would be no restriction to whale movements. As such any potential for behavioural responses are not expected to impact on migratory movements of transiting humpback whales and as identified from the DoE Conservation Advice be a potential noise impact for marine humpbacks when calving, resting, foraging or confined within migratory pathways (Commonwealth of Australia 2015b).

Noise from helicopters is highly transient and below behavioural thresholds. Therefore, it is not considered to pose any risk of physiological hazard or behavioural effects to cetacean unless they hover above the animal for an extended period of time, which is not required for this activity.

The proposed side scan sonar device is a high frequency source operating at approximately 120 – 410 kHz. The frequency response of the proposed device is outside the functional hearing group auditory bandwidth (hearing range) for low

	frequency cetaceans (Baleen whales) (7 Hz – 22 kHz) (Southall et al. 2007), fish and marine turtles (Popper et al. 2014). The lower range (120 – 180 kHz) of the side scan sonar frequency overlaps with the estimated functional hearing group for medium and high frequency cetaceans (toothed whales and dolphins) (Southall et al. 2007). The listed species within the Protected Matters Search, the sperm whale (Physeter microcephalus), killer whale (Orcinus orca) and spotted bottlenose dolphin (Tursiops aduncus) are the only Medium or High frequency cetaceans that have an estimated bandwidth that overlaps with the side scan sonar frequency range. However, based on these species habitat preferences, their presence is likely to be rare and limited to infrequent transiting. Sperm whales, killer whales and bottlenose dolphins are also known to have the most sensitive hearing from 5 – 20 KHz, 18 – 42 kHz and 40 to 100 kHz, respectively, which are all outside the side scan sonar frequency range (Masden et al. 2002, Nachtigal et al. 2000, Szymanski et al. 1999). The source level of the proposed side scan sonar is approximately 212 dB re 1µPa which is below the known injury threshold for medium and high frequency cetaceans (Southall et al. 2007). Behavioural impacts to medium and high frequency cetaceans are expected to be very localised based on measured noise levels (<250m) (Hartin et al. 2011). Given the rare and infrequent presence of medium or high frequency cetaceans within the operational area and the highly directional nature (focused towards seabed) of the side scan sonar, the potential for behavioural effects is considered highly unlikely. <u>Whale Sharks</u> Cartilaginous fish (such as whale sharks) lack a swim bladder and are considered less sensitive to sound than bony fish. The hearing capabilities of the whale shark have not been studied, but it has been suggested that they are likely to be most responsive to low frequency sounds (Myberg 2001). Individuals may transit through during their migration to and from the Ningaloo Coast and may exhibit some behavioural responses to the noise generated by vessel activities. However, the behavioural responses are expected to be restricted to the immediate area of vessel activities. <u>Marine Turtles</u> No data exist for underwater vessel noise impacts on marine turtles (Popper *et al.*2014) but it would be expected that marine turtles would implement avoidance measures upon detection of vessel noise. The Operational Area does not contain any critical habitats for marine turtles, however the Operational Area overlaps with the flatback turtle Montebello Islands internesting buffer, which is deemed a BIA. These habitats are widely distributed in the NWS Province. Although highly unlikely it is acknowledged that marine turtles may be present transiting the Operational Area in low densities. Vessel noise associated with the Petroleum Activities Program may have a minor disruption to individuals, however, there is no threat to overall population viability. Given the fauna associated with Operational Area is predominantly pelagic species of fish with a low abundance of transient species such as marine turtles, whale sharks and large whales transiting through the Operational Area, and no known EPBC listed critical habitat occur within the Operational Area, potential impacts form vessel noise are likely to be restricted to temporary avoidance behaviour to individuals transiting the Operational Area, and are therefore considered low. Demersal fish communities in the Continental Slope Demersal Fish Communities KEF, 5km from the Operational Area, are unlikely to be affected by vessel noise. Although highly unlikely, it is acknowledged that marine turtles may be present transiting the Operational Area in low densities. Vessel noise associated with the Petroleum Activities Program may have a minor disruption to individuals, however there is no threat to overall population viability. Given the fauna associated with Operational Area is predominantly pelagic species of fish with a low abundance of transient species such as marine turtles, whale sharks and large whales transiting through the Operational Area, and no known EPBC listed critical habitat occur within the Operational Area, potential impacts form vessel noise are likely to be restricted to temporary avoidance behaviour to individuals transiting the Operational Area, and are therefore considered low.
Summary	Given the adopted controls, it is anticipated that noise generated by activity vessels is unlikely to result in a potential impact greater than minor and temporary disruption to a small proportion of the populations and no impact on critical habitat or activity is

	anticipated. No significant cumulative impacts over the life of the Petroleum Activities Program or in relation to other operations and activities in the region (e.g. Pluto, Balnaves or Wheatstone) are expected.
Summary of Control Measures	
• Compliance with EPBC Regulations 2000 – Part 8 Division 8.1 Interacting with cetaceans Exception: The above requirements do not apply to in emergency circumstances compliance with the requirement would increase the risk of harm to environment or property. • Compliance with EPBC Regulations 2000 Division 8.3 (Regulation 8.07) - Interacting with Cetaceans Exception: The above requirements do not apply during landing and takeoff and in emergency circumstances.	

Routine and Non-Routine Discharges: Activity Vessels

Source of Risk	Environmental Value Potentially Impacted									Evaluation		
	Water Quality	Marine Sediment Quality	Air Quality	Marine Primary Producers	Other Habitats & Communities	Protected Species	Soil & Groundwater	Socio-Economic	Protected Areas	Consequence	Likelihood	Residual Risk
Routine discharge of deck and bilge water, grey water, sewage and putrescibles wastes from the activity vessels to the marine environment.	X									F	1	L

Description of Source of Risk

The activity vessels routinely generate/discharge the following:

- small volumes (up to 15 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 and can contain water, oil, detergents, solvents, chemicals, particles and other liquids, solids or chemicals
- variable water discharge from activity vessel decks directly overboard or via deck drainage systems and may contain small quantities of oil, grease and detergents if present on deck. Water sources could include rainfall events and/or from deck activities such as cleaning/wash-down of equipment/decks
- cooling water from machinery engines on the activity vessels and brine water produced during the desalination process of reverse osmosis to produce potable water on board.

Potential Environmental Impact

Value	Description of Potential Environmental Impact
Water Quality	No significant impacts from the planned (routine and non-routine) discharges that are listed above are anticipated because of the minor quantities involved, the limited duration of vessel activities during the Petroleum Activities Program, the expected localised mixing zone and high level of dilution into the open water marine environment of the Operational Area. This includes impacts on values and sensitivities in the Montebello CMR or on benthic habitat present within 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.

Summary of Control Measures

- Compliance with Marine Order 96 (Pollution prevention – sewage), as required by vessel class.
- Compliance with Marine Order 95 (pollution prevention – garbage), as required by vessel class.
- Bilge water contaminated with hydrocarbons must be contained and disposed of onshore, except if the oil content of the effluent without dilution does not exceed 15 ppm or an IMO approved oil/water separator (as required by vessel class) is used to treat the bilge water.

Routine and Non-Routine Discharges: Discharge of Chemicals and Hydrocarbons to the Marine Environment

Source of Risk	Environmental Value Potentially Impacted									Evaluation		
	Water Quality	Marine Sediment Quality	Air Quality	Marine Primary Producers	Other Habitats & Communities	Protected Species	Soil & Groundwater	Socio-Economic	Protected Areas	Consequence	Likelihood	Residual Risk
The discharge of chemicals and hydrocarbons to the subsea marine environment	X	X			X	X				F	1	L
The discharge of preservation fluid, including MEG, during dewatering, as well as flowline hydrotesting testing activities.	X	X			X	X				F	2	L

Description of Source of Risk

Dewatering, Reflooding, Leak testing

Dewatering & Reflooding

All subsea equipment contains preservation fluids to prevent corrosion and any other deterioration of the equipment before production commences. Pigging during preparation or re-flooding (if required) involves discharge of the treated seawater, preservation fluids, contained in the Brunello and Julimar 18" flowlines and the 4" MEG pipeline. These planned discharges are necessary for safe and efficient operation of the wells and flowlines.

Chemicals proposed for pipeline/flowline preservation were chosen based on technical suitability and consideration of environmental performance, as part of controls described in the *Julimar Development Project Pipeline Installation EP* (EA-72-RI-008.01).

Dewatering fluid will be flushed from the MEG pipeline and production flowlines to the Wheatstone Platform (discharged from a caisson at ~45 m below LAT) and may be associated with either:

- preparation activities (where the pig train is followed by air and then compressed nitrogen); or
- contingency re-flooding, if additional testing is required, or an extended period occurs prior to commissioning, or where other technical issues require it (where a pig train is followed with treated seawater).

Each line may be dewatered twice (~3,000m^3 and 150m^3 of treated seawater per line for the 18" and MEG flowlines respectively).

Leak Testing

Minor volumes (approximately <55 m^3 of treated water) are likely to be discharged as a result of flowline and pipeline leak testing.

Discharges from IMR activities

Chemicals and hydrocarbons may be discharged intermittently and for short durations as a result of planned routine operations and maintenance (IMR) activities (e.g. discharge of subsea control fluid) and non-routine operations and maintenance (IMR) activities (e.g. acid cleaning) and may include:

- discharge from subsea cleaning activities such as acid marine growth removal, spool cleaning, and pigging.
- discharge of chemicals during IMR activities.
- discharge of residual control fluids and hydrocarbons remaining in subsea lines and equipment as a result of subsea intervention isolation works (e.g. hot or cold stab intervention).
- dewatering, hydrotest or other discharge of chemicals remaining in sections of subsea lines and equipment or the use of chemicals for subsea IMR activities (e.g. arising from spool replacement).

Discharges range from approximately 2 to 5L of dye (during pressure leak testing) to approximately 150 L of hydrocarbons during spool replacement or dilute preservation fluids (< 550 ppm).

Discharges from Operations

Subsea control fluid is used to control valves remotely from the facility. Small amounts of subsea control fluid may be discharged from valves on the seabed when they are operated. Discharges range from approximately 1-30 L of control fluid from manifolds and trees per operation.

Cumulative Impacts

Cumulative impacts associated with the Petroleum Activities Program are detailed in relation to other petroleum activities

only, as detailed below.

Dewatering, flooding, cleaning, gauging and testing from Wheatstone Platform

The following discharges associated with Wheatstone trunkline and flowlines pre-commissioning are planned immediately prior to the Petroleum Activities Program:

- Discharge of trunkline flooding fluid (approximately 220,000 m3 max. volume) (Hydrosure, an (biocide and oxygen scavenger), fluorescein dye) – scheduled to occur prior to the dewatering for this Petroleum Activities Program with discharges at the Wheatstone Platform.
- Discharge of flooding, cleaning, gauging and testing (FCGT) fluid (approximately 20,000m3) (Hydrosure (biocide and oxygen scavenger), fluorescein dye, diluted with air and untreated seawater) - scheduled to occur prior to the dewatering for this Petroleum Activities Program with discharges to the Wheatstone Platform.

The following are approximate discharges from IMR activities at the Wheatstone Platform:

- Chemical dye releases (10 to 20 L) during pressure and leak testing
- Control fluid releases (5 to 10 L) during hotstab/coldstab interventions and valve cycling operations
- Hydrocarbon (1 to 10 m3), MEG (100 L) and scale inhibitor (50 L) during intervention isolations and subsea equipment replacements
- Acid (20 L) during calcium deposit removal
- Hydraulic fluid (20 L) from operation of ROVs
- Dilute (<550 ppm) preservation fluids: Corrosion inhibitor, oxygen scavenger, biocide (5 to 10 L)
- Grout bag filling/hose flush (20 L).

Discharges from Pluto Production Activities

During the course of the Petroleum Activities Program, routine and non-routine discharges may occur associated with IMR along the Pluto flowlines and MEG lines. The IMR discharges associated with Pluto are expected to occur nodally at the Pluto fields and at the facility. These are similar to those outlined above for Wheatstone. Discharges at well heads (including Xena and the Pluto platform are over 4km from the Operational Area and as such, are not considered from a cumulative impact perspective.

Discharges from Woodside Balnaves Activities

Infrastructure associated with the Balnaves development field (over 4km from Operational Area) will have small planned discharges during the operations cessation program. The discharge plume associated the Balnaves operations cessation activities (which is likely to be treated seawater with residual hydrocarbons), will not extend beyond the Balnaves Operational Area and as such, will not result in any cumulative impacts on water quality, marine sediment quality, protected species or other habitats in the Julimar Operational Area

Potential Environmental Impact	
Value	**Description of Potential Environmental Impact**
Water Quality, Marine Sediment Quality, Protected Species and other habitats	There is the potential for localised water quality reduction through contamination of the water column resulting in potential adverse effects to marine biota as a result of hydrocarbon and chemical toxicity effects of the discharges to the subsea marine environment. The planned discharges of hydrocarbons and chemicals, however, are minor and will be minimised as far as practicable. Many of these releases (e.g. dewatering) will occur at the caisson end and will result in negligible impact to areas outside of the discharge plume. **Planned Non Routine Discharges** *IMR activities* The release of minor quantities of hydrocarbons (up to approximately 150 L) to the subsea environment during planned non-routine IMR activities may result in localised and temporary reduction in water quality, localised and temporary contamination of marine sediments resulting in toxicity effects to biota (water column: plankton, seabed: benthic infauna and epifauna) in the vicinity of the planned release. Hydrocarbons may disperse in the water column, resulting in slightly increased biological oxygen demand. However, due to mixing, dilution is expected to be rapid and the concentration of hydrocarbons and elevated oxygen demand is expected to be below that which will affect marine biota within a relatively short distance of the release. Additionally, if the release did result in sediment contamination, there may be potential for dissolved oxygen levels to decrease resulting in a temporary change to the infauna structure and composition over a localised area, in close proximity to the subsea release. Subsea IMR activities may also require the planned non-routine use and discharge of chemicals to ensure the integrity of the equipment. Chemicals discharged into the marine environment may result in localised temporary reduction in water quality with the potential to affect biota (plankton) confined to an immediate area close to the release point. However, discharges associated with subsea IMR activities occur over short durations and will be rapidly diluted to low concentrations that are unlikely to result in toxic effects of marine biota in the open ocean environment, including within the Montebello CMR which overlaps the Operational Area or on demersal fish populations in the Continental Slope Demersal Fish Community which is 5 km from the Operational Area at its closest point. IMR activities occurring at the same time (or immediately prior to/ post) to those occurring for Wheatstone and Pluto subsea infrastructure, have the potential to increase the extent of localised and temporary reductions in water quality, potentially resulting in impacts to biota over a larger area or for a longer duration. These cumulative impacts will be similar in nature to those discussed above for IMR activities, however, depending on the timing, they may prolong the duration, or extend the discharge mixing zone boundary, if IMR activities occur in close proximity to each other. The overarching risk assessment conclusions, however, remain the same due to the lack of key regionally significant benthic sensitivities and high degree of mixing in the open ocean. *Dewatering and Reflooding* Modelling was commissioned for discharge of the Julimar flowlines at the Wheatstone Platform caisson (45m below LAT). The modelling assessment included near field dispersion of the hydrotest fluid at three different current speeds. Modelling undertaken by DHI (2014) used current speeds which represented a median/average (50%) and two contrasting lower and upper limit cases: • 5-10 percentile exceedence (fast current, high dilution and rapid advection) • 50 percentile exceedence (median currents, average dilution and advection) • 90-95 percentile exceedence (slow currents, low dilution and slow advection) The near field modelling showed the hydrotest discharge plumes to be larger and more diluted for the faster currents. For the 10% current exceedance simulation the plume had a concentration of 15 and 4.3 ppm for a distances of 50 and 500 m respectively (DHI 2014). For the 90% currents exceedance simulation the plume has a concentration of 7.9 and 0.43 ppm for distance of 50 and 500 m respectively (DHI 2014). Woodside has previously commissioned modelling to assess the near field dispersion

	of a subsea dewatering discharge for the accepted GWF-1 Pipeline Installation EP. The largest single volume for the Julimar discharge (~3000 m3) is greater than that for GWF-1 (1,449 m3), however, given the similar water depths, region and discharge rate, it is expected that the plume dynamics would behave similarly, with Julimar discharge persisting for slightly longer in the environment owing to the greater discharge volume and duration. Therefore, the existing modelling for GWF-1 pipeline hydrotest discharge has been deemed suitable to assess potential impacts from the Julimar dewatering discharge. Based on the GWF-1 modelling, an LC50 of 1- 10ppm (over 96 hours) the modelling indicates that the plume would dilute to below 10ppm within close proximity of the discharge location (APASA 2012). Furthermore, the LC50 is based on 96 hours while the planned duration of discharge is less than 12 hours. Therefore the likelihood of fish or pelagic invertebrates being exposed to concentrations at these levels for greater than 96 hours is negligible. It is expected that mobile fish and other marine fauna associated with the soft sediment habitat will adapt their behaviour and move away from the discharge if exposed. Benthic communities at the Wheatstone Platform caisson comprise the filter feeding biota attached to the hard substrate of the consolidated sediments and limestone ridge. The filter feeding biota located in the surrounding area of the Wheatstone Platform caisson are likely to be exposed to toxic concentrations of discharge which may lead to a minor portion of the biota exhibiting partial or total mortality (DHI 2014 and APASA 2012). Loss of the small portion of filter feeder habitat may temporarily impact demersal fish populations associated with the cemented sediment outcrops, however the ecological integrity of filter feeder communities will be maintained in the wider region. Impacts will be confined to a localised area not effecting the ecosystem function (equivalent to an F consequence level) (DHI 2014 and APASA 2012). Offshore plankton populations may be affected but such toxic impacts would likely only occur in the immediate area of the discharge plume but given the fast population turnover of open water plankton populations (ITOPF 2011), the potential ecological impacts are considered very minor, this includes within the small portion of the Montebello CMR within the Operational Area boundary (DHI 2014 and APASA 2012). Dewatering release will occur at the Wheatstone Platform caisson, away from the CMR boundary. Therefore, the potential ecological consequence is expected to be localised, temporary and negligible (soft sediment habitat and plankton populations) but expected minor impacts are predicted for the heterogeneous filter feeding habitat only associated with the Wheatstone platform caisson. Discharges of flooding fluid associated from FCGT and dewatering activities of Wheatstone's trunkline and flowlines may occur at the Wheatstone Platform caisson. These impacts have been assessed in the accepted Chevron Trunkline FCGT Dewatering and Drying EP as have the following potential environmental impacts: • Direct disturbance to locally or regionally significant habitat and indirect disturbance to habitat through sediment dispersion. • Temporary and localised reduction in water quality resulting in acute toxicity effects on marine fauna. There is potential that this petroleum activities and Wheatstone's hydrotest fluid discharges may have cumulative impacts on the environment. However, given the nature and scale of discharges of the Wheatstone activity are two orders of magnitude higher than release from this activity it is not expected that this activity will result in a change to impacts documented in the Trunkline FCGT Dewatering and Drying EP. *Leak Testing* Given the volumes (approximately 55 m^3 treated seawater) and the fact that the chemicals are diluted within the total volume of discharge 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. **Planned Routine Discharges** *Operations* Subsea control fluid is the main planned routine chemical discharge subsea, which occurs each time a valve is closed, i.e. for short periods of time and in small volumes. Upon discharge, the fluid is expected to rapidly dilute, given the nature of the receiving environment (i.e. open ocean) and therefore may result in temporary contamination in the immediate vicinity to the release location.

	No impacts to the 'ancient coastline at the 125 m depth contour' KEF are predicted as the majority of Operational Area is soft sediments and no typical characteristics of this KEF have been identified during surveys of the area. The filter feeding communities associated with consolidated sediment and limestone ridge at the Wheatstone area of the Operational Area are also unlikely to be affected given the small and temporary nature of the discharges and rapid dilution. Impacts on the demersal sensitivities in the Continental Slope Demersal Fish Communities KEF are unlikely, given the distance of the Operational Area to the KEF boundary (5km). The potential impacts, from routine and non-routine discharges, to water quality and marine sediments is expected to be localised, temporary and generally negligible and potentially resulting in localised, slight impacts to water column biota such as plankton and to soft sediment macrofauna (infauna and epifauna) and minor impacts on the filter feeding communities associated with hard substrate habitat in the area of the Wheatstone platform. It is expected that motile fish and other larger marine fauna are likely to exhibit avoidance behaviour and move away from the discharge (chemical or hydrocarbon) if exposed and therefore impacts on protected species and pelagic fish are expected to be limited. Given the isolated nature and short duration, small volume scale of the planned discharges cumulative impacts are not considered applicable and are not considered further.
Summary	Given the adopted controls, it is anticipated that the release of hydrocarbons and chemicals described above, is unlikely to result in a potential impact greater than slight and/or temporary contamination above background levels, water quality standards, or known effect concentrations and localised and temporary toxic impacts to water column biota and benthic communities (associated with soft sediment and hard substrate habitats) and negligible impacts are predicted for protected species. When considered in relation to routine and non-routine discharges of a similar nature in the broader region, no significant cumulative impacts are expected to occur due to the relatively small volumes discharged in the open ocean environment, the well mixed nature of the receiving environment and the infrequency of discharges; no significant cumulative impacts beyond those described above are expected.

Summary of Control Measures

- Chemicals for use selected as per Woodside Environment Procedure Offshore Chemical Assessment (or equivalent)
- Compliance with Woodside Engineering Operating Standard: Subsea Isolation
- Compliance with Woodside Engineering Operating Standard: Subsea and Pipelines Pre-commissioning / Commissioning
- Compliance with Woodside Engineering Standard: Pipelines Flooding, Cleaning, Gauging and Hydrotesting
- During IMR activities subsea chemical use and discharge will be recorded.

Atmospheric Emissions: Fuel Emissions

Source of Risk	Environmental Value Potentially Impacted									Evaluation		
	Water Quality	Marine Sediment Quality	Air Quality	Marine Primary Producers	Other Habitats & Communities	Protected Species	Soil & Groundwater	Socio-Economic	Protected Areas	Consequence	Likelihood	Residual Risk
Internal combustion engines on activity vessels			X							F	1	L

Description of Source of Risk

Atmospheric emissions will be generated by the activity vessels from internal combustion engines (including all equipment and generators) during the Petroleum Activities Program. Emissions will include SO_2, NOx, ozone depleting substances, CO_2, particulates and Volatile Organic Compounds (VOCs).

Potential Environmental Impact

Value	Description of Potential Environmental Impact
Air quality and Water quality	Fuel combustion has the potential to result in localised, temporary reduction in air quality. Potential impacts include a localised reduction in air quality, generation of dark smoke and contribution to greenhouse gas emissions. Given the short duration and exposed location of the activity vessels (which will lead to the rapid dispersion of the low volumes of atmospheric emissions), the potential impacts are expected to be minor.
Summary	Given the adopted controls, it is considered that fuel combustion emissions will not result in a potential impact greater than a minor and temporary exceedance over air and/or water quality standards. No cumulative impacts associated with atmospheric emissions from activity vessels from Pluto, Balnaves or Wheatstone, in combination with the Petroleum Activities Program, are envisaged.

Summary of Control Measures

- Compliance with Marine Order 97 (marine pollution prevention – air pollution).

Light Emissions: Activity Vessels

Source of Risk	Environmental Value Potentially Impacted									Evaluation		
	Water Quality	Marine Sediment Quality	Air Quality	Marine Primary Producers	Other Habitats & Communities	Protected Species	Soil & Groundwater	Socio-Economic	Protected Areas	Consequence	Likelihood	Residual Risk
Lighting emissions from activity vessels						X				F	1	L

Description of Source of Risk

Vessels undertaking IMR activities will have lighting to allow safe working conditions. Lighting may be required over the side of vessels during the Petroleum Activities Program for night work (such as lifting operations or IMR activities). During IMR activities underwater lighting is generated over short periods of time while ROVs are in use.

Potential Environmental Impact

Value	Description of Potential Environmental Impact
Protected Species	Light emissions can affect fauna in two main ways: • Behaviour: many organisms are adapted to natural levels of lighting and the natural changes associated with the day and night cycle as well as the 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. Given the fauna associated with Operational Area is predominantly pelagic species of fish with a low abundance of transient species such as marine turtles, whale sharks and large whales transiting through the Operational Area, and no known EPBC listed critical habitat occur within the Operational Area, potential impacts from lighting are highly unlikely. 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 (Lutcavage et al. 1997; Pendoley 1997; Witherington and Martin 1996, 2003). Artificial lighting may affect the location that turtles emerge to the beach, the success of nest construction, whether nesting is abandoned, and even the seaward return of adults (Salmon et al. 1995, Salmon 2005). The Operational Area does not contain any known critical habitat for any species of marine turtle (nearest landfall (Montebello Islands) is located approximately 48km from Operational Area). However, a BIA for internesting flatback turtles overlaps with the southern portion of the Operational Area. Although highly unlikely, it is acknowledged that marine turtles may be present transiting the Operational Area in low densities. 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 support vessels. Demersal fish communities in the Continental Slope Demersal Fish Communities KEF, 5km from the Operational Area, are highly unlikely to be affected by vessel noise. Lighting from the presence of a 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. The Petroleum Activities Program will be undertaken in an open ocean, offshore environment approximately 48 km from the nearest landfall (Montebello Islands). Vessel

	activities will be intermittent and of short duration (planned inspections following the introduction of hydrocarbons and dewatering activities involving limited field time and unplanned maintenance), with light spill limited to the immediate vicinity of vessels.
Summary	It is anticipated that lighted generated by vessels is highly unlikely to result in a potential impact greater than slight and temporary disruption to a small proportion of the populations and no impact on critical habitat or activity is anticipated. No significant cumulative impacts over the life of the Petroleum Activities Program or in relation to other operations and activities in the region (e.g. Pluto, Balnaves or Wheatstone) are expected.
Summary of Control Measures	
Lighting is not considered a key risk for this Petroleum Activities Program due to the open ocean, offshore environment. No controls have been applied for this risk as light management will be consistent with that required to provide a safe working environment for vessel personnel.	

UNPLANNED ACTIVITIES (ACCIDENTS / INCIDENTS / EMERGENCY SITUATIONS)

Loss of Well Containment

Source of Risk	Environmental Value Potentially Impacted									Evaluation		
	Water Quality	Marine Sediment Quality	Air Quality	Marine Primary Producers	Other Habitats & Communities	Protected Species	Soil & Groundwater	Socio-Economic	Protected Areas	Consequence	Likelihood	Residual Risk
Hydrocarbon release to the marine environment due to a loss of well containment arising from catastrophic damage to Xmas Tree and failure of subsurface valves.	X	X	X	X	X	X		X	X	B	1	H

Description of Source of Risk

Background

A loss of well integrity/control is an uncontrolled release of reservoir hydrocarbon or other well fluids to the surface, resulting from an over-pressured formation fluid (hydrocarbon). Woodside has identified a blowout as the scenario with the worst environmental outcome as a result of loss of well integrity. A blowout could occur during operations of the Julimar Field Production System due to:

- failure of all the predefined technical well barriers or activation of the same have failed (Scandpower 2013)
- anchor drag (or similar event) removing the Xmas tree.

Credible worst case scenario – 'loss of well containment'

The Petroleum Activities Program consists of the operation of up to five wells, with an additional contingency three wells, if required. A loss of well integrity of any one of the wells could result in a loss of containment of hydrocarbons. Woodside identified the worst-case credible spill scenario for a loss of well containment to be an uncontrolled subsea release for 77 days. The 77-day (11 weeks) scenario assumes that the maximum depth of the hydrocarbon reservoir would be open and takes into account the estimated time to drill a relief well under the Mutual Aid Memorandum of Understanding.

Quantitative hydrocarbon spill modelling – 'loss well containment'

Spill modelling was undertaken by RPS APASA, on behalf of Woodside, to determine the fate of hydrocarbon released for the 11-week blowout scenario, based on the assumptions in below. Modelling was undertaken over all seasons to address year-round operations.

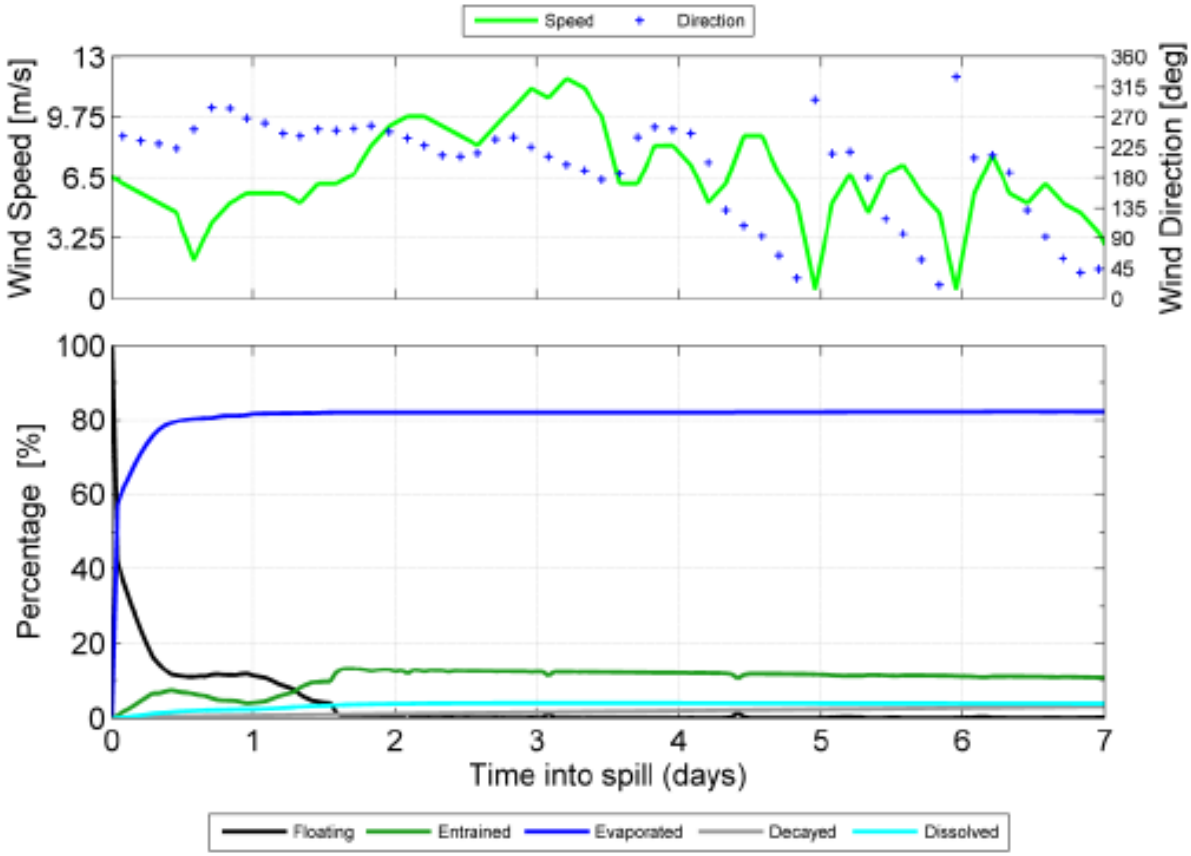
Summary of credible scenario-loss of well containment

	Loss of well containment
Total discharge at Seabed	77 days / 484,000 bbl
Water Depth	148 m
Fluid	Brunello Condensate

Blowout scenario modelling assessed each loss of well containment extent for anytime during the year using a historic sample of wind and current data for the study area that spanned ten years (1997 to 2006 inclusive). A total of 200 simulations were modelled, with each simulation initialised at a randomly-selected point in time and hence, experiencing a different time series of environmental conditions. According to APASA's sensitivity modelling process, it was determined that simulations should be run for 14 days after last release of condensate. Hydrocarbons are likely to fall below thresholds concentrations in timeframes shorter than this however APASA has determined this to be an appropriately conservative timeframe to capture all hydrocarbon potential impacts above set thresholds.

Hydrocarbon Characteristics

Weathering processes under realistic variable wind conditions are illustrated in the example mass balance weathering graph below for an instantaneous release at the surface. The graph demonstrates that approximately 80% of the released condensate would be expected to evaporate within the first 24 hours. The majority of floating hydrocarbons will become entrained within the first 36 hours from release due to winds and waves.



Proportional mass balance plot representing an example of weathering of a surface spill of Brunello Condensate (one release of 50 m^3 over 1 hour) subject to variable speeds.

Subsea Plume dynamics

The loss of well containment 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.

For a pressurised discharge of condensate at the seabed (depth of 148 m), the blowout model (OILMAP-Deep) calculated that at the outset, the oil component of the condensate would be atomized into very small droplets (~2–13 µm) and entrained by the rising gas cloud. Despite reaching the surface, due to the lift produced by the rising plume, the droplets will tend to remain within the wave-mixed layer of the water column (3–10 m) where they resist surfacing due to their weak buoyancy relative to other mixing processes.

Range of assumed inputs and range of calculated outputs, by OILMAP Deep model, for subsea loss of well containment

	Variable	Brunello Condensate
Assumed discharge	Release Depth (m) Hydrocarbon temp (C°) Gas:oil ratio (scf/bbl) Hydrocarbon flow rate (bbl/day) Diameter of exit hole (m)	148 m 55°C 41,667 6,286 0.157 m
Calculated gas plume dynamics	Plume diameter (m) Plume Trapping height (m ASB)	9.7 m 148
Calculated droplet size distribution	droplets of size 2.1 µm droplets of size 4.2 µm	16.5% 26.0%

	droplets of size 6.3 µm	23.6%
	droplets of size 8.4 µm	17.2%
	droplets of size 10.6 µm	10.7%
	droplets of size 12.7µm	6.0%

Potential Environmental Impact

Zone of Consequence

Surface Hydrocarbons: Quantitative hydrocarbon spill modelling results predicted surface hydrocarbons would remain below the 10 g/m^2 threshold concentration. Hence, no ZoC plots have been provided for these results.

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 entrained hydrocarbon ZoC would be expected to contact Rankin Bank, the Montebello/Barrow/Lowendal Islands Group, the Pilbara Southern Island Group, Ningaloo Coast and Muiron Islands with potential to also contact the Glomar Shoals, Dampier Archipelago and the open ocean adjacent to Shark Bay. The table below indicates entrained contact locations for receptors as identified by the modelling. The ZoC may extend up to approximately 750 km south of the release site.

Dissolved Aromatic Hydrocarbons: In the event of the loss of well containment scenario occurring, a plume of dissolved hydrocarbons would form downcurrent of the well site with the trajectory dependent on prevailing current conditions at the time. The modelling indicated that the dissolved hydrocarbon ZoC may contact Rankin Bank and the shorelines of the Ningaloo Coast however the probability is very low (<8%). The table below indicates the contact locations for receptors as identified by the modelling. The ZoC may extend up to approximately 300 km from the release site.

Accumulated Hydrocarbons: Quantitative hydrocarbon spill modelling results for maximum local accumulated hydrocarbon concentrations indicated that no shoreline accumulation above threshold concentrations (<100 g/m^2) is predicted.

Summary of Potential Impacts

The table below 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.

Zone of Consequence (ZoC) – Key Receptor Locations and Sensitivities with the Summary Hydrocarbon Spill Contact for a 77-day subsea blowout of Brunello Condensate

Environmental setting	Location / name	Environmental, Social, Cultural, Heritage and Economic Aspects presented as per the Environmental Risk Definitions (Woodside's Risk Management Operating Standard)																															Hydrocarbon contact and fate (Condensate/Marine diesel)			
		Physical		Biological																							Socio-economic and Cultural									
		Water Quality	Sediment Quality	Marine Primary Producers			Other Communities / Habitats								Protected Species										Other Species		Fisheries – commercial	Fisheries – traditional	Tourism and Recreation	Protected Areas / Heritage – European and Indigenous / Shipwrecks	Offshore Oil & Gas Infrastructure (topside and subsea)				
		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						Surface hydrocarbon (≥10 g/m^2)	Entrained hydrocarbon (≥500 ppb)	Dissolved aromatic hydrocarbon (≥500 ppb)	Accumulated hydrocarbons (>100 g/m^2)
Offshore[1]	Commonwealth waters	✓	✓					✓		✓					✓	✓				✓		✓	✓	✓		✓		✓		✓			X	X	
	Agro-Rowley Terrace CMR	✓						✓							✓	✓			✓			✓	✓	✓		✓			✓				X		
	Montebello CMR	✓	✓	✓			✓	✓							✓	✓			✓	✓	✓	✓	✓	✓	✓	✓		✓	✓*				X		
	Gascoyne CMR	✓	✓												✓	✓			✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓			X		
	Shark Bay CMR	✓	✓					✓							✓	✓	✓		✓	✓		✓	✓	✓	✓	✓			✓				X		
Submerged Shoals[2] and Oceanic Reefs	Glomar Shoals	✓	✓	✓			✓	✓		✓						✓				✓		✓		✓	✓	✓		✓					X		
	Rankin Bank	✓	✓	✓			✓	✓		✓						✓				✓		✓		✓	✓	✓		✓					X	X	
Islands	Montebello Islands (including State Marine Park)	✓	✓	✓	✓	✓	✓	✓				✓		✓	✓	✓	✓			✓	✓	✓	✓	✓	✓	✓	✓		✓	✓				X		
	Lowendal Islands (including State Nature Reserve)	✓	✓	✓	✓	✓	✓	✓				✓		✓	✓	✓	✓			✓	✓	✓	✓	✓	✓	✓	✓		✓	✓				X		
	Barrow Island (including State Nature Reserves, State Marine Park and Marine Management Area)	✓	✓	✓	✓	✓	✓	✓				✓		✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓			X		

[1] Note: hydrocarbons cannot accumulate on open ocean, submerged receptors, or receptors not fully emergent
[2] Note: Surface hydrocarbon contact is predicted with open water above Rankin Bank and Glomar Shoals, however, as they are submerged receptors they will not be contacted by surface hydrocarbons

Environmental setting	Location / name	Environmental, Social, Cultural, Heritage and Economic Aspects presented as per the Environmental Risk Definitions (Woodside's Risk Management Operating Standard)																												Hydrocarbon contact and fate (Condensate/Marine diesel)			
		Physical		Biological																						Socio-economic and Cultural							
		Water Quality	Sediment Quality	Marine Primary Producers			Other Communities / Habitats							Protected Species								Other Species		Fisheries – commercial	Fisheries – traditional	Tourism and Recreation	Protected Areas / Heritage – European and Indigenous / Shipwrecks	Offshore Oil & Gas Infrastructure (topside and subsea)				
		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						Surface hydrocarbon (≥10 g/m²)	Entrained hydrocarbon (≥500 ppb)	Dissolved aromatic hydrocarbon (≥500 ppb)	Accumulated hydrocarbons (>100 g/m²)
	Muiron Islands (WHA, State Marine Park)	✓	✓	✓	✓		✓	✓		✓		✓		✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓			✓	✓			X		
	Dampier Archipelago (including State Nature Reserve and proposed Marine Park)	✓	✓	✓	✓	✓	✓					✓	✓		✓	✓	✓		✓	✓		✓	✓	✓	✓	✓			✓	✓			X		
	Pilbara Islands – Southern Island Group (Serrurier, Thevenard and Bessieres Islands – State Nature Reserves)	✓	✓		✓		✓		✓			✓		✓	✓	✓	✓		✓	✓		✓	✓	✓	✓	✓			✓	✓			X		
	Pilbara Islands – Northern Island Group (Sandy Island Passage Islands – State nature reserves)	✓	✓		✓		✓		✓			✓		✓	✓	✓	✓		✓	✓		✓	✓	✓	✓	✓			✓	✓			X		
	Ningaloo Coast (North/North West Cape, Middle and South) (WHA, Ningaloo Commonwealth Marine Reserve, State Marine Park)	✓	✓	✓	✓	✓	✓	✓		✓		✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓			✓	✓			X	X	
	Shark Bay – Open ocean	✓	✓	✓	✓		✓	✓				✓		✓	✓	✓	✓		✓	✓		✓	✓	✓	✓	✓			✓	✓			X		

Summary of Potential Impacts to environmental values(s)	
Summary of Potential Impacts to protected species	
Setting	***Receptor Group***
Offshore	**Cetaceans**: Marine mammals that have direct physical contact with entrained or dissolved aromatic hydrocarbons may suffer 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 (Etkins 1997; IPIECA 1995). 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 on relation to a number of large scale hydrocarbon spills, Geraci & Aubin (1988) 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, entrained and dissolved hydrocarbons exceeding threshold concentrations may drift across the migratory routes 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 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 integrity is unlikely to affect an entire population. Cetacean populations that are resident within the potential ZoC may be more susceptible to impacts from spilled hydrocarbons as individuals may remain within an area affected by a spill. Such species (e.g. spotted bottlenose dolphins) are more likely to occupy coastal waters (refer to the mainland and islands sections 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. 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 sublethal 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 north of the Operational Area in approximately 200–1000 m of water. A loss of well containment could result in a disruption to a significant portion of the humpback or pygmy blue whale populations. Such disruption could include behavioural impacts (e.g. avoidance of impacted areas), sub-lethal biological effects (e.g. skin irritation, irritation from ingestion or inhalation) 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: Contact with entrained hydrocarbons can result in hydrocarbon adherence to body surfaces (Gagnon & Rawson 2010) causing irritation of mucous membranes in the nose, throat and eyes leading to inflammation and infection (NOAA 2010a). Oiling can also irritate and injure skin which is most evident on pliable areas such as the neck and flippers (Lutcavage *et al*. 1995). A stress response associated with this exposure pathway includes an increase in the production of white blood cells, and even a short exposure to hydrocarbons, such as crude oil, may affect the functioning of their salt gland (Lutcavage *et al*. 1995). However direct oiling is no likely as there was no predicted surface hydrocarbons above 10 g/m^2. Hydrocarbons in surface waters may also impact turtles when they surface to breathe and inhale toxic vapours. Although no surface hydrocarbons are predicted above 10 g/m^2, it is likely that there may still be a volatile airborne release as the hydrocarbons surface. Their breathing pattern, involving large 'tidal' volumes and rapid inhalation before diving, results in direct exposure to petroleum vapours that are the most toxic component of the hydrocarbon spill (Milton & Lutz 2002). This can lead to lung damage and congestion, interstitial emphysema, inhalant pneumonia and neurological impairment (Etkins 1997; IPIECA 1995). Due to the absence of potential nesting habitat and location offshore (approximately 145 km from the WA coastline and 48 km from nesting beaches) the Operational Area is highly unlikely to represent important habitat for marine turtles. It is, however, acknowledged that the Operational Area overlaps

	with the flatback turtle internesting BIA for the Montebello Islands, which extends for ~80 km from known nesting locations and there are small areas of filter feeding communities which are typical of the bioregion, including sponges, which can provide food for foraging turtles. In the event of a loss of well containment there is potential that dissolved and entrained hydrocarbons exceeding threshold concentrations may be present in offshore waters extending up 300 km and 600 km, respectively, from the release site. Therefore, a hydrocarbon spill may have a minor disruption to a portion of the population but there is no threat to overall population viability. Potential impacts to nesting and 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 (ITOPF 2011). They may also be impacted when they return to the surface to breathe and inhale the toxic vapours associated with the hydrocarbons, resulting in damage to their respiratory system. In general, seasnakes frequent the waters of the continental shelf area around offshore islands and potentially submerged shoals (water depths <100 m; see Submerged Shoals below) and while individuals may be present in the Operational Area, their abundance is not expected to be high given the deep water and offshore location of the activity. Therefore, a hydrocarbon spill may have a minor disruption to a portion of the population but there is no threat to overall population viability.
	Sharks (including whale sharks) and Rays: Hydrocarbon contact may affect whale sharks through ingestion (entrained/dissolved hydrocarbons), particularly if feeding. Whale sharks may transit offshore open waters when migrating to and from Ningaloo Reef, where they aggregate for feeding from March to July. Whale sharks may also carry out opportunistic feeding in offshore waters and the Operational Area, and therefore the ZoC, overlaps the whale shark migration BIA within which whale sharks are seasonally present between April and October. 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 (Ningaloo and the Barrow/Montebello/Lowendal Island Group). There are confirmed foraging grounds off Ningaloo and the Barrow/Montebello/Lowendal Island Group. The Operational Area overlaps with the wedge-tailed shearwater foraging area during its breeding season (August to April). While there is no predicted surface slick, at 10 g/m^2, seabirds or migratory shorebirds can ingest hydrocarbons through contaminated prey resulting in reduced survival and lifetime reproductive success (Wiese et al 2001). Therefore, a hydrocarbon spill may result in impacts on feeding habitat and a disruption to a significant portion of the habitat but this is not expected to result in a threat to the overall population viability of seabirds or shorebirds.
Submerged Shoals	**Marine Turtles:** There is the potential for marine turtles to be present at submerged shoals such as Rankin Bank and Glomar Shoals. Rankin Bank and Glomar Shoals may at times be a foraging habitat for marine turtles, given the coral and filter feeding biota of this shallow shoal. This area, however, is not a known foraging location and satellite tracking of individual green turtles in the nearshore environment of the NWS Province did not indicate any overlap of the tracked post-nesting migratory routes and the Operational Area (Chevron 2011). It is, however, acknowledged that individual marine turtles may be present at Rankin Bank and Glomar Shoals and the surrounding areas. Therefore, a hydrocarbon spill may have a minor disruption to a portion of the population (see offshore 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 Rankin Bank and Glomar Shoals. The potential impacts of exposure are as discussed previously in Offshore – Seasnakes. A hydrocarbon spill may have a minor disruption to a portion of the population but there is no threat to overall population viability. Seasnake species in Australia generally show strong habitat preferences (Heatwole & Cogger 1993); 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 the Glomar Shoals and Rankin Bank. 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 and Glomar Shoals are likely to be localised and 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 Montebello/Barrow/Lowendal Islands Group, the Ningaloo Coast and Shark Bay, which may be potentially impacted by entrained and dissolved hydrocarbons exceeding threshold concentrations in the event of a loss of well containment. The predicted ZoC for entrained hydrocarbon extends past Exmouth Gulf and down to Shark Bay, while the predicted ZoC for dissolved extends just past Exmouth Gulf. 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. The potential impacts of exposure are as discussed previously in Offshore – Cetaceans. However, nearshore populations of cetaceans and dugongs are known to exhibit site fidelity and are often resident populations. Therefore, avoidance behaviour may have greater impacts to population functioning. Nearshore dolphin species (e.g. spotted bottlenose dolphins) may exhibit higher site fidelity than oceanic species although Geraci (1988) observed relatively little impacts beyond behavioural disturbance. Additional potential environment impacts may also include the potential for dugongs to ingest hydrocarbons when feeding on oiled seagrass stands or indirect impacts to dugongs due to loss of this food source due to dieback in worse affected areas. Therefore, a hydrocarbon spill may have an impact on feeding habitats and result in a disruption to a 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.
	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 Montebello/Barrow/Lowendal Islands, the Ningaloo Coast, Muiron Islands, Pilbara Islands (Northern and Southern Island Groups) and Shark Bay. The nearshore waters of these turtle habitat areas may be exposed to dissolved and entrained hydrocarbons exceeding threshold concentrations. The potential impacts of exposure are as discussed previously in Offshore – Marine Turtles. In the nearshore environment, turtles can ingest hydrocarbons when feeding (e.g. on oiled seagrass stands/macroalgae) or can be indirectly affected by loss of food source (e.g. seagrass due to dieback from hydrocarbon exposure) (Gagnon & Rawson 2010). In addition, hydrocarbon exposure can impact on turtles during the breeding season at nesting beaches. Contact with gravid adult females or hatchlings may occur in nearshore waters where entrained hydrocarbons are expected to make shoreline contact. In the event that entrained hydrocarbons reach the shoreline or internesting coastal waters (as predicted for the Montebello/Barrow/Lowendal Islands Group, Dampier Archipelago, Muiron Islands and the Ningaloo Coast), there is the potential for impacts to turtles utilising the affected area. During the breeding season, turtle aggregations near nesting beaches in the NWMR, within the wider ZoC, are most vulnerable due to greater turtle densities and potential impacts may occur at the population level but it is not expected to impact on overall population viability.
	Seasnakes: As discussed previously (see 'Submerged shoals – seasnakes') impacts to seasnakes for the mainland and island nearshore waters (including Montebello/Barrow/Lowendal Islands the Ningaloo Coast, Muiron Islands, Northern and Southern Pilbara Island Groups and Shark Bay) from direct contact with hydrocarbons may occur but there is expected to be no threat to overall population viability.
	Sharks (including whale sharks) and Rays: Whale sharks and manta rays, known to frequent the Ningaloo Reef system (and form feeding aggregations in late summer/autumn) and transit along the Pilbara cost are vulnerable to entrained and dissolved aromatic hydrocarbon spill impacts, with both taxa having similar modes of feeding. Whale sharks are versatile feeders, filtering large amounts of water over their gills, catching planktonic and nektonic organisms (Jarman & Wilson 2004). Whale

	sharks at Ningaloo Reef have been observed using two different feeding strategies, including passive sub-surface ram-feeding and active surface feeding (Taylor 2007). Passive feeding consists of swimming slowly at the surface with the mouth wide open. During active feeding sharks swim high in the water with the upper part of the body above the surface with the mouth partially open (Taylor 2007). These feeding methods would result in potential for individuals that are present in worse affected spill areas to ingest potentially toxic amounts of entrained/dissolved aromatic hydrocarbons into their body. Large amounts of ingested hydrocarbons may affect their endocrine and immune system in the longer term. The presence of hydrocarbons may cause displacement of whale sharks from the area where they normally feed and rest, and potentially disrupt migration and aggregations to these areas in subsequent seasons. Whale sharks may also be affected indirectly by entrained/dissolved aromatic hydrocarbons through the contamination of their prey. The preferred food of whale sharks are fish eggs and phytoplankton which are abundant in the coastal waters of Ningaloo Reef in late summer/autumn, driving the annual arrival and aggregation of whale sharks in this area. If the spill event were to occur during the spawning season, this important food supply (in worse spill affected areas of the reef) may be diminished or contaminated. The contamination of their food supply and the subsequent ingestion of this prey by the whale shark may also result in long term impacts as a result of bioaccumulation. There is the potential for other resident shark and ray populations to be impacted directly from hydrocarbon contact or indirectly through contaminated prey or loss of habitat. However, it is probable that shark species will move away from the affected areas. Stochastic spill model outputs indicate potential impacts from entrained and/or dissolved aromatic hydrocarbons to the benthic communities of nearshore, subtidal communities of the Montebello/Barrow/Lowendal Islands Group, Dampier Archipelago, the Pilbara Islands – Southern and Northern Group, Ningaloo coast, and Shark Bay, 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. However, widespread habitat loss is unlikely and the consequences to resident shark and ray population (if present) are expected to be minor.
	Seabirds and/or Migratory Shorebirds: In the unlikely event of a major spill, there is potential for seabirds, and resident and non-breeding overwintering shorebirds that use the nearshore waters for foraging and resting, to be exposed to 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 (IPIECA 2004; AMSA 2012). 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. 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: • Montebello/Barrow/Lowendal Islands group (including known nesting habitats on Boodie, Double and Middle Islands) • Pilbara Islands Northern Island Group (Passage Islands chain including Great Sandy Islands and North Sandy Island Nature Reserves) • Pilbara Middle and Southern Island groups • Ningaloo Coast • North West Cape • Muiron Islands • Shark Bay. A hydrocarbon spill may result in sub-lethal or lethal impacts to seabirds in the event that entrained hydrocarbons overlap foraging areas and result in the contamination of prey species. Migratory birds/shorebirds may also be affected, with entrained hydrocarbons potentially affecting birds through impacts to prey species.
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 oil spills

	(ITOPF 2011). 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 hydrocarbons are capable of eliminating the toxicants once placed in clean water, hence individuals exposed to a spill are likely to recover (CONCAWE 1996). Where fish mortalities have been recorded, the spills (resulting from the groundings of the tankers *Amoco Cadiz* in 1978 and the *Florida* in 1969) have occurred in sheltered bays. A spill of hydrocarbons due to a loss of well integrity 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: Mortality and sub lethal effects may impact populations located close to the loss of well containment and within the ZoC for entrained 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 result in localised medium/long term impacts on demersal fish habitat (e.g. seafloor) and therefore may impact on a portion of the continental slope demersal fish communities (approximately 5 km from the Operational Area). Demersal fish may also be impacted in other KEF features including the 'Ancient coastline at 125 m depth contour' that is within the ZoC for entrained hydrocarbons (≥500 ppb).
Submerged shoals	**Pelagic Fish Populations**: Detection and avoidance predicted for pelagic fish populations (see offshore description above) may result in minor and localised impacts.
	Demersal Fish: Demersal fishes include species that have a strong affinity for a particular location (i.e. site attached fish). Site attached species have small home ranges and as such are at higher risk from hydrocarbon exposure than non-resident, more wide-ranging fish species that may move to avoid spilled hydrocarbons. The exact impact on resident fish populations is entirely dependent on actual hydrocarbon concentration, duration of exposure and water depth of the affected communities. It is also noted that the early life stage of resident fish populations is particularly sensitive to hydrocarbon exposure. Of note are Glomar Shoals and Rankin Bank, which have been identified as hosting varied habitats that support a diverse demersal fish assemblage. Demersal fishes may be impacted by entrained and dissolved hydrocarbon fractions. Mortality and sub lethal effects may impact populations within the ZoC for entrained/dissolved aromatic 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. The fish fauna with the ZoC are widely distributed and therefore impacts from a hydrocarbon spill are not likely to affect the population viability of demersal fish species. Recovery of fish populations following disturbance from a hydrocarbon spill may be tied to recovery of disturbed habitats (e.g. reefs).
Mainland and islands (nearshore waters)	**Pelagic Fish Populations:** Detection and avoidance predicted for pelagic fish populations (see offshore description above) may result in minor and localised impacts.
	Demersal Fish (including site attached fish): Demersal fishes include species that have a strong affinity for a particular location (i.e. site attached fish) and as described in 'submerged shoals' may be at higher risk from hydrocarbon exposure than non-resident fish species. The exact impact on resident fish populations is entirely dependent on actual hydrocarbon concentration, duration of exposure and water depth of the affected communities. It is also noted that the early life stage of resident fish populations is particularly sensitive to hydrocarbon exposure. Demersal fishes may be impacted by entrained and dissolved hydrocarbon fractions. Mortality and sub lethal effects may impact populations within the ZoC for entrained/dissolved aromatic 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 or site attached fish habitat, e.g. seafloor or coral reef. The fish fauna with the ZoC are broadly distributed; impacts from a hydrocarbon is not expected to affect the population viability of demersal fish species. Recovery of fish populations following disturbance from a hydrocarbon spill may be tied to recovery of disturbed habitats (e.g. reefs).
Summary of potential impacts to marine primary producers	
Setting	***Receptor Group***

Submerged Shoals	The waters overlying the submerged Rankin Bank (entrained and dissolved) and Glomar Shoals (entrained) have the potential to be exposed to hydrocarbons above threshold concentrations (at or greater than 500 ppb). These permanently submerged habitats, which represent sensitive open water benthic community receptors, extend from deep depths to relatively shallow water. Given the depth of these shoals, it is likely the potential for biological impact is significantly reduced when compared to the upper water column layers. However, potential biological impacts could include sub-lethal stress and in some instances total or partial mortality of sensitive benthic organisms such as corals and the early life stages of resident fish and invertebrate species. Exposure to lower dissolved aromatic hydrocarbon concentrations may increase mortality in the early life stages of species affected. This may result in localised and long-term effects to the shallow hard coral communities at these shoals
Mainland and Islands (nearshore waters)	**Coral Reef**: The quantitative spill risk assessment and output ZoC indicate there would be potential for entrained hydrocarbon/dissolved aromatic hydrocarbons (≥500 ppb threshold concentration) to contact shallow nearshore waters and therefore exposure of subtidal corals associated with the fringing reefs located at a number of mainland and island locations. Areas that may be contacted by entrained hydrocarbons (≥500 ppb threshold concentration) include the Montebello/Barrow/Lowendal Islands Group, Dampier Archipelago, Pilbara Southern, Middle and Northern Islands Groups, Ningaloo Coast and Shark Bay while dissolved hydrocarbons may contact the Ningaloo coast (≥500 ppb threshold concentration). There is potential for these reefs to be exposed to entrained and/or dissolved aromatic hydrocarbons concentrations that are considered to induce toxicity effects, particularly for reproductive and juvenile stages of invertebrate and fish species. 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 (Negri & Heyward 2000). This could result in impacts to the shallow water fringing coral communities/reefs of the offshore islands (e.g. Barrow/Montebello/Lowendal Islands) and also the mainland coast (e.g. Ningaloo coast). In the unlikely event of a spill occurring at the time of coral spawning at potentially affected coral locations or in the general peak period of biological productivity, there is potential for a significant reduction in successful fertilization and coral larval survival due to the sensitivity of coral early life stages to hydrocarbons (Negri & Heyward 2000). Such impacts are likely to result in the failure of recruitment and settlement of new population cohorts. In addition, some non-coral species may be affected via direct contact with entrained and dissolved aromatic hydrocarbons, resulting in sub-lethal impacts and in some cases mortality. This is with particular reference to the early life-stages of coral reef animals (reef attached fishes and reef invertebrates), which can be relatively sensitive to hydrocarbon exposure. Coral reef fish are site attached, have small home ranges and as reef residents they are at higher risk from hydrocarbon exposure than non-resident, more wide-ranging fish species. The exact impact on resident coral communities (which may include fringing reefs of the offshore islands and/or the Ningaloo reef system) will be entirely dependent on actual hydrocarbon concentration, duration of exposure and water depth of the affected communities. Over the worst affected sections of reef habitat, coral community live cover, structure and composition is predicted to reduce, manifested by loss of corals and associated sessile biota. Recovery of these impacted reef areas relies on coral larvae from neighbouring coral communities that have either not been affected or only partially impacted. For example, there is evidence that Ningaloo Reef corals and fish are partly self-seeding (Underwood 2009) with the supply of larvae from locations within Ningaloo Reef of critical importance to the healthy maintenance of the coral communities. Therefore, a hydrocarbon spill may result in large-scale impacts to coral reefs, with long-term effects (recovery >10 years) likely.

	Seagrass Beds / Macroalgae and Mangroves: Spill modelling has predicted entrained hydrocarbons ≥500 ppb and dissolved aromatic hydrocarbons ≥500 ppb, have the potential to contact a number of shoreline sensitive receptors such as those supporting biologically diverse, shallow subtidal and intertidal communities. The variety of habitat and communities types, from the upper subtidal to the intertidal zones support a high diversity of marine life and are utilised as important foraging and nursery grounds by a range of invertebrate and vertebrate species. Entrained/dissolved hydrocarbons 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 (Heintz *et al*., 2000). In addition, there is the potential for secondary impacts on shorebirds, fish, sea turtles, rays, and crustaceans that utilise these intertidal habitat areas for breeding, feeding and nursery habitat purposes. Mangrove habitat and associated mud flats and salt marsh at Ningaloo Coast (small habitat areas), the Pilbara islands and the Montebello Islands have the potential to be exposed. Smothering 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 sublethal 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 (NOAA, 2010b). At wave-sheltered or wave-exposed shorelines, the potential for chronic sublethal toxicity impacts beyond immediate physical and acute effects (which may delay recovery in an affected area), may be reduced as the condensate comprises a low proportion (5.9%) of persistent residual fractions (BP >380°C). Depending on the trajectory of the entrained and dissolved hydrocarbon plume, macroalgal/seagrass communities including at the Montebello/Barrow/Lowendal Islands, Dampier Archipelago, the Pilbara Southern, Middle and Northern Islands Groups (documented as low and patchy cover), Muiron Islands (associated with limestone pavements) and Ningaloo Coast (patchy and low cover associated with the shallow limestone lagoonal platforms). Seagrass and macroalgal beds occurring in the intertidal and subtidal zone may be susceptible to impacts from entrained/dissolved hydrocarbons. Toxicity effects can also occur due to absorption of soluble fractions of hydrocarbons into tissues (Runcie *et al*. 2004). The potential for toxicity effects of entrained hydrocarbons may be reduced by weathering processes that should serve to lower the content of soluble aromatic components before contact occurs. Exposure to entrained/dissolved aromatic hydrocarbons may result in mortality, depending on actual entrained/dissolved aromatic hydrocarbon concentration received and duration of exposure. Physical contact with entrained hydrocarbon droplets could cause sub-lethal stress, causing reduced growth rates and a reduction in tolerance to other stress factors (Zieman *et al*. 1984). Impacts on seagrass and macroalgal communities are likely to occur in areas where hydrocarbon threshold concentrations are exceeded.
Summary of potential impacts to other habitats and communities	
Setting	***Receptor Group***
Offshore	**Benthic Fauna Communities**: In the event of a major release at the seabed, the 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 consolidated sediment habitat/limestone ridge habitat within and outside the Operational Area are not expected to have widespread exposure to released hydrocarbons. A localised area relating to the hydrocarbon plume at the point of release is predicted, which would result in a small area of seabed and associated epifauna and infauna exposed to hydrocarbons. Evidence from the Deepwater Horizon spill in the Gulf of Mexico recorded low taxa richness and high nematode/harpacticoid-copepod ratios within 3 km of the release location and moderate impacts up to 17 km away (Montagna *et al.* 2013). The communities were likely exposed to dispersed hydrocarbons as the response included subsea dispersant application. A loss in benthic biodiversity has been correlated to a decline in deep-water ecosystem functioning (Danovaro *et al*. 2008). The location of the petroleum activity and the 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 of the NWS Province) is an important component of the primary marine food web. Planktonic communities are generally mixed including phytoplankton (cyanobacteria and other microalgae) and secondary consuming zooplankton (crustaceans (e.g. copepods), and the eggs and larvae of fish and invertebrates (meroplankton). Exposure to hydrocarbons in the water column can result in changes in species composition with declines or increases in one or more species or taxonomic groups (Batten 1998). Phytoplankton may also experience decreased rates of photosynthesis (Goutz *et al*. 1984; Tomajka 1985). For zooplankton, direct effects of contamination may include suffocation, changes in behaviour, or environmental changes that make them more susceptible to predation (Chamberlain & Robertson 1999). Impacts on plankton communities are likely to occur in areas where surface, entrained or dissolved aromatic hydrocarbon threshold concentrations are exceeded, but communities are expected to recover relatively quickly (within weeks or months). This is due to high population turnover with copious production within short generation times that also buffers the potential for long-term (i.e. years) population declines (ITOPF 2011). Therefore, any impacts are likely to be on exposed planktonic communities present in the ZoC and temporary.
	Open Water – Physical Displacement of Fauna from Gas Plume: The effect of the physical extent of the gas plume in the environment is expected to have a limited and localised effect on identified receptors such as the physical barrier created by the gas plume, which may cause the displacement of transient and/or mobile biota such as pelagic fish, megafauna species (migratory whales) and plankton. It is acknowledged that the physical extent of the plume may displace some open water species transiting the offshore waters of this area of the NWS. The extent of the plume is relatively small in comparison to the surrounding offshore environment but the overall impact to the in-water biota and the marine environment in general is expected to be slight to minor short-term impact to communities present in the ZoC.
Submerged Shoals	**Open Water – Productivity/Upwelling**: The submerged shoals of Glomar Shoals and Rankin Bank are areas associated with sporadic upwelling and associated primary productivity events. Spill model results predict entrained hydrocarbons/dissolved aromatic hydrocarbons (at or above the 500 ppb threshold) may reach Rankin Bank and entrained hydrocarbons (at or above the 500 ppb threshold) may contact Glomar Shoals. 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 Ancient Coastline at 125 m depth contour KEF) 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 (White *et al*. 2012). 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. Barrow and Montebello Islands) and to the west of the Ningaloo reef system are known locations of seasonal upwelling events and productivity. The seasonal productivity events are critical to krill production, which supports megafauna aggregations such as whale sharks and manta rays in the region. This has the potential to result in lethal and sub-lethal impacts to a certain portion of plankton in affected areas, depending on concentration and duration of exposure and the inherent toxicity of the crude. 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 sublethal impacts from exposure to hydrocarbons, particularly if a spill coincides with spawning seasons or if a spill reaches nursery areas close to the shore (e.g. seagrass and mangroves) (ITOPF 2011). Fish spawning (including for commercially targeted species such as snapper and mackerel) occurs in nearshore waters at certain times of the year and nearshore waters are also inhabited by higher numbers of juvenile fishes than offshore waters. Modelling indicated that in the unlikely event of a major spill there is potential for entrained hydrocarbons to occur in the surface water layers above threshold concentrations in nearshore waters including, but not limited to, the Dampier Archipelago, Montebello/Barrow/Lowendal Islands

	Group, Pilbara Southern, Middle and Northern Islands Groups, the Muiron Islands and the Ningaloo Coast, and Shark Bay. This, and the potential for possible lower concentration exposure for dissolved aromatic hydrocarbons, have the potential to result in lethal and 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 in the Gulf of Mexico which used juvenile abundance data, from shallow-water seagrass meadows, as indices of the acute, population-level responses of young fishes to the Deepwater Horizon (DWH) spill. Results indicated that there was no change to the juvenile cohorts following the DWH spill. Additionally there were no significant post-spill shifts in community composition and structure, nor were there changes in biodiversity measures (Fodrie & Heck 2011). Any impacts to spawning and nursery areas are expected to be minor and short term, as would flow on effects to adult fish stocks into which larvae are recruited.
	Non Biogenic Coral Reefs: The coral communities fringing the offshore Pilbara region (e.g. the Southern Island Group) may be exposed to entrained hydrocarbons (at or above 500 ppb) and consequently exhibit lethal or sub-lethal impacts resulting in partial or total mortality of keystone sessile benthos, particularly, hard corals and thus potential community structural changes to these shallow, nearshore benthic communities may occur. In the event that these reefs are exposed to entrained hydrocarbons, impacts are expected to result in localised long-term effects.
	Filter Feeders: Hydrocarbon exposure to offshore, filter-feeding communities (e.g. deepwater communities of Ningaloo coast and the Muiron Islands in 20–200 m) may occur depending on the depth of the entrained and dissolved aromatic hydrocarbons. See discussion above on potential impacts.
	Sandy Shores/Estuaries/Tributaries/Creeks (Including Mudflats)/Rocky Shores: Shoreline exposure for the upper and lower areas differ, the upper shore has the potential to be exposed to surface slicks, while the lower shore is subjected to dissolved or entrained hydrocarbon. Shoreline contact and accumulation of hydrocarbons is not expected at levels of ecological consequence; however, potential impacts may occur due to entrained hydrocarbon contact with shallow, subtidal and intertidal zones of the Montebello/Barrow/ Lowendal Islands Group, the Northern and Southern Island Groups, Muiron Islands, the Ningaloo Coast and Shark Bay (open ocean). In-water toxicity of the entrained hydrocarbons reaching these shores will determine impacts to the marine organisms, such as sessile barnacle species and/or mobile gastropods and crustaceans such as amphipods. Lethal and sub-lethal impacts may be expected where the entrained hydrocarbon concentration threshold is >500 ppb. Impacts may result in localised changes to the community structure of these shoreline habitats, which would be expected to recover in the medium term (2–5 years).
Key Ecological Features	**Key Ecological Features** potentially impacted by the hydrocarbon spill from a loss of well integrity event are: • Ancient coastline at 125 m depth contour' • Continental slope demersal fish communities • Glomar Shoals • Exmouth Plateau • Canyons that link the Cuvier Abyssal Plan with the Cape Range Peninsula • Commonwealth waters adjacent to Ningaloo Reef. 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 control event are predicted to result in moderate impacts with values of the KEF areas 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.
Summary of potential impacts to water quality	
Setting	***Aspect***
Offshore	**Open Water – Water Quality**: Water quality would be affected due to hydrocarbon contamination which is described in terms of the biological effect concentrations. These are defined by the ZoC

	descriptions for each of, entrained and dissolved hydrocarbon fates and their predicted extent. Furthermore, water quality is predicted to have minor long term and/or significant short term hydrocarbon contamination above background and/or national/international quality standards.
Submerged Shoals	**Open Water – Water Quality:** Water quality would be reduced due to hydrocarbon contamination that is predicted to be at or above biological effect concentrations for the surrounding marine waters over Rankin Bank and Glomar Shoals. The submerged Rankin Bank have the potential to be exposed to entrained/dissolved aromatic hydrocarbons (at or greater than 500 ppb). Similarly, Glomar Shoals has the potential to be contacted by entrained hydrocarbons (at or greater than 500 ppb). 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.
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. Such reduction in water quality is predicted to have minor long term or significant short term hydrocarbon contamination above background and/or national/international quality standards.
Summary of potential impacts to marine sediment quality	
Setting	***Receptor Group***
Offshore	**Marine Sediment Quality**: In the event of a major hydrocarbon release at the seabed, modelling indicates that a pressurised release of condensate would atomise into droplets that would be rapidly transported into the water column. 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:** Entrained hydrocarbons (at or above the defined thresholds) are predicted to potentially contact shallow, nearshore waters of identified islands and mainland coastlines. Such hydrocarbon contact may lead to reduced marine sediment quality by several processes, such as adherence to sediment and deposition shores or seabed habitat.
Summary of potential impacts to air quality	
A hydrocarbon release during a loss of well containment has the potential to result in localised, temporary reduction in air quality. Potential impacts are expected to be a slight and temporary localised effect to ecosystems, species and/or habitats in the area. There is potential for human health effects for workers in the immediate vicinity of atmospheric emissions. The ambient concentrations of methane and VOCs released from diffuse sources is difficult to accurately quantify, although their behaviour and fate is predictable in open offshore environments as it is dispersed rapidly by meteorological factors such as wind and temperature. Methane and VOC emissions from a hydrocarbon release in such environments are rapidly degraded in the atmosphere by reaction with photo chemically-produced hydroxyl radicals. Due to the unlikely occurrence of a loss of well containment; the temporary nature of any methane or VOC emissions (from either gas surfacing or weathering of liquid hydrocarbons from a loss of well containment); the predicted behaviour and fate of methane and VOCs in open offshore environments; and the significant distance from the Operational Area to the nearest sensitive air shed (town of Dampier – 160 km away), the potential impacts are expected to be minor and temporary.	
Summary of potential impacts to protected areas	
The quantitative spill risk assessment results indicate that the open water environment protected within the Commonwealth Marine Reserves 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. Impact on the protected areas is discussed in the sections above for ecological the values and sensitivities and below	

for socio-economic values. Additionally, such hydrocarbon contact may alter stakeholder understanding and/or perception of the protected marine environment, given these represent areas largely unaffected by anthropogenic influences and contain biological diverse environments.

Summary of potential impacts to socio-economic values

Setting	*Receptor Group*
Offshore	**Fisheries - Commercial:** Spill scenarios modelled are unlikely to cause significant direct impacts on the target species of Commonwealth and offshore State fisheries within the defined 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 (Merkel *et al*. 2012). Given these pelagic species are distributed over a wide geographical area, the impacts at the population or species level are considered minor in the unlikely event of a spill. *Northwest Slope Trawl Fisheries:* The predicted ZoC resulting from a loss of well containment may result in direct impacts on the species fished by the Northwest Trawl Fishery. This fishery targets benthic species (mainly Australian scampi) in greater than 200 m water depth. Higher intensity fishing is located near Rankin Bank, approximately 30 km from the location of a potential loss of well containment, 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. *State Fisheries*: The predicted ZoC resulting from a major spill may impact on the area fished by the number of state fisheries, particularly the Pilbara Demersal Scalefish Fishery. This fishery uses a range of gear types (trawl, trap and line) and operates in water depths between 50 and 200 m, targeting demersal finfish species, including snapper. In the unlikely event of a major hydrocarbon spill, there is potential for the targeted fish species to be exposed to entrained and/or dissolved hydrocarbons in the upper water column. However, the potential for direct impact would be reduced as target species (demersal finfish) are generally on or near the seabed. Demersal species (such as finfish and crustaceans) have limited mobility and therefore, may not be able to easily move away from the location of loss of well containment. A major and continuous spill is likely to lead to exclusion of Pilbara Line Fishers from the 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 (NOAA 2002). Seafood safety is a major concern associated with spill incidents. Therefore, actual or potential contamination of seafood can affect commercial and recreational fishing, and can impact seafood markets long after any actual risk to seafood from a spill has subsided (NOAA 2002). A major spill would result in the establishment of an exclusion zone around the spill affected area. There would be a temporary prohibition on fishing activities for a period of time and subsequent potential for economic impacts to affected commercial fishing operators.
	Tourism (including Recreational Fishing): Recreational fishers predominantly target tropical species, such as emperor, snapper, grouper, mackerel, trevally and other game fish (Fletcher & Santoro 2014). Recreational angling activities include shore-based fishing, private boat and charter boat fishing, with the peak in activity between April and October (Fletcher & Santoro 2014; Smallwood *et al.* 2011). Limited recreational fishing takes place in the offshore waters of the Operational Area. Impacts on species that are recreationally fished are described above and under 'Summary of potential impacts to other species'. A major loss of hydrocarbon from the Petroleum Activities Program may lead to exclusion of marine nature-based tourist activities. Additionally, there is potential for stakeholder perception that the environment will be contaminated over a large area and for the long term resulting in a potential decline in users and a loss of revenue for operators.

	Offshore Oil and Gas Infrastructure: In the unlikely event of a loss of well containment event, 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 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 Wheatstone Platform. Other nearby facilities include: Pluto Platform, Armada Claire FPSO, and John Brooks. Operation of these facilities is likely to be affected in the event of a well blow-out spill. Other exploration activities being undertaken in the area may also be impacted by an established spill exclusion zone.
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 the Rankin Bank and the Glomar Shoals may be put into effect, depending on the trajectory of the plume, resulting in a loss of revenue for operators.
Mainland and islands (nearshore waters)	**Fisheries - Commercial:** *Nearshore Fisheries and Aquaculture:* In the unlikely event of a loss of well containment, there is the possibility that target species in some areas utilised by a number of state fisheries, prawn fisheries, pearl aquaculture in nearshore waters of the Montebello Islands, wild oysters in the Pearl Oyster Managed Fishery, beche-de-mer and aquarium fisheries in the nearshore waters that are within the ZoC 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. *Onslow Prawn Managed Fishery:* In the event of a major spill, the modelling indicated the ZoC tends to remain offshore and not extend to nearshore waters closest to the mainland Pilbara coast, including the actively fished areas of the designated Onslow Prawn Managed Fishery and managed prawn nursery areas. Similarly, 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 (Ronnback *et al.* 2002), whereas juvenile tiger prawns are most abundant in areas of seagrass (Masel &Smallwood 2000). Adult prawns also inhabit coastline areas but tend to move to deeper waters to spawn. In the event of a major spill, the model predicted shallow subtidal and intertidal habitats at Montebello Islands, Barrow Island, Lowendal Islands, Dampier Archipelago, Northern and Southern Island Group, Muiron Islands 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: Although no designated traditional fisheries have been identified it is recognised that indigenous communities fish in the shallow coastal and nearshore waters of Ningaloo and therefore may be potentially impacted if a hydrocarbon spill from a loss of well containment were to occur. Impacts would be similar to those identified for commercial fishing in the form of a potential exclusion zone and contamination/tainting of fish stocks.
	Tourism and Recreation: In the unlikely event of a major spill, the nearshore waters of island groups including Barrow/Lowendal/Montebellos and the Pilbara islands (Northern and Southern Island groups) and mainland coasts, Ningaloo and Dampier, could be reached by entrained hydrocarbon, 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 have a recreational value for local residents and visitors (regional, national and international). If a major spill resulted in hydrocarbon contact, there could be restricted access to beaches for a period of days to weeks, until natural weathering or tides and currents remove the hydrocarbons. In the event of a major spill, tourists and recreational users may also avoid areas due to perceived impacts, including after the hydrocarbon spill has dispersed. There is potential for stakeholder perception that this remote environment will be contaminated over a large area and for the longer term resulting in a prolonged period of tourism decline. Oxford Economics (2010) assessed the duration of hydrocarbon spill related tourism impacts and found that

	on average, it took 12 to 28 months to return to baseline visitor spending. There is likely to be significant impacts to the tourism industry, wider service industry (hotels, restaurants and their supply chain) and local communities in terms of economic loss as a result of spill impacts to tourism. Recovery and return of tourism to pre-spill levels will depend on the size of the spill, effectiveness of the spill clean-up and change in any public misconceptions regarding the spill (Oxford Economics 2010).
	Cultural Heritage: A total of seven historic shipwrecks were identified for the Montebello/Barrow Island area and include the two wrecks located at Trial Rocks (Montebello Islands), namely *Trial* and *Tanami*. The spill results do not predict surface slicks contacting the identified wrecks. However, shipwrecks occurring in the subtidal zone will be exposed to entrained and dissolved hydrocarbons and marine life that shelter and take refuge in and around these wrecks may be affected by in-water toxicity of dispersed hydrocarbons, The consequences of such hydrocarbon exposure may include all or some of the following: large fish species moving away and/or resident fish species and sessile benthos such as hard corals exhibiting sub-lethal and lethal impacts (which may range from physiological issues to mortality). Although shoreline contact from hydrocarbons is unlikely to impact the foreshore and hinterland of the Ningaloo Coast, it is acknowledged that the area contains numerous Indigenous sites such as burial grounds, middens and fish traps that provide a historical account of the early habitation of the area and a tangible part of the culture of local Indigenous groups (DEC 2002). Additionally artefacts, scatter and rock shelter are contained on Barrow and Montebello islands. 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 WHA, marine parks, listed shipwrecks. Potential impacts have, therefore been discussed above.

Summary of Potential Impacts to environmental values(s)

In the unlikely event of a major hydrocarbon release within the Operational Area, the ZoC includes the sensitive marine environments and associated receptors of the Montebello's (including the Montebello CMR), Barrow and Lowendal Islands, Dampier Archipelago, the Muiron Islands, Ningaloo Coast (North, Middle and South), the Northern and Southern Island Group off Onslow and open ocean Shark Bay (including Dirk Hartog, Beriner and Dorre Islands) and any sensitive receptors in the open waters amongst these key receptor locations. In summary, long term impacts may occur at sensitive nearshore and shoreline habitats, particularly, areas of the Ningaloo Coast, as a result of a major spill of hydrocarbon from loss of well integrity within the Operational Area.

The overall environmental consequence is defined as B which equates to 'serious, long term (>10 years) impact and impact on highly valued ecosystems, species and habitat'.

Value	Potential Consequence	Rank	Explanation
Protected species	Disruption of a significant portion of the population. Impacts on critical habitats or activities. No threat to overall population viability.	C	The consequences of hydrocarbon impact to EPBC Act listed species may result in disruption of a significant portion of the population. Marine turtles (during nesting and internesting seasons) and marine mammals (including migratory whale species) may potentially be impacted through direct physical damage or behavioural changes such as avoidance behaviour (see potential impacts offshore and nearshore waters – protected species). Given the occurrence of transient marine mammal species (migratory whale populations and dugongs, particularly when travelling with young) and nesting marine turtles species is high at key periods of the year, the potential impacts may affect a significant portion of the population and impact on critical life function activities such as resting, feeding, breeding and nesting.
Marine primary producers	Large scale and long-term effects. Recovery >10 years or permanent.	B	The nearshore, fringing benthic primary producer habitats (corals, seagrass, macroalgae and mangroves) of offshore islands and mainland coasts such as the Ningaloo Coast, Barrow/Montebello/Lowendal Islands, Muiron Islands, Southern Island Group, Shark Bay, Dampier Archipelago may be impacted by hydrocarbon exposure. The reef-building corals of Ningaloo reef system and Rankin Bank are the marine primary producers most likely to be affected if hydrocarbon exposure takes place. Impacts to corals include widespread mortality of adult corals and lethal impacts to coral reproduction, spawning and recruitment success if the spill occurs at the time of mass coral spawning and the subsequent larval metamorphosis and recruitment phase.

			Furthermore, recovery projections for impacted reef communities are in timescale of >10 years (see potential impacts to marine primary producers).
Other communities /habitats	Localised but long term effect on community/habitat structure. Community maintains ecological integrity though an unacceptable change in species composition may occur	C	Detrimental impacts to keystone species, coral communities of the benthic primary producer habitats and food sources such as plankton, may lead to secondary effects to the species and communities they support (resident fish and sessile biota). The associated reef-attached fish assemblages and shark populations may be impacted by the loss of reef habitat for refuge and prey. Benthic infauna and including epifauna associated with hard substrate communities in close proximity to the release location may be affected, however, the broader benthic community a few kilometres from the release location are unlikely to be affected by a hydrocarbon spill. Planktonic communities may be impacted, however are expected to recover rapidly with no long term effects. Nearshore habitats such as sandy shores, estuaries, tributaries, creeks, mangroves and rocky shores may be affected however impacts will be limited as the modelling predicted no surface slicks and no accumulation above ecological thresholds. The impacts to values of KEFs affected may include: the contamination of sediments, impacts to benthic sediment fauna and associated impacts to demersal fish populations and reduced biodiversity. Recovery of affected areas are most likely of the timescale of recovery time medium term 5 to 10 years.
Water quality	Minor long term or significant short term contamination above background and/or national/international quality standards and/or known biological effect concentrations on scale >2 km.	C	Water quality throughout the ZoC will be affected, with the particular effects determined by the volume and nature of the spilled hydrocarbons. Based on the exceedance of defined hydrocarbon thresholds, if a hydrocarbon release occurs, water quality impacts on the scale of >2 km is predicted with biological effect concentrations above Rankin Bank and in nearshore waters of the offshore islands (e.g. Barrow/Montebello/Lowendal Islands) and mainland coast (.e.g. Ningaloo Coast).
Marine sediment quality	Long to medium term contamination above background and/or national/international quality standards and/or known biological effect concentrations on scale >2 km.	C	Based on the exceedance of hydrocarbon thresholds for ecological impacts if a spill occurs, sediment quality impacts on the scale of >2 km of marine sediments.
Socio-economic	Moderate medium term (<5 years) impacts to tourism, oil and gas activities and commercial fishing in the area.	D	The consequence of a hydrocarbon spill on socio-economic values in the area (tourism, commercial and recreational fisheries, and offshore oil and gas activities) will be moderate and medium term (<5 years). There could be economic losses for the tourism industry, wider service industry and local communities if there is a prolonged period of tourism decline. There could also be economic losses for commercial fisheries, if there is a prohibition on fishing activities for a period of time and on oil and gas operations if it is determined that production activities must cease.
Air Quality	Slight and temporary (<1 year) localised effect to ecosystems, species and/or habitats in the area.	F	A hydrocarbon release during a loss of well containment has the potential to result in localised, temporary reduction in air quality. The nearest human sensitive receptor to the Petroleum Activities Program is Dampier approximately 160 km south-east. Given the short duration and exposed location of the Petroleum Activities Program away from sensitive air sheds (which will lead to rapid dispersion) the potential impacts are expected to be minor.
Protected	Significant long term	B	The Marine Protected Areas (MPAs) potentially impacted in the

areas	effect on one or more of protected area values.		event of a hydrocarbon spill are shown in **Table 5-9**.The protected areas in closest proximity are the Montebello CMR (within), Montebello Islands Marine Park (48 km), Lowendal Nature Reserve (69 km) Barrow Island Nature Reserve (71 km) and Pilbara Islands Nature Reserves (118 km). The consequences of a condensate spill from a loss of well integrity event may result in long-term impacts to the conservation values of the protected areas affected (such potential impacts include: the loss of benthic primary producer habitat and reduced water quality and biodiversity), depending on the nature and extent of the hydrocarbons reaching the protected area.
Summary of Control Measures			
• Wells operated and tested in accordance with Woodside's accepted Well Operations Management Plan (WOMP) • Routine testing is undertaken for wells and pipelines in the Julimar Field Production System. • Compliance with the following Safety Critical Performance Standards: o Reservoir Isolation o Wells • Activity Vessel Safe Work Procedures developed and implemented. • Subsea first response toolkit and capping stack available for use.			

Loss of Containment of Subsea Infrastructure

Source of Risk	Environmental Value Potentially Impacted									Evaluation		
	Water Quality	Marine Sediment Quality	Air Quality	Marine Primary Producers	Other Habitats & Communities	Protected Species	Soil & Groundwater	Socio-Economic	Protected Areas	Consequence	Likelihood	Residual Risk
Loss of containment of subsea infrastructure as a result of: • Failure of the subsea infrastructure integrity (i.e. erosion or corrosion/mechanical); • Dragged anchor; or • Dropped object from activity vessels onto live flowline.	X	X			X	X		X	X	E	1	L

Description of Source of Risk

The hazard associated with a subsea loss of containment is associated with the release of hydrocarbons (in the form of condensate and gas) conveyed in the subsea equipment (e.g. flowlines), to the environment. Woodside identified of the following credible scenarios that could result in a loss of containment of the subsea infrastructure:

- Dropped object from an activity vessel
- Dragged anchor across subsea infrastructure
- Failure of the subsea infrastructure integrity (e.g. erosion, corrosion/mechanical: including loss of integrity during well clean up).

To assess the potential consequences, worst credible hydrocarbon release scenarios from a loss of containment of subsea infrastructure were identified. As a result, a worst case credible hydrocarbon release scenario has been defined as the rupture of one of the subsea hydrocarbon flowlines. The total volume of the worst case flowline release will be approximately 3000m^3. The release will consist of gas, condensate and water. This could result in a release to the environment of up to 107m^3 of water, 300 m^3 of condensate and 150MMscf of associated gas. This scenario is based on an instantaneous large borehole release (such as major rupture or failure of the flowline), and assumes that the entire inventory of the flowline is released.

Quantitative Spill Risk Assessment

Modelling was undertaken by RPS APASA to determine the fate of Brunello condensate released from a flowline rupture adjacent to the Brunello well center.

The modelling assessed the extent of a condensate spill volume of 300 m^3 for all seasons, using an historic sample of wind and current data for the region. A total of 100 simulations for each season were modelled with each simulation tracked for 21 days.

Hydrocarbon Characteristics

See above sections for Brunello Condensate characteristics.

Subsea Plume dynamics

The loss of containment of subsea infrastructure that has been modelled is based on forecasts the size of the hydrocarbon droplets that would be released as determined by the OILMAP-Deep model. For a pressurised discharge of condensate at the seabed (depth of 148 m), the OILMAP-Deep model calculated that at the outset, the oil component of the condensate would be atomized into relatively small droplets (~1 to 7 µm) and entrained by the rising gas cloud. By the end of the release the droplet sizes are predicted to be in the range of 52-313 µm and therefore, any surface hydrocarbons will most likely originate from the latter stages of the subsea release.

Range of assumed inputs and range of calculated outputs by OILMAP Deep model for loss of containment of subsea infrastructure

Variable	Brunello condensate		
	0-10 min	10-30 min	30-150 min

Assumed discharge	Release Depth (m) Hydrocarbon temp (C°) Gas:oil ratio (scf/bbl)	148 55. 38,462		
	Hydrocarbon flow rate (bbl/hr)	944	472	472
	Diameter of exit hole (m)	0.457		
Calculated gas plume dynamics	Plume diameter (m) Plume Trapping height (m above seabed)	8.6 m 148 m (surface)		
Calculated droplet size distribution	16.5% droplets of size μ 26.0% droplets of size 23.6% droplets of size 17.2% droplets of size 10.7% droplets of size 6.0% droplets of size	1.2 μm 2.3 μm 3.5 μm 4.6 μm 5.8 μm 6.9 μm	6.1 μm 12.1 μm 18.2 μm 24.2 μm 30.3 μm 36.4 μm	52.1 μm 104.2 μm 156.3 μm 208.3 μm 260.4 μm 312.5 μm

Potential Environmental Impact

Zone of Consequence

In the unlikely event of a spill of comingled condensate as a result of loss of flowline containment the ZoC would be confined to a relatively small area off offshore open water environment and would be of a short duration.

Surface Hydrocarbons: In the event this scenario occurred, surface hydrocarbons would form down current of the release location with the trajectory dependent on prevailing current conditions at the time. Concentrations of 10 g/m^2 or greater are predicted to less than 5 km from the release site and are not forecast to contact any shoreline receptors.

Entrained Hydrocarbons: In the event this 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 entrained hydrocarbon ZoC would be confined to open water, extending for up to approximately 50 km from the release location. No contact with any sensitive receptors above threshold concentrations (>500 ppb) is predicted, excepting the Montebello CMR.

Dissolved Hydrocarbons: In the event that this scenario occurred, a plume of dissolved 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 dissolved hydrocarbon ZoC would be confined to open water, extending for up to approximately 10 km from the release location. No contact with any sensitive receptors above threshold concentrations (>500 ppb) is predicted, excepting the offshore Montebello CMR.

Value	Description of Potential Environmental Impact
Protected species, other habitats and communities, water quality, marine sediment quality and socio-economic values	Further detail on impacts specific to a spill from the subsea infrastructure are provided below. There is no predicted contact with any mainland or island nearshore sensitive receptors above threshold concentrations (>500 ppb for entrained and dissolved or <10 g/m^2 for surface) therefore impacts are expected to be limited to the offshore environment. **Protected Species** Protected species, including pygmy blue whales, humpback whales, whale sharks, marine turtles, may be encountered within the Operational Area and therefore, could be impacted by a loss of containment of subsea infrastructure. No critical habitats have been identified within the ZoC. The ZoC may spatially overlap with the BIAs identified in the Operational Area, however, it is considered that protected species that are present will bepredominantly transiting through the area. Given the relatively small ZoC, it is expected that any potential impacts will be low and temporary in nature. **Other Habitats and Communities** Within the Operational Area there is the potential for plankton communities to be impacted by a loss of containment of subsea infrastructure where entrained hydrocarbon threshold concentrations are exceeded, but communities are expected to recover quickly (weeks/months) due to high population turnover (ITOPF 2011). With the relatively small ZoC and the fast population turnover of open water plankton populations it is expected that any potential impacts will be low and temporary in nature. Within the vicinity of the immediate release area there is the potential for benthic communities associated with the unconsolidated, soft sediment habitat and any epifauna

	associated with the cemented outcroppings to be exposed to hydrocarbons. There is not expected to be widespread exposure and impacts to these communities is therefore predicted to be localised and short to medium term. **Other Species** Pelagic fish populations in the open water offshore environment of the Operational Area are highly mobile and have the ability to move away from a loss of containment of subsea infrastructure. Fish populations are likely to be distributed over a wide geographical area so impacts on populations or species level are considered to be negligible. Combined with these factors and the relatively small ZoC and the rapid dispersion of condensate it is expected that any potential impacts will be negligible. The 'Continental Slope Demersal Fish Communities' has been identified as a key ecological feature, approximately 5 km from the Operational Area. Mortality and sub lethal effects may impact populations located close to the flowline rupture and within the ZoC for entrained and dissolved hydrocarbons (≥500 ppb). These impacts result in localised short to medium term impacts on demersal fish habitat e.g. seafloor and therefore, may impact on the continental slope demersal fish communities. **Water Quality** It is likely water quality will be reduced at the 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 highly localised in nature due to the relatively small ZoC. The potential impact is therefore, expected to be low. **Sediment Quality** Modelling predicted that the condensate would be atomized into relatively small droplets and entrained by the rising gas cloud. 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 short to medium term. **Socio-economic** A loss of containment of subsea infrastructure is considered unlikely to cause significant direct impacts on the target species fished by the Commonwealth and State Fisheries which overlap with the Operational Area. These fisheries target demersal fish species that occur in water depths of 50–200 m or pelagic species which are highly mobile, however impacts are likely to be limited due to the relatively small area of the ZoC. However, there is potential that a fishing exclusion zone would be applied in the area of the spill, which would put a localised 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. **Protected Areas** The quantitative spill risk assessment results indicate that the open water environment protected within the Montebello CMR may be affected by the released hydrocarbons. The impacts on the key values of the CMR are discussed above.
Summary	In the unlikely event of an unplanned hydrocarbon release from the subsea infrastructure to the marine environment, combined with the adopted controls, it is considered that any potential impact to water quality (in comparison to background levels and/or international standards) would be localised and temporary in nature, resulting in localised, minor and short term impacts to habitats, populations and shipping/fishing concerns. The overall environmental consequence is defined as E which equates to 'minor, short-term (1–2 years) impacts, but not affecting ecosystem function.

Summary of Control Measures

- Inspection, monitoring and maintenance undertaken and are fit for service.
- Routine testing is undertaken to confirm ability to isolate wells and pipelines in the Julimar Field Production System.
- Compliance with the following Safety Critical Performance Standards:
  - Reservoir Isolation
  - Wells
- Implementation of the Julimar Subsea Inspection, Monitoring and Maintenance Plan.
- Activity Vessel Safe Work Procedures developed and implemented.

Vessel Collision

Source of Risk	Environmental Value Potentially Impacted									Evaluation		
	Water Quality	Marine Sediment Quality	Air Quality	Marine Primary Producers	Other Habitats & Communities	Protected Species	Soil & Groundwater	Socio-Economic	Protected Areas	Consequence	Likelihood	Residual Risk
Loss of hydrocarbons to marine environment due to a vessel collision (e.g. activity vessel)	X				X	X		X	X	E	1	L

Description of Source of Risk

Activity vessels will be utilised intermittently throughout the Petroleum Activities Program. This temporary presence in the Operational Area may result in a navigational hazard for commercial shipping and other oil and gas operators within the immediate area. The total marine diesel storage capacity of an activity vessel could be in the order of 1,000 m3 total, distributed through multiple isolated tanks, typically located mid-ship and can range in typical size of 22-135 m3. However, some activity vessels may have isolated fuel tank volumes up to 337m3.

Industry experience

Registered vessels or foreign flag vessels in Australian waters are required to report events to the Australian Transport Safety Bureau (ATSB), AMSA or Australian Search and Rescue (AusSAR).

From a review of the ATSB marine safety and investigation reports, two vessel collisions occurred in October 2010 in the port of Dampier, where a support vessel collided with a barge being towed and a vessel sunk on being contacted by a passing vessel. There was no reported pollution as a result of either incident. Causes of both incidents are not applicable to the Petroleum Activities Program due to the nature of the incidents, in that they occurred in port under pilot direction. The risk of collision within ports, as it is a nearshore activity, is beyond the scope of this EP. However, it does demonstrate the highly unlikely likelihood of hydrocarbons being released if a vessel collision occurred.

From 2010 to 2011, the ATSB's annual publication (ATSB, 2011) defines the individual safety action factors identified in marine accidents and incidents: 42% related to navigation action, of that 15% related to poor communication and 42% related to poor monitoring, checking and documentation. The majority of these related to the grounding instances. Given the offshore location of the Petroleum Activities Program, vessel grounding is not considered a credible risk.

Description of Credible Spill Scenarios

For a vessel collision to result in the worst-case scenario of a hydrocarbon spill, potentially impacting the marine environment, several factors must align. The sequence of events is as follows:

- the identified causes of vessel interaction must result in a collision
- the collision must have enough force to penetrate the vessel hull
- the collision must be in the exact location of a fuel tank, which is customarily located inboard of ballast or other water holding tanks
- the fuel tank must be full, or at least of volume, whereby the fuel level is higher than the point of penetration.

The probability of this chain of events aligning to result in a breach of fuel tanks resulting in a spill that could potentially affect the marine environment is considered remote.

The environmental risk analysis and evaluation undertaken identified and assessed a range of potential scenarios that could result in a loss of vessel structural integrity and damage could occur to fuel storage tank(s) resulting in a loss of marine diesel to the marine environment. The scenarios considered damage to single and multiple fuel storage tanks in the activity vessels, due to various combinations of vessel to vessel collisions

The scenario considered was a collision of the activity vessel with a third party vessel (i.e. commercial shipping, other petroleum related vessels and commercial fishing vessels). The likelihood was assessed as being remote given standard vessel operations and equipment in place to prevent collision at sea, the standby role of an activity vessel (low vessel speed) and its operation in close proximity to the subsea infrastructure (exclusion area) and the construction and placement of storage tanks. This scenario was assessed on the worst case scenario, that being an instantaneous loss of 337 m^3 from a diesel (Marine Gas Oil) tank.

Operational Area Credible Spill Scenarios for Hydrocarbon Spill as a Result of Loss of Vessel Structural Integrity

Scenario	Marine Diesel Volumes	Preventative and Mitigation Controls	Credibility	Max. Possible Volume loss (m^3)

Breach of fuel tanks due to activity vessel-other vessel collision including (commercial shipping/ fisheries/ oil and gas vessels)	Activity vessels has multiple marine diesel tanks typically ranging between 22-135 m^3 each.	Typically double wall, tanks which are located midship (not bow or stern) Vessels are not anchored and steam at low speeds when relocating within Operational Area. Normal maritime procedures would apply during such vessel movements	**Credible**	135m^3
Breach of fuel tanks due to activity vessel-other vessel collision including (commercial shipping/ fisheries/oil and gas vessels)	Activity vessels with isolated tanks up to 337m^3	Typically double wall, tanks which are located midship (not bow or stern) Vessels are not anchored and steam at low speeds when relocating within Operational Area. Normal maritime procedures would apply during such vessel movements	**Credible**	337m^3

Quantitative Hydrocarbon Risk Assessment

While some activity vessels for the Petroleum Activities Program have a worst case credible loss of 135m^3 of marine diesel (based on the use of the Nor Australis), the 337 m^3 spill modelling within the Operational Area was deemed conservative for the vessel collision scenario, in the event that other vessels, with larger tanks, are used (i.e. during dewatering).

Existing modelling conducted by RPS APASA assessed the extent of a marine diesel spill of 337 m^3 during any season, using an historic sample of wind and current data for the region. A total of 300 simulations were modelled, with each simulation tracked for 14 to 21 days. Modelling was conducted for three seasonal periods, with 100 simulations per season:

1. Summer (Oct to Mar)
2. Winter (May to Aug)
3. Transitional (Sept and April)

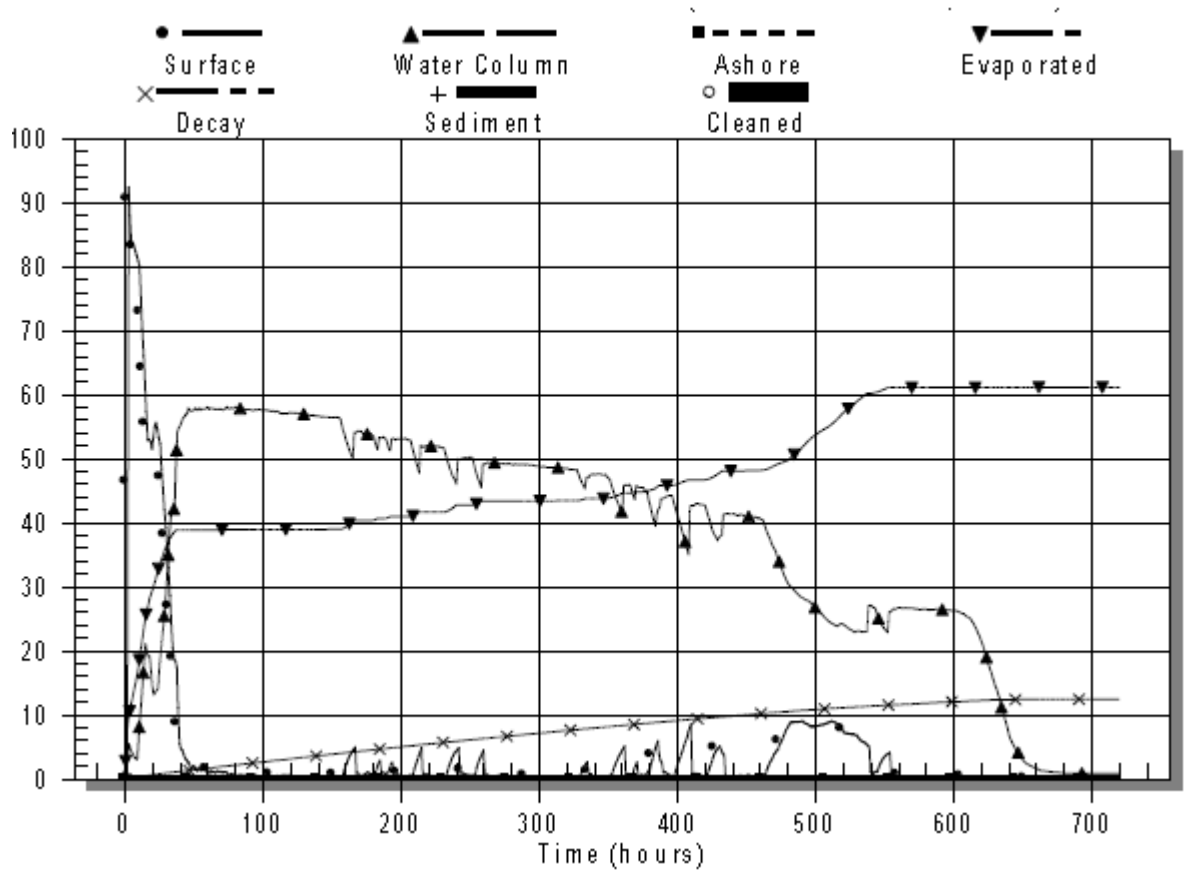
Hydrocarbon characteristics

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 40% by mass would be expected to evaporate over the first day or two (see below figure). 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. 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 no potential for the spill to extend beyond a localised area around the release site. The characteristics of the marine diesel used in the modelling are given in the table below.

Characteristics of the marine diesel used in the modelling

Hydrocarbon Type	Initial Density (kg/m^3) at 15˚C	Viscosity (cP @ 25˚C)	Component BP (˚C)	Volatiles <180	Semi volatiles 180-265	Low Volatility (%) 265-380	Residual (%) >380
				Non-Persistent			Persistent
Marine Diesel (surrogate for marine gas oil – MGO)	829.1	4.0	% of total	6	34.6	54.4	5



Proportional mass balance plot representing weathering of a surface spill of marine diesel

Potential Environmental Impact

Zone of Consequence

Surface hydrocarbons: The model results for the transitional period (April to September) were presented as they are the worst case extent of any season. In the event this vessel collision 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. Surface hydrocarbons are predicted to drift north-east during summer and south-west during winter and transitional periods. The modelling indicates locations within reach of surface hydrocarbon ZoC are restricted to offshore areas, including the Montebello CMR with no shoreline contact. Model results show concentrations occurring up to approximately 70 km away, with the main drift direction either towards the northeast or southwest.

Entrained hydrocarbons: The model results for the transitional periods (April and September) were presented as they represent the worst case extent. In the event that this vessel collision scenario occurred, a plume of entrained hydrocarbons would form downcurrent of the release location with the trajectory dependent on prevailing current conditions at the time. The modelling indicates locations within reach of entrained hydrocarbon ZoC are restricted to offshore areas up to approximately 85 km from the release site with the main drift direction either towards the northeast or southwest depending on season, including the offshore portion of the Montebello CMR.

Dissolved hydrocarbons: Dissolved hydrocarbons above threshold concentrations (>500 ppb) were not predicted by the modelling to occur at any location. Therefore, no contact with any sensitive receptors is predicted.

Accumulated hydrocarbons: Accumulated hydrocarbons above threshold concentrations (>100 g/m^2) were 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 small and localised, restricted to the open ocean only (Commonwealth waters). Consequently, a ZoC summary table is not presented.

Value	Description of Potential Environmental Impact
Protected Species, Other Habitats, Species and Communities, Water	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

Quality, Protected Areas	diesel also contains additives that contribute to its toxicity. **Protected Species** Protected species, including pygmy blue whales, humpback whales, whale sharks, marine turtles, may be encountered within the Operational Area and therefore, could be impacted by a marine diesel spill. No critical habitats or aggregation areas (feeding, breeding, resting) have been identified within the ZoC. Although the ZoC may spatially overlap with the BIAs identified in the Operational Area. it is considered that protected species that are present will be predominantly transiting through the area. 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 small area of the potential spill and the dilution and weathering of any spill, the likelihood of ecological impacts to marine fauna (protected species), combined with the relatively small ZoC and the rapid dispersion of marine diesel, it is expected that any potential impacts will be low and temporary in nature. **Other Habitats, Species and Communities** Within the Operational Area, there is the potential for plankton communities that may potentially be impacted by a marine diesel spill where entrained hydrocarbon threshold concentrations are exceeded, but communities are expected to recover quickly (weeks/months) due to high population turnover (ITOPF 2011). 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 and temporary in nature. Pelagic fish populations in the open water offshore environment of the Operational Area 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. ancient coastline at 125 m depth contour KEF) are within the Operational Area neither are likely to be directly impacted by a marine diesel spill as hydrocarbons are confined to the top 25 m. **Water Quality** It is likely water quality will be reduced at the 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 highly localised in nature due to the relatively small ZoC and the rapid dispersion of marine diesel. The potential impact is therefore expected to be low. **Protected areas** Entrained and dissolved hydrocarbons (at or exceeding thresholds) are predicted to contact the Montebello CMR.
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 Operational Area. These fisheries target demersal fish species (demersal finfish and crustacea) that inhabit waters in the range of >60–200 m depth or pelagic species which are highly mobile therefore marine diesel spill due is expected to only result in negligible impacts, if any, considering the relatively small area of the ZoC and hydrocarbons are confined to the top 25 m. However, 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.
Summary	In the unlikely event of an unplanned hydrocarbon release to the marine environment due to vessel collision, combined with the adopted controls, it is considered that any potential impact to water quality (in comparison to background levels and/or international standards) would be localised and temporary in nature, resulting in localised, minor and short-term impacts to habitats, populations and shipping/fishing concerns. The overall environmental consequence is defined as C which equates to 'major, long-term (5–10 years) impacts to ecosystems, species or habitats'.

Value	Potential Consequence	Rank	Explanation

Protected species	Minor and temporary disruption to a small portion of the population. No impact on critical habitat or activity.	F	A marine diesel spill from a vessel collision would be of a short duration and relatively localised. There is potential to affect transiting megafauna within the spill affected area.
Other communities /habitats	Localised and short-medium term effect on community/ habitat structure. Full recovery expected.	F	Plankton communities may potentially be impacted by a marine diesel spill where entrained hydrocarbon threshold concentrations are exceeded, but communities are expected to recover quickly (weeks/months) due to high population turnover refuge and a source of prey items for fish assemblages.
Water quality	Minor or significant short-term contamination above background levels and/or national/ international quality standards and/or known biological effect concentrations on a scale of >2 km	F	Based on the exceedance of hydrocarbon thresholds for ecological impacts if a spill occurs, water quality impacts to marine waters (direct temporary contamination) is likely to occur in offshore, open waters only.
Socio-economic	Minor, short-term impact on commercial fishery operators	E	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 fishing within the area of the spill.

Summary of Control Measures

- Vessels compliant with Marine Order 30 (Prevention of Collisions) 2009
- Vessels compliant with Marine Order 21 (Safety of navigation and emergency procedures) 2012
- Notify AHS to generate a temporary Maritime Safety Information Notifications (MSIN) and temporary Notice to Mariners (NTM) for activities where vessels will be in field >3 weeks.
- AMSA RCC is notified prior to commencement of preparation activities and at commencement of operations.
- All activity vessels have undertaken a Woodside Marine Assurance Inspection (or equivalent)
- Activities in close proximity to other vessels or the Wheatstone platform are planned and controlled to prevent collision.

Bunkering

Source of Risk	Environmental Value Potentially Impacted									Evaluation		
	Water Quality	Marine Sediment Quality	Air Quality	Marine Primary Producers	Other Habitats & Communities	Protected Species	Soil & Groundwater	Socio-Economic	Protected Areas	Consequence	Likelihood	Residual Risk
Loss of hydrocarbons to marine environment from bunkering.	X					X				F	2	L

Description of Source of Risk

Diesel bunkering activities are not planned for IMR vessels, as they can steam back to Dampier to refuel; however, bunkering may be required during extended emergencies or extended periods of work, such as the dewatering activity where it may be more efficient or critical that bunkering takes place offshore.

Credible Scenario

Bunkering of marine diesel between the activity vessels may occur within the Operational Area.

Two credible scenarios for the loss of containment of marine diesel during bunkering operations were identified:

1. 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, in the order of <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).
2. partial or total failure of a bulk transfer hose or fittings during bunkering, combined with a failure in procedure to shutoff fuel pumps, for a period of up to five minutes, resulting in approximately 8 m^3 marine diesel loss to the deck and/or into the marine environment

Quantitative Spill 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 8m^3 surface spill from bunkering activities would be well within the ZoC for the vessel collision scenario. 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 above sections 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 Impact

Zone of Consequence

Previous modelling studies for 8 m^3 marine diesel releases, spilt at the surface, as result of bunkering activities, indicated that the potential for exposure to surface hydrocarbons exceeding 10 g/m^2 was confined to within the immediate vicinity (approximately 1 km) of the release site. Therefore, it is considered that there is no potential for contact with sensitive receptor locations above surface threshold concentrations (10 g/m^2) from an 8 m^3 spill of marine diesel within the Operational Area.

Value	Description of Potential Environmental Impact
Protected Species and Water Quality	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. 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 expected to be very minor.
Summary	Given the adopted controls, it is expected that a bunkering spill 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 Control Measures
• Compliance with MARPOL 73/78 Annex I, as applied in Australia under the Commonwealth Protection of the Sea (Prevention of Pollution from Ships) Act 1983 (Part II Prevention of pollution from oil); and Marine Order 91 (Marine pollution prevention – oil) 2006 • Bunkering procedures will be developed and implemented for all vessels that will bunker in the Operational Area to prevent loss of hydrocarbons to the marine environment.

Deck Spills

Source of Risk	Environmental Value Potentially Impacted									Evaluation		
	Water Quality	Marine Sediment Quality	Air Quality	Marine Primary Producers	Other Habitats & Communities	Protected Species	Soil & Groundwater	Socio-Economic	Protected Areas	Consequence	Likelihood	Residual Risk
Accidental discharge of hydrocarbons/hazardous chemicals from activity vessel deck activities and equipment (e.g. cranes)	X				X	X				F	1	L

Description of Source of Risk

Deck spills can result from spills from stored hydrocarbons/ chemicals or equipment. Vessels typically store hydrocarbon/ chemicals in various volumes (20 L, 205 L; up to approximately 4,000–6,000 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).

Potential Environmental Impact

Value	Description of Potential Environmental Impact
to water quality, other habitats and communities and protected species	Accidental spills of hydrocarbons or chemicals from the activity vessels may have a minor temporary impact on water quality in the immediate area of the spill; however, the impacts are expected to be very localised due to the small volumes, dispersion and dilution in the open ocean environment. The biological consequences of such a small volume spill on identified open water sensitive receptors relate to the potential for minor impacts to protected species, plankton and fish populations (surface and water column biota) that are within the spill affected area. This may include impacts to these values in the Montebello CMR, if the spill occurs in boundary of the reserve. No impacts to commercial fisheries are expected. 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 minor.
Summary	Given the adopted controls, it is considered that other hydrocarbon/chemical deck spills to the marine environment is unlikely to result in a potential impact to water quality greater than minor and/or temporary contamination above background levels, quality standards or known effect concentrations and unlikely to result in a potential impact greater than minor and temporary disruption to a small proportion of biological populations with no impact on critical habitat or activity.

Summary of Control Measures

- Vessels compliant with Marine Order 91 (Marine Pollution Prevention - Oil)
- Chemicals for use selected as per Woodside Environment Procedure Offshore Chemical Assessment (or equivalent)
- Compliance with Woodside's Environmental Performance Standards Procedure or equivalent
- Spill response bins/kits are maintained and available.

Release of Chemicals and Hydrocarbons to the Subsea Marine Environment due to Failure of Seals or Minor Leaks

Source of Risk	Environmental Value Potentially Impacted									Evaluation		
	Water Quality	Marine Sediment Quality	Air Quality	Marine Primary Producers	Other Habitats & Communities	Protected Species	Soil & Groundwater	Socio-Economic	Protected Areas	Consequence	Likelihood	Residual Risk
Accidental discharge of hydrocarbons/chemicals from equipment used in subsea IMR activities or loss of integrity leaks during preparation activities or operations (excluding loss of containment from operational flowlines).	X				X	X				F	1	L

Description of Source of Risk

During operations there is the potential of small leaks from the umbilicals, valves, flowline and pipelines. The accidental discharge of hydrocarbons and chemicals to the subsea marine environment can result from the failure of seals, on the field production system, resulting in leaks releasing MEG, subsea hydraulic fluids, scale inhibitor etc. A MEG or umbilical release could result in loss of process chemicals or control fluids ranging from 1-25 m^3, based on the volumes contained in the flowlines. A valve loss of containment could results in control fluids leaking up to approximately 1m^3 per day.

The ROV requires hydraulic fluid to function, which is supplied through hoses containing approximately 100 L of fluid. On occasion hydraulic lines to the ROV arms and other tooling may become caught resulting in minor leaks to the marine environment. Hydraulic lines may be isolated to prevent full loss of inventory, if detected. However, if a hydraulic leak occurs, subsea ROV activities cease to allow servicing to fix the leak. Similar, small volume hydraulic leaks may occur from equipment operating via hydraulic controls subsea.

Data from previous Woodside activities demonstrates that spill are most likely to originate from hydraulic hoses and are typically less than 25 L.

Potential Environmental Impact

Value	Description of Potential Environmental Impact
Water quality, other habitats and communities and protected species	There is the potential for localised water column pollution and adverse effects to marine biota as a result of the unplanned discharge of hydrocarbons and chemicals the subsea marine environment. Potential impacts are expected to be minor in that the discharge is short duration and therefore the likelihood that fish, plankton or benthic fauna are exposed to lethal concentrations are negligible. Furthermore, it is expected that motile fish and other marine fauna will exhibit avoidance behaviour and move away from the discharge, if exposed. The habitats in the Operational Area are mostly composed of benthic communities typical of the North West Shelf and the seabed is expected to be flat and featureless, with small outcroppings of cemented sediments in the north-east. Impacts on benthic communities are predicted to be negligible due to the short duration and small volumes and therefore unlikely to result in lethal stress to infauna or epifauna communities. Impacts associated with the values of the Montebello CMR are unlikely, given that the small length of the Operational Area infrastructure within the CMR (0.4 km) and the localised discharge area. No impacts to the 'ancient coastline at the 125m depth contour' KEF are predicted as the majority of Operational Area is soft sediments and no typical characteristics of this KEF have been identified during surveys of the area. Additionally, no impacts on the continental slope demersal fish communities KEF are envisaged, given the distance from the Operational Area to the KEF (5km). Potential impacts to marine fauna such as pelagic fish species and protected species (e.g. marine mammals) are expected to be limited to avoidance of the discharge in a localised area. Plankton populations in the upper surface layers may be affected in the

	immediate discharge; 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.
Summary	Given the adopted controls, it is considered that hydrocarbon/chemical subsea spills to the marine environment are unlikely to result in a potential impact to water quality greater than minor and/or temporary contamination above background levels, quality standards or known effect concentrations. Minor volume subsea spills are unlikely to result in a potential impact greater than minor and temporary disruption to a small proportion of biological populations with no impact on critical habitat or activity.

Summary of Control Measures

- Chemicals for use selected as per Woodside Environment Procedure Offshore Chemical Assessment (or equivalent)
- Compliance with Woodside Engineering Operating Standard: Subsea Isolation
- Equipment for IMR activities will undergo the following:
  - Any subsea equipment authorize hydrocarbons will be maintained to reduce the risk of loss of hydrocarbon containment to the marine environment
  - Any in ocean equipment (e.g. ROV) will be inspected to ensure equipment is not leaking and critical hydraulic hoses are in good working order prior to deployment
  - Leak testing undertaken at the end of all work programs to confirm integrity of the subsea system
  - HPU reservoir level monitoring for leak detection
- Subsea infrastructure inspections

Loss of Hazardous or Non-Hazardous Waste

Source of Risk	Environmental Value Potentially Impacted									Evaluation		
	Water Quality	Marine Sediment Quality	Air Quality	Marine Primary Producers	Other Habitats & Communities	Protected Species	Soil & Groundwater	Socio-Economic	Protected Areas	Consequence	Likelihood	Residual Risk
Accidental loss of solid hazardous or non-hazardous waste to the marine environment	X				X	X				F	1	L

Description of Source of Risk

The activity vessels will generate a variety of solid wastes including packaging, domestic wastes and hazardous wastes such as oil rags, batteries and waste oil. Hence, there is the potential for solid and hazardous wastes to be lost overboard to the marine environment. Woodside's marine 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 back loading activities, periods of adverse weather and incorrect waste storage.

Potential Environmental Impact

Value	Description of Potential Environmental Impact
Protected Species, Other Communities and Habitats and Water Quality	The potential impacts of solid and hazardous 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	Given the adopted controls, it is considered that the accidental discharge of solid waste described is unlikely to result in a potential impact greater than minor and/or temporary contamination above background levels, water quality standards, or known effect concentrations.

Summary of Control Measures

- Compliance with Marine Order 94 (pollution prevention – packaged harmful substances), as required by vessel class.
- Compliance with Marine Order 95 (pollution prevention – garbage), as required by vessel class
- Recovery of dropped objects determine safe and practicable.

Vessel Collison with Marine Fauna

Source of Risk	Environmental Value Potentially Impacted									Evaluation		
	Water Quality	Marine Sediment Quality	Air Quality	Marine Primary Producers	Other Habitats & Communities	Protected Species	Soil & Groundwater	Socio-Economic	Protected Areas	Consequence	Likelihood	Residual Risk
Accidental collision between activity vessels and threatened and migratory marine fauna.						X				F	1	**L**

Description of Source of Risk
The activity 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. This variance is due to vessel type, vessel operation (specific activity, speed), physical environment (e.g. water depth) and the type of animal potentially present; coupled with their behaviour.

Potential Environmental Impact	
Value	**Description of Potential Environmental Impact**
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 (Laist *et al*. 2001, Jensen & Silber 2003). 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. Vessel collisions have been recognised as a threat in the most recent conservation management plan for the blue whale (commonwealth of Australia 2015). Activity 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 outcomes is reduced. No known key aggregation areas (resting, breeding or feeding) are located within or immediately adjacent to the Operational Area; however, the pygmy blue whale migration corridor BIA is just north of the Operational Area. The Petroleum Activities Program is proposed to commence in 2016 and continue to operate for a period up to five years; therefore, it is likely that activity will overlap with the pygmy blue migration season which occurs between April and August (northern migration) and October and December (southern migration). This could result in pygmy blue whales transiting the Operational Area during these months. Humpback whales may also transit through the Operational Area between the months of June and October**.** Other whale species known to frequent the area are expected in low numbers only. According to the data of Vanderlaan and Taggart (2007), it is estimated that the risk is less than 10% at a speed of 4 knots. Vessel-whale collisions at this speed are uncommon and, based on reported data contained in the US National Ocean and Atmospheric Administration database (Jensen & Silber 2003) 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 Province waters including the Operational Area, during their migrations to and from Ningaloo Reef. The northward migration was identified as a BIA along the 200m isobath which traverses the Operational Area. However, it is expected that whale shark presence within the area would be of a relatively short duration and not of significant numbers given the main aggregations are recorded in coastal waters, particularly, the Ningaloo Reef edge. A BIA for internesting flatback turtles during summer overlaps with the southern part of the Operational Area. Scientific literature and expert opinion on the flatback internesting range and patterns show that it is highly unlikely for flatbacks to be encountered within the

	offshore Operational Area, although individuals may infrequently transit the area and may forage on the small areas of filter feeding communities at the north eastern extent of the Operational Area. It is unlikely that vessel movement associated with the Petroleum Activities Program will have a significant impact on marine fauna populations given (1) the low presence of transiting individuals, (2) avoidance behaviour commonly displayed by whales, whale sharks and turtles and (3) low operating speed of the activity vessels (generally less than 8 knots or stationary, unless operating in an emergency).
Summary of Control Measures	
• Compliance with EPBC Regulations 2000 – Part 8 Division 8.1 Interacting with cetaceans Exception: The above requirements do not apply in emergency circumstances compliance with the requirement would increase the risk of harm to environment or property.	

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

Response Activity / Source of Risk	Resource / Receptors																										Potential Impact Description / Reference	Summary of Control Measures
	Physical												Ecology								Human								
	Subsidence & Compaction	Land/ Sea Use	Sediment Quality/ Composition	Seabed Features/ Profile	Air Quality	Visibility	Ozone Layer	Climate	Marine Water Quality	Water Flow Characteristics (marine)	Terrestrial Noise Levels	Underwater Noise Levels	Fish & Pelagic Communities	Benthic Marine Flora/ Fauna	Marine mammals	Marine Habitats	Communities/ Biodiversity	Coral Reefs	Sea Turtles	Seabirds	Natural Resource Depletion	Employment/ Income	Public Health & Safety	Aesthetics	Tourism / Recreation	Cultural/ Historical Sites	Fishing	Navigation/ Traffic & Transport		
Monitor and Evaluate																												
Air Emissions					■			■															■	■	■				Refer to routine atmospheric emissions in Appendix A.	Potential impacts of the response activities will be monitored and reported back for input into the daily planning and operational net environmental benefit analysis (NEBA) process. Operational NEBAs will be undertaken to determine if there is net environmental benefit to continuing the response activity. SMP documentation including an SMP Operational Plan, SMP Implementation Plan and SMP Process and Methodology Guideline will be used to steer the SMP planning and execution. The SMP will be continually reviewed and updated based on the situational
Vessel operational discharges			■						■				■	■	■			■	■										Routine and Non-Routine Discharges: Discharge of Chemicals and Hydrocarbons to the Marine Environment in Appendix A
Vessel anchoring	■													■				■											Refer to physical presence Disturbance to the seabed from laydown and removal of RTM mooring chains and subsea infrastructure, and IMR and ROV activities in Appendix A
Proximity to other vessels (shipping and fisheries)																									■		■	■	Refer to physical presence: Proximity of the project vessels to third party vessels in Appendix A.
Noise emissions												■	■		■				■										Refer to Routine Acoustic Emissions: Activity vessels, helicopters, side scan sonar and mechanical equipment in Appendix A.
Lighting for night work/ navigational safety						■													■	■				■				■	Refer to Routine Light Emissions: Activity Vessels in Appendix A.

Invasive Marine Species (IMS)																													Invasive marine species (IMS) management was assessed as not being applicable to the Operational Area however, Woodside will assess and manage IMS risks for all vessels entering an IMS Management Area through the Woodside Invasive Marine Species Management Plan.	awareness information generated by the OMPs.
Collisions with marine fauna																													Refer to Physical Presence: Vessel collision with marine fauna in Appendix A	
Drilling of an intervention well																														
																													If required, risks, impacts and controls will be identified within a separate Well Operational Management Plan	
Source Control																														
Air Emissions																													Refer to routine atmospheric emissions in Appendix A.	Deployment of the SFRT would be controlled under Woodside's existing offshore construction management system and the relevant SFRT operating procedures. Deployment of the capping stack would be controlled under the service provider's management system with overall control of the construction vessel(s) controlled by Woodside. Woodside has a MoU with Australian offshore operators to provide mutual aid to facilitate and expedite mobilising a MODU and the intervention well would be drilled under a specific
Vessel operational discharges																													Routine and Non-Routine Discharges: Discharge of Chemicals and Hydrocarbons to the Marine Environment in Appendix A	
Vessel anchoring																													Refer Physical Presence: Disturbance to Seabed from Dewatering and IMR Activities in Appendix A	
Proximity to other vessels (shipping and fisheries)																													Refer to physical presence: Proximity of the project vessels to third party vessels in Appendix A.	
Noise emissions																													Refer to Routine Acoustic Emissions: Activity vessels, helicopters, side scan sonar and mechanical equipment in Appendix A.	
Lighting for night work/ navigational																													Refer to Routine Light Emissions: Activity Vessels in Appendix A.	

safety																													approved well delivery management plan with relevant regulatory approvals.
Invasive Marine Species (IMS)																												Invasive marine species (IMS) management was assessed as not being applicable to the Operational Area however, Woodside will assess and manage IMS risks for all vessels entering an IMS Management Area through the Woodside Invasive Marine Species Management Plan.	
Collisions with marine fauna																												Refer to Physical Presence: Vessel collision with marine fauna in Appendix A	
Disturbance to seabed																												Refer Physical Presence: Disturbance to Seabed from Dewatering and IMR Activities in Appendix A	
Containment and Recovery																													
Air Emissions																												Refer to routine atmospheric emissions in Appendix A	The Operational and Scientific Monitoring Plan outlines the programs that will apply during wildlife response. Woodside will have access to trained personal and equipment through internal and external arrangements. Potential impacts of the response activities will be monitored and reported back for input into the daily planning and operational NEBA process Operational NEBA will be undertaken to determine if there is net environmental benefit to continuing
Equipment/ material/ worker transport																												Physical Receptors: Response equipment such as booms and skimmers could act as obstacles or trap wildlife. Ecological Receptors: • Sorbent material could be consumed by wildlife. • Disturbance from noise • Human Receptors: • Exclusion of area where containment and recovery response is taking place • Commercial and recreational fishing impacted in area where recovery response is taking place.	

		containment and recovery operations. Equipment will be operated in accordance with manufacturer's instructions/guidance Decanting (from vessel tanks and temporary storage) will occur in accordance with AMSA guidance. Woodside has a contract with a licenced waste management providers who manage the transport, storage and treatment of waste associated with a containment and recovery response. Waste management providers are trained in managing the risks associated with secondary contamination.
Vessel operational discharges	Routine and Non-Routine Discharges: Discharge of Chemicals and Hydrocarbons to the Marine Environment in Appendix A	
Vessel anchoring	Refer Physical Presence: Disturbance to Seabed from Dewatering and IMR Activities in Appendix A	
Proximity to other vessels (shipping and fisheries)	Refer to physical presence: Proximity of the project vessels to third party vessels in Appendix A.	
Noise emissions	Refer to Routine Acoustic Emissions: Activity vessels, helicopters, side scan sonar and mechanical equipment in Appendix A.	
Lighting for night work/ navigational safety	Refer to Routine Light Emissions: Activity Vessels in Appendix A.	
Invasive Marine Species (IMS)	Invasive marine species (IMS) management was assessed as not being applicable to the Operational Area however, Woodside will assess and manage IMS risks for all vessels entering an IMS Management Area through the Woodside Invasive Marine Species Management Plan.	
Collisions with marine fauna	Refer to Physical Presence: Vessel collision with marine fauna in Appendix A	
Waste generation/disposal	Physical and Ecological Receptors: • Secondary contamination of habitat and wildlife	
Oiled Wildlife Response		

Air emissions																															Refer to routine atmospheric emissions in Appendix A.
Vessel operational discharges																															Routine and Non-Routine Discharges: Discharge of Chemicals and Hydrocarbons to the Marine Environment in Appendix A
Vessel anchoring																															Refer to physical presence Disturbance to the seabed from laydown and removal of RTM mooring chains and subsea infrastructure, and IMR and ROV activities in Appendix A
Proximity to other vessels (shipping and fisheries)																															Refer to physical presence: Proximity of the project vessels to third party vessels in Appendix A.
Noise emissions																															Refer to Routine Acoustic Emissions: Activity vessels, helicopters, side scan sonar and mechanical equipment in Appendix A.
Invasive Marine Species (IMS)																															Invasive marine species (IMS) management was assessed as not being applicable to the Operational Area however, Woodside will assess and manage IMS risks for all vessels entering an IMS Management Area through the Woodside Invasive Marine Species Management Plan.
Capturing wildlife																															Ecological Receptors: • Inefficient capture techniques could cause undue stress. • Pre-emptive capture could cause undue impacts when risk of oiling is not certain. • Injury to wildlife.

The Operational and Scientific Monitoring Plan outlines the programs that will apply during wildlife response.

Woodside will have access to trained personal and equipment through internal and external arrangements.

Potential impacts of the response activities will be monitored and reported back for input into the daily planning and operational NEBA process.

Operational NEBAs will be undertaken to determine if there is net environmental benefit to continuing the response activity.

Implementation in accordance with the primary, secondary and tertiary response strategies outlined in the Pilbara Regional Oiled Wildlife Response Operational Plan.

Waste management contract for safe disposal of carcasses after necessary autopsies.

																											• Exhaustion • Disturbance from noise Human Receptors: • Exclusion of use of the area where oiled wildlife response is taking place • Health implications for individuals coming into contact with oiled wildlife.	
Transporting wildlife																											Physical Receptors: Refer to routine atmospheric emissions in Appendix A. Ecological Receptors: • Disturbance from noise • Injury to wildlife. • Thermoregulation stress. Human Receptors: • Exclusion of use of the area where oiled wildlife response is taking place • Health implications for individuals coming into contact with oiled wildlife.	
Stabilisation of wildlife																											Ecological Receptors: • Disturbance from noise • Injury to wildlife. • Thermoregulation stress. • Triage process means potential for some animals to be euthanized. Human Receptors: • Exclusion of use of the area where oiled wildlife response is taking place • Health implications for individuals coming into contact with oiled wildlife. • Stress to public	
Cleaning and rinsing (incl.																											Physical Receptors: Refer to routine	

Post-cleaning stabilisation)																											atmospheric emissions in Appendix A. Ecological Receptors: • Injury to wildlife. • Exhaustion • Removal of water-proofing of feathers. Human Receptors: • Exclusion of use of the area where oiled wildlife response is taking place • Health implications for individuals coming into contact with oiled wildlife. • Stress to public	
Rehabilitation (diet quality, cage sizes, flooring substrate, ambient temperature, housing density etc.)																											Ecological Receptors: • Stress. • Captive diet (lack of nutrition). • Injury to wildlife. • Thermoregulation stress. Human Receptors: • Exclusion of use of the area where oiled wildlife response is taking place • Stress to public	
Release of wildlife																											Ecological Receptors: • Release site unfamiliar. • Return to oiled area of capture (for animals with high site fidelity). • Stress of adjusting back to natural environment conditions. • Stress of transport to release site. • Stress of additional human presence (e.g. media). Human Receptors: • Exclusion of use of the area where oiled wildlife response is taking place • Stress to public	
Waste																											Physical and Ecological	

generation/ disposal																													Receptors: • Secondary contamination	
Lighting for night work/ navigational safety																													Refer to Routine Light Emissions: Activity Vessels in Appendix A.	
Collisions with marine fauna																													Refer to Physical Presence: Vessel collision with marine fauna in Appendix A	
Waste Management																														
Air emissions																													Refer to routine atmospheric emissions in Appendix A.	Contract with waste management provider Veolia. Waste Management Plan for Oil Spill Response Waste treatment strategies in place
Noise emissions																													Refer to Routine Acoustic Emissions: Activity vessels, helicopters, side scan sonar and mechanical equipment in Appendix A.	
Waste generation/disposal																													Physical and Ecological Receptors: • Secondary contamination of habitat and wildlife	

Key

Positive Impact
Negative Impact (Minor, short-term)
Negative Impact (Moderate, medium term)
Negative Impact (Major, long term)
Impact negative but not evaluated

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 and Science	Email with Fact Sheet Follow-up email with Fact Sheet	**Feedback summary:** No response at the time of submission.	Woodside believes it has given the stakeholder adequate time and information upon which to provide feedback about the activity.	**Response/Action:** No further action required.
Department of Mines and Petroleum	Email with Fact Sheet Follow-up email with Fact Sheet	**Feedback summary:** No response at the time of submission.		**Response/Action:** No further action required.

Organisation	Method	Feedback	Woodside assessment	Woodside's Response
Australian Maritime Safety Authority (maritime safety)	Email with Fact Sheet and shipping fairway map & well coordinates	**Date:** 25 August 2015 **Feedback summary:** The Authority acknowledged by email that it had received advice about Woodside's proposed petroleum activities. AMSA provided a vessel traffic plot of the proposed activity area and advised majority of traffic will be survey and support craft for surrounding fields. AMSA requested its Joint Rescue Coordination Centre (JRCC) is updated about activities for the distribution of Auscoast warning broadcasts. A subsequent email exchange in in April 2016 provided further advice regarding IMR activities. AMSA confirmed activities related to standard inspections and maintenance work would not warrant notification and that this requirement would only be triggered where a vessel was onsite for prolonged periods. Additionally, AMSA advised that the Australian Hydrographic Service must be contacted no less than four working weeks before activity commence to support Notices To Mariners. AMSA requested feedback following the activity and interaction with commercial shipping.	Woodside acknowledges the Department's response. AMSA data is consistent with Woodside's assessment of commercial shipping in the region. Woodside notes JRCC and AHS communications advice which has been included in the appropriate performance standard and measurement criteria. AMSA will be contacted prior to commencement of preparation activities, at commencement of operations.	**Date:** 02 September 2015 (updated April 2016) **Response/Action:** Woodside to contact AMSA NauticalAdvice@amsa.gov.au prior to commencement of preparation activities and at commencement of operations.

Organisation	Method	Feedback	Woodside assessment	Woodside's Response
Australian Hydrographic Service (AHS)	Email with Fact Sheet Follow-up email with Fact Sheet	**Date:** 1 September 2015 **Feedback summary:** AHS advised by email that a temporary Notice to Mariners is in place for pipe laying operations. AHS asked Woodside to confirm if this information is correct. AHS requested a digital file to chart pipeline and subsea structures.	The stakeholder raised no claims or objections. Woodside notes AMSA advice for AHS communications advice and timing. Further clarification was provided by AHS. AHS will be contacted no less than four weeks prior to activity which requires vessel presence in field >2-3 weeks so that AHS can generate a temporary Maritime Safety Information Notifications (MSIN) and temporary Notice to Mariners (NTM). In December 2015, AHS requested copies of data sets and shape files for the pipeline. Via sendfile on 15 February 2016, Woodside provided the "As Laid" ASCII data sets and ArcGIS shape files for the pipeline. The "As Built" data sets and shape files will be provided to AHS post the end of construction in approximately April 2016. In a subsequent email exchange between Woodside and AHS in February 2016, AHS confirmed that the 'As Laid' ASCII datasets already provided are sufficient to promulgate the necessary Notice to Mariners and nautical chart changes.	**Date:** 3 September 2015 (updated April 2016) **Response/Action:** Woodside to contact AHS at hydro.ntm@defence.gov.au no less than 4 working weeks prior to activity which requires vessel presence in field >3 weeks.

Organisation	Method	Feedback	Woodside assessment	Woodside's Response
Department of Fisheries (Western Australia)	Email with Fact Sheet and fisheries map	**Date:** 10 August 2015 **Feedback summary:** The Department acknowledged by letter on 10 August that it had received advice about Woodside's petroleum activities. The Department provided a list of commercial fishing interests that are in or close proximity to proposed activity area. The Department recommended that Woodside engage WAFIC, Recfishwest and directly with fishers. 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 of survey activities on fish spawning. The Department provided a list of species. The Department provided advice about disturbance to benthic habitats from installation of sub-sea facilities. The Department requested ongoing attention is paid to mitigation measures to reduce impacts to as low as practicable. The Department also requested oil, fluids and gases are safely removed from pipelines and well access points before activities commence. The Department recommended resources for to demonstrate Woodside	Woodside notes the Departments advice. Woodside confirmed its liaison with WAFIC and Recfishwest. Woodside also confirmed which fisheries were engaged, advice was accepted by DoF. In the event of a spill, which may impact State fisheries, Woodside will contact the Department of Fisheries within the requested 24-hour notice period. 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 confirms mitigation measures have been put in place to minimise impacts to the benthic habitat. 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	**Date:** 16 October 2015 **Response/Action:** No further action required.

Organisation	Method	Feedback	Woodside assessment	Woodside's Response
		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. All requests provided by the Department are to be shared with all vessel operators associated with the proposed petroleum activity. The Department requests all potential impacts and Woodside strategies to mitigate are identified in the final EP and PEPs. The Department requested a written response from Woodside addressing all concerns raised in its letter.	manage Invasive Marine Species risk when not on contract to the company.	

Organisation	Method	Feedback	Woodside assessment	Woodside's Response
Commonwealth fisheries - Western Tuna and Billfish Fishery - North West Slope Trawl Fishery - Western Skipjack Fishery - Southern Bluefin Tuna - Western Deepwater Trawl Fishery	Email with Fact Sheet and fisheries map.	**Feedback summary:** No response at the time of submission.	Woodside believes it has given potentially affected fishers adequate time and information upon which to provide feedback about the proposed activity.	**Response/Action:** No further action required.

Organisation	Method	Feedback	Woodside assessment	Woodside's Response
Western Australian Fisheries - Mackerel Fishery - Pilbara Trawl Fishery - Pilbara Trap Fishery - Pilbara Line Fishery	Letter with Fact Sheet and fisheries map Email with Fact Sheet and fisheries map	**Feedback summary:** No response at the time of submission.	Woodside believes it has given potentially affected fishers adequate time and information upon which to provide feedback about the proposed activity. Woodside engages on an ongoing basis with the Department of Fisheries (DoF), the Western Australian Fishing Industry Council (WAFIC) and other relevant stakeholders to identify the best method/s for engaging with Western Australian fishing licence holders. Woodside is consistently advised that contact details held by the DoF remains the most up-to-date and appropriate contact method. Woodside distributes hardcopy information to each licence holder based on contact details purchased from DOF annually. DoF and WAFIC, through recent engagement with Woodside, confirmed this method was most appropriate for engaging with fishing licence holders. Woodside facilitates alternative engagement methods when requested by interested fishers. Commencing in 2016, Woodside has established regular meetings (unrelated to any specific activity) with DoF and WAFIC to ensure ongoing and consistent engagement with the peak fishing bodies and members.	**Response/Action:** No further action required.

Organisation	Method	Feedback	Woodside assessment	Woodside's Response
Department of Defence – Defence Property Services Group	Email with Fact Sheet Follow-up email with Fact Sheet	**Feedback summary:** No response at the time of submission.	Woodside believes it has given potentially affected fishers adequate time and information upon which to provide feedback about the proposed activity.	**Response/Action:** No further action required.
Department of Transport	Email with Fact Sheet	**Date:** 3 August 2015 **Feedback summary:** The Department thanked Woodside by email on 3 August 2015, for advice about the proposed activity.	The stakeholder raised no claims or objections.	**Response/Action:** No further action required.
	Email with Woodside's draft Oil Pollution First Strike Plan	**Feedback summary:** No response at the time of submission.	The stakeholder raised no claims or objections.	**Response/Action:** No action required.

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	**Feedback summary:** No response at the time of submission	Woodside believes it has given the stakeholder adequate time and information upon which to provide feedback about the proposed activity.	**Response/Action:** No further action required.
	Email with Woodside's draft Oil Pollution First Strike Plan	**Feedback summary:** No response at the time of submission. **Attached:** Appendix G	The stakeholder raised no claims or objections.	**Response/Action:** No further action required.
Department of Parks and Wildlife	Email with Fact Sheet Phone call received from the Department	**Date:** 19 August 2015 **Feedback summary:** The Department acknowledged by email that is had received advice about Woodside's petroleum activities. The Department advised it had no specific comments about the proposed activity. The Department advised that it expects operators to acquire or gain access to baseline water and sediment quality data for lands and waters managed by the Department or within marine reserves that may be affected by petroleum activities or incidents. In the absence of baseline data, the Department expects that the baseline state of areas is likely to be pristine and that operators are responsible to return an area to this same condition in the event of any impacts. The Department expects Woodside to maintain capacity to provide an oiled wildlife response.	The stakeholder raised no claims or objections in relation to the proposed activity. Woodside notes the Departments general advice. Woodside acknowledges DPAW request to be notified in event of a spill and has included notification step in the Julimar Operations Oil Pollution First Strike Plan. Notification will be made if there is a potential for oiled wildlife or the spill is expected to contact land or waters manage by DPaW.	**Date:** 21 August 2015 **Response/Action:** No action required. **Attached:** Appendix G

Organisation	Method	Feedback	Woodside assessment	Woodside's Response
		The Department advised that it will maintain its advisory and regulatory role in the event of spills and requests Woodside engage the Department in any industry-coordinated-incident response. The Department provided advice about the support it could provide in the event of a response. The Department advised that it has prepared industry guidance and standards documents for the treatment and rehabilitation of oiled wildlife. The Department requests that the use of dispersants is restricted in areas likely to impact water quality and that any application is used in accordance with the Department of Transport Dispersant Use Guidelines only. **Attached:** Appendix G		
Australian Customs Service – Border Protection Command	Email with Fact Sheet Follow-up email with Fact Sheet	**Feedback summary:** No response at the time of submission.	Woodside believes it has given the stakeholder adequate time and information upon which to provide feedback about the proposed activity.	**Response/Action:** No further action required.
Commonwealth Fisheries Association	Email with Fact Sheet	**Feedback summary:** No response at the time of submission.		**Response/Action:** No further action required.
Western Australian Fishing Industry Council	Email with Fact Sheet	**Feedback summary:** No response at the time of submission.		**Response/Action:** No further action required.

Organisation	Method	Feedback	Woodside assessment	Woodside's Response
Pearl Producers Association	Email with Fact Sheet	**Feedback summary:** No response at the time of submission.		**Response/Action:** No further action required.
Recfishwest	Email with Fact Sheet	**Feedback summary:** No response at the time of submission.		**Response/Action:** No further action required.
WWF	Email with Fact Sheet	**Feedback summary:** No response at the time of submission.		**Response/Action:** No further action required.
Australian Conservation Foundation	Email with Fact Sheet	**Feedback summary:** No response at the time of submission.		**Response/Action:** No further action required.
Wilderness Society	Email with Fact Sheet	**Feedback summary:** No response at the time of submission.	Woodside believes it has given the stakeholder adequate time and information upon which to provide feedback about the proposed activity.	**Response/Action:** No further action required.
International Fund for Animal Welfare	Email with Fact Sheet	**Feedback summary:** No response at the time of submission.		**Response/Action:** No further action required.
APPEA	Email with Fact Sheet	**Feedback summary:** No response at the time of submission.		**Response/Action:** No further action required.
AMOSC	Email with Fact Sheet	**Feedback summary:** No response at the time of submission.		**Response/Action:** No further action required.