VERMILION
Oil & Gas
Australia Pty. Ltd.

VERMILION OIL & GAS AUSTRALIA

WANDOO FACILITY ENVIRONMENT PLAN SUMMARY

WPA-7000-RH-0023

Date	Originator	Checker	Approver
7 August 2017	Environmental Advisor	HSE Manager	Managing Director

Revision history

Revision	Date	Description	Originator	Checker	Approver
1	20.02.2014	Issued to DMP for Information (Wandoo Facility EP; Revision 7)	Environmental Advisor	HSES Advisor	Managing Director
2	03.10.2014	Issued for NOPSEMA Acceptance (Wandoo Facility EP; Revision 8)	Environmental Advisor	PPR	Managing Director
3	07.08.2017	Issued for NOPSEMA Acceptance (Wandoo Facility EP; Revision 12)	Environmental Advisor	HSE Manager	Managing Director

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Abbreviations and definitions

AFFF	Aqueous Film Forming Foam
AFMA	Australian Fisheries Management Authority
ALARP	As Low as Reasonably Practicable
AMOSC	Australian Maritime Oil Spill Centre
AMSA	Australian Maritime Safety Authority
ANZECC	Australian and New Zealand Environment and Conservation Council
APASA	Asia-Pacific ASA
APPEA	Australian Petroleum Production and Exploration Association
CALM	Catenary Anchor Leg Mooring
CASA	Civil Aviation Safety Authority
CEE	Catastrophic Environmental Event
CGS	Concrete Gravity Structure
DMP	Department of Mines and Petroleum
DoEE	Department of the Environment and Energy
DoF	Department of Fisheries
DoT	Department of Transport
DPaW	Department of Parks and Wildlife
EP	Environment Plan
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
ESD	Emergency Shutdown
FHA	Floating Hose Assembly
GHG	Greenhouse Gas
HFO	Heavy Fuel Oil
HVAC	Heating, Ventilation and Air Conditioning
IBC	Intermediate Bulk Container
ICT	Incident Command Team
KEF	Key Ecological Feature
LNG	Liquefied Natural Gas
MCS	Monitoring and Control System
MoC	Management of Change
MODU	Mobile Offshore Drilling Unit
MoU	Memorandum of Understanding
NATA	National Association of Testing Authorities
NEBA	Net Environmental Benefit Analysis
NOPSEMA	National Offshore Petroleum Safety and Environmental Management Authority
NWS	North West Shelf
ODS	Ozone Depleting Substances
OIW	Oil in Water
OPGGS(E)R	Offshore Petroleum Greenhouse Gas Storage (Environment) Regulations 2009
OPP	Oil Pollution Plan
OSCP	Oil Spill Contingency Plan

OSMP	Operational and Scientific Monitoring Plan
OSRL	Oil Spill Response Ltd
OSTM	Oil Spill Trajectory Modelling
PFW	Produced Formation Water
ROV	Remotely Operated Vehicle
SES	State Emergency Service
SSSV	Subsea Safety Valve
UNESCO	United Nations Educational, Scientific and Cultural Organisation
VOGA	Vermilion Oil and Gas Australia Pty Ltd
WA	Western Australia
WAFIC	Western Australian Fishing Industry Council
WHA	World Heritage Area
WNA	Wandoo A
WNB	Wandoo B
WPF	Wandoo Production Facility
ZPI	Zone of Potential Impact

1 Introduction

1.1 Overview

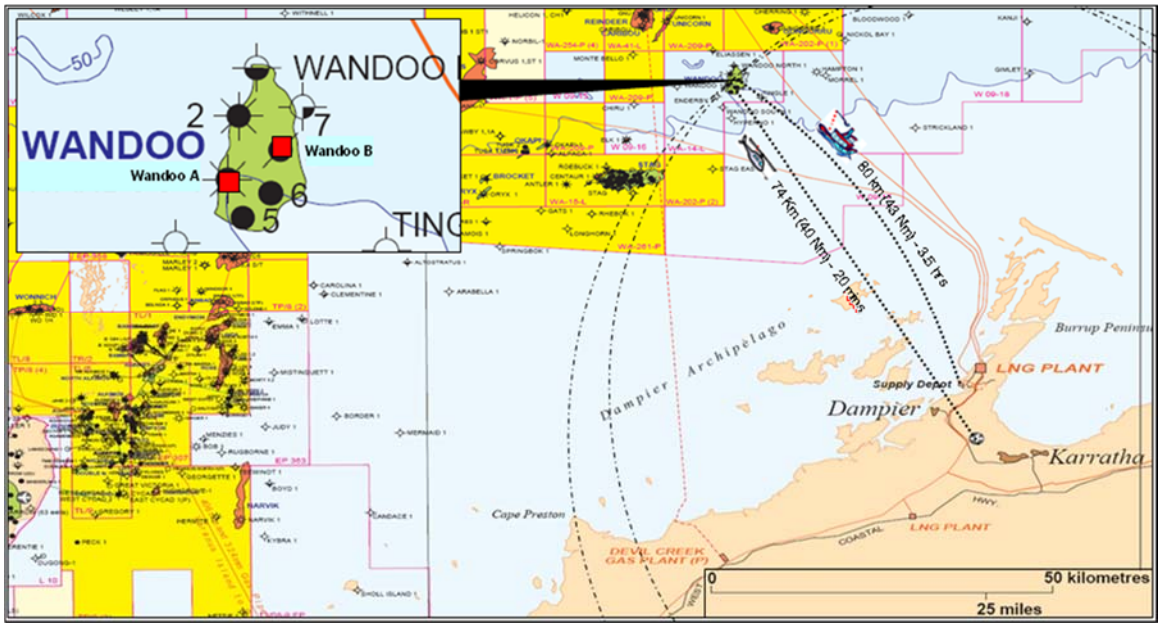
Vermilion Oil and Gas Australia Pty Ltd (VOGA) is the licensed permit holder of production licence area WA-14L, which contains the Wandoo Production Facility (WPF). VOGA has been operating in the Permit Area since 2005. The WPF processes subsea well fluids, oil is produced at Wandoo (unmanned monopod) and piped to the Wandoo B (WNB) platform for processing. Oil is stored in a Concrete Gravity Structure (CGS) prior to export.

The Wandoo Facility Environment Plan (EP) [WPA-7000-YH-0007] has been prepared in accordance with the requirements of the Offshore Petroleum Greenhouse Gas Storage (Environment) Regulations 2009 (OPGGS(E)R) and is a revision of an existing EP under which the WPF had been operating (Revision 8). The Wandoo Facility EP is written to allow for the continuation of production at the WPF for a period of five years from the date of its acceptance by the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA). This Wandoo Facility EP summary has been prepared as per the requirements of Regulation 11(3) and (4) of the OPGGS(E)R.

Table 1-1: Overview of activity description

Detail	Description
Title	WA-14-L
Field	Wandoo Field
Hydrocarbon type	Wandoo Crude, having lost the majority of its lighter fractions due to microbial biodegradation in the reservoir, is heavier than most light crude oils typically produced on the North West Shelf (NWS), has a low pour point, virtually no paraffin wax and low asphaltene content. Laboratory data indicates that 52% of the WNB oil is likely to be persistent hydrocarbons (boiling point >375°C).
Activity location	The Permit Area is located in Commonwealth waters in the Carnarvon Basin off the northwest coast of Western Australia (WA), approximately 80 km northwest of Dampier and 110 km northeast of Barrow Island. The Wandoo facilities, including the Wandoo A (WNA) Monopod, WNB production platform, Catenary Anchor Leg Mooring (CALM) Buoy and anchorage are located within the Permit Area in water depths of approximately 54 m.
Activity description	The Wandoo Field was discovered in 1991. Extraction of crude oil commenced in 1993 from WNA supporting a helideck and five production wells. In 1997, the WNB production platform, which is a CGS, was installed and connected to WNA by of a subsea pipeline. The oil produced from WNA is piped to the WNB production platform. Oil is stored in the CGS supporting the WNB processing facilities, and then offloaded through flexible pipelines to a CALM Buoy located 1.2 km north of the WNB platform. A floating hose is used to transfer the oil from the CALM Buoy to export tankers moored to the CALM Buoy. Export tankers are present to offload the oil every three to five weeks.
Duration	The end of field life is currently modelled to be 2030.

Figure 1-1: Location of the WA-14-L Permit Area and WPF



Geographical coordinates of WPFs are provided in Table 1-2.

Table 1-2: Coordinates of the WPF

Facility	Latitude	Longitude
WNA	20°08' 20" S	116°25' 17.5" E
WNB	20°07' 43" S	116°26' 04" E
Anchorage	20°05' 00" S	116°23' 48" E
CALM Buoy	20°07' 02" S	116°26' 02" E

1.2 Titleholder

VOGA is a wholly owned subsidiary of Vermilion Energy, a Canadian-based oil and gas exploration and production company.

1.3 Nominated liaison person

VOGA's nominated liaison person details are:

Namek Jivan
Health, Safety, Environment & Security Advisor
Vermilion Oil & Gas Australia Pty Ltd
Level 5, 30 The Esplanade
Perth, Western Australia 6000

Phone: +61 (08) 9215 0300
Email: njivan@vermilionenergy.com

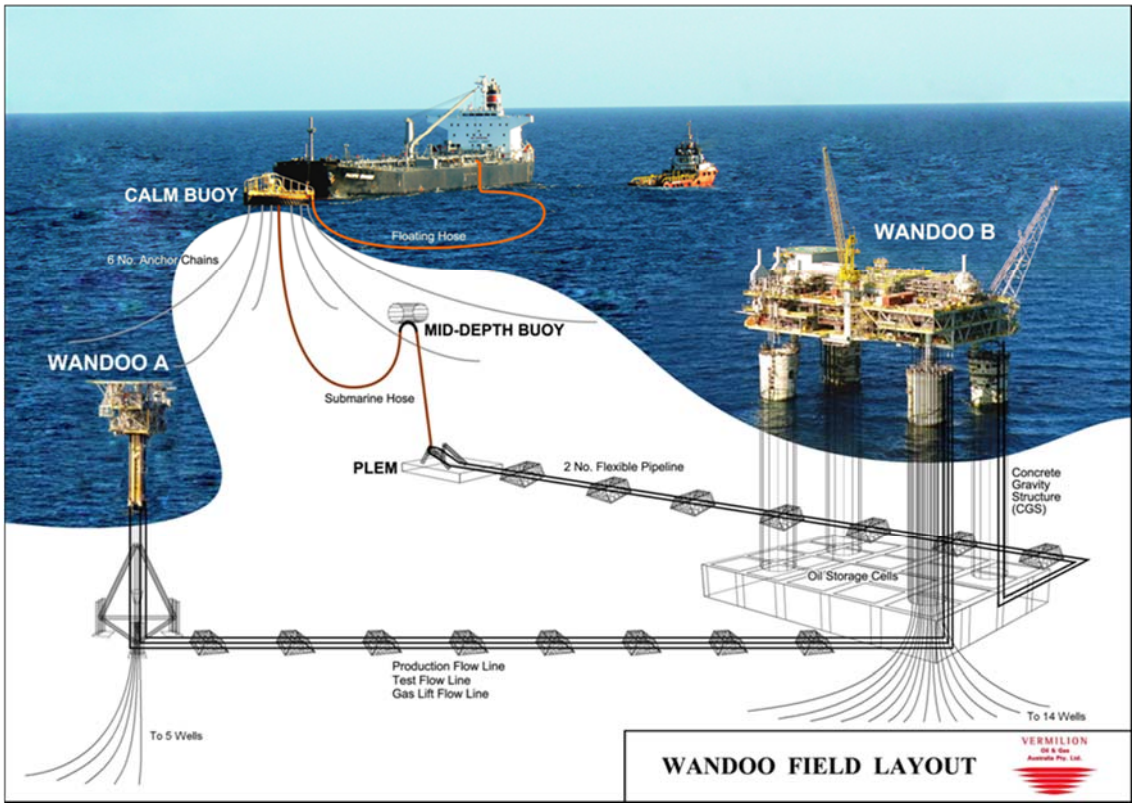
2 Description of the activity

2.1 Process description

Extraction of crude oil from the Wandoo Field commenced in 1993 from a single unmanned monopod wellhead platform (WNA) supporting a helideck and five production wells. In 1997, the WNB production platform, which is a CGS, was installed and connected to WNA by a subsea pipeline.

The oil produced from WNA is piped to the WNB production platform. Oil is stored in the CGS supporting the WNB processing facilities, and then offloaded through flexible pipelines to a CALM Buoy located 1.2 km north of WNB (Figure 2-1). A floating hose is used to transfer the oil from the CALM Buoy to export tankers situated at a mooring facility. Export tankers are chartered to offload the oil.

Figure 2-1: The WPF field layout



2.2 Timing of activities

The Wandoo facility operates 24 hours per day, 365 days per year with the end of field life currently modelled to be 2030.

2.3 Field infrastructure

2.3.1 WNA platform

The WNA platform is a 'normally not-manned' wellhead platform that consists of a fixed structure without processing equipment.

2.3.2 WNB platform

The central oil production process and storage platform, consists of a single integrated three-level deck, supported on a CGS. WNB has 13 oil production wells and one gas reinjection well. All have dry trees. The topsides comprise processing facilities, oil storage within the CGS, utilities, accommodation and a helipad. It also contains an integrated deck structure that is approximately 69 m long and 40 m wide. The height of the integrated deck structure is 10 m from the Cellar Deck level (lowest deck level) to the Main Deck level (highest deck level).

2.4 Hydrocarbon production

2.4.1 Wandoo well types

Artificial lift is required to produce wells in the Wandoo Field as the Wandoo reservoir pressure is sub-hydrostatic. Artificial lift is currently provided by using gas lift, with excess gas injected into the reservoir through WNB-10 source/injection well. In general, wells in the Wandoo Field produce liquids that are approximately 95% water and 5% oil. Wells in the Wandoo Field only produce 100% oil immediately following a drilling campaign. The percentage of oil within the well fluids reduces to the norm of 5% over a period of nine months following a drilling campaign.

2.4.2 Oil storage and export system

The two large oil storage compartments in the CGS base are filled with oil floating on top of seawater (ballast water), and maintained at a drawdown pressure by keeping the water level in Shaft 4 at an elevation of 15 m below LAT.

When export of the oil is required, the oil is exported to the tanker moored at the remote CALM Buoy. Normal practice is to export from both compartments simultaneously with concurrent oil production. One oil export pump is provided for each storage compartment.

Tanker movements occur every three to five weeks, depending on production rates and market requirements. Duration of export activity is typically 24-48 hours depending on the export cargo size and transfer rate.

2.4.3 Produced formation water treatment and discharge

Water produced from the wells is treated and processed through the production process and is discharged as produced formation water (PFW). PFW is made up of a number of constituents:

- water;
- trace hydrocarbons;
- trace total and dissolved metal/metalloids;

- total ammonia;
- radionuclides;
- trace production chemicals; and
- physical properties (temperature, salinity, pH, etc.).

Currently, Wandoo discharges up to 26,100 m^3/day of PFW and ballast water. With the addition of a second Induced Static Flotation Unit (IFSU), this may increase by 7,600 m^3/day. An improved oil in water (OIW) recovery process, made possible by the addition of a second IFSU, means that while the volume of PFW being discharged to the ocean increases, the concentration of hydrocarbons in the PFW would be reduced. As the ISFU achieves 90% of the oil recovery from PFW in the Wandoo process, the addition of a second IFSU within the lifecycle of the EP will reduce OIW levels by 30%.

2.5 Support activities

2.5.1 Crane operations

Platform cranes transfer materials to and from the support boats and any materials on the WNA and WNB platforms. The cranes on WNA and WNB are powered by diesel engines.

2.5.2 Vessel operations

Support vessels supply food and transport equipment required for operational activities. They also back-load materials and wastes for return to shore for disposal. Vessel related activities within the Operational Area comply with the Platform Operations Manual [VOG-7000-MN-0001]. Vessels supporting the Wandoo facility when outside the Operational area comply with applicable maritime regulations.

Other support activities include refuelling, waste management and the management of hazardous substances, which is undertaken in accordance with the relevant Management Procedures.

2.5.3 Helicopter operations

Principal access to the WNA and WNB is by helicopter. Helicopter related activities are in accordance with the Wandoo Work Management Manual [WPA-7000-YG-00121]. Approximately four helicopter movements to the WNB production platform take place each week, and one movement per week to the WNA facility. Helicopter transport is also used on occasion for small items requiring urgent delivery.

2.5.4 Waste management

The VOGA Waste Management Procedure [WPA-7000-YH-0009] specifies that all wastes, apart from approved discharges are stored in suitable containers on WNA and WNB and returned to shore for disposal.

The waste streams covered by this procedure fall into three main categories:

1. Recyclable (non-hazardous).

2. General (non-hazardous).

3. Hazardous.

The procedure provides detailed information and guidance to ensure that waste is correctly identified, classified, labelled, stored, transported, treated, and disposed of in accordance with regulatory and VOGA requirements.

2.6 Facility maintenance activities

Maintenance activities such as deck cleaning, pigging, welding, cutting, spray painting and abrasive blasting is undertaken as required on the facility in accordance with Platform Operations Manual [VOG-7000-MN-0001] and the Wandoo Work Management Manual [WPA 7000-YG-00121].

2.7 Subsea surveys, maintenance and inspection activities

Various subsea surveys will be undertaken as required including metrology surveys, sidescan sonar surveys, sub-bottom profiling surveys, metocean surveys and remotely operated vehicle (ROV) surveys.

Maintenance activities including subsea welding and cutting, cleaning and marine growth removal, repair and replacement of subsea assets will be undertaken as required. Commercial divers often undertake maintenance activities.

2.8 Oil spill response activities

Activities proposed in response to an oil spill response may include the following, dependant on the size, type and trajectory of the spill.

2.8.1 Source control

Source control is one of the first response strategies that should be considered when mounting a spill response. Source control minimises the volume of hydrocarbons lost to the environment by regaining control at the source of the spill. In many cases, source control can be as simple as turning off a valve.

2.8.2 Monitoring and evaluation

Monitoring and evaluation is a technique used to understand the behaviour and likely trajectory of an oil spill to assist with selecting the most appropriate spill response strategy and to evaluate results during the response process. Several methods can be used to monitor and evaluate, including:

- Surveillance from field infrastructure, MODU and vessels;
- Aerial surveillance;
- Satellite tracking buoys; and
- Oil spill trajectory modelling.

2.8.3 Chemical dispersion

Chemical dispersion involves the application of chemical dispersant, which accelerates the natural dispersion process. The chemical dispersant breaks down the oil into small droplets, which are then rapidly dispersed into the water column and away from the ocean surface where it can be more easily biodegraded. The objective of dispersant use is to enhance the amount of oil that physically mixes into the water column, reducing the potential for a surface slick to contaminate shoreline habitats or to contact birds, marine mammals or other marine fauna that exist on the water surface or shoreline.

2.8.4 Containment and recovery

Booms and skimming equipment can be used to create physical barriers on the water surface to contain and recover the oil spill where information (including predictive spill fate modelling) indicates a likely threat to environmental, social and cultural sensitivities. This strategy is often used in the offshore environment close to the hydrocarbon source. Once contained, an attempt to recover the hydrocarbons from the surface waters can be undertaken.

2.8.5 Mechanical dispersion

Mechanical dispersion is the use of fire monitors, engine wash or other means to mechanically/physically disperse spilt oil into the water column, thereby increasing the speed with which weathering and biodegradation occurs.

2.8.6 Protection and deflection

The deployment of protection and deflection booms, along with a combination of sediment barriers and filter fences, can assist with minimising the potential impact and/or deflecting a slick away from sensitive areas towards those where collection can be more effective without impacting high value habitat areas.

2.8.7 Shoreline clean-up

Shoreline clean-up is the removal of oil from shorelines.

2.8.8 Oiled wildlife response

Includes the capture, recovery, assessment, cleaning and rehabilitation of oiled wildlife.

3 Description of the environment

3.1 Overview

This section describes the environment conditions in and around the Permit Area, as well as within the wider Zone of Potential Impact (ZPI). The ZPI is the area that could be impacted from both planned and unplanned events that may result from the operations. The description of the environment within the Permit Area covers both WNA and WNB, as they are within close proximity of each other.

The ZPI is based on the worst credible environmental hazard – a 0-5% probability of sea-surface exposure (reported to 1 µm) from an 80-day spill based on the unlikely event of an instantaneous release of Wandoo crude from the CGS tank. The 1 µm threshold is conservative in terms of environmental effects on marine fauna, however is more indicative of the perceived area of a spill that may trigger socio-economic impacts as a precautionary measure (RPS APASA, 2014). The ZPI is based on the cumulative trajectory modelling (50 spills) of a spill of Wandoo crude oil during summer, transitional and winter wind and current conditions as this presents the maximum area.

The information herein is based primarily on scientific research publications in the public domain. Environmentally sensitive areas are predominantly located at the shoreline and in near-shore/ coastal waters.

3.2 Physical environment

The Permit Area is situated in the middle/outer shelf waters of the NWS. Circulation of seawater in the Permit Area is influenced by the Indonesian Throughflow from the western Pacific and Leeuwin Current which continues the transport of warm water further south. Sediments in the Permit Area are typically comprised of unconsolidated fine to coarse sands dominated by carbonates. Areas closer to shore may have a larger component of terrigenous sediments, particularly around inputs such as rivers and creeks. Sediment quality and water quality in the region is generally considered to be high, with low levels of metals and other contaminants (Fandry et al., 2006).

Currents in the continental shelf region around the Permit Area, and much of the offshore ZPI, are typically tidal currents influenced by wind-driven surface currents. Water movement is predominantly south easterly during flood tides and north westerly during ebb tides. Winter swells are typically in the range of 1 m to 2 m, but occasionally reach 3 m in the presence of severe cold fronts. In summer the swell is smaller, more variable and tends westerly. Swells generated by tropical cyclones in summer may range between 8 m and 10 m.

Winds vary seasonally, with a tendency for westerly winds in summer (October to April) and southerly winds in winter (May to September). During winter months (June to August), the winds are typically more variable, but mostly from the east.

3.3 Biological environment

3.3.1 Benthic habitat and communities

Benthic habitats within the Permit Area comprise soft sediments and associated benthic fauna. The infaunal community of these soft sediments is essentially similar to that found at other locations throughout the region with low numbers of species and low abundance, with no particular areas of significant value. Hard corals (Order *Scleractinia*) are not likely to be present within the Permit Area due to water depths being too great to support zooxanthellae and a lack of hard substrate. Soft corals (Order *Alcyonacea*) are also unlikely to be present in the Permit Area as they have similar habitat requirements to hard corals.

Coral reefs, seagrasses, mangroves and macroalgae are widespread throughout the shallower areas of the ZPI. Significant areas of these sensitive habitats located within vicinity of the Permit Area include: the waters of the Dampier Archipelago, around offshore island groups such as the Montebello Island Group and the Barrow and Thevenard Islands. At the outer extent, sensitive habitats include the Scott, Cartier and Ashmore reefs, the south coasts of the southern islands of Indonesia from Timor in the east to central Java in the west. To the far west, the Christmas Islands and associated reefs, as well as the isolated Cocos (Keeling) Islands and associated reefs and marine habitats could also be potentially affected. These areas contain habitats that are recognised as an important resource for a diverse range of fauna species providing breeding, calving, feeding/foraging and migratory areas.

3.3.2 Marine fauna

3.3.2.1 Listed marine species

Species of conservation significance within the Permit Area and ZPI were identified through a search of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) Protected Matters database (DoEE, 2016a).

3.3.2.2 Marine reptiles

One seasnake and five species of turtles listed as protected under the EPBC Act may potentially occur within the Permit Area and the leaf-scaled seasnake (*Aipysurus foliosquama*), Olive Ridley turtles (*Lepidochelys olivacea*) and saltwater crocodile (*Crocodilus porosus*) also potentially occurring within the ZPI (DoEE, 2016a).

Turtle nesting occurs on soft sandy beaches and are widespread throughout the ZPI. All species have been documented nesting in the northern Australia region, with the exception of the leatherback turtle and Olive Ridley turtle. Important turtle nesting sites in the ZPI include the Ningaloo Marine Park, the Montebello and Barrow islands group (including the Lowendal Islands), Dampier Archipelago, Port Hedland and Eighty Mile Beach, as well as the Alas Purwo National Park and Meru Betiri National Park.

Ashmore Reef and Cartier Reef are also significant breeding areas for green turtles and are internationally recognised for their abundance and diversity of seasnakes (Guinea, 2007).

3.3.2.3 Birds

Four threatened species and six migratory species of birds may potentially occur within the Permit Area, with a number of threatened and migratory species of birds potentially occurring within the ZPI (DoEE, 2016a).

Important seabird breeding sites within the ZPI include the Montebello/Barrow islands group, the Rowley Shoals, Eighty Mile Beach, Roebuck Bay, the Cocos (Keeling) Islands, and Christmas Island.

3.3.2.4 Sharks and rays

Five species of shark, two species of sawfish and two species of rays listed as threatened or migratory under the EPBC Act potentially occur in the Permit Area. Seven species of shark, four species of sawfish and two species of rays listed under the EPBC Act may potentially occur in the ZPI (DoEE, 2016a).

Given the widespread distribution of sharks and rays globally, the NWS is not of particular importance to any listed threatened or migratory species, with the exception of the whale shark. Whale sharks aggregate seasonally to feed in the coastal waters of the Ningaloo coast, approximately 250 km southwest of the Permit Area, between March and June (Wilson et al., 2006). This whale shark aggregation in Ningaloo waters is internationally significant, with similar aggregation only occurring in a few places in the world.

There are a number of areas within the ZPI that are recognised as biologically important areas for sawfish. These include Eighty Mile Beach, Roebuck Bay, King Sound and Camden Sound. Sawfish are known to utilise these areas for foraging, nursing and pupping (DoEE, 2016b).

3.3.2.5 Marine mammals

Eight marine mammals are listed at threatened and 15 marine migratory under the EPBC Act, may potentially occur in the Permit Area and ZPI respectively (DoEE, 2016a).

Several areas within the ZPI have been recognised as critical habitats for marine mammals. These include the humpback whale calving area in Camden Sound and resting areas in Shark Bay and Exmouth Gulf, and the dugong feeding grounds in Shark Bay, Exmouth Gulf and coastal waters near Broome. Roebuck Bay and Camden Sound are recognised as an important area for Australian snubfin dolphins, and Jurien Bay and the Abrolhos Islands are important breeding and foraging areas for Australian sea lions.

In addition, areas along the humpback whale migration route are known to be important corridors through which the whales travel and occasionally pass close to shore. Within the ZPI these include the coastal waters from Point Cloates to North West Cape.

3.4 Social and economic environment

3.4.1 National Heritage and shipwrecks

There are no Commonwealth Heritage or National Heritage sites in the Permit Area, although eight places within the ZPI are listed on the National Heritage list. These are:

- The Ningaloo Coast;

- Shark Bay;
- The West Kimberley;
- Lesueur National Park;
- Dampier Archipelago;
- Dirk Hartog Landing Site 1616 – Cape Inscription Area;
- HMAS Sydney II and HSK Kormoran Shipwreck Sites; and
- Batavia Shipwreck Site and Survivor Camps 1629 – Houtman Abrolhos.

The Ningaloo Marine Area (Commonwealth waters) and the HMAS Sydney II and JSK Kormoran and Mermaid Reef – Rowley Shoals are also listed on the Commonwealth Heritage List. Historic shipwrecks of National and State heritage value are legally protected under the *Historic Shipwrecks Act 1976* (Commonwealth) and *Maritime Archaeology Act 1973* (WA). There are no known shipwrecks within the Permit Area, but there are an extensive number within the ZPI.

3.4.2 Fisheries and aquaculture

Several Commonwealth and State managed fisheries occur within the ZPI, some of which overlap the Permit Area. However, fishing activity is highly unlikely to occur within the Permit Area due to safety exclusion zones. Five Commonwealth managed and 15 State managed fisheries are potentially active within the ZPI, in addition to considerable commercial aquaculture. The closest known aquaculture facilities to the Permit Area are at Dampier Archipelago (approximately 40 km from the Permit Area) and Montebello Islands (approximately 90 km from the Permit Area).

The following Commonwealth managed fisheries that occur within the projected ZPI:

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

State-based fisheries are active within the ZPI, including fisheries within the North West bioregion and the northern area of the Gascoyne bioregion. Fisheries potentially active within the ZPI include:

- North Coast Prawn Managed Fishery;
- North Coast Demersal Scalefish Fishery;
- North Coast Near-shore and Estuarine Fishery;
- Exmouth Gulf Prawn Fishery;
- Gascoyne Demersal Scalefish Fishery;
- Mackerel Fishery;
- Pearl Oyster Fishery;
- Beche-de-mer Fishery;

- Northern Shark Fishery;
- West Coast Rock Lobster Managed Fishery;
- Shark Bay Crab Interim Managed Fishery;
- Shark Bay Scallop Fishery;
- Shark Bay Prawn Fishery;
- Abrolhos Islands and Mid-West Trawl Limited Entry Fishery; and
- West Coast Demersal Scalefish (Interim) Managed Fishery.

3.4.3 Traditional Indonesian fishing

Under the Memorandum of Understanding (MoU) between Australia and Indonesia, fishers using traditional fishing methods only are permitted to operate in an area of Australian waters in the Timor Sea. The peak fishing season is between August and October with fishers departing the region at the onset of the northwest monsoon season. The MoU represents an area of 200 nm within the Australian Fishing Zone encompassing Scott Reef and associated reefs including Seringapatam Reef, Browse Island, Ashmore Reef, Cartier Reef and various banks.

3.4.4 Commercial shipping and defence

The region supports significant commercial shipping activity, the majority of which is associated with the WA oil and gas and mining industries, with a high density of vessel traffic in waters surrounding the Permit Area. There are no military related uses within the Permit Area. However the ZPI encompasses military installations near Exmouth, including a naval communication station and pier facility.

3.4.5 Oil and gas industry

The petroleum exploration and production industry is a significant stakeholder in the region. Petroleum companies have been undertaking exploration and production activities on the NWS for decades. The Permit Area is directly surrounded by a number of other permits, including WA-202-P, WA-209-P, WA-261-P, WA-41-L and WA-15-L, all held by other titleholders.

There is also extensive existing and proposed Liquefied Natural Gas (LNG) infrastructure within the ZPI and broader region, including that associated with the NWS Joint Venture, the Pluto LNG plants at Dampier, the Gorgon LNG plant at Barrow Island and the Wheatstone LNG plant at Onslow.

3.4.6 Tourism and recreation

No tourism activities take place within the Permit Area, although tourism activities do occur within the ZPI and play an important social and economic role in the region. Tourism related activities include fishing and diving charters, shore-based activities and seasonal whale/whale shark watching, with activity often associated with marine protected areas or other coastal nature reserves. Major tourism precincts within the ZPI include the Ningaloo Coast, the Exmouth Gulf and Broome. Tourism is also one of the main economic activities on Christmas Island and the Cocos (Keeling) Islands.

3.5 Areas of environmental significance

3.5.1 World Heritage Areas

There are three World Heritage Areas (WHAs) within the ZPI – Ningaloo Coast WHA, Shark Bay WHA and the Komodo National Park WHA.

The Ningaloo Coast was inscribed into the World Heritage List in 2011 under the United Nations' Educational, Scientific and Cultural Organisation (UNESCO) Operational Guidelines for the Implementation of the World Heritage Convention. The listing recognises the outstanding universal values of the Ningaloo Coast. The Ningaloo Coast WHA has a high diversity of marine habitats, including coastal mangrove systems, lagoons, reef, open ocean, continental slope and the continental shelf and includes both the Commonwealth and State marine parks (CALM and MPRA, 2005). The most dominant habitat of the Ningaloo WHA is the Ningaloo Reef, the largest coastal fringing reef in Australia. The Ningaloo Reef supports both tropical and temperate species of marine fauna and flora, and more than 300 species of coral (CALM and MPRA, 2005).

Shark Bay has the largest and richest seagrass beds in the world, covering an area of 4800 km^2, supporting an important dugong population. In addition, Shark Bay hosts some of the oldest forms of life on earth – stromatolites – which are colonies of algae that form hard dome-shaped deposits (UNESCO, 2013). Shark Bay WHA covers an area of approximately 10,000 km^2 and was inscribed into the World Heritage list in 1991.

The Komodo National Park was inscribed into the World Heritage list in 1991 under the UNESCO Operational Guidelines for the Implementation of the World Heritage Convention (UNESCO, 2014). The National Park covers 219,322 hectares and consists of three larger islands Komodo, Padar and Rinca, and 26 smaller ones. The majority of the WHA is marine. The marine fauna and flora are generally the same as that found throughout the Indo Pacific area, though species richness is very high, notable marine mammals include blue whale and sperm whale as well as ten species of dolphin, dugong, and five species of sea turtles (UNESCO, 2014).

3.5.2 Marine reserves and protected areas

There are 17 Commonwealth Marine Reserves within the ZPI. The marine reserves are managed under transitional arrangements in the absence of Management Plans yet to come into effect. In addition, there are 10 gazetted and two proposed WA State Marine Protected Areas within (or partially within) the ZPI.

While there are no Commonwealth National Parks within the Permit Area, there are two National Parks that lie within the ZPI – Christmas Island and Pulu Keeling National Park. There are also two Indonesian National Parks containing protected marine areas in the ZPI. These protected areas provide important habitats, including foraging/feeding, nesting, calving and resting areas for a number of protected and species. These areas are particularly important for turtles (green, hawksbill, flatback and loggerhead), humpback whales, whale sharks, dugongs, Australian sea lions and migratory birds.

3.5.3 Wetlands of international importance (Ramsar wetlands)

There are currently six declared Ramsar wetlands that lie within the ZPI;

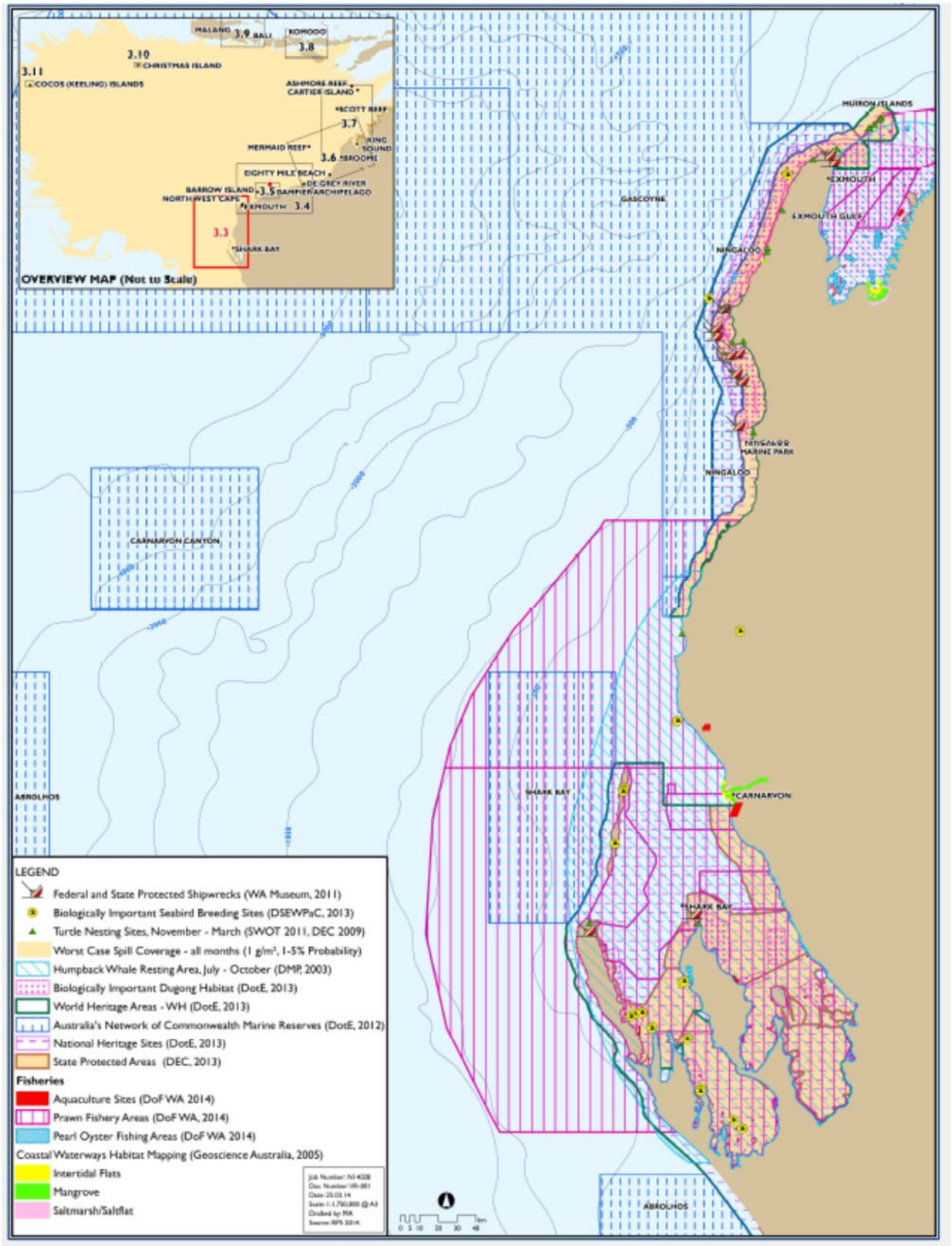
- The Dales, Christmas Island;

- Hosnies Spring;
- Ashmore Reef Commonwealth Marine Reserve;
- Eighty Mile Beach;
- Roebuck Bay; and
- Pulu Keeling National Park.

3.5.4 Key Ecological Features

Key Ecological Features (KEFs) have been identified through the marine bioregional planning process and are described as those parts of the marine ecosystem that are considered to be important for the biodiversity or ecosystem functioning and integrity of a Commonwealth Marine Area (DoEE, 2008). Within the ZPI, nineteen KEFs have been identified.

Figure 3-1: Environmentally sensitive areas map – Shark Bay to North West Cape



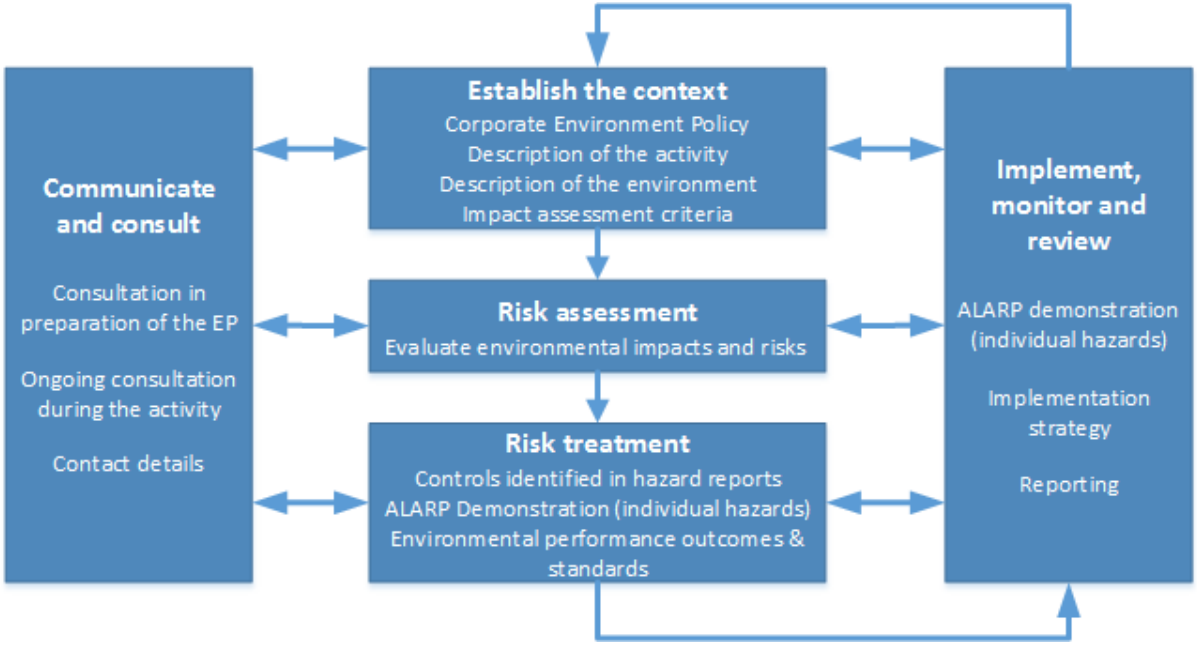
4 Description of environmental risks and impacts

4.1 Risk identification and assessment

In accordance with Division 2.3, Regulation 13(5) of the OPGGS (E) Regulations 2009, an environmental risk assessment was undertaken to evaluate impacts and risks arising from the petroleum activity.

The framework adopted by VOGA in compiling the Wandoo Facility EP is consistent with the methodology described in AS/NZS ISO 31000:2009 *Risk management—Principles and guidelines*, the VOGA Risk Management Manual [VOG-2000-MN-0001] and NOPSEMA Guidance (N04750-GN1344, Revision 3). Figure 4-1 depicts this methodology where the requirements are addressed.

Figure 4-1: Content requirements of the Wandoo Facility EP within the framework outlined in AS/NZS ISO 31000



The scope of operations covered by the Wandoo Facility EP was confirmed in terms of its timing(s), extent, and the nature of the activities included within it. This scope is reflected in the activities described in Section 2.

Potential environmental hazards associated with activities and accidental events were identified, and impacts determined in a qualitative manner in an environmental hazard review workshop. Existing controls were identified in the same workshop. Each hazard employs a hierarchy of controls which relies on the following (in order of preference):

- **Elimination**: Refers to the elimination of a hazard. For example, the use of a renewable energy source eliminates the emissions associated with power generation;
- **Substitution**: This refers to scenarios where an alternative arrangement is used to reduce the risk levels. For example, using a lower emission fuel type;

- **Prevention**: removing the causes of a particular impact or decrease their likelihood. As an example, a simpler plant with fewer leak points.
- **Reduction**: Limits the scale and consequence of a particular impact. For example, changes to process systems to reduce the size of hazardous inventories.
- **Mitigation**: Controls in place to respond to an incident, such as oil spill contingency planning.

In the case of complex or high hazard risks, environmental impact modelling was carried out to ensure that the impacts were thoroughly understood.

The severity, frequency, and subsequently the initial risk ranking was allocated to each hazard in accordance with the VOGA Risk Management Manual [VOG-2000-MN-0001]. The risk rankings were reviewed and additional controls were considered to reduce the residual risk to As Low as Reasonably Practicable (ALARP).

The performance outcomes, performance standards and measurement criteria associated with the controls were developed in a series of performance standard workshops. The residual risk score for each environmental hazard was assigned taking into account the risk reduction from both the existing and additional controls. The implementation strategy describes how the additional controls will be implemented.

4.2 Impact assessment

An assessment of impact for each identified hazard was conducted by:

- defining impact assessment criteria;
- quantifying magnitude of the stressor, including where applicable, quantity, concentration of contaminant and level of disturbance;
- consideration of timing and duration of the impact and other factors affecting the impact and risk (depth, temperature, tides, etc.);
- consideration of environmental features affected either directly or indirectly; and
- evaluation of the significance or acceptability of the impact.

Impact is considered by VOGA to be acceptable when it is unlikely to cause significant harm to the environment.

4.3 Catastrophic Environmental Events and Critical Controls

An event with a consequence ranking of 4 is defined as a Catastrophic Environmental Event (CEE). A physical control, measure or procedure that has a key role in preventing, detecting, controlling or mitigating a CEE is defined as a Critical Control. Although performance objectives are developed for all environmental controls, Critical Controls are subjected to more stringent management.

4.3.1 Identifying Catastrophic Environmental Events

Environmental hazards for the Wandoo facilities are listed in Section 4.6. It is important to note that there will usually be a range of possible impacts resultant from each hazard and only some of

these may have catastrophic potential. The overview of all environmental hazards and each individual hazard report identify the worst credible impact resultant from each hazard.

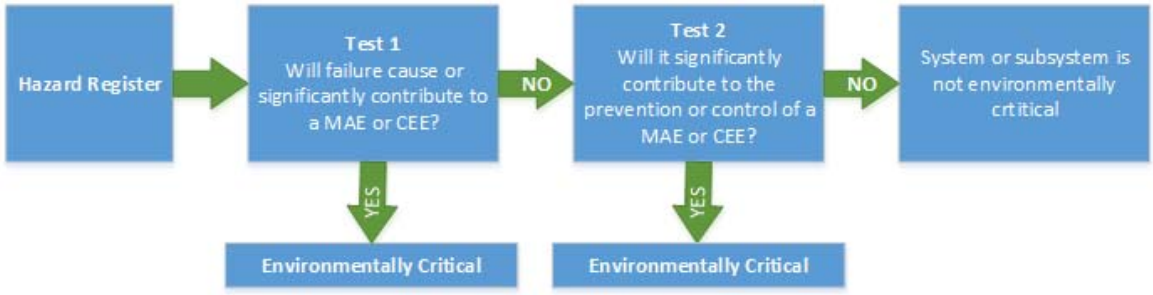
Based on the description of the hazard and the range of possible impacts for each hazard it is possible to determine those circumstances where a release would have catastrophic potential. It is only under these circumstances that a CEE would result.

4.3.2 Identifying Critical Controls

Once an event has been identified as a CEE the controls associated with that event must be assessed to determine which controls are considered critical. To confirm the applicability of a control measure as critical, it is necessary to apply a reasoned process as depicted in Figure 4-2.

For identified CEEs, the controls associated with those events have been subjected to the above process and Critical Controls identified. Critical Controls, where identified have been defined in the relevant hazard assessments.

Figure 4-2: Critical Element identification process



4.4 VOGA risk ranking

The risk ranking assessment was undertaken in accordance with Australian/New Zealand Standard AS NZS ISO 31000:2009 *Risk Management – Principles and Guidelines* and the VOGA Risk Management Manual [VOG-2000-MN-0001] and the VOGA risk assessment procedure. The VOGA risk assessment matrices shown below were used, taking into account the consequence and probability of 22 identified sources of potential environmental impact.

Table 4-1: Risk level and action

H	**High Risk:**	Intolerable – Stop activities unless risk controls that will reduce the risk are implemented
UM	**Upper Range Medium Risk:**	Tolerable (higher region) on demonstration of ALARP
LM	**Lower Range Medium Risk:**	Tolerable on demonstration of ALARP
L	**Low Risk:**	Acceptable

4.5 Demonstrating ALARP and acceptability of risk

Demonstrating ALARP has been undertaken in accordance with VOGA's Risk Management Manual and NOPSEMA Guidance Note [N-04300-GN0166]. Demonstrating that risks levels are ALARP is a two-step process. Firstly, residual risk levels must be tolerable, that is not within the "High" risk

area of the VOGA Risk Matrix as per Table 4-1. Secondly, once deemed tolerable further risk reduction measures must be identified and assessed for implementation as described below.

Following the identification of risk mitigation controls and recovery measures, VOGA reviews the residual risk and assesses whether there are any further measures required to reduce the residual risk to ALARP. For well construction activities and well intervention projects, risks are considered to have been reduced to ALARP if the risks are within the tolerable region of the VOGA Risk Matrix and have been subject to a detailed assessment process that has concluded that there are no further reasonably practicable measures that can be implemented to further reduce the level of risk.

When deciding whether risks are managed to ALARP, the following items are considered:

- duration and regularity of operations;
- risk;
- layers of protection;
- feasibility of additional controls or alternative arrangements;
- practicality of additional controls or alternative arrangements;
- cost of additional controls or alternative arrangements;
- effectiveness of additional controls or alternative arrangements;
- impact on risks from additional controls or alternative arrangements; and
- lessons learnt from past campaigns and industry.

This decision is valid where:

- all environmental hazards have been identified and assessed;
- risk levels have been evaluated; and
- residual risk levels are tolerable, compliant and ALARP.

Performance standards have been defined to ensure that the risks are reduced to ALARP on an ongoing basis. The VOGA risk matrix defines an upper threshold above which no risk is tolerable. Below this threshold is the ALARP region, where risks should be further reduced until the cost of any additional action outweighs the incremental benefit gained. Numerical values for acceptance criteria are used to define the extremes of risks.

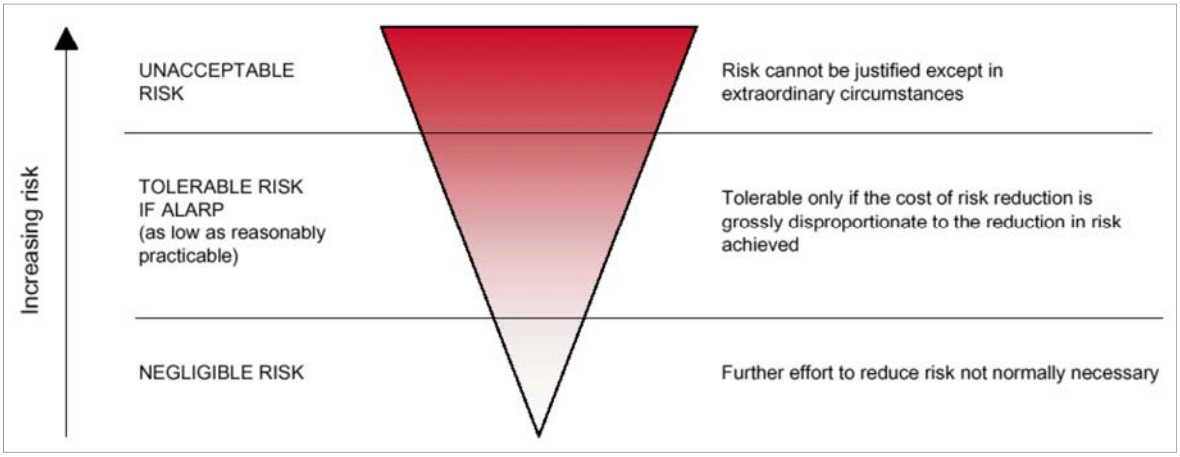
For those risks with a separate ALARP and acceptability assessment, an ‘acceptable’ risk is one where the qualitative level likelihood and consequence has been assessed as falling within or below the tolerable range on the VOGA Risk Matrix. Considerations include (but are not limited to):

- the OPGGS(E)R;
- principles of ecologically sustainable development;
- the environment;
- stakeholders;
- economics;
- internal context (policies, culture, standards and other guiding factors within VOGA); and
- external context (the environment outside VOGA’s company structure, stakeholder expectations, biological, ecological sustainability, social and cultural features, standards and law.

Figure 4-3 presents a framework for risk acceptability on the basis of gross disproportion. If the cost of implementing an additional measure (or layer) can be shown to be grossly disproportionate to the benefit gained, then the risk can be accepted on the basis that it is ALARP. It is important to note that the acceptability criteria are stated in terms of practicality, not affordability.

As per the VOGA risk management approach, after assessment and application of reasonable and practical controls, those risks which are categorised as low are considered acceptable without further risk treatment.

Figure 4-3: Framework for risk acceptability



4.6 Environmental risks and impacts summary

VOGA conducted a risk assessment workshop for the proposed activity and found that there were no high or upper-medium risks, 15 lower-medium and seven low risks. A summary of the risks and their scores is provided below in Table 4-2.

The impacts outlined above have been considered in terms of the regional environment and the local marine ecosystem. VOGA's systems, practices and procedures ensure that its operation activities meet the defined performance outcomes and standards and all relevant legislative requirements. The commitments associated with these outcomes and standards contribute to ensuring that the residual environmental risk associated with operations of the WPF is reduced to ALARP.

VOGA has developed a range of performance standards (controls) that will be implemented throughout the life of the WPF to ensure the potential environmental impacts identified through the risk assessment are managed appropriately. A summary of the major environmental hazards and controls are detailed in Section 5.

Table 4-2: Summary of environmental risks from operational activities

EP Risk No.	Hazard	Potential Hazard Consequence	Maximum Potential Consequence	Frequency of Event	Residual Risk Ranking
EP-OP-R01 (CEE-01)	Liquid hydrocarbon release from wells	• Toxic effects on marine organisms and decline in water quality.	**4 - Catastrophic** Non-recoverable loss of species, damage to ecosystem, protected habitat or environmental assets. Multiple fatalities of cetaceans or other protected species.	**A** - Highly unlikely to occur. 1 to 3 occurrences in 100 years within world-wide industry.	LM
EP-OP-R02 (CEE-02)	Liquid hydrocarbon release from export equipment, submarine hose, floating hose, export flow lines, subsea pipelines	• Toxic effects on marine organisms and decline in water quality.	**4 - Catastrophic** Non-recoverable loss of species, damage to ecosystem, protected habitat or environmental assets. Multiple fatalities of cetaceans or other protected species.	**A** - Highly unlikely to occur. 1 to 3 occurrences in 100 years within world-wide industry.	LM
EP-OP-R03 (CEE-03)	Crude oil spill from CGS	• Toxic effects on marine organisms and decline in water quality.	**4 - Catastrophic** Non-recoverable loss of species, damage to ecosystem, protected habitat or environmental assets. Multiple fatalities of cetaceans or other protected species.	**A** - Highly unlikely to occur. 1 to 3 occurrences in 100 years within world-wide industry.	LM
EP-OP-R04	Environmental impacts of oil spill response	• Increased entrained fraction of hydrocarbons in the water column after adding dispersants. • Toxicity effects on marine fauna from dispersant. • Disturbance to benthic habitat, adjacent vegetation and other environmentally sensitive areas. • Scouring of sediments. • Waste generation, disposal and management.	**3 - Major** Significant (e.g. 50%) but recoverable (in >1 year) species, habitat damage or environmental assets. Single fatality of cetaceans or other protected species.	**B** - Not likely to occur. 1 to 3 occurrences in 30 years within world-wide industry.	LM

EP Risk No.	Hazard	Potential Hazard Consequence	Maximum Potential Consequence	Frequency of Event	Residual Risk Ranking
EP-OP-R05	Diesel spill to sea	• Toxic effects on marine organisms and decline in water quality.	**3 - Major** Significant (e.g. 50%) but recoverable (in >1 year) species, habitat damage or environmental assets. Single fatality of cetaceans or other protected species.	**A** - Highly unlikely to occur. 1 to 3 occurrences in 100 years within world-wide industry..	LM
EP-OP-R06	Discharge of PFW and ballast water from Facility	• Toxicity effects to marine organisms from OIW and chemicals (biocide, corrosion inhibitor, water clarifier, scale inhibitor, O_2 scavenger) in PFW and ballast water. • Decline in water quality associated with lowered dissolved oxygen concentrations as a result of elevated water temperature.	**1 - Minor** Short term (hours or days), localised disruption of behaviours, ecosystem or environmental assets.	**E** - Probability of repeated incidents. Annual occurrence or more.	LM
EP-OP-R07	Noise	• Injury to hearing or other organs of marine fauna. • Masking or interfering with biologically important sounds. • Disturbance leading to behavioural changes or displacement of fauna.	**1 - Minor** Short term (hours or days), localised disruption of behaviours, ecosystem or environmental assets.	**E** - Probability of repeated incidents. Annual occurrence or more.	LM
EP-OP-R08	Atmospheric emissions	• A localised reduction in air quality due to contribution to global greenhouse gases. • A localised reduction in air quality due to particulate matter from diesel combustion.	**1 - Minor** Insignificant volume flared/vented to atmosphere.	**E** - Probability of repeated incidents. Annual occurrence or more.	LM
EP-OP-R09	Artificial light	• Disorientation, attraction or repulsion of marine fauna and birds. • Altered foraging and breeding behaviours.	**1 - Minor** Short term (hours or days), localised disruption of behaviours, ecosystem or environmental assets.	**E** - Probability of repeated incidents. Annual occurrence or more.	LM

EP Risk No.	Hazard	Potential Hazard Consequence	Maximum Potential Consequence	Frequency of Event	Residual Risk Ranking
EP-OP-R10	Discharge of cooling water from Facility	• Minor thermal impacts to marine organisms. • Localised reduction water quality.	**1 - Minor** Short term (hours or days), localised disruption of behaviours, ecosystem or environmental assets.	**E** - Probability of repeated incidents. Annual occurrence or more.	LM
EP-OP-R11	Vessel and Facility deck drainage and vessel bilge water discharge	• Reduction in water quality. • Toxicity effects to marine organisms in the immediate vicinity of the discharge.	**1 - Minor** Short term (hours or days), localised disruption of behaviours, ecosystem or environmental assets.	**E** - Probability of repeated incidents. Annual occurrence or more.	LM
EP-OP-R12	Discharge of sewage, greywater and putrescible waste from Facility and vessels	• Nutrient enrichment and increased biological demand of surrounding waters. • Low level contamination of organisms caused by ingestion of waste materials. • Increase in scavenging behaviour of marine fauna and seabirds.	**1 - Minor** Short term (hours or days), localised disruption of behaviours, ecosystem or environmental assets.	**E** - Probability of repeated incidents. Annual occurrence or more.	LM
EP-OP-R13	Discharge of desalination brine	• Localised elevation in seawater salinity. • Localised reduction in water quality.	**1 - Minor** Short term (hours or days), localised disruption of behaviours, ecosystem or environmental assets.	**E** - Probability of repeated incidents. Annual occurrence or more.	LM
EP-OP-R14	Non-hazardous and hazardous waste	• Marine pollution (litter). • Injury and entanglement of marine fauna and seabirds. • Potential toxicity effects to marine fauna. • Land and onshore groundwater contamination.	**1 - Minor** Short term (hours or days), localised disruption of behaviours, ecosystem or environmental assets.	**E** - Probability of repeated incidents. Annual occurrence or more.	LM
EP-OP-R15	Use and discharge of chemicals for maintenance and inspection activities	• Reduced water quality. • Toxicity effects to marine organisms.	**1 - Minor** Short term (hours or days), localised disruption of behaviours, ecosystem or environmental assets.	**E** - Probability of repeated incidents. Annual occurrence or more.	LM

EP Risk No.	Hazard	Potential Hazard Consequence	Maximum Potential Consequence	Frequency of Event	Residual Risk Ranking
EP-OP-R16	Disturbance to marine fauna and seabirds	• Potential injury/death and/or temporary and localised displacement of marine fauna or seabirds.	**2 - Serious** Temporary (i.e. weeks or months), recoverable impacts on ecosystem, protected habitat or environmental assets. Disturbance of patterns, e.g. migrations, but no fatalities of cetaceans/protected species.	**B** - Not likely to occur. 1 to 3 occurrences in 30 years.	L
EP-OP-R17	Liquid hydrocarbon release from topsides process	• Toxic effects on marine organisms and decline in water quality.	**2 - Serious** Temporary (i.e. weeks or months), recoverable impacts on ecosystem, protected habitat or environmental assets. Disturbance of patterns, e.g. migrations, but no fatalities of cetaceans/protected species.	**B** - Not likely to occur. 1 to 3 occurrences in 30 years.	L
EP-OP-R18	Ancillary hydrocarbon or chemical spills	• Toxic effects on marine organisms and decline in water quality.	**2 - Serious** Temporary (i.e. weeks or months), recoverable impacts on ecosystem, protected habitat or environmental assets. Disturbance of patterns, e.g. migrations, but no fatalities of cetaceans/protected species.	**B** - Not likely to occur. 1 to 3 occurrences in 30 years.	L

EP Risk No.	Hazard	Potential Hazard Consequence	Maximum Potential Consequence	Frequency of Event	Residual Risk Ranking
EP-OP-R19	Physical presence of infrastructure	• Disturbance to marine fauna including marine mammals, reptiles and birds. • Interaction with commercial and recreational fishing and shipping. • Provision of an artificial habitat for benthic and pelagic organisms. • Changes to visual amenity. • Seabed scour.	**1 - Minor** Short term (hours or days), localised disruption of behaviours, ecosystem or environmental assets.	**D** - Possibility of isolated incidents. 1 to 3 occurrences in 3 years.	L
EP-OP-R20	Seabed disturbance	• Seabed scour. Increase in turbidity of the water column/reduction light penetration. • Localised smothering of benthos. • Localised reduction in benthic productivity.	**1 - Minor** Short term (hours or days), localised disruption of behaviours, ecosystem or environmental assets.	**C** - Possibility of occurring sometime. 1 to 3 occurrences in 10 years.	L
EP-OP-R21	Tanker and vessel biosecurity	• Changes to habitat structure. • Predation of native species. • Potential introduction of invasive marine species.	**1 - Minor** Short term (hours or days), localised disruption of behaviours, ecosystem or environmental assets.	**B** - Not likely to occur. 1 to 3 occurrences in 30 years.	L
EP-OP-R22	Liquid hydrocarbon release from flow lines and risers	• Toxic effects on marine organisms and decline in water quality.	**1 - Minor** Short term (hours or days), localised disruption of behaviours, ecosystem or environmental assets.	**B** - Not likely to occur. 1 to 3 occurrences in 30 years.	L

5 Description of hazards and control measures

5.1 Liquid hydrocarbon release from wells

5.1.1 Activity

VOGA's Safety Case and environmental hazard review workshops for the proposed activity identified that a well failure resulting in a loss of hydrocarbon could occur from the following activity/causes:

- Well intervention operations;
- Loss of well integrity;
- Structural failure of platform due to fatigue/ageing asset;
- Vessel collision with platform; and
- Dropped object or swinging load onto the wellhead.

Reservoir modelling has indicated that a maximum worst case release from production wells could result in up to 35,700 m^3 of hydrocarbon liquid of over 60 days (595 m^3/day) into the environment. VOGA has assumed that at least 60 days would be required to drill a relief well and control a well release based on the Source Control Contingency Plan [VOG-5000-PD-0001].

5.1.2 Assessment

To determine the potential benefit of applying dispersant across different seasons, VOGA commissioned RPS APASA to undertake additional modelling, a process that generated 50 spill trajectories per season per case (with and without application of dispersant). Single spill trajectories with the highest amount of oil reaching the shore for each season were identified without the use of dispersant and then compared to the same trajectory after the application of dispersant.

For modelling, dispersant was applied 48 hours following hydrocarbon release to an area of 40 km x 40 km, centred upon the release site. The modelling use of dispersants was undertaken at the moderate exposure level of 10 g/m^2 as this is when dispersants are effective in water.

Sea surface exposure

During summer, modelling results indicated that once on the sea surface, the Wandoo Crude was predicted to travel along the coastline to the east-northeast, due to the overall direction of the prevailing winds. The plume makes initial shoreline contact after 21 days, at a point northeast of Port Hedland.

The modelling results show that during the transitional season (September to February) the crude oil is subjected to highly variable wind strength and direction. Due to these variable conditions, the plume dispersed widely along the northern coastline of WA, either side of the spill site. The use of dispersant with a 40% success rate reduces the surface oil concentration by 18% over the 60-day spill event (reduced from 74% to 56%).

During winter, the overall wind direction is relatively consistent, with the crude oil predicted to move to the east north-east towards Broome. The use of dispersant with a 40% success rate reduces surface oil concentrations by ~30% at Day 40.

Entrained hydrocarbons

Conservative thresholds were used to indicate potential zones of exposure for entrained hydrocarbons. The lowest threshold concentration was set at 10 ppb, which corresponds generally with the lowest trigger levels for chronic exposure for entrained hydrocarbons in the (ANZECC, 2000) water quality guidelines.

The potential zones of sea surface exposure (low, moderate and high), with and without dispersant applied were modelled. As expected, during summer and winter the extent of entrained hydrocarbons was dramatically changed as a result of the dispersant application. Without the use of dispersant, no subsurface plumes were predicted (according to the low exposure reporting threshold, 960-9,600 ppb-hrs).

During the transitional period, modelling results indicated that without the use of dispersant, the subsurface plumes were isolated and limited, and predicted to occur from the east of the release site.

The use of dispersant resulted in a potential zone of low entrained hydrocarbon extending adjacent the mainland coastline from offshore Carnarvon to Dampier.

Shoreline accumulation

Observations by Lin and Mendelssohn (1996), demonstrated that more than 1 kg/m^2 of oil during the growing season would be required to impact marsh or mangrove plants significantly.

The probability of shoreline exposure is generally higher during summer (with a few exceptions such as exposure of the Montebello Islands during transitional season). Further interrogation of the oil spill modelling output indicates the average volume of oil ashore is 18,214 m^3 in summer, 2,531 m^3 in transitional and 17,701 m^3 in winter (RPS APASA, 2012). The depending on the weather and ocean conditions at the time, initial to oil contact to the shoreline of Dampier Archipelago may occur 84 hours post spill. Spill response planning has be established based on the total maximum volume of shoreline and minimum shoreline contact.

Sensitive receptors

Table 5-1: Summary of environmental impacts due to a release of Wandoo Crude from a surface spill release

Environmental sensitivity	Exposure mechanism	Impact
Marine habitats		
Coral reef communities	Surface	No coral reef communities are found within the Permit Area. Within the ZPI, sporadic fringing coral reefs are expected to occur around the majority of islands and significant coral reefs can be found around Dampier Archipelago, Ningaloo Reef and the Montebello/Barrow/Lowendal islands. Spill modelling results indicate that in the event of a loss of well control: • No entrained oil is expected to reach coral reef communities; • Moderate surface hydrocarbon exposures to intertidal coral communities may occur at the Montebello/Lowendal Islands, Dampier Archipelago and Ningaloo Reef regardless of season; and • High surface hydrocarbon exposures to intertidal coral communities may occur at the Montebello Islands and Dampier Archipelago during summer and transitional seasons. Direct contact with surface oils could lead to chemical toxicity across cellular structure leading to coral bleaching and colony death. Instead of acute mortality, it is more likely that oil effects occur in sub-lethal forms, such as reduced photosynthesis, growth or reproduction (NOAA, 2014). However, surface oil contact is limited to intertidal corals, which will be periodically exposed to the surface hydrocarbons as well as planktonic stages of corals in particular during periods of coral spawning. Intertidal coral reefs within the region such as those at Montebello/Barrow/Lowendal Islands and Dampier Archipelago also have the potential for smothering due to shoreline accumulation. Modelling outputs are an aggregate of all potential spill trajectories and therefore it is not credible that all receptors would be exposed at any one time. On this basis, impacts to these areas (including spawning) are likely to be limited and re-colonisation/recovery could be expected over time. In the event of a loss of well control there is a potential for hydrocarbon exposures to result in significant but recoverable (in >1 year) species or habitat damage.
Macro-algae	Surface	Macro-algal habitat within the region is widespread and there are no specifically identified areas of significant environmental value. In the event of a loss of well control and subsequent spill, macro-algae in intertidal areas have the potential to be exposed to surface hydrocarbons. Residues may be left in the area as the tide ebbs, but will be flushed with each flood tide. Studies have shown that macro-algae appear to recover rapidly from oiling, irrespective of the degree of impact and level of oiling. This is attributed to the fact that most of the new algae growth is produced near the base of the plant while distal parts (which would be exposed to the oil contamination) are continually lost (Connell and Miller, 1981). In the event of a loss of well control there is a potential for hydrocarbon exposures to intertidal areas, where macro-algae may occur, to result in temporary and recoverable impacts to macro-algal habitats.
Seagrass	Surface	No seagrasses are found within the Permit Area. Within the ZPI, seagrasses cover extensive areas of Shark Bay and can be found

Environmental sensitivity	Exposure mechanism	Impact
		adjacent to offshore island including those of Dampier Archipelago and Montebello and Barrow islands. Spill modelling results indicate: • No entrained oil is predicted to impact these seagrass habitats ecosystems; and • There is a potential for moderate and high surface hydrocarbon exposures to occur around the Dampier Archipelago and Montebello and Barrow Islands. Oil may smother leaves of seagrass beds in shallow inter tidal areas. Intertidal seagrass communities would theoretically be the most susceptible because the leaves and rhizomes may both be affected. The primary impacts to seagrasses are likely to be caused by a reduction in available light and subsequent reduction in photosynthesis. However, the reduction will only be over areas for short periods of time as the slick moves with currents, wind and tides and as such impacts are limited. Hence, while impacts are possible, they will not be extensive throughout the ZPI. In the event of a loss of well control there is a potential for hydrocarbon exposures to result in significant but recoverable species or habitat damage.
Mangroves	Shoreline	No mangrove communities are found within the Permit Area. Significant areas of mangrove occurring within the ZPI include the Dampier Archipelago, Montebello Islands and the Ningaloo coastline. Spill modelling results show that: • A maximum volume of 581.7 m^3 may occur at Dampier Archipelago; and • Oil at a thickness of 1 kg/m^2 has the potential to impact the Dampier Archipelago and Montebello Islands. Observations by Lin and Mendelssohn (1996), demonstrated that more than 1 kg/m^2 of oil during the growing season would be required to impact marsh or mangrove plants significantly. However mangrove recovery from hydrocarbon exposures is possible but can long time. Subsequently the impact is significant but recoverable species of habitat damage.
Intertidal beaches/ mudflats/rocky shorelines/ intertidal reef platforms	Shoreline	Intertidal beaches and mudflats are widespread throughout the ZPI. Three intertidal beach/mudflat areas of significance occur within the region (Bandicoot Bay, Eighty Mile Beach and Roebuck Bay). Roebuck Bay and Eighty Mile Beach are also declared Ramsar wetlands. Spill modelling results indicate that moderate shoreline accumulation may occur at Bandicoot Bay, Eighty Mile Beach and Roebuck Bay. Oil has the potential to interfere with infaunal organisms in these areas either by modifying the habitat or smothering the feeding respiratory and/or locomotory structures of these organisms. Hydrocarbons may be left on the intertidal shores as the tide ebbs, but it would be expected that this would be flushed with each flood tide. Natural flushing is more likely to reduce impacts in exposed areas of shoreline. Subsequently the impact is short term localised disruption of ecosystem.
Sandy beaches	Shoreline	The values associated with sandy beaches are assessed with regard to the following environmental sensitivities: marine reptiles,

Environmental sensitivity	Exposure mechanism	Impact
		seabirds and other users.
Protected and threatened species		
Fish and sharks	Entrained	Fish and sharks are expected to be present within the Permit Area and ZPI. However, their presence is generally transient and sporadic (Etkin, 2003). Fish and sharks are most likely to be impacted by entrained hydrocarbons as they dwell in the water column. Fish and shark kills as a result of a spill in the open are unlikely, due to the predicted zones of low potential exposure from entrained hydrocarbons for this scenario. The larval stage of fish is more likely to be susceptible; however, in comparison to predation and natural loss, any impacts would be over a small proportion of the marine environment in which they may occur and any measurable impact at the population level is considered to be low. In addition, fish mortality from oil spills is rarely reported and significant population level impacts are unlikely. Whale sharks are vulnerable during seasonal aggregations when they are observed swimming close to the surface, but otherwise remain away from surface for long periods and to depths beyond 700 m (DoEE, 2016b). Mako sharks are pelagic and tend to occur in waters less than 50 m deep, with occasional dives up to 640 m deep. As such impacts are unlikely. Subsequently the impact is localised disruption of behaviours/ecosystem.
Marine mammals	Surface/ entrained	Eight cetaceans listed as threatened or migratory under the EPBC Act may potentially occur in the Permit Area and 15 listed marine mammals may potentially occur in the ZPI. The northward migration path of the humpback whale is seaward of the Permit Area and large numbers of humpback whales travel through this area annually between July and August. Dolphins are also known to occur and transit through the Permit Area and ZPI. **Entrained** Spill modelling results predict that there are no zones of entrained hydrocarbons during summer and winter season. An isolated low exposure subsurface plume is predicted to occur to the east of the well location during transitional season, Other than the potential for small numbers of cetaceans that may transit through this area it is unlikely that marine mammals will be exposed to entrained hydrocarbons in the event of a spill. **Surface** Modelling also predicts that moderate and high surface hydrocarbon exposures have the potential to extend across the ZPI including the migration route during all seasons. It is possible for whales to be exposed to surface hydrocarbons if the hydrocarbon release occurs during the migration period. Marine mammals are also likely to come in contact with surface oil as they return to the surface to breathe. However, short-term inhalation of petroleum vapours at concentrations similar to those found in oceanic spills may not be detrimental either in terms of structural tissue damage or respiratory gas exchange. Cetaceans will not be sensitive to the physical effects of oiling as they are smooth skinned hairless mammals and oil tends not to stick to their skin. Oiling of pinnipeds (seals and sea lions) can cause removal of natural water repellent oils from their fur making them less buoyant and susceptible to hypothermia (Kucklick et al., 1997). However, given that oil will be significantly weathered and dispersed by the

Environmental sensitivity	Exposure mechanism	Impact
		time it reaches the pinniped habitats, it is unlikely to result in significant exposure to a large population. The highest potential risks for dugongs are related to direct ingestion of seagrass or macro-algae exposed to acute or chronic toxicity and or drastic reduction on seagrass coverage due to hydrocarbon spills (Heinsohn et al., 1977). As explained for these receptors, impacts are unlikely to be extensive and are recoverable. Given that the area of potential impact is relatively small in relation to the offshore environment, and cetaceans and other marine mammals would be transitory, any interface with hydrocarbons is unlikely to cause an impact to significant numbers. However, the impact is classified as major as there is potential for exposure to individual cetaceans and other protected species.
Marine reptiles	Surface	Species of sea snakes and marine turtles are known to occur in the Permit Area and the ZPI. Spill modelling results predicts zones of high and moderate surface hydrocarbon exposures in these areas in the event of a well blowout. Marine reptiles are likely to come in contact with oil in the event of a spill as they surface to breathe. Harmful effects may occur through ingestion of oil, inhalation of toxic vapours (e.g. close to the spill source) or irritation to the head, neck and flippers due to oil contact with the skin. Within the immediate vicinity of the spill event, where hydrocarbons are still fresh, this could lead to fatal impacts on individuals, but is unlikely to have a population effect. The impact is classified as major as there is potential for single fatalities of protected species.
	Shoreline	No significant marine reptile habitat is known to occur within the Permit Area. However, important turtle nesting sites within the ZPI include the Ningaloo Marine Park, Montebello/Barrow/Lowendal Islands, Dampier Archipelago, and Eighty Mile Beach. Spill modelling results indicate that moderate shoreline accumulation may occur at Ningaloo Marine Park, Montebello/Barrow/Lowendal Islands, Dampier Archipelago, and Eighty Mile Beach. A maximum volume of 581.7 m^3 at a maximum thickness of 1 kg/m^2 may occur at Dampier Archipelago. In the unlikely event that hydrocarbons did accumulate at a turtle nesting area, there is potential for adult turtles and/or hatchlings to be impacted. Potential impacts include smothering of adults and hatchling and/ or avoidance behaviour of adult turtles. This could result in failed or aborted nesting attempts or a reduction in survival rates of hatchlings. As many turtle species do not nest exclusively within a single area and, as all of these areas would not be impacted for this scenario, the impact is unlikely to affect the viability of the species, but may result in a significant but recoverable impact to the population if hatchlings over a season are impacted. The impact is classified as catastrophic as there is a potential for more than a single protected species fatality.
Seabirds	Surface	A number of threatened and migratory birds may occur within the Permit Area and ZPI. Modelling results predict zones of high (25 µm) and moderate (10 µm) surface hydrocarbon exposures within the Permit Area and the ZPI in the event of a well blowout. Scholten et al. (1996) indicates that a layer of 25 µm thick would be harmful to birds that contact the slick. Estimates for the minimal thickness of oil that will result in harm to seabirds through ingestion from preening of contaminated feathers, or the loss of thermal protection of their feathers, has been estimated at 10 µm (French, 2009) to 25 µm (Koops et al., 2004). Oil spills can have a variety of effects including fouling of the plumage, ingestion of oil, effects on reproduction and physical disturbance. Many of the species that occur offshore are surface-feeding or plunge-diving pelagic birds, so that oil slicks would

Environmental sensitivity	Exposure mechanism	Impact
		potentially interfere with feeding and increase exposure risk. Seabirds are expected to be present within the Permit Area and the ZPI but their presence is transient and sporadic. Hence population level impacts are unlikely but mortality of protected seabirds may occur.
	Shoreline	There are no critical habitats for seabirds within the Permit Area. However, seabird breeding areas are found on Montebello/Barrow Islands, Rowley Shoals, Eighty Mile Beach and Roebuck Bay within the ZPI. Spill modelling results indicate that moderate (100 µm) shoreline accumulation may occur at Montebello/Barrow Islands, Eighty Mile Beach and Roebuck Bay during all seasons. Moderate shoreline accumulation may occur at Rowley Shoals during summer and winter seasons. Given these shorelines provide habitat for a range of species, a large number of seabird mortalities may potentially occur if an oil spill reaches these areas during critical periods. Given all areas will not be impacted, the impacts are not likely to affect species viability. The impact is classified as catastrophic as there is a potential for more than a single protected species fatality.
Socio-economic receptors		
Fisheries and aquaculture	Surface/ Entrained	Several managed commercial fisheries occur in the ZPI some of which overlap the Permit Area. Fishing within the Permit Area is unlikely due to the safety exclusions zones and most fisheries operate in deep water seaward of the Permit Area. No fishing has been recorded in the Permit Area since 2012. However, several commercial fisheries have recorded catch efforts in the ZPI. In the event of a significant oil spill, surface oil is less likely to result in direct impacts to the fish, but may interfere with fishing operations through damage to vessels and fishing gear, exclusion to areas during clean-up operations and any follow up monitoring and surveillance activities. There is also a potential that perceptions of fish tainting due to the spill could indirectly result in economic impacts to the fishery. Fish species themselves, are more likely to be impacted by entrained hydrocarbons as they dwell in the water column. However, impacts are likely to limited as spill modelling predicts low exposure zone of entrained hydrocarbons in the vicinity of the Permit Area and the majority of species dwell deeper in the water column. The larval stage of fish is more likely to be susceptible. However, in comparison to predation and natural loss, any impacts would be over a small proportion of the marine environment in which they may occur and any measurable impact at the population level is considered to be low. In addition, fish mortality from oil spills is rarely reported and the likelihood of hydrocarbon residues reaching the seabed in significant volumes is low. While there are a number of fisheries operate within the ZPI, the impacts will not be extensive across their large areas of operation and would be temporary.
Other users	Surface	A number of tourist destinations occur within the ZPI including Shark Bay and the Ningaloo Coast. There is a wide variety of marine nature-based tourism in these areas such as diving, whale-watching, snorkelling and charter fishing. It is estimated that approximately $127 million is spent per year by visitors to the Ningaloo Marine Park, with a large portion of is this attributed to the whale shark tourism industry. In the event of a loss of well, depending on the fate and trajectory of the oil, there is the potential for temporary disruptions to tourism activities that could have a temporary impact to the tourism industry. As persistent hydrocarbons are likely to dissipate from the environment over time and, as the volumes ashore suggest remediation may be difficult or expensive, impacts are

Environmental sensitivity	Exposure mechanism	Impact
		expected to be extensive but temporary. More broadly in the region, the impacts to humans and the activities themselves are not likely to be significant. However, there is the potential for temporary closure of recreational activities, including diving due to the risk to public health and safety. This would be short term and limited to the area immediately affected by a spill. There is a possibility of impacts to tourism operators due to actual or perceived impacts to aesthetics and the regional marine resources by the general public through negative media attention. Any closures would be short term in nature, as entrained hydrocarbons will naturally disperse and any shoreline accumulation would breakdown due to natural weathering processes. Potential impacts are considered to be extensive but temporary.
Protected Areas		
World Heritage Areas/ Commonwealth Marine Protected Areas/ State Marine Protected Area	Surface/ shoreline	The Ningaloo Coast WHA and Shark Bay WHA occur within the ZPI may be impacted in the event of a well blowout. There are no Commonwealth Marine protected areas or State Marine Reserves within the Permit Area but do occur within the ZPI. The values associated with these areas have been assessed in terms of the protected/threatened species and marine habitat and socioeconomic receptor sections outlined above.

5.1.3 Control measures

The modelling used as a basis for the discussions present conservative scenarios, as they do not consider:

- The likelihood of a loss of well fluids during intervention operations at Wandoo is remote by industry standards, due to the range of controls in place such as the SSSV and other shutdown valves (wing and master valves) provided on each well. In the event of an emergency, these valves are designed to close in sequence according to the Emergency Shutdown (ESD) logic, isolating the reservoir from the well and limiting the release to the inventory of the well only.
- The sub-hydrostatic nature of the reservoir which is well understood because of the production history in the Permit Area.
- Production wells that have been recently constructed have a limited operating life span where the conditions would allow for the well to naturally flow. Typically, the new well bore will be in operation for a six to nine month period where it can naturally flow.
- VOGA has not considered flow restrictions that would reduce the scale of the event such as intervention equipment, partially closed isolation valves or partially operational well control equipment.
- VOGA's spill response measures that will help reduce the likelihood of oil reaching coastal habitats.

The risk associated with a release of hydrocarbon from wells is inherent to the operation and maintenance of a petroleum facility. These risks can be managed through the implementation of effective control measures and associated performance monitoring (Table 5-2).

Table 5-2: Liquid hydrocarbon release from wells - summary of hazards and controls

Source of Risk (Hazard)	Control Preventative Measures
Well intervention operation. Rigless well intervention SL/electric line coiled tubing/hydraulic workover/well pumping operations. Entering into production well.	Primary well control systems.
	Secondary well control equipment.
	Well barrier envelope.
Loss of barrier envelope during production operations.	Well design.
	Corrosion monitoring.
	Instrument protective and alarm systems.
	Well integrity management monitoring of barrier status.
Well maintenance equipment failure.	Equipment maintenance, inspection and testing.
Human error during work-over, intervention or production operations.	Permit to work system.
	Contractor/vendor selection and management.
Vessel collision with platform.	Navigation aids.
	Conductor protection frame.
	500 m restriction zone surrounding the facility.
	Emergency communications.
	Platform location published on marine charts.
	Vessel operations restricted in adverse weather.

Source of Risk (Hazard)	Control Preventative Measures
Structural failure of the platform due to fatigue/ageing asset.	Structural design.
	Asset integrity management.
Dropped object/ swinging load onto wellhead during well intervention activities.	Lifting management procedures.
	Crane maintenance.

Control Mitigation Measures	
Isolation of wells as part of the facility ESD.	
Wandoo Emergency Response Plan [VOG-2000-RD-0017]/ Source Control Contingency Plan [VOG-5000-PD-0001].	
Oil spill response arrangements.	The Wandoo Field OSCP is established to mitigate the oil spill hazards identified in the respective environment plan.
	Response strategies provided in the OPPs are appropriate to: • the nature and scale and associated environmental impact of the potential spill hazards; • the nature and scale and associated environmental impact of the potential spill response strategies; and • the environmental sensitivities and priorities as outlined within the respective environment plan.
	The Wandoo Field OSCP describes incident management system and interfaces.
	Decision making processes support mitigation of environmental impact of spills and assessment of effectiveness of response strategies.
	The Wandoo Field OSCP shall contain processes to assess, test and maintain arrangements to meet the Wandoo Field OSCP outcomes through: • assurance processes; • capability assessment; and • review triggers.
Resources defined and available in a timely manner.	Equipment, services and personnel required for the first 20 days are identified within the OPPs.
	A logistics management plan is in place to inform deployment of resources in a timely manner
	Contracts are established for equipment and services for the full duration of a response.
Response strategy - Monitor and evaluate.	Ensure the most effective response strategies are being applied and environmental impact of the spill and response strategies are measured.
Response Strategy - Chemical dispersant application.	Increase the rate of biodegradation to reduce the environmental impact from surface oil and oil stranding on shoreline sensitivities.
Response strategy - Mechanical dispersant application.	Assist natural dispersion of oil into the water column to reduce environmental impact from surface oil.
Response strategy - Containment and recovery.	Reduce overall volume of surface oil to minimise impacts to environmental sensitivities.
Response strategy - Protection and deflection.	Minimise environmental impacts to priority near-shore environmental sensitivities by reducing oil contact.
Response strategy - Shoreline	Remove stranded hydrocarbons from shorelines without causing

Control Mitigation Measures	
clean-up.	greater environmental impact than leaving the hydrocarbons in-situ.
Response strategy - Oiled wildlife response.	Minimise and mitigate the number of wildlife oiled following a spill.
OSCP arrangements are accessible.	Current oil spill response arrangements are accessible to all personnel in the event of an oil spill.
OSCP arrangements are understood.	Oil spill response personnel understand and competently perform their response roles.

5.2 Liquid hydrocarbon release from export equipment, submarine hose, floating hose and export flow lines

5.2.1 Activity

Crude oil is exported from the Wandoo facilities into an offtake tanker every three to five weeks, typically lasting for 24 to 48 hours depending on the cargo size. The transport of hydrocarbons carries an inherent risk of spills that needs to be managed.

The following three credible crude oil spill hazard scenarios have been identified:

- Loss of crude oil from export system (assumed to be up to 300 m^3 of Wandoo Crude);
- Breach of an oil tanker cell (assumed to be up to 10,000 m^3 of Wandoo Crude); and
- Breach of oil tanker's fuel tank (assumed to be up to 1300 m^3 heavy fuel oil [HFO]).

5.2.2 Assessment

Loss of crude oil from export system

A subsea release will behave differently from a surface spill. Initially, the plume will rise until it reaches the surface, after which it will largely behave like a surface release. However, the level of entrainment is higher for a subsurface release, and the rate of entrainment largely depends on the exit velocity.

Due to the small potential spill volume, any impacts are anticipated to be localised and short term in nature. The closest sensitive habitats to the Permit Area are located in the Dampier Archipelago and Montebello Islands, 40 km and 90 km from the Permit Area respectively. As a significantly larger instantaneous spill of 10,000 m^3 has only a low probability of impacting these habitats, it is considered highly unlikely that crude from the above spill scenarios would reach these habitats.

Minor impacts could occur on fauna in the immediate vicinity of the spill, including plankton, fish, marine mammals, reptiles and seabirds.

Breach of an oil tanker cell

RPS APASA undertook spill trajectory modelling on an instantaneous 10,000 m^3 surface release of Wandoo Crude (tracked for 40 days) using summer, winter and transitional wind and current conditions. The modelling results indicate that once on the sea surface, the crude oil was predicted to travel northeast due to the prevailing winds during summer conditions. The oil

makes contact with the shorelines on or about Day 30 at the southern end of Eighty Mile Beach, north of Port Hedland.

The modelling results indicate that once on the sea surface, the crude oil was predicted to travel northwest due to the prevailing winds during summer conditions and a westerly direction during transitional and winter conditions.

The probability of shoreline contact was highest during summer and lowest during winter. The minimum time to contact was also lowest during winter conditions (2.5 days). The application of dispersant did not have a significant impact on the probability of shoreline contact. The largest reduction in probability of contact was 2% during winter conditions. The application of dispersant had a minimal impact on time to contact during winter and transitional conditions. However, the application of dispersant has the potential to reduce the time to shoreline contact by 5.4 days during summer conditions.

As expected, the extent of entrained hydrocarbons changed considerably during all seasons when dispersant was applied from on average <40 km to >300 km from the release site. Without the use of dispersant, subsurface plumes remained localised and were mostly limited to the low exposure threshold, with the exception of a small moderate exposure zone surrounding the release site.

Breach of oil tanker's fuel tank

HFO is a heavy, viscous, slowly spreading oil that loses little volume through evaporation of volatile components with a high proportion (83%) of persistent, non-volatile residual components (boiling point greater than 380°C). HFO has little to no tendency to entrain within the water column; it is also unlikely to disperse and biodegrade rapidly due to its persistent characteristics.

Potential physical impacts from HFO floating at the sea surface include coating of emergent habitats, oiling of wildlife at sea surface, and ingestion. HFO is a particularly persistent oil which has a high degree of stickiness, and therefore oiling of habitats and fauna by residual oil is the exposure pathway of greatest concern.

Sensitive receptors

Detailed descriptions of the potential effects of hydrocarbons on the surrounding marine environment in the event of a loss of well control (43,620 m^3) and instantaneous spill from the CGS (39,747 m^3) are provided in Table 5-1 and Table 5-4 respectively. The impacts associated with a 10,000 m^3 spill would be significantly less.

5.2.3 Control measures

The risk associated with a release of hydrocarbon from the export system is inherent to the operation of an offshore petroleum facility. These risks can be managed through the implementation of effective control measures and associated performance monitoring.

VOGA's assessment of the proposed activity concluded that the risks are being managed to ALARP because:

- there are sufficient layers of protection in place for the current risk level; and

- additional controls and alternative arrangements were not considered to be practical due to the associated increase to other risks.

Table 5-3: Liquid hydrocarbon release from export equipment, submarine hose, floating hose and export flow lines - summary of hazards and controls

Source of Risk (Hazard)	Control Preventative Measures
Offtake tanker station keeping failure causing hose rupture.	Marine breakaway coupling on the floating hose assembly (FHA).
	Hawser is fit for purpose.
	Structural integrity of CALM Buoy mooring.
	Weather restrictions apply to offtake activities.
	Wandoo Mooring Master/tanker pilot on board tanker during offtake.
Crude oil spill due to submarine hose, FHA or marine break coupling failure.	Asset integrity management.
	Operating within design limits.
Vessel collision with tanker whilst on station and connected to the Wandoo asset.	Weather restrictions apply to offtake activities.
	Platform location published on Marine Charts.
	Tanker navigation lights.
	Tanker VHF radio communications with shipping traffic.
Dropped objects/swinging load onto export systems.	Lifting management procedures.
	Crane maintenance.
Crude oil spill due to anchor drag during project activities between the north face of WNB and the CALM Buoy.	Cautionary zones around the subsea production systems are marked on field navigational charts.

Control Mitigation Measures	
Visual monitoring of FHA during offtake.	
Emergency shutdown of crude oil transfer in the event of a leak.	
Wandoo Emergency Response Plan [VOG-2000-RD-0017].	
Oil spill response arrangements.	The Wandoo Field OSCP is established to mitigate the oil spill hazards identified in the respective environment plan.
	Response strategies provided in the OPPs are appropriate to: • the nature and scale and associated environmental impact of the potential spill hazards; • the nature and scale and associated environmental impact of the potential spill response strategies; and • the environmental sensitivities and priorities as outlined within the respective environment plan.
	The Wandoo Field OSCP describes incident management system and interfaces.
	Decision making processes support mitigation of environmental impact of spills and assessment of effectiveness of response strategies.
	The Wandoo Field OSCP shall contain processes to assess, test and maintain arrangements to meet the Wandoo Field OSCP outcomes through: • assurance processes; • capability assessment; and • review triggers.

Control Mitigation Measures	
Resources defined and available in a timely manner.	Equipment, services and personnel required for the first 20 days are identified within the OPPs.
	A logistics management plan is in place to inform deployment of resources in a timely manner
	Contracts are established for equipment and services for the full duration of a response.
Response strategy - Monitor and evaluate.	Ensure the most effective response strategies are being applied and environmental impact of the spill and response strategies are measured.
Response Strategy - Chemical dispersant application.	Increase the rate of biodegradation to reduce the environmental impact from surface oil and oil stranding on shoreline sensitivities.
Response strategy - Mechanical dispersant application.	Assist natural dispersion of oil into the water column to reduce environmental impact from surface oil.
Response strategy - Containment and recovery.	Reduce overall volume of surface oil to minimise impacts to environmental sensitivities.
Response strategy - Protection and deflection.	Minimise environmental impacts to priority near-shore environmental sensitivities by reducing oil contact.
Response strategy - Shoreline clean-up.	Remove stranded hydrocarbons from shorelines without causing greater environmental impact than leaving the hydrocarbons in-situ.
Response strategy - Oiled wildlife response.	Minimise and mitigate the number of wildlife oiled following a spill.
OSCP arrangements are accessible.	Current oil spill response arrangements are accessible to all personnel in the event of an oil spill.
OSCP arrangements are understood.	Oil spill response personnel understand and competently perform their response roles.

5.3 Crude oil spill from CGS

5.3.1 Activity

The storage of hydrocarbons carries an inherent risk of spills, which needs to be managed. The hazard review identified the following credible causes of a release from the CGS:

- Degradation/collapse of the CGS shaft due to fatigue, corrosion of steel reinforcement, extreme storm;
- Impact from a colliding vessel; and
- Tanker station keeping failure.

5.3.2 Assessment

Oil spill trajectory modelling (OSTM) on an instantaneous 39,747 m^3 subsurface release of Wandoo Crude from the CGS tank using summer, winter and transitional wind and current conditions was undertaken.

Sea surface exposure

The modelling results indicate that once on the sea surface, the crude oil was predicted to travel north-east due to the prevailing winds in summer, and a westerly direction during transitional and winter conditions. Modelling indicated that the application of dispersant will make no discernible difference to the predicted sea surface exposure zones.

Entrained hydrocarbons

The potential zones of high entrained hydrocarbon concentration (>48,000 ppb-hrs) were predicted to be greatest in the 0-10 m water depth and predominantly extend to the northeast from the release site during summer and the transitional period and southwest during winter. The overall extent of entrained hydrocarbons did not change significantly as a result of the application of dispersant.

Shoreline accumulation

The probability of shoreline contact was highest during summer and lowest during winter. The depending on the weather and ocean conditions at the time, initial to oil contact to the shoreline of Montebello Islands may occur 72 hours post spill. Spill response planning has be established based on the total maximum volume of shoreline and minimum shoreline contact.

Sensitive receptors

Table 5-4: Summary of environmental impacts due to a release of Wandoo Crude from the CGS tank

Environmental sensitivity	Exposure mechanism	Impact
Marine habitats		
Coral reef communities	Entrained and surface	No coral reef communities are found within the Permit Area. Within the ZPI, sporadic fringing coral reefs are expected to occur around the majority of islands and significant coral reefs can be found around Dampier Archipelago, Ningaloo Reef and the Montebello/Barrow/Lowendal islands. Spill modelling results indicate that in the event of an instantaneous release of crude from the CGS: • High entrained hydrocarbon exposures have the potential to extend to coral reef communities around Montebello/Barrow/Lowendal islands during winter season; • Moderate entrained hydrocarbons exposures have the potential to reach coral communities around Ningaloo Reef during winter season; • High surface hydrocarbon exposures to intertidal coral communities may occur at the Montebello/Lowendal Islands and the Dampier Archipelago regardless of season; and • High surface hydrocarbon exposures to intertidal coral communities may occur at the Ashmore and Scott Reef during summer and winter seasons. The periodic exposure to entrained hydrocarbons as the affected water moves past the corals could result in lethal impacts to some corals. Sub-lethal effects on adult colonies include increased mucous production, decreased growth rates, changes in feeding behaviour and expulsion of zooxanthellae. Planktonic stages of coral are more likely to be susceptible to entrained oils than adult colonies (Heyward et al., 1994). Direct contact with surface oils could lead to chemical toxicity across cellular structure leading to coral bleaching and colony death. Instead of acute mortality, it is more likely that oil effects occur in sub-lethal forms, such as reduced photosynthesis, growth or reproduction (NOAA, 2014). However, surface oil contact is limited to intertidal corals, which which will be periodically exposed to the surface hydrocarbons as well as planktonic stages of corals in particular during periods of coral spawning. Intertidal coral reefs within the region such as those at Montebello/Barrow/Lowendal Islands, Dampier Archipelago and Ashmore and Scott Reef also have the potential for smothering due to shoreline accumulation. Modelling outputs are an aggregate of all potential spill trajectories and therefore it is not credible that all receptors would be exposed at any one time. On this basis, impacts to these areas (including spawning) are likely to be limited and re-colonisation/recovery could be expected over time. In the event of an instantaneous release from the CGS there is a potential for hydrocarbon exposures to result in significant but recoverable (in >1 year) species or habitat damage.
Macro-algae	Surface	Macro-algal habitat within the region is widespread and there are no specifically identified areas of significant environmental value. In

Environmental sensitivity	Exposure mechanism	Impact
		the event of an instantaneous release of crude from the CGS, macro-algae in intertidal areas have the potential to be exposed to surface hydrocarbons. Residues may be left in the area as the tide ebbs, but will be flushed with each flood tide. Studies have shown that macro-algae appear to recover rapidly from oiling, irrespective of the degree of impact and level of oiling. This is attributed to the fact that most of the new algae growth is produced near the base of the plant while distal parts (which would be exposed to the oil contamination) are continually lost (Connell and Miller, 1981). In the event of an instantaneous release from the CGS, there is a potential for hydrocarbon exposures to intertidal areas where macro-algae may occur, to result in temporary and recoverable impacts to macro-algal habitats.
Seagrass	Surface and entrained	No seagrasses are found within the Permit Area. Within the ZPI, seagrasses cover extensive areas of Shark Bay and can be found adjacent to offshore island including those of Dampier Archipelago and Montebello and Barrow islands. Spill modelling results indicate: • High entrained hydrocarbon exposures have the potential to extend to seagrass communities around Montebello and Barrow islands during winter season; • Moderate entrained hydrocarbons exposures have the potential to reach seagrass communities around the Exmouth Gulf during winter season; and • High surface hydrocarbon exposures to intertidal coral communities may occur at the Montebello/Lowendal Islands and the Dampier Archipelago regardless of season. Oil may smother leaves of seagrass beds in shallow inter tidal areas. Intertidal seagrass communities would theoretically be the most susceptible because the leaves and rhizomes may both be affected. The primary impacts to seagrasses are likely to be caused by a reduction in available light and subsequent reduction in photosynthesis. However the reduction will only be over areas for short periods of time as the slick moves with currents, wind and tides and as such impacts are limited. Hence, while impacts are possible, they will not be extensive throughout the ZPI. In the event of an instantaneous release from the CGS, there is a potential for hydrocarbon exposures to result in significant but recoverable species or habitat damage.
Mangroves	Shoreline	No mangrove communities are found within the Permit Area. Significant areas of mangrove occurring within the ZPI include the Dampier Archipelago, Montebello Islands and the Ningaloo coastline and Hosnies Spring Christmas Island. Hosnies Spring is also a declared Ramsar wetland. Spill modelling results show that a maximum volume of 2,355 m^3 may occur at the Montebellos; and oil at a thickness of 1 kg/m^2 has the potential to impact the Dampier Archipelago and Montebello Islands. Observations by Lin and Mendelssohn (1996), demonstrated that more than 1 kg/m^2 of oil during the growing season would be required to impact marsh or mangrove plants significantly. However mangrove recovery from hydrocarbon exposures is possible but can long time. Subsequently the impact is significant but recoverable species of habitat damage.
Intertidal	Shoreline	Intertidal beaches and mudflats are widespread throughout the ZPI. Three intertidal beach/mudflat areas of international conservation

Environmental sensitivity	Exposure mechanism	Impact
beaches/ mudflats/rocky shorelines/ intertidal reef platforms		significance occur within the region (Bandicoot Bay, Eighty Mile Beach and Roebuck Bay). Spill modelling results indicate that moderate shoreline accumulation may occur at Bandicoot Bay, Eighty Mile Beach and Roebuck Bay. Oil has the potential to interfere with infaunal organisms in these areas either by modifying the habitat or smothering the feeding respiratory and/or locomotory structures of these organisms. Hydrocarbons may be left on the intertidal shores as the tide ebbs, but it would be expected that this would be flushed with each flood tide. Natural flushing is more likely to reduce impacts in exposed areas of shoreline. Subsequently the impact is short term localised disruption of ecosystem.
Sandy beaches	Shoreline	The values associated with sandy beaches are assessed with regard to the following environmental sensitivities: marine reptiles, seabirds and other users.
Protected and threatened species		
Fish and sharks	Entrained	Fish and sharks are expected to be present within the Permit Area and ZPI. However, their presence is generally transient and sporadic (Etkin, 2003). Fish and sharks are most likely to be impacted by entrained hydrocarbons as they dwell in the water column. Fish and shark kills as a result of a spill in the open water are unlikely, as spill modelling indicates limited zones of high entrained hydrocarbon exposure. Fish and sharks also have the ability to detect and avoid areas of contamination. The larval stage of fish is more likely to be susceptible; however, in comparison to predation and natural loss, any impacts would be over a small proportion of the marine environment in which they may occur and any measurable impact at the population level is considered to be low. In addition, fish mortality from oil spills is rarely reported and significant population level impacts are unlikely. Whale sharks are vulnerable during seasonal aggregations when they are observed swimming close to the surface, but otherwise remain away from surface for long periods and to depths beyond 700 m (DoEE, 2016b). Mako sharks are pelagic and tend to occur in waters less than 50 m deep, with occasional dives up to 640 m deep. As such, impacts are unlikely. Subsequently the impact is localised disruption of behaviours/ecosystem.
Marine mammals	Surface/ entrained	Eight cetaceans listed as threatened or migratory under the EPBC Act may potentially occur in the Permit Area, and 15 listed marine mammals may potentially occur in the ZPI. The northward migration path of the humpback whale is seaward of the Permit Area and large numbers of humpback whales travel through this area annually between July and August. Dolphins are also known to occur and transit through the Permit Area and ZPI. **Entrained** Spill modelling results predict that a potential zone of low entrained hydrocarbon exposure will travel as far south as One Arm Point and as far north as Geraldton during the winter season. A potential zone of high entrained hydrocarbon exposure will also extend to the Montebello, Barrow and Lowendal Islands during winter season. Marine mammals that transit through this area will be exposed to entrained hydrocarbons in the event of a spill.

Environmental sensitivity	Exposure mechanism	Impact
		Surface Modelling also predicts that moderate and high surface hydrocarbon exposures have the potential to extend across the ZPI including the migration route during all seasons. It is possible for whales to be exposed to surface hydrocarbons if the hydrocarbon release occurs during the migration period. Marine mammals are also likely to come in contact with surface oil as they return to the surface to breathe. However short-term inhalation of petroleum vapours at concentrations similar to those found in oceanic spills may not be detrimental either in terms of structural tissue damage or respiratory gas exchange. Cetaceans will not be sensitive to the physical effects of oiling as they are smooth skinned hairless mammals and oil tends not to stick to their skin. Oiling of pinnipeds (seals and sea lions) can cause removal of natural water repellent oils from their fur, making them less buoyant and susceptible to hypothermia (Kucklick, 1997). However given that oil will be significantly weathered and dispersed by the time it reaches the pinniped habitats, it is unlikely to result in significant exposure to a large population. The highest potential risks for dugongs are related to direct ingestion of seagrass or macro-algae exposed to acute or chronic toxicity and or drastic reduction on seagrass coverage due to hydrocarbon spills (Heinsohn et al., 1977). As explained for these receptors, impacts are unlikely to be extensive and are recoverable. Given that the area of potential impact is relatively small in relation to the offshore environment, and cetaceans and other marine mammals would be transitory, any interface with hydrocarbons is unlikely to cause an impact to significant numbers. However, the impact is classified as major as there is potential for exposure to individual cetaceans and other protected species.
Marine reptiles	Surface	Species of seasnakes and marine turtles are known to occur in the Permit Area and the ZPI. Spill modelling results predicts zones of high and moderate surface hydrocarbon exposures in these areas in the event of an instantaneous release of crude from the CGS. Marine reptiles are likely to come in contact with oil in the event of a spill as they surface to breathe. Harmful effects may occur through ingestion of oil, inhalation of toxic vapours (e.g. close to the spill source) or irritation to the head, neck and flippers due to oil contact with the skin. Within the immediate vicinity of the spill event, where hydrocarbons are still fresh, this could lead to fatal impacts on individuals, but is unlikely to have a population effect. The impact is classified as major as there is potential for single fatalities of protected species.
	Shoreline	No significant marine reptile habitat is known to occur within the Permit Area. However, important turtle nesting sites within the ZPI include the Ningaloo Marine Park, Montebello/Barrow/Lowendal Islands, Dampier Archipelago, Eighty Mile Beach, Alas Purwo National Park and Meru Betiri National Park. Spill modelling results indicate that high shoreline accumulation may occur at Montebello/Barrow/Lowendal Islands, Dampier Archipelago, and Eighty Mile Beach. A maximum volume of 2,355 m^3 may occur at the Montebellos; and oil at a thickness of 1 kg/m^2 has the potential to impact the Dampier Archipelago and Montebello Islands. In the event that hydrocarbons did accumulate at a turtle nesting area, there is potential for adult turtles and/or hatchlings to be impacted. Potential impacts include smothering of adults and hatchling and/or avoidance behaviour of adult turtles. This could result in failed or aborted nesting attempts or a reduction in survival rates of hatchlings. As many turtle species do not nest exclusively within a single area, and as all of these areas would not be impacted for this scenario,

Environmental sensitivity	Exposure mechanism	Impact
		the impact is unlikely to affect the viability of the species, but may result in a significant but recoverable impact to the population if hatchlings over a season are impacted. The impact is classified as catastrophic as there is a potential for more than a single protected species fatality.
Seabirds	Surface	A number of threatened and migratory birds may occur within the Permit Area and ZPI. Modelling results predict zones of high (25 µm) and moderate (10 µm) surface hydrocarbon exposures within the Permit Area and the ZPI in the event of an instantaneous crude release from the CGS. Scholten et al. (1996) indicates that a layer of 25 µm thick would be harmful to birds that contact the slick. Estimates for the minimal thickness of oil that will result in harm to seabirds through ingestion from preening of contaminated feathers, or the loss of thermal protection of their feathers, has been estimated at 10 µm (French, 2009) to 25 µm (Koops et al., 2004). Oil spills can have a variety of effects including fouling of the plumage, ingestion of oil, effects on reproduction and physical disturbance. Many of the species that occur offshore are surface-feeding or plunge-diving pelagic birds, so that oil slicks would potentially interfere with feeding and increase exposure risk. Seabirds are expected to be present within the Permit Area and the ZPI, but their presence is transient and sporadic. Hence population level impacts are unlikely but mortality of protected seabirds may occur.
	Shoreline	There are no critical habitats for seabirds within the Permit Area. However, seabird breeding areas are found on Montebello/Barrow Islands, Rowley Shoals, Eighty Mile Beach and Roebuck Bay within the ZPI. Spill modelling results indicate that high (>1,000 µm) shoreline accumulation may occur at Montebello/Barrow Islands, Eighty Mile Beach and Roebuck Bay during all seasons. Given these shorelines provide habitat for a range of species, a large number of seabird mortalities may potentially occur if an oil spill reaches these areas during critical periods. Given all areas will not be impacted, the impacts are not likely to affect species viability. The impact is classified as catastrophic as there is a potential for more than a single protected species fatality.
Socio-economic receptors		
Fisheries and aquaculture	Surface/ entrained	Several managed commercial fisheries occur in the ZPI, some of which overlap the Permit Area. Fishing within the Permit Area is unlikely due to the safety exclusions zones and most fisheries operate in deep water seaward of the Permit Area. No fishing has been recorded in the Permit Area since 2012. However, several commercial fisheries have recorded catch efforts in the ZPI. In the event of a significant oil spill, surface oil is less likely to result in direct impacts to the fish, but may interfere with fishing operations through damage to vessels and fishing gear, exclusion to areas during clean-up operations and any follow-up monitoring and surveillance activities. There is also a potential that perceptions of fish tainting due to the spill could indirectly result in economic impacts to the fishery. Fish species themselves are more likely to be impacted by entrained hydrocarbons as they dwell in the water column. However, impacts are likely to be limited, as spill modelling indicates limited zones of high entrained hydrocarbon exposures and the majority of species dwell deeper in the water column. The larval stage of fish is more likely to be susceptible. However, in comparison to predation and natural loss, any impacts would be over a small proportion of the marine environment in which they may occur and any measurable impact at the population level is considered to be low. In addition, fish mortality from oil spills is rarely reported and the

Environmental sensitivity	Exposure mechanism	Impact
		likelihood of hydrocarbon residues reaching the seabed in significant volumes is low. While there are a number of fisheries that operate within the ZPI, the impacts will not be extensive across their large areas of operation, and would be temporary.
Other users	Surface	A number of tourist destinations occur within the ZPI, including Shark Bay, the Ningaloo Coast, Christmas and Cocos Islands. There is a wide variety of marine nature-based tourism in these areas such as diving, whale-watching, snorkelling and charter fishing. It is estimated that approximately $127 million is spent per year by visitors to the Ningaloo Marine Park, with a large portion of this attributed to the whale shark tourism industry. In the event of an instantaneous CGS release, depending on the fate and trajectory of the oil, there is the potential for temporary disruptions to tourism activities that could have a temporary impact to the tourism industry. As persistent hydrocarbons are likely to dissipate from the environment over time and, as the volumes ashore suggest remediation may be difficult or expensive, impacts are expected to be extensive but temporary. More broadly in the region, the impacts to humans and the activities themselves are not likely to significant. However, there is the potential for temporary closure of recreational activities, including diving due to the risk to public health and safety. This would be short term and limited to the area immediately affected by a spill. There is a possibility of impacts to tourism operators due to actual or perceived impacts to aesthetics and the regional marine resources by the general public through negative media attention. Any closures would be short term in nature, as entrained hydrocarbons will naturally disperse and any shoreline accumulation would break down due to natural weathering processes. Potential impacts are considered to be extensive but temporary.
Protected areas		
World Heritage Areas/ Commonwealth Marine Protected Areas/ State Marine Protected Area	Surface/ shoreline/ entrained	The Ningaloo Coast, Shark Bay and Komodo WHA occur within the ZPI and may be impacted in the event of an instantaneous CGS spill. There are no Commonwealth Marine protected areas or State Marine Reserves within the Permit Area but they do occur within the ZPI. The values associated with these areas have been assessed in terms of the protected/threatened species and marine habitat and socioeconomic receptor sections outlined above.

5.3.3 Control measures

VOGA carried out an assessment of alternative arrangements and additional controls for the proposed activity to reduce risk from a release from the CGS. The outcome of the assessment is summarised below:

- The installation of automatic identification radar to reduce the likelihood of a vessel collision causing a release from the CGS. VOGA considered that the additional control would only provide an early warning and may not provide an effective barrier to prevent the event. This measure was rejected.
- A source control plan for CGS was identified as required and developed.
- VOGA considered that the replacement of the CGS structure with an alternative was not feasible. Alternatives considered were WNB topsides replaced with subsea wells with tie back to shore or replacing the CGS with a Floating Storage and Offloading or a pipeline to shore.
- Limiting the inventory in the storage cells to reduce the potential impact in the event of a release from the CGS. If implemented, this measure would reduce the commercial viability of the operation as it would significantly reduce the production rates. It may also increase the presence of a tanker in the field, incurring additional risk associated with this activity.

Table 5-5: Crude oil spill from CGS - summary of hazards and controls

Source of Risk (Hazard)	Control Preventative Measures
Degradation/collapse of CGS shaft due to fatigue, corrosion of steel reinforcement, extreme storm etc.	Structural design of the CGS.
	Asset Integrity Management System.
	Management of Change (MoC) processes for changes to structural loading.
Passing vessel collision with Platform.	Emergency communications.
	Navigation aids.
	Platform location published on Marine Charts.
	500 m restriction zone surrounding the facility.
Attending vessel collision with Platform.	Station keeping requirements for vessels.
	Structural design of the CGS.
	Vessel operations restricted in adverse weather.
	Permission required for field entry, CALM Buoy approach, mooring-up and departure.
Tanker station keeping failure.	Hawser is fit for purpose.
	Structural integrity of CALM Buoy mooring.
	Tanker position controlled by support vessel.
	Weather restrictions.

Control Mitigation Measures	
Wandoo Emergency Response Plan [VOG-2000-RD-0017]/ Source Control Contingency Plan [VOG-5000-PD-0001].	
Oil spill response arrangements.	The Wandoo Field OSCP is established to mitigate the oil spill hazards identified in the respective environment plan.
	Response strategies provided in the OPPs are appropriate to: • the nature and scale and associated environmental impact of the potential spill hazards;

Control Mitigation Measures	
	• the nature and scale and associated environmental impact of the potential spill response strategies; and the environmental sensitivities and • priorities as outlined within the respective environment plan.
	The Wandoo Field OSCP describes incident management system and interfaces.
	Decision making processes support mitigation of environmental impact of spills and assessment of effectiveness of response strategies.
	The Wandoo Field OSCP shall contain processes to assess, test and maintain arrangements to meet the Wandoo Field OSCP outcomes through: • assurance processes; • capability assessment; • and review triggers.
Resources defined and available in a timely manner.	Equipment, services and personnel required for the first 20 days are identified within the OPPs.
	A logistics management plan is in place to inform deployment of resources in a timely manner
	Contracts are established for equipment and services for the full duration of a response.
Response strategy - Monitor and evaluate.	Ensure the most effective response strategies are being applied and environmental impact of the spill and response strategies are measured.
Response Strategy - Chemical dispersant application.	Increase the rate of biodegradation to reduce the environmental impact from surface oil and oil stranding on shoreline sensitivities.
Response strategy - Mechanical dispersant application.	Assist natural dispersion of oil into the water column to reduce environmental impact from surface oil.
Response strategy - Containment and recovery.	Reduce overall volume of surface oil to minimise impacts to environmental sensitivities.
Response strategy - Protection and deflection.	Minimise environmental impacts to priority near-shore environmental sensitivities by reducing oil contact.
Response strategy - Shoreline clean-up.	Remove stranded hydrocarbons from shorelines without causing greater environmental impact than leaving the hydrocarbons in-situ.
Response strategy - Oiled wildlife response.	Minimise and mitigate the number of wildlife oiled following a spill.
OSCP arrangements are accessible.	Current oil spill response arrangements are accessible to all personnel in the event of an oil spill.
OSCP arrangements are understood.	Oil spill response personnel understand and competently perform their response roles.

5.4 Environmental impacts of oil spill response

5.4.1 Activity

While spill response activities are intended to reduce the potential environmental consequences of a hydrocarbon spill, response activities could potentially exacerbate or cause further environmental harm. Decisions regarding spill response activities need to consider both the potential environmental impacts associated with taking no action and the potential environmental impacts associated with a response activity or combination of spill response activities. Poorly planned and coordinated response activities can result in a lack of or inadequate information and poor decisions being made during incident response.

Response activities can result in:

- Spreading of hydrocarbons further beyond the zone of contamination (e.g. secondary contamination due to hull contamination of response vessels);
- Inadequate surveillance leading to poor information and unforeseen impacts; or
- Inappropriate response strategy implemented and additional sensitive receptors impacted (e.g. use of dispersants when containment and recovery would have been of greater benefit).

5.4.2 Assessment

A summary of the credible spill response strategies for each of the spill scenarios is illustrated in Table 5-6.

Table 5-6: Summary of credible spill response strategies for each spill scenario

	Category A	Category B	Category C	Category D	Category E	Category F
Upper credible scenario	*Single release 300 m^3 Wandoo Crude*	*Single release 827 m^3 diesel spill*	*Single release 1300 m^3 HFO*	*Single release 10,000 m^3 Wandoo Crude*	*Continuous 727 m^3/day (for 60 days) Wandoo Crude spill*	*Single release 250,000 bbl over 24 hours from CGS*
Predicted outcomes	*Based on modelling for other scenarios, oil is expected to remain offshore and not impact shorelines*	*Is expected to evaporate and spread rapidly with no shoreline impact*	*Based on modelling for other scenarios, oil is expected to remain offshore and not impact shorelines*	*Shoreline impact varies with season, modelling suggests a 49% probability of contact to any shoreline during summer within about 3 days*	*Modelling suggests a greater than 80% probability of contact to any shoreline throughout all seasons within about 3-4 days*	*Modelling suggests a probability of 21% of shoreline impact during summer within about 4 days*
Source control	Yes	Yes	Yes	Yes	Yes	Yes
Monitor and evaluate	Yes	Yes	Yes	Yes	Yes	Yes
Chemical dispersion	Yes	No	Yes	Yes	Yes	Yes
Mechanical dispersion	Yes	No	Yes	Yes	Yes	Yes

	Category A	Category B	Category C	Category D	Category E	Category F
Upper credible scenario	*Single release 300 m^3 Wandoo Crude*	*Single release 827 m^3 diesel spill*	*Single release 1300 m^3 HFO*	*Single release 10,000 m^3 Wandoo Crude*	*Continuous 727 m^3/day (for 60 days) Wandoo Crude spill*	*Single release 250,000 bbl over 24 hours from CGS*
Containment and recovery	Yes	No	Yes	Yes	Yes	Yes
Protection and deflection	No	No	No	Yes	Yes	Yes
Shoreline clean-up	No	No	No	Yes	Yes	Yes
In-situ burning	No	No	No	No	No	No
Oiled wildlife response	Yes	Yes	Yes	Yes	Yes	Yes

Source control

Source control activities such as emergency shut down and isolation of equipment will reduce the volume of oil released to the marine environment. Consequently, these response strategies will not create additional impacts on the marine environment over and above the spill itself.

Drilling a relief well may be required if there is a total loss of well control. The response process to be followed in the event of a loss of well control incident is outlined in the Wandoo Field Source Control Contingency Plan [VOG-5000-PD-0001]. If a relief well was required, it would be drilled using a semi-submersible or jack-up Mobile Offshore Drilling Unit (MODU) located within the Permit Area. The impacts associated with drilling a relief well are detailed in the Well Construction EP [WPA-7000-YH-0001].

Monitor and evaluate

There are a number of generic impacts that could potentially arise from vessel and aircraft operation. The nature of these additional routine impacts (e.g. discharges, emissions, vessel movements) and unplanned impacts (e.g. diesel spills) are described within various Wandoo Facility EP hazard sections.

Chemical dispersion

The application of chemical dispersant is highly effective in assisting the natural process of biodegradation and minimising the risk of oil impacts to vulnerable coastal receptors on the Dampier Archipelago and the Barrow, Montebello, Great Sandy and Lowendal islands, as well as the mainland of the WA coastline.

Potential impacts from the use of chemical dispersants include:

- Increased toxicity to marine habitats and fauna due, to the addition of dispersant chemicals to the marine environment; and
- Increased toxicity to marine habitats and fauna due to dispersed oil in the water column in the form of entrained oil and dissolved oil.

The decision to use chemical dispersants, as with all response strategies, is governed by the outcomes of a Net Environmental Benefit Analysis (NEBA). In this case, a NEBA will consider the benefit of reducing the volume of floating oil against the potential impacts of increasing the volume of subsurface oil and the introduction of the chemical dispersant itself.

Containment and recovery

A containment and recovery spill response should generally have an increase in net environmental benefit for most species and habitats. However, during a shallow-water response, there is the potential that disturbance to benthic communities could occur due to vessel activities and/or boom anchoring. Vessel size and/or draft will limit speed, manoeuvrability and access to operate.

Physical disturbance of habitat during deployment and retrieval of sorbents could occur. Poorly deployed or tended sorbent material could also crush or smother sensitive organisms. If sorbents are left in place for too long, there is a risk that the sorbents can break apart and become an ingestion hazard to wildlife.

Waste generated from the containment and recovery process includes oily sorbents. The collection of oil and the transport of oil and oiled equipment to either an offshore processing or an onshore disposal/wash-down site will create the potential for an accidental release of hazardous wastes as described in non-hazardous and hazardous waste (Section 5.14). Free-floating oil removed during skimming operations can be recycled. Emulsions formed during the process must be treated (broken) before recycling. Oil-contaminated waste from the treatment phase will be treated as waste water.

Mechanical dispersion

In addition to generic vessel impacts, the potential use of vessels for propeller-washing to mechanically disperse spilt oil in shallow coastal waters introduces the potential for damage to sensitive seabed habitats such as coral reefs, macro-algae beds and seagrasses. Potential damage could occur from accidental vessel grounding or propeller-wash (turbulence) in shallow water. These impacts could include scouring of sediments and physically damaging/removing subtidal habitat, together with any supported invertebrate communities. Mechanical dispersion will only be carried out in waters deeper than 20 m; hence impacts to sediments and subtidal habitats are unlikely.

Protection and deflection

Protection and deflection could involve the use of vessels near shallow coastal areas where sensitive habitats and aggregations of wildlife may be present. In addition to generic vessel impacts, the operation of vessels near shallow waters increases the risk of damage to sensitive habitats (hard corals, macro-algae, and seagrasses) from vessel grounding, manoeuvring and anchoring. Sensitive habitat areas will be avoided during vessel grounding and anchoring.

Poorly placed deflection booms could potentially direct floating oil to shoreline areas where impacts could be more severe (e.g. mangrove areas) and, also, exacerbate the level of impact and recovery time for the ecosystem. Sensitive receptors identified in the Wandoo Facility EP will be avoided when placing protection and deflection booms.

Sediment barriers used for protection and deflection may become contaminated on the oil side and filter fence materials will have to be disposed of as oily wastes.

Shoreline clean-up

OSTM indicates that there is a high probability of shoreline contact under a range of scenarios, with locations most likely to be impacted being the Montebello Islands, the Rowley Shoals and the coastline between Port Hedland and Broome.

Accessing shorelines for clean-up will have associated ecological constraints, especially if accessing uninhabited, sensitive coastal areas. Environmentally intrusive or potentially damaging activities should only be considered if there is a positive net environmental benefit. If significant shoreline oiling occurs, removal of vegetation may be required. Habitat removal will have significant impacts on the function of coastal ecosystems.

Physical clean-up methods can alter the elevation or profile of beaches, which may lead to erosion of beaches following the clean-up process, particularly if heavy machinery is used. The impact of shoreline clean-up techniques on various habitat types has been evaluated in the Wandoo Facility EP.

Oiled wildlife response

Hazing involves the use of visual, auditory or sensory deterrents to keep healthy marine fauna away from the oil. This can lead to the separation of groups or adults/juveniles, collisions with marine fauna, inadvertent movement of animals into the oiled area, or scattering of oiled animals.

Pre-emptive capture involves the capture and relocation of marine fauna before they become oiled. Potential impacts include relocation to inappropriate areas that will not support the animal's requirements (e.g. habitat, food sources).

The goal of search and capture is to collect as many live oiled animals as quickly as possible and in the best possible condition to maximise survival. Marine fauna may be injured during collection and, if their condition is already poor due to oil contact, inexperienced handling can rapidly exacerbate their condition.

Field stabilisation is required prior to further treatment of oiled animals, to ensure they can cope with the cleaning and rehabilitation process that will follow. Effective field stabilisation requires deployment of adequate handlers to appropriate locations in a timely manner.

Although there are potential impacts to marina fauna from oiled wildlife response, these impacts are likely to be less than the potential impacts to marine fauna from oil. Following a spill, some slightly oiled fauna may survive, but those that are very heavily oiled are likely to die. Prompt initialisation of an oiled wildlife response that quickly and effectively collects wildlife and provides a means for humane euthanasia, or rehabilitation and release, minimises wildlife suffering.

5.4.3 Control measures

All spill response strategies are subject to a NEBA which is described in the Wandoo Field Oil Spill Contingency Plan (OSCP) [WAN-2000-RD-0001], and considers:

- Risk, impacts and benefits associated with each strategy and whether it is consistent with the Wandoo Facility EP;

- Environmental sensitivities and their priority (environmental significance, severity of impact and recovery time);
- Seasonal and migratory patterns; and
- State (WA) jurisdictional requirements and approvals.

The control measures applicable to each response strategy are outlined in Table 5-7.

Table 5-7: Environmental impacts of oil spill response - summary of hazards and controls

Source of Risk (Hazard)	Control Preventative Measures
Response strategy - Monitor and evaluate.	Ensure the most effective response strategies are being applied and environmental impact of the spill and response strategies are measured.
Response Strategy - Chemical dispersant application.	Application of chemical dispersant in accordance with the dispersant application zones.
Response strategy - Mechanical dispersant application.	Application of mechanical dispersant activities in accordance with application zones.
Response strategy - Containment and recovery.	Deployment of equipment will be undertaken by trained incident response personnel.
Response strategy - Protection and deflection.	Deployment of equipment will be undertaken by trained incident response personnel.
	Booms shall only be installed after consultation and approval from the Department of Transport.
Response strategy - Shoreline clean-up.	Shoreline assessments will be used to select appropriate shoreline clean-up techniques.
Response strategy - Oiled wildlife response.	Induction and training for onshore and offshore teams.
OSCP arrangements are accessible.	Current oil spill response arrangements are accessible to all personnel in the event of an oil spill.
OSCP arrangements are understood.	Oil spill response personnel understand and competently perform their response roles.
Control Mitigation Measures	
Environmental monitoring of impact of the spill and response strategies.	

5.5 Diesel spill to sea

5.5.1 Activity

Diesel is bunkered onto the facility from a supply vessel and stored in Shaft 2 before being transferred into the pedestal tank. The main potential causes of loss of diesel include:

- Loss of diesel from the diesel bunkering vessel (or any other vessel) caused by collision with another vessel or the Facility;
- Diesel spill caused by hose rupture during bunkering operation; and
- Potential overflow from pedestal tank or day tanks, or rupture of diesel distribution network.

5.5.2 Assessment

Marine habitats

The modelling by RPS APASA (2012) showed that diesel at the moderate exposure threshold (10 µm) would not reach the shoreline.

Diesel at the low exposure threshold (1 µm) had a 4% probability of contacting shorelines and a 1% probability of reaching the significant coral reef communities and mangroves fringing the Montebello and Legendre islands. Significant impacts from this phase of hydrocarbon are considered unlikely, given the low probability of the diesel reaching these habitats and the low level of impacts likely at this exposure level,.

Marine fauna

Fish, marine mammals, marine reptiles and seabirds that come into contact with marine diesel may be directly affected.

A diesel spill may result in the localised mortality of planktonic organisms as they are unable to move away from affected areas. Potential effects are considered negligible, given the relative abundance of these types of organisms, the extent of their potential habitat in the offshore environment, and the localised nature of a single spill trajectory.

The area of moderate exposure is limited to offshore waters within 162 km of the release site. Within this area there is potential for fish, marine mammals, marine reptiles and seabirds to be affected by acute toxicity of diesel, however given the localised nature of a single spill trajectory and the fact that the majority of species are highly mobile, avoidance behaviour would be likely and high levels of mortality of fish and other species is not predicted.

The potential impacts of the diesel spill from bunkering and the pedestal tank are likely to be similar to those described for the diesel spill from a vessel collision, though at a much more localised scale due to the smaller volume and duration of the spill.

The potential impacts of spill response activities are discussed in Section 5.4.2.

5.5.3 Control measures

Table 5-8: Diesel spill to sea - summary of hazards and controls

Source of Risk (Hazard)	Control Preventative Measures
Loss of diesel from support/bunkering vessel caused by collision with another vessel or the Facility.	Navigational lights on vessels.
	Permission required for field entry, mooring-up and departure.
	Station keeping requirements for vessels.
	Speed limit for all vessels inside the 500 m restricted zone.
	Vessel operations restricted in adverse weather.
Diesel spill caused by hose rupture during bunkering.	Pressure rating of the diesel hose exceeds the maximum pressure from the vessel pump.
	Breakaway coupling along hose to prevent spill due to vessel loss of position.
	Bunkering procedure.
	Station keeping requirements for vessels.

Source of Risk (Hazard)	Control Preventative Measures
Potential overflow from pedestal tank or day tanks or rupture of diesel distribution network.	Crane pedestal has high level alarm.
Control Mitigation Measures	
SOPEP for vessels addresses potential spill response.	
Wandoo Emergency Response Plan [VOG-2000-RD-0017].	
Oil Spill Response arrangements.	

VOGA carried out an assessment of alternative arrangements and additional controls to reduce the risk from diesel spills. An alternative arrangement for diesel delivery was identified. The potential impact of a diesel spill could be decreased by reducing the supply vessel's diesel inventory. This alternative was rejected as it would require diesel bunkering to be carried out more frequently, potentially resulting in:

- Increased vessel movements with associated increased collision and spill frequency;
- Increased risk of release during bunkering; and
- Additional fuel usage and cost.

No additional controls were identified.

5.6 Discharge of PFW and ballast water from Facility

5.6.1 Activity

Water naturally present in the reservoir from which the hydrocarbons are extracted is treated, processed and discharged as PFW. The composition of the PFW varies from field to field but PFW typically contains concentrations of trace petroleum hydrocarbons, phenols, organic acids, metals, radioisotopes and residual process chemicals.

Currently, Wandoo discharges up to 26,100 m^3/day of PFW and ballast water. With the addition of a second IFSU, this will increase up to 33,500 m^3/day. An improved OIW recovery process, made possible by the addition of a second IFSU by 2018, means that while the volume of PFW being discharged increases, the concentration of hydrocarbons in the PFW will be reduced. As the ISFU achieves 90% of the oil recovery from PFW in the Wandoo process, the addition of a second IFSU will reduce OIW levels by 30%.

5.6.2 Assessment

PFW contains the following components that have the potential to impact the marine environment. These can be summarised as follows:

- Trace hydrocarbons;
- Trace total and dissolved metal/metalloids;
- Total ammonia;
- Radionuclides;
- Trace production chemicals; and

- Physical properties (temperature, salinity, pH, etc.).

Net assessment

The increased water throughput will result in a reduced net change in the potential area of impact. The modelling results indicate that the area of exposure is within 1,360 m of the platform for all constituents. Although the maximum distance from the platform for ammonia dispersion may increase, the area of potential impact from OIW is likely to reduce. Modelling predicts that the potential exposure for metals and production chemicals for the proposed scenario will be similar to the current scenario.

The hydrocarbon content of the PFW has the potential to impact on a number of key sensitivities such as plankton, marine mammals and reptiles, and fish as outlined above. As a decrease in the overall area of exposure for hydrocarbons is predicted, the likelihood of exposure of key sensitivities will decrease.

Modelling results predict that the potential area of exposure for ammonia may increase for the proposed scenario, however no increase in impacts to key sensitivities is expected as:

- Ammonia breaks down rapidly in the marine environment. It is rapidly assimilated from water by phytoplankton, algae and bacteria as sources of nitrogen (Dodds et al., 2002; Smith, 2003); and
- Ammonia will only impact certain sensitivities; potential impacts include eutrophication and impacts to planktonic species and fish.

In comparison to the current scenario the proposed scenario presents a decrease in the overall impact of PFW. As hydrocarbons in PFW are more persistent and likely to impact on marine sensitivities than other components, a substantial decrease in the area of exposure of hydrocarbons of 121,940 m^2 to 88,645 m^2 will overall reduce potential PFW impact. As ammonia breaks down rapidly in the marine environment and only impacts certain sensitivities, increasing the potential area of impact for ammonia from 200 m to 300 m is unlikely to result in an increase in potential impacts. Therefore increasing the PFW flow rate is expected to result in a decrease in the overall environmental impact of PFW and ballast water discharge.

Table 5-9: Key ecological sensitivities and potential effects from PFW exposure

Sensitive receptor	Potential interaction with PFW	Potential Impact within the PFW Mixing Zone	Net Impact Assessment
Coral reef communities, seagrass, mangroves, intertidal mud and sand flats, rock shorelines intertidal platforms	Not present in the vicinity of the area of potential impact.	No impact as these marine habitats are not present in the area of potential exposure.	No impact, the marine habitats are not present in the area of potential PFW exposure.
Macroalgae	Macroalgae is not known to occur in the Permit Area although may be present on the platform as marine growth in the upper layer of the water column.	If macroalgae is present on the platform it will likely be exposed to PFW. Hydrocarbon concentrations in PFW are too low to impact on macroalgae. Exposure to ammonia may result in eutrophication, this is unlikely in the open water marine environment at Wandoo.	In the event that macroalgae is exposed to PFW, impacts are unlikely as hydrocarbon concentrations are too low to impact on macroalgae and eutrophication as a result of ammonia is unlikely in the open water environment at Wandoo.
Marine mammals	Eight cetaceans that are listed as threatened or migratory under the EPBC Act may potentially occur in the Permit Area. The main migration path of humpback whales during the northward migration (July to October) is believed to be centred along the 200 m bathymetric contour (Jenner et al., 2001), which is seaward of the Permit Area but is unlikely to intercept the current or proposed area of potential impact. Blue whales have the potential to transit in the Permit Area. Antarctic blue whales have a similar migration path to that of the humpback whale.	Hydrocarbons Marine mammals may be exposed to hydrocarbons in the PFW as they surface to breathe. The modelling results indicate that decreasing the OIW concentration and increasing the flow rate will reduce the area of potential exposure, therefore the likelihood of exposure of marine mammals is lower for the proposed flow rate. Within the area of exposure the modelling results also predict that the continuous duration the OIW concentration is above assessment criteria lower for the proposed flow rate. Results of PFW monitoring and field sampling also indicate that the concentrations hydrocarbons in the PFW and surface water are currently low. The hydrocarbon concentration will decrease for the proposed scenario.	An overall reduction in PFW exposure to marine mammals is predicted. Marine mammals are highly unlikely to remain within the PFW for a sufficient duration to result in an impact.

Sensitive receptor	Potential interaction with PFW	Potential Impact within the PFW Mixing Zone	Net Impact Assessment
	Sei whales are not often found near the coastline and the species is infrequently recorded in Australian waters. There is also a lack of recordings of fin whale sightings in Australia. Therefore, it is unlikely that fin and Sei whales will be present in the Permit Area. Bryde's whale may be present in the Permit Area however numbers would likely be low and limited to individuals transiting through the area. The killer whale is primarily found in cold deep waters (Bannister et al., 1996) and is unlikely to be present is unlikely to intercept the area of potential exposure. The spotted bottlenose dolphin is generally considered to be a warm water dolphin that occupies in-shore waters, often in depths of less than 10 m (Bannister et al., 1996). The Indo-Pacific humpback dolphin may be present within the Permit Area on occasion.	The likelihood of marine mammals being exposed to hydrocarbons is lower for the proposed flow rate. Ammonia Impacts to marine mammals as a result of ammonia exposure are unlikely as their size allows them to tolerate high ammonia concentrations. Therefore the likelihood of marine mammals being impacted by ammonia is unlikely for the current and proposed flow rate.	
Marine reptiles	One species of seasnake and five species of turtle listed as protected under the EPBC Act may potentially occur within the Permit Area: • Short-nosed Seasnake (Aipysurus apraefrontalis) • Loggerhead Turtle (*Caretta caretta*) • Green Turtle (*Chelonia mydas*) • Leatherback Turtle (*Dermochelys coriacea*) • Hawksbill Turtle (Eretmochelys	Hydrocarbons Marine reptiles may be exposed to hydrocarbons in the PFW as they surface to breathe. The modelling results indicate that decreasing the OIW concentration and increasing the flow rate will reduce the area of potential exposure, therefore the likelihood of exposure is lower for the proposed flow rate. Within the area of exposure the modelling results also predict that the continuous duration the OIW concentration is above assessment criteria lower for the proposed flow rate. Results of PFW monitoring and field sampling also	An overall reduction in impacts to marine reptiles from PFW is predicted. Marine reptiles are highly unlikely to remain within the PFW for a sufficient duration to result in an impact.

Sensitive receptor	Potential interaction with PFW	Potential Impact within the PFW Mixing Zone	Net Impact Assessment
	imbricate) • Flatback Turtle (*Natator depressus*) Individual loggerhead turtles occur in the Permit Area however populations of turtles are unlikely to occur within the relatively small area of potential impact The Permit Area does not represent an important habitat for this species. Short-nosed seasnake prefers the reef flats or shallow waters along outer reef edges in water depths to 10 m and generally stay within 50 m of the reef (Watson et al., 2009). This species will not interact the current or proposed area of potential impact.	indicate that the concentrations hydrocarbons in the PFW and surface water are currently low. The hydrocarbon concentration will decrease for the proposed scenario. The likelihood of marine mammals being exposed to hydrocarbons is lower for the proposed flow rate. Ammonia Impacts to marine reptiles as a result of ammonia exposure are unlikely as their size allows them to tolerate high ammonia concentrations. Therefore the likelihood of marine reptiles being impacted by ammonia is the same for the current and proposed flow rate.	
Fish, sharks and rays	Nine species of sharks and rays are listed as Threatened or Migratory under the EPBC Act that may potentially occur in the Permit Area: • Whale Shark (*Rhincodon typus)* • Grey Nurse Shark (*Carcharias taurus)* • Great White Shark (*Carcharodon carcharias)* • Dwarf Sawfish (*Pristis clavata)* • Green Sawfish (*Pristis zijsron)* • Shortfin Mako (*Isurus oxyrinchus)* • Longfin Mako (*Isurus paucus)* • Reef Manta Ray (*Manta alfredi)* • Giant Manta Ray (*Manta birostris).* Whale sharks could potentially occur within the Permit Area between March and June.	Hydrocarbons The main exposure pathway of sharks and rays to hydrocarbons is through the ingestion of entrained droplets. As the potential area of exposure for the current and proposed flow rate mainly exists in the top 2 m and as fish and sharks mainly dwell in the lower sections of the water column and are highly mobile, the likelihood of exposure is low. Within the area of exposure the modelling results also predict that the continuous duration the OIW concentration is above assessment criteria is lower for the proposed flow rate. Results of PFW monitoring and field sampling also indicate that the concentrations hydrocarbons in the PFW and surface water are currently low. The hydrocarbon concentration will decrease for the proposed scenario. The likelihood of fish and sharks being exposed to hydrocarbons is lower for the proposed flow rate.	Impacts to fish and sharks may occur as a result of exposure to ammonia and hydrocarbons. As the potential area of exposure for the current and proposed flow rate mainly exists in the top 2 m and as fish and sharks mainly dwell in the lower sections of the water column and are highly mobile, the likelihood of sufficient exposure to result in an impact is low.

Sensitive receptor	Potential interaction with PFW	Potential Impact within the PFW Mixing Zone	Net Impact Assessment
	Sawfish occur in in-shore coastal waters and riverine environments of tropical northern Australia and are unlikely to occur in the Permit Area. Mako sharks have a widespread distribution and are unlikely to occur in large numbers. Rays are commonly sighted inshore, but also found around offshore coral reefs, rocky reefs and seamounts. Rays are unlikely to occur in large numbers within the Permit Area. Various species of fish are present in the Permit Area.	Ammonia The area of exposure for ammonia mainly exists in the top 2 m for the current and proposed scenario, as fish and sharks mainly dwell in the lower sections of the water column and are highly mobile the likelihood of exposure is low. Within the area of exposure modelling results predict the duration and frequencies of exposure are similar for the current and proposed scenario. Results of PFW monitoring and field sampling also indicate that the concentrations ammonia in the PFW and surface water are currently low. This will remain the same no increase in ammonia concentration is proposed. The likelihood of fish and sharks being impacted by ammonia is the same for the current and proposed flow rate.	
Seabirds	Two Critically Endangered, one Endangered, one Vulnerable and three MIgratory species of birds may transit through the Permit Area on occasion: • Curlew Sandpiper (*Calidris ferruginea)* • Eastern Curlew (*Numenius madagascariensis*) • Southern Giant Petrel (*Macronectes giganteus*) • Australian Fairy Tern (*Sternula nereis nereis)* • Common Noddy (*Anous stolidus)* • Lesser Frigatebird (*Fregata ariel)* • Osprey (*Pandion haliaetus).*	Hydrocarbons As the modelling results indicate that decreasing the OIW concentration and increasing the flow rate will reduce the area of potential exposure, the likelihood of seabirds intercepting the PFW is lower for the proposed flow rate. Ammonia Sea birds are unlikely to be exposed to ammonia for periods long enough to cause impacts for bother scenarios.	An overall reduction in potential impacts to seabirds is predicted due to the reduced area of potential exposure.

Sensitive receptor	Potential interaction with PFW	Potential Impact within the PFW Mixing Zone	Net Impact Assessment
Plankton	Ubiquitous in the Permit Area.	Hydrocarbons As the modelling results indicate that decreasing the OIW concentration and increasing the flow rate will reduce the area of potential exposure, the likelihood of exposure of plankton is lower for the proposed flow rate. Ammonia The modelling results predict that increasing the flow rate and maintaining the same ammonia concentration will result in an increase in the maximum distance from the platform from 200 m to 300 m. As plankton and larvae are constantly transiting the area due to ocean current transportation a slight increase in the area of exposure is unlikely to result in an increase in impacts to plankton. Eutrophication as a result of excessive plankton growth is also unlikely to occur in the open water environment at Wandoo.	An overall reduction in potential impacts to plankton is predicted due to the reduced area of potential exposure.
Fisheries and aquaculture	Some managed fisheries overlap the current and proposed area of potential exposure.	Some managed fisheries overlap the area potential exposure. Fishing in the vicinity of the area of potential impact is unlikely as fishing is not permitted in the petroleum safety zone and most fisheries operate in deep water seaward of the Permit Area.	No impact from PFW as a result of current or proposed scenario flow rates.
Shipping	Shipping lanes overlap the proposed area of potential impact.	The PFW has no potential impact on shipping activities.	No impact from PFW as a result of current or proposed scenario flow rates.
Other users	There are no tourism activities in the vicinity of the current or proposed area of potential exposure.	As there are no tourism activities in the vicinity of the PFW there is no potential impact.	No impact from PFW as a result of current or proposed scenario flow rates.

Sensitive receptor	Potential interaction with PFW	Potential Impact within the PFW Mixing Zone	Net Impact Assessment
National/ World Heritage Areas Commonwealth/State Marine Protected Areas	None in the vicinity of the current or proposed area of potential exposure.	None in the vicinity of the current or proposed area of potential exposure hence no potential impact.	No impact from PFW as a result of current or proposed scenario flow rates.
Key ecological features	None in the vicinity of the current or proposed area of potential exposure.	None in the vicinity of the current or proposed area of potential exposure hence no potential impact.	No impact from PFW as a result of current or proposed scenario flow rates.

5.6.3 Control measures

Table 5-10: Discharge of PFW and ballast water from Facility - summary of hazards and controls

Source of Risk (Hazard)	Control Preventative Measures
Planned PFW discharge.	OIW concentration monitored and alarmed in the Monitoring and Control System (MCS).
	PFW discharge overboard can be diverted inboard.
	PFW discharge flow rates are monitored.
	Routine external laboratory testing to ensure PFW chemistry is within assumed levels.
	Chemical dosing concentrations are monitored.
	Chemical assessment and selection process.
Discharge of active biocide.	Pigging procedures.
Process upsets.	Instrument protective and alarm systems (interface level low level trips in production and second stage separators).
	Produced Water Adaptive Management Strategy (WNB-7000-RP-0010).
Planned discharge of ballast water.	OIW concentration monitored and alarmed in the MCS.
	Ballast water discharge overboard can be deferred to allow for fault finding.
Control Mitigation Measures	
None identified.	

VOGA carried out an assessment of alternative arrangements and additional controls to control the risk of PFW discharge. An ALARP assessment was undertaken to ensure that risks associated with increased water throughput are reduced to ALARP. All four of the following measures were recommended for implementation:

1. Bypass coalescer – permanently bypass the coalescer to avoid spikes in OIW concentrations.

2. Add base sediment and water (BSW) meter to rundown – will be implemented as part of PFW system upgrades in line with increased throughput. This measure would allow independent inline monitoring of the BSW rundown line similar to the PFW analyser. The net benefit would be avoidance of spikes in OIW concentrations in BSW rundown.

3. Add OIW analyser to combined ballast water and PFW – will be implemented as part of PFW system upgrades in line with increased throughput. This measure would allow for an independent check against the analysers on the individual PFW and BSW lines. This will allow early detection of any analyser malfunction and avoidance of spikes in OIW concentrations.

4. Divert ballast water to the IFSU – will be implemented as part of PFW system upgrades in line with increased throughput. This measure would ensure that any OIWs in ballast water that may be diverted overboard could be recovered/minimised prior to discharge. This measure will further reduce OIW concentrations in ballast water discharged overboard.

5.7 Noise

5.7.1 Activity

The following activities associated with Wandoo operations, generate noise:

- Vessel and helicopter operations;
- Operation of cooling water and firewater pumps;
- Geophysical surveys:
  - side-scan sonar; and
  - sub-bottom profiling surveys (using pingers, boomers, chirps and sparkers).

5.7.2 Assessment

The highest sound emission levels will be from the hydrographic and geophysical surveys. Typical sound intensities and frequencies produced from geophysical and hydrographic surveys are presented in Table 5-11 below. Sound frequencies and peak sound levels produced are in the range of 0.5 to 500 kHz and of 202 to 245 dB re 1 µPa at 1 m from the array respectively. Sounds increase in wavelength with distance from the source experiencing rapid loss at higher frequencies (Swan et al., 1994).

Modelling has previously been undertaken to determine the sound levels at increasing horizontal distance away from the source array for two geophysical sparker sound sources – the Applied Acoustics Squid 500 and the Squid 200. The sound exposure levels were predicted for four different combinations of water depth and spark type. The peak sound level for the Squid 2000 and the Squid 500 were 222 dB re 1 µPa peak and 216 dB re 1 µPa respectively at 1 m from the array. In all four cases modelled, the received sound exposure levels are predicted to have dropped below 160 dB re 1 μPa^2 within 20 m of the source for the Squid 500 and within 40 m of the source for the Squid 2000 (Duncan and Salgado-Kent, 2011). Any impact of sound and vibrations from similar survey equipment used during operations is expected to quickly attenuate through the water column.

As the chirps, boomers and echo sounders generate sound pulses within the frequency range of the sparker 0-300 kHz, it is expected sound levels generated by these surveys will decrease from the source array at a similar level. The side-scan sonar generates sound pulses of a higher frequency hence the sound level from the side-scan sonar is expected to decrease more rapidly with increasing distance from the source array.

Under normal operating conditions when a vessel is idling or moving around the field, the vessel noise would be detectable only over a short distance. Noise from support vessels, would be at its maximum level, when there is a support vessel using main engines and bow thrusters to keep an export tanker on the CALM Buoy. The noise from a vessel holding its position using bow thrusters and strong thrust from its main engines (relatively small proportion of time) may be detectable above background noise levels during calm weather conditions, for 20 km or more from the vessel although this range of audibility will be reduced under noisier (windier) background conditions (BHP Billiton, 2005).

The main acoustic source associated with helicopters is the impulsive noise from the main rotor and high-speed impulsive noise related to trans-sonic effects on the advancing blade. Dominant

tones in noise spectra from helicopters and fixed wing aircraft are generally below 500 Hz (McCauley, 1994). Other tones associated with the main and tail rotors and other engine noise can result in a larger number of tones at various frequencies (BHP Billiton, 2005).

Noise from platform operations is expected to be low as all operating equipment including generators, engines and machinery is above sea level. The frequency and level of noise received under water from topside operations will depend on a number of variables including the type of infrastructure; the types and sizes of engines; as well as the local hydro-acoustic and geo-acoustic environment.

Table 5-11: Typical frequency and sound ranges from equipment expected to be used for operations

Source	Frequency (KHz)	Sound (dB re 1 µPa at 1 m)
Side-scan sonar	100-500	220-226
Sub-bottom profiling (Chirps system)	3-40	202-208
Sub-bottom profiling (Boomers)	0.5 -5	204-227
Sub-bottom profiling (Sparker) (e.g. Squid 500 and Squid 2000)	0-300	216-222
Multi-beam echosounders	10.5-200	225-245
Single-beam echo sounders	10-200	210-230
Vessel operations	0.005-1.2	182

Marine mammals

Marine mammals are sensitive to noise in the marine environment. Their use of sound for communication, prey capture, predator avoidance, navigation and their physiological features (i.e. large gas-filled organs) make them vulnerable to both disturbance and physiological damage from underwater noise of sufficient magnitude.

Odontocetes or toothed cetaceans (sperm whale, beaked whales and dolphins) produce echo clicks that have the highest sound levels of any recorded marine mammal ranging from 220-230 dB at 1 µPa at 1 m at frequencies between 10 and 100 kHz (DoIR, 2007). This is of a similar frequency to that of the hydrographic surveys. However behavioural responses have not been observed in odontocetes unless received levels exceeded 186 dB re 1 µPa (USN, 1999), which is not expected beyond 40 m from the source (Duncan and Salgado-Kent, 2011).

Baleen whales (e.g. blue and humpback whales) communicate using low-frequency signals (12 Hz to 8 kHz but predominantly less than 1 kHz) (McCauley, 1994). Their low-frequency hearing capability is above the energy output range generated by geophysical and hydrographic surveys. Therefore no significant impacts to baleen whales are expected.

The humpback whale is the most commonly sighted whale in the region, with northerly migrations potentially through the Project area between April and August (peaking in July) and southerly migrations between August and October (peaking mid-August to mid-September). Behavioural responses to underwater noise included ‘stand-off’ behaviour for migrating humpback whales at received sound levels of 157 to 164 dB re 1 µPa. Resting pods exhibit ‘stand-off’ behaviour at received sound levels of 143 dB re 1 µPa and avoidance at 140 dB re 1 µPa (McCauley et al., 2000). These noise levels would be expected to occur within approximately 40 m for migrating whales and 480 m for resting pods from a typical geophysical survey.

Dugongs exhibit greatest sensitivity to sounds in the 1 kHz to 2 kHz range, which is within the range of energy output of the geophysical and hydrographic surveys (DoIR, 2007). Dugongs generally calve in shallow tropical waters (<1 m deep), between August and September, although may calve as late as December (DoIR, 2007). Dugongs are migratory and are known to occur around the islands of the NWS, Shark Bay, Exmouth Gulf and the Dampier Archipelago where seagrass beds occur (Gales et al., 2004). There is a low likelihood of encountering dugongs during operational activities as the nearest potential dugong habitat is the Dampier Archipelago that is located 40 km from the Permit Area.

No known aggregation, resting, breeding or feeding areas for marine mammals lies in close proximity to the Permit Area. Therefore, the risk of acoustic disturbance to cetaceans is expected to be minimal as it is expected that they would need to be within 40 m of the noise source in order to exhibit a behavioural response.

Stationary sources of offshore noise, such as that associated with the operation of the platform, being cooling water and firewater pumps, appears less disruptive to cetaceans than moving sources, such as ships (NMFS, 2001). However, severe sound emissions from offshore developments have the potential to induce stress and may cause abandonment of sensitive habitats (none of which are in the vicinity of the Permit Area), such as calving and nursery sites (McCauley, 1994). Given the noise sources associated with operational activities, the impact of platform noise is expected to be minimal.

Turtles

Electro-physical studies have indicated that marine turtle hearing is most sensitive to sounds between 100 Hz to 700 Hz (McCauley, 1994), which is below the range generated by hydrographic and geophysical surveys. No absolute thresholds are known for the sensitivity to underwater noise or the levels required causing pathological damage. Studies indicate that turtles may begin to show behavioural responses to an approaching seismic array at received sound levels of approximately 166 dB re 1 µPa, and avoidance at around 175 dB re 1 µPa (McCauley et al., 2000); these sound levels are expected to occur between 20 m and 40 m from the source array based on geophysical sparker modelling outlined above. As such, impacts on turtle species are expected to be minimal.

It is not expected that behavioural responses from turtles would be initiated more than 5 km of a nesting beach and as the nearest turtle nesting beaches are located at the Dampier Archipelago 40 km away, there is not expected to be any impact on turtle hatchlings.

Sharks

Previous studies indicate that sharks are sensitive to low frequency sounds in the 10 Hz to 800 Hz range and insensitive to frequencies above 1 kHz (Myrberg, 1996). The risk of acoustic disturbance to sharks will be low as the sounds generated by surveys range from 0.5 kHz to 500 kHz.

Also, given their generally wide-ranging habitat and known avoidance response to sound, shark species, including whale sharks, are not expected to exhibit significant negative behavioural or physical impacts from operational activities.

Fish

A considerable body of literature exists on the behavioural response of fish to vessel noise (Olsen, 1990). These studies have shown that fish avoid approaching vessels to some degree, usually by swimming down or horizontally away from the vessel path (BHP Billiton, 2005). The degree of observed effect weakens with depth and the effect is temporary with normal schooling patterns resuming shortly after the noise source has passed. Surface and mid-water dwelling fishes may theoretically be adversely affected by noise generated during vessel movements and normal production operations.

It has been observed that acoustic noise can lead to behavioural responses in fish. However, the nature and extent of the response varies and depends on a range of parameters including the species involved, propagation and aspect of the array. McCauley (1994), applying the behavioural observations of benthic fish to noise by Pearson et al. (1992), indicated sound levels at which behavioural changes in fish would be observed. These included:

- A startled response (at ~200 to 205 dB re 1 µPa) will occur directly beneath the array. At this point most fish flee the sound of the array (i.e. sudden flexions of the body followed by rapid swimming or a series of shudders);
- An alarm response (at ~180 dB re 1 µPa) will occur. Based on the modelling results this sound level would occur within 40 m of the array; and
- A subtle behavioural response (at ~160 dB re 1 µPa) will occur. Based on the modelling results this sound level would occur within 40 m of the array.

Birds

Birds generally hear at a narrower frequency range than mammals, with best hearing at frequencies between 1 kHz and 5 kHz (Dooling and Popper, 2007). However, there is little information available specific to seabird and shorebird hearing and thresholds for disturbance.

Invertebrates

Crustaceans such as crabs, prawns, scampi and lobster do not possess gas-filled cavities and hence have a reduced risk of acoustic disturbance compared with marine mammals, reptiles and fish with air bladders (Parry and Gason, 2006). Webb and Kempf (1998) exposed brown shrimp to sound source levels of 190 dB re 1 µPa at 1 m depth via a 15-gun array and no evidence of mortality or reduced catch rates for the shrimp was found.

ROV surveys of the NWS similar to the Permit Area have indicated that benthic communities are generally sparse with low densities of organisms (e.g. crustaceans, molluscs and polychaetes).

5.7.3 Control measures

Table 5-12: Noise - summary of hazards and controls

Source of Risk (Hazard)	Control Preventative Measures
Operation of cooling water (sea lift) and fire water pumps.	No management measures identified since: • Firewater pumps only run for critical function testing for a short time or for firefighting; and • Cooling water pumps will have minimal impact since pump motors are located on deck.
Vessel operation.	The interaction of vessels with cetaceans within the Wandoo Field will

Source of Risk (Hazard)	Control Preventative Measures
	be consistent with the EPBC Regulations (2000) where practicable.
Helicopter operation.	No controls identified specifically to manage noise exposure to cetaceans. Flight plans are based on passenger safety and Civil Aviation Safety Authority (CASA) requirements.
Geophysical and hydrographic surveys such as: side scan sonar and sub-bottom profiling; multi beam and single beam echo sounder surveys.	For geophysical and hydrographic surveys, the interaction of vessels with cetaceans within the Wandoo Field will be consistent with the EPBC Regulations (2000) where practicable.
Control Mitigation Measures	
None identified.	

5.8 Atmospheric emissions

5.8.1 Activity

Atmospheric emissions will occur during the normal operation of the Wandoo Facility due to a number of activities/operations, including:

- Flaring, blowdown and venting;
- Venting of tanker cargo tanks;
- Operation of WNA chemical pump (pneumatic) and instrument gas system, both of which result in small gas emissions;
- Vessels (excluding tanker) and helicopter operations;
- Power generation and gas lift compressor;
- Use of refrigerants (in Heating, Ventilation and Air Conditioning [HVAC] systems); and
- Diesel-powered equipment on WNA and WNB (non-turbine equipment, e.g. crane, firewater pumps, emergency diesel generator and portable equipment).

5.8.2 Assessment

Release of Greenhouse Gas (GHG) and non-GHGs

The release of GHG from operational activities such as flaring, blowdown, venting and operation of vessels, helicopters and other machinery can add to the GHG load in the atmosphere, which can contribute to global warming potential.

Non-GHGs are also released from operational activities such as flaring, blowdown, venting and operation of vessels, helicopters and other machinery.

Atmospheric emissions in the vicinity of the facility will be quickly dissipated into the surrounding atmosphere. Atmospheric emissions will not impact avifauna or the health or amenity of the nearest human settlements of Dampier and Karratha (over 40 km away) due to the rapid dispersion of emissions.

Release of ozone depleting substances (ODS)

ODS are used in closed refrigeration systems. ODS have the potential to contribute to ozone layer depletion if released to the atmosphere.

It is unlikely that ODS will be accidently released to the atmosphere, as refrigeration systems are serviced by a third party on a regular basis to minimise the potential for accidental release.

In summary, the quantities of gaseous emissions are relatively small and will under normal circumstances, quickly dissipate into the surrounding atmosphere.

5.8.3 Control measures

Table 5-13: Atmospheric emissions - summary of hazards and controls

Source of Risk (Hazard)	Control Preventative Measures
Flaring during normal operations.	Flaring volumes are monitored daily to ensure that any increase in flaring is identified and can be addressed in a timely manner.
Flaring during blowdown.	No controls identified. Blowdown is a requirement for major accident event prevention. Volumes are recorded as per flared gas (above).
Venting via flare (flame out scenario).	Detection to confirm both pilot burners are functioning with alarm if they go out.
Venting of low pressure process vessels/ systems.	No controls identified. Venting of low pressure vessels, tanks and shafts is predominantly inert gas and is a requirement to prevent unsafe environment developing within.
Venting of tanker cargo tanks.	No controls identified. Venting of tankers cargo tanks is predominantly inert gas from the tankers boilers and is a safety requirement to prevent tank explosions.
Operation of WNA chemical pump (pneumatic) and instrument gas system, both of which result in process gas emissions during use.	No controls identified.
Vessels operations (offtake tankers' emissions excluded from scope of EP).	Low sulphur diesel is used for vessels re-fuelling in Dampier, in accordance with MARPOL 73/78 Annex VI requirements to minimise SOx emissions.
	Use of HFO is not permitted within the field (except tankers).
Helicopter operations.	No controls identified. Fuel specification is as per helicopter engine specification, and fuel usage is as per flight plan and operational requirements.
Power generation and gas lift compressor.	Emissions associated with power generation are eliminated on WNA and CALM Buoy by utilising renewable energy.
	Low sulphur diesel is used for power generation, in accordance with MARPOL 73/78 Annex VI requirements to minimise SOx emissions.
	Fuel gas is used in preference to diesel for power generation when reservoir conditions permit.
	Power generator and gas lift compressor maintained to optimise efficiency.
Use of refrigerants (in HVAC systems).	Refrigeration system subject to regular maintenance.
Diesel powered equipment on WNA and WNB (e.g. crane, firewater pumps, emergency diesel	Low sulphur diesel is used for diesel powered equipment on WNA and WNB.

Source of Risk (Hazard)	Control Preventative Measures
generator and portable equipment).	
Control Mitigation Measures	
None identified.	

5.9 Artificial light

5.9.1 Activity

Sources of artificial lighting include:

- WNA and WNB facilities lighting;
- Vessels and tankers lighting; and
- Flaring.

Lighting is required for the safe operation of the Wandoo facilities and vessels.

Facility and support vessel deck lighting is kept on 24 hours a day for maritime safety purposes [Part 30 (Prevention of Collisions) of the Marine Orders made under the *Navigation Act 1912*].

5.9.2 Assessment

Artificial lighting has the potential to affect marine fauna by altering the use of visual cues for orientation, navigation or other purposes. This results in behavioural responses that can alter migration, foraging and breeding activity in marine reptiles, seabirds, fish and dolphins, create competitive advantages for some species, and reduce reproductive success and/or survival in others.

Previous studies have found that fish and zooplankton species are attracted to light sources (Meekan et al., 2001). The attraction of organisms to the light results in an increased food source for marine predators that aggregate around the edges of the light halos. This attraction is considered to be localised and, other than some opportunistic predation, is not considered to represent a significant risk of impacts.

Artificial lighting along or adjacent to turtle nesting beaches poses a particular issue as it has the potential to alter nocturnal behaviours, particularly the selection of nesting sites and the passage of adult females and emerging hatchlings from the beach to the sea (Limpus, 2009). Turtle hatchlings are particularly sensitive to artificial light as they orientate towards light (typically the horizon/wave breaking zone) when emerging from the nest. Hatchlings attracted to artificial light as they emerge from a nest can result in disorientation and increased risk of predation. Similarly, when hatchlings have successfully reached the ocean the attraction and congregation of hatchlings around offshore lights may increase predation from seabirds and sharks. As the Facility is located approximately 40 km from the nearest turtle nesting beaches at Dampier Archipelago and about 100 km northeast of the Montebello Commonwealth Marine Reserve, lighting from the Facility will not have an impact on emergent hatchlings.

Seabirds are known to aggregate around permanent offshore structures such as platforms (Verhejen 1985; Wiese et al., 2001), due to the aggregation of marine life at all trophic levels, creating food sources and shelter for seabirds (Surman, 2002). Bright lights can also disorientate

birds, thereby increasing the likelihood of seabird mortality through collision with infrastructure. Studies in the North Sea indicate that migratory birds are attracted to lights on offshore platforms when travelling within a radius of 3-5 km from the light source. Outside this area their migratory path will be unaffected (Marquenie et al., 2008).

Light generated by flaring events is not continuous and the flare is invisible during the day therefore it is unlikely to affect substantially marine fauna, and as such was not assessed further.

There is no evidence to suggest that artificial light sources adversely affect the migratory, feeding or breeding behaviours of cetaceans. Cetaceans predominantly utilise acoustic senses to monitor their environment rather than visual cues (Simmonds et al., 2004). Therefore light is not considered to be a significant factor in cetacean behaviour or survival.

5.9.3 Control measures

Table 5-14: Artificial light - summary of hazards and controls

Source of Risk (Hazard)	Control Preventative Measures
WNA and WNB.	No controls identified as Facility lighting is specified for safe working practices.
Vessels and tankers.	No controls identified as vessel lighting is specified for safe working practices and is not permanently in the Field.
Flaring.	No controls identified.
Control Mitigation Measures	
None identified.	

5.10 Discharge of cooling water from Facility

5.10.1 Activity

Seawater is used as a heat exchange medium for the cooling of compressors and turbines. Seawater is drawn from the ocean and absorbs heat from the process being cooled.

Once the process heat is transferred into the cooling water, it is discharged overboard back to the sea. The maximum discharge rate is 1,000 m^3/hr and the return temperature is 2-3°C above supply temperature.

To prevent marine growth in the cooling water system, seawater is treated by a Marine Growth Preventing System which involves producing chlorine electrically and continuous dosing of hypochlorite at 2 mg/L.

5.10.2 Assessment

The cooling water is discharged to the sea. When discharged to sea, the cooling water is initially subject to turbulent mixing and some transfer of heat to the surrounding waters and atmosphere. The plume disperses and rises to the sea surface where further dilution and loss of heat will occur. The plume of heated water moves in accordance with the prevailing currents. Temperatures drop swiftly with distance from the discharge point.

Potential thermal impacts to marine organisms include alteration of the physiological processes (especially enzyme mediated processes) (Wolanski, 1994). These alterations may cause a variety

of effects, ranging from behavioural response (including attraction and avoidance behaviour), to minor stress, to potential mortality after prolonged exposure. Fish have a tendency to avoid outfalls in the warmer (summer) months and actively enter them in winter months. Changes to breeding patterns of various invertebrates have also been noted.

The temperature of the discharge is 2°C to 3°C higher than the ambient sea temperature. These water temperatures are within the range of temperatures recorded on the NWS and naturally occurring organisms in the area would likely be tolerant of such increases. Potential thermal impacts are also limited by the dilution of the discharge and by convection losses.

The only biota that may be exposed to the thermal discharge for long periods are fouling species (e.g. barnacles), and possibly fish, marine turtles, marine mammals and seabirds in the immediate vicinity of the discharge point, or planktonic species that drift with the cooling water discharge as it disperses and decreases in temperature. The heated water will prevent species that are less tolerant to elevated temperatures from settling and becoming established in close proximity to the discharge point. Significant impacts on a larger ecosystem or population level to fish or plankton are not expected to occur, given that the area of raised water temperature will be highly localised and within the range of temperature on the NWS.

Sodium-hypochlorite is toxic to aquatic organisms. However, only a low concentration is used in the cooling water and the substance is extremely reactive. Sodium-hypochlorite will react with organic matter and rapidly disperse due to turbulent mixing, therefore removed before reaching the environment and no toxic impacts on marine organisms when discharged.

Control measures

Table 5-15: Discharge of cooling water from Facility - summary of hazards and controls

Source of Risk (Hazard)	Control Preventative Measures
Use of seawater for cooling compressors and turbines.	No controls identified. Seawater is used to provide cooling to machinery to ensure safe and fuel efficient operation.
Use of marine growth prevention chemical in the seawater system.	No controls identified as the low concentration of sodium-hypochlorite in the cooling water discharge would rapidly disperse due to turbulent mixing, and have no toxic impacts on marine organisms when discharged.
Control Mitigation Measures	
None identified.	

5.11 Vessel and Facility deck drainage and vessel bilge water discharge

5.11.1 Activity

Drainage from the production and deck areas of WNA and WNB mainly consists of wash-down water, seawater spray and rainwater, and may contain small quantities of oil and grease, detergents and dirt from the decks. The volume of drainage depends on rainfall and the frequency of deck washing. Inventory records indicate that an average of 126 L of deck wash detergent is used per month.

The discharge of contaminated bilge water from vessels can contain water, oil, dispersants, detergents, solvents, chemicals, particles and other liquids, solids or chemicals, similar to Facility deck drainage.

5.11.2 Assessment

The Main Deck is generally used for the permanent or temporary storage of bulk fuels and/or chemicals. These areas are either fully bunded or the deck drainage has been sealed or secondary containment is provided to prevent accidental discharges to the ocean. Bunds around engines and machinery/equipment are also connected to the closed drain system.

Contaminated liquids from WNA drip trays and/or bunds are collected and transferred into an iso-container, and managed in accordance with the Waste Management Procedure [WPA-7000-YH-0009].

An OIW monitor is used to record the oil content in any overboard discharge to ensure that the OIW content is less than 30 mg/L.

When an offtake tanker is no longer moored at the CALM Buoy, it is not considered a facility and must discharge slops water with an OIW content no greater than 15 mg/L (Marine Orders – Part 91 Marine Pollution Prevention Oil).

Depending on the type and volume of pollutants on the deck, the deck drainage has the potential to create ocean surface sheens and short-term, localised reduction in water quality when discharged overboard. Toxicity to marine organisms is from trace amounts of dissolved hydrocarbons in the oil water drainage after treatment and is similar to the effects of PFW as described in Section 5.6.

Discharge of detergent results in the addition of inorganic nutrients and surfactants to the ocean. It is expected that nutrient addition will have little environmental consequences as the phytoplankton and microbial activity in the surrounding waters would ensure that any environmental impact would be minimal. Reduction in water quality will affect surface waters (<5 m) only and the discharged water would be rapidly diluted in the dynamic oceanic environment.

The greatest risk at the WNB Platform location will be to plankton and pelagic fish. However, given the biodegradability/low persistence of the wastes, and the minimal volumes involved, the impact on the surrounding water quality would be temporary and localised. As a result, it is not expected that marine fauna or plankton will be exposed to chemicals or hydrocarbons in quantities that would induce acute or chronic toxicity impacts.

5.11.3 Control measures

Table 5-16: Vessel and Facility deck drainage and vessel bilge water discharge - summary of hazards and controls

Source of Risk (Hazard)	Control Preventative Measures
Drainage from WNA production areas may contain oil and grease, detergents and dirt.	Biodegradable detergents used during wash-down activities.
	Drip trays or bunds are used where required to contain potential residual spills.
Drainage from WNB Facility may contain oil, grease, detergents and other hazardous chemicals.	Biodegradable detergents used during wash-down activities.
	All designated chemical storage areas and hydrocarbon process areas are bunded.
	Drip trays or temporary bunds are used where required to contain potential residual spills.
	Drainage from decks in hazardous areas is collected through

Source of Risk (Hazard)	Control Preventative Measures
	hazardous drain system.
Drainage from vessel decks may contain oil, grease, spilled hazardous chemicals and detergents.	Bulk hazardous chemicals are transported in chemical cradles.
Bilge discharge from vessels.	No bilge discharge within the 500 m restricted zone.
Control Mitigation Measures	
None identified.	

5.12 Discharge of sewage, greywater and putrescible waste from Facility and vessels

5.12.1 Activity

Sewage from the Platform consists mainly of sanitary waste, greywater and a small component of macerated food waste. The volume of sewage effluent produced has been estimated on an average sewage production (human waste and associated toilet water etc.) of 60 L per person per day. The mass of nutrients discharged in sewage effluent from the WNB Platform was estimated to include 1.6 kg per month of nitrogen and 0.38 kg per month of phosphorus. In addition, there is a small volume of biodegradable organics.

Greywater is discharged from the laundry, shower and hand basins from the fixed facility, vessels and tankers. The estimated volume of greywater produced was based on an average water consumption of 140 L per person per day. The greywater is comprised of potable water, soaps and detergents and is discharged directly to the ocean.

Putrescible waste is generated from food scraps from the kitchens on the Platform and support vessels. The food scraps are macerated to a size small enough to pass through a 25 mm mesh (as per the requirements of MARPOL) prior to discharge overboard. The volume of putrescible waste discharged overboard is estimated at 1.9 L per person per day. Scraps that cannot be macerated or are not readily degradable (e.g. bones) are bagged and disposed of onshore with the general waste.

5.12.2 Assessment

Sewage and greywater

Sewage and greywater generated at the Facility and on support vessels are treated to comply with the discharge requirements of MARPOL 73/78 Annex IV and *Protection of the Sea (Prevention of Pollution from Ships) Act 1983*.

The primary concerns related to the discharge of sewage, greywater and putrescible waste are nutrient enrichment of surrounding waters and increased biological oxygen demand, resulting in changes to plankton in the immediate area. In a study of sewage discharge in deep ocean waters, Friligos (1985) reported no appreciable differences in the inorganic nutrient levels between the outfall area and background concentrations, suggesting rapid uptake of nutrients and/or rapid dispersion in the surrounding waters.

Wastewater discharges into the open ocean have little potential for impact where the waters are well mixed and the volume of discharge is relatively small. Any wastewater discharged from the Wandoo Platform will be dispersed due to the wind-driven surface water currents, and rapidly mixed through the surface layer of water.

Putrescible waste

Food scraps will be macerated to a size small enough to pass through a 25 mm mesh (as required under MARPOL) and discharged overboard. The overboard discharge of macerated food wastes would create a localised and temporary increase in the nutrient load of the surface waters. This may in turn act as a food source for scavenging marine fauna or seabirds, resulting in a localised increase of scavenging species around the Facility. The rapid consumption of this food waste by scavenging fauna and physical and microbial breakdown ensures that the impacts of putrescible waste discharges are insignificant. The small volume of food scraps relative to the total biological productivity of the area means that the environmental effect of their discharge would be insignificant.

Biodegradable matter (i.e. macerated food scraps and sewage) may result in localised increases in nutrient levels, which may stimulate microbial activity and therefore act as a food source for scavenging birds and/or animals.

Given the Facility's location, there are no nearby sensitive environments or biological communities that are at risk from the discharge of sewage, greywater or putrescibles wastes. Sewage and sullage effluent from the Platform and support vessels will be subject to rapid dilution and dispersion by the prevailing currents and waves. It is likely that the highly dispersive marine environment and high water column productivity are preventing long-term accumulation of organics under the Facility.

5.12.3 Control measures

Table 5-17: Discharge of sewage, greywater and putrescible waste from Facility and vessels - summary of hazards and controls

Source of Risk (Hazard)	Control Preventative Measures
Greywater discharged from the Facility.	Sewage effluent from the WNB Facility is macerated to pass through a 25 mm mesh (as required under MARPOL).
	Food waste from the WNB Platform is macerated to pass through a 25 mm mesh (as required under MARPOL).
Greywater discharged from support vessels.	Vessels >400 T or certified for >15 persons must comply with MARPOL 73/78 (Annex IV; Regulation 8) including: • Equipped with either a sewage treatment plant or sewage comminuting and disinfecting system or a sewage holding tank; • Wastes shall be macerated to <25 mm prior to discharge; and • Untreated sewage will be stored on-board in suitable holding tanks and disposed of onshore at a reception facility or to a carrier licensed to receive the waste, or discharged at a distance of more than 12 nautical miles from the nearest land.
Control Mitigation Measures	
None identified.	

5.13 Discharge of desalination brine

5.13.1 Activity

Desalination brine is discharged from the reverse osmosis desalination plant that produces potable water from seawater for use on WNB (approximately 500 m^3/day). The salinity of the discharged desalination brine is slightly higher than seawater and contains small quantities of scale inhibitor. On average, seawater has a salt concentration of 35,000 ppm, while the desalination discharge has a salt concentration in the range of about 38,500 to 40,000 ppm.

5.13.2 Assessment

Upon discharge to the sea, the desalination brine, being of greater density than seawater, will sink and disperse in the currents. The largest increase of salinity will be experienced in the immediate vicinity of the discharge point. The near-field dilution will occur rapidly resulting in a return to ambient salinity levels within 10 m of the discharge (Raventos et al., 2006). Other studies have also confirmed that elevated salinity declines rapidly close to the discharge, even where simple diffusers are utilised (Fernandez-Torquemada et al., 2005).

As most marine species are able to tolerate short-term fluctuations in salinity in the order of 20% to 30% (Walker and McComb, 1990), it is expected that pelagic species would be able to tolerate the short-term exposure to the slight increase in salinity caused by the discharged desalination brine, and therefore minimal environmental impact is predicted.

Dilution to background salinity is expected to occur in the immediate vicinity of the discharge point and well within the 500 m restricted area. The relatively small volumes involved would mean that no change in salinity would be detectable outside a localised area. Therefore no biological impact is likely to result from salinity variations.

5.13.3 Control measures

Table 5-18: Discharge of desalination brine - summary of hazards and controls

Source of Risk (Hazard)	Control Preventative Measures
Wastewater discharged from the reverse osmosis desalination plant.	No controls were identified and none are believed to be required.
Discharge of back flush water from potable water system containing Scale Inhibitor.	No controls were identified and none are believed to be required. Note: Concentration of Scale Inhibitor used in these water treatment systems will not adversely impact upon any marine organisms. Any residual inhibitor will rapidly disperse when discharged to the ocean.
Control Mitigation Measures	
None identified.	

5.14 Non-hazardous and hazardous waste

5.14.1 Activity

Wastes generated at the Wandoo Facility are divided into two streams:

- Non-hazardous waste (general and recyclable); and

- Hazardous waste.

Recyclable waste generated at the Facility includes aluminium cans, glass, paper and recyclable scrap metal.

5.14.2 Assessment

If accidentally discharged overboard (i.e. dropped object during vessel transfers), solid wastes can cause smothering of benthic habitats as well as injury or death to marine fauna or seabirds through ingestion or entanglement (e.g. turtles mistaking plastics for jellyfish, rope getting caught around the necks of marine fauna and seabirds).

The potential impacts of hazardous solid wastes are contamination of the marine environment including localised changes to water quality and toxic effects on marine species.

Items of solid hazardous waste, such as paint cans containing paint residue or batteries, would settle on the seabed if dropped overboard. Over time, this would result in the leaching of hazardous materials to the seabed, which is likely to result in a small area of substrate becoming toxic and unsuitable for colonisation by benthic fauna.

No discharge of solid waste is expected during normal operations. Furthermore, the benthic habitat in the operational area primarily comprises bare sediments, and as such any impacts of garbage would be negligible, however if an incident was to occur, VOGA would seek to retrieve the dropped object(s).

5.14.3 Control measures

Table 5-19: Non-hazardous and hazardous waste - summary of hazards and controls

Source of Risk (Hazard)	Control Preventative Measures
Generation of recyclable waste (non-hazardous), e.g. paper, cans, glass recyclable scrap metal.	Recyclable material bins are provided on the facility for segregated recyclable waste and waste sent to a licensed waste contractor for disposal.
Generation of general (non-hazardous) waste.	Solid inert (general) waste bins provided on the facility with waste sent to a licensed waste contractor for disposal.
Generation of hazardous waste.	Solid low-level hazardous waste bins provided on the facility with waste sent to a licensed waste contractor for disposal.
	Waste oils and contaminated water drums provided on the facility. Content is recycled for oil separation and drums are recycled by a licensed waste contractor.
	Slop crude oil is reprocessed through WNB process.
	Greases collection drums are provided on the facility and waste is sent to a licensed waste contractor for disposal.
	Waste drums are provided for the collection of miscellaneous chemical waste (including laboratory waste, corrosion inhibitor, acids, alkalis, biocides adhesives), and waste is sent to a licensed contractor.
	Waste drums are provided for the collection of flammable liquid wastes, production sand and process sludge and waste is sent to a licensed waste contractor for disposal.
	Dedicated bins are provided on the facility for medical waste and waste is sent to third party medical facility for disposal.

Source of Risk (Hazard)	Control Preventative Measures
	Skips storing loose solid material either have lids or are covered by tarps in high wind conditions.
	Liquid containers are closed for transport.
Subsea maintenance generating solid non-hazardous waste (e.g. grout, metal filings).	Grout selection process will include lowest toxicity.
Control Mitigation Measures	
None identified.	

5.15 Use and discharge of chemicals for maintenance and inspection activities

5.15.1 Activity

Chemicals are used during maintenance and inspection activities such as pigging, flushing, hydrotesting/pressure testing, leak testing and chemical cleaning.

A summary of the chemicals used for the various maintenance and inspection activities includes:

- Hydrotesting/pressure testing – Biocide;
- Pigging – Biocide;
- Flushing - Biocide or biocide and corrosion inhibitor;
- Leak testing - Fluorescein dye;
- Chemical cleaning - Sulphamic acid; and
- Helideck firefighting foam testing - 1% Aqueous Film Forming Foam (AFFF).

5.15.2 Assessment

Biocide and corrosion inhibitor is assessed in Section 5.6.

The United States of America Environmental Protection Authority classifies fluorescein as non-toxic and has approved it for use in public drinking water supplies. Fluorescein is biodegradable and photodegradable with decomposition products of carbon dioxide, water and a trace amount of sodium (Farmer and Blew, 2009).

Sulphamic acid may be harmful to aquatic organisms, however the sulphamic acid is neutralised with caustic soda and discharged to the hazardous drain system. The neutralised sulphamic acid is tested prior to discharge to ensure the pH is 7.

The helideck AFFF is tested annually with an estimated volume of 0.031 m^3/year discharged overboard, either directly or through the drainage system.

5.15.3 Control measures

Table 5-20: Use and discharge of chemicals for maintenance and inspection activities - summary of hazards and controls

Source of Risk (Hazard)	Control Preventative Measures
Use of chemicals for maintenance and inspection activities.	All hazardous liquid chemicals are stored in bunded areas/chemical cradles.
	Only chemicals selected in accordance with the VOGA chemical assessment process are used.
Pigging, flushing hydrotesting/pressure testing using biocide.	Pigging procedures.
	Hydrotesting and flushing procedures are developed on the case-by-case basis to minimise potential hazardous waste release and impact assessed.
Flushing using corrosion inhibitor.	No controls identified as low concentrations of corrosion inhibitor are added during flushing.
Leak testing using fluorescein dye.	No controls identified as fluorescein not considered hazardous (it is biodegradable and photodegradable with decomposition products of carbon dioxide, water and a trace amount of sodium).
Chemical cleaning with sulphamic acid.	Sulphamic acid is neutralised with caustic soda prior to discharge.
Control Mitigation Measures	
None identified.	

5.16 Disturbance to marine fauna and seabirds

5.16.1 Activity

The movement of offtake tankers, supply vessels and helicopters has the potential to interfere with or possibly cause vessels to collide with marine fauna. In-field vessel movements at the Wandoo Facility are estimated to be twice per week. Tanker movements occur at three-to-five week intervals.

It is estimated that helicopter movements at the Wandoo Facility are in the order of four to five per week.

5.16.2 Assessment

Marine fauna that are present in surface waters are most susceptible to vessel strike due to their proximity to the vessel (hull, propeller or equipment) and their limited ability to avoid vessels (i.e. diving). The species of marine fauna that are likely to be most susceptible to vessel strike include turtles and cetaceans (e.g. whales and dugongs).

All other marine fauna species including seabirds, cetaceans (dolphins) and fish species (including whale sharks) are likely to avoid any moving vessels and are considered at low risk of potential vessel strike.

During the movement of the supply vessel and offtake tanker into or out of the Permit Area, or between the WNB platform and WNA monopod, it will be moving slowly (3 knots or less), allowing time for any marine fauna to move out of the immediate area. As a result, it is highly unlikely that there will be any collision with marine species. The vessels supporting the operational activities will endeavour to maintain safe distances from any whales sighted.

5.16.3 Control measures

Table 5-21: Disturbance to marine fauna and seabirds - summary of hazards and controls

Source of Risk (Hazard)	Control Preventative Measures
Marine operations including diving, ROV, supply, bunkering and export activities.	The interaction of vessels with cetaceans within the Wandoo Field will be consistent with the EPBC Regulations (2000) where practicable.
Helicopter movements.	No controls identified as the duration of take-off and landing at the Facility is short and impact of the activity to seabirds is negligible.
Control Mitigation Measures	
None identified.	

5.17 Liquid hydrocarbon release from topsides process

5.17.1 Activity

Loss of crude oil from the topsides production facilities may occur due to failure of process piping and vessels from over pressuring, human error during process break-ins, erosion and corrosion, process up-sets and dropped objects.

A hydrocarbon release from the topsides process facilities is likely to continue for a significant duration depending on the size of the release, inventory and operating pressure. In the event of a leak detected by the fire and gas system, the ESD system will isolate the entire topsides process to minimise the inventory that could be released into the environment.

The maximum credible volume of crude oil that may be released due to a leak from the topsides facility is assumed to be the maximum volume of the largest vessel (100 m^3).

5.17.2 Assessment

The impact assessment outlined in Section 5.22 is relevant for a spill from the topsides as the volume is similar to a spill from the flow lines and risers. A detailed description of the environmental impact of a hydrocarbon spill is provided in Section 5.1.

The risk associated with a release of hydrocarbon from process topsides is inherent to the operation of a petroleum facility. These risks can be managed through implementation of effective control measures and associated performance monitoring.

5.17.3 Control measures

Table 5-22: Liquid hydrocarbon release from topside process - summary of hazards and controls

Source of Risk (Hazard)	Control Preventative Measures
Loss of integrity of liquid hydrocarbon containing equipment.	Vessels are designed and tested to maximum allowable operating pressure.
	Hydrocarbon contained from rotating equipment.
	Pressure safety devices to prevent overpressure leading to loss of containment.
	Instrumentation initiators, alarms and final elements to prevent process excursions
	Asset integrity management.

Source of Risk (Hazard)	Control Preventative Measures
	Competency management of Wandoo personnel.
Human error during process break-ins.	Isolation controls to ensure adequate drainage, venting and positive isolation prior to performing a process break-in.
Process upsets resulting in unplanned hydrocarbon release through produced water discharge.	Instrumentation initiators, alarms and final elements – prevent process excursions
Dropped objects/ swinging loads onto topsides equipment.	Lifting management procedures.
	Crane maintenance.

Control Mitigation Measures
Platform ESD.
Topsides hazardous drains and bunding on WNB.
Wandoo Emergency Response Plan [VOG-2000-RD-0017].
Oil Spill Response arrangements.

5.18 Ancillary hydrocarbon or chemical spills

5.18.1 Activity

Potential sources of minor chemical spills include:

- Water foaming agents used in firefighting (AFFF) may enter the sea if activated;
- Chemical spill due to materials handling and storage (1,450 L chemical bulky);
- Other non-process chemicals such as paints and thinners, laboratory chemicals, medical wastes and cleaning agents. Spills of non-process chemicals may occur from incidents with storage, handling and transport. However, these are likely to be either of very minor quantity (usually less than 50 L); and
- Sludge from equipment and vessel clean-out.

Minor hydrocarbon spills may also occur due to:

- Accidental release of hydraulic oil through leak/rupture of ROV umbilical. This is estimated to be less than 50 L;
- Diesel or chemical spill due to materials handling and storage (1,450 L chemical intermediate bulk containers [IBCs], 205 L diesel); and
- Hydrocarbon discharge due to removal and replacement of subsea.

5.18.2 Assessment

The impacts associated with the accidental discharge of liquid hazardous materials are related to the nature of the material spilled, the volume and its behaviour in the marine environment (sink/float/disperse etc.). In the event of a spill from Wandoo Facility to the marine environment the hazardous materials would be subjected to rapid dispersion and dilution by the open ocean water conditions and prevailing currents.

If hazardous materials are accidentally lost overboard, potential impacts will include a temporary and highly localised decline in water quality with limited potential for toxicity to marine fauna due

to the temporary exposure and low toxicity resulting from the rapid dilution in the marine environment. Potential impacts are likely to be limited to the immediate vicinity and unlikely to affect overall population viability. A visible oil sheen on the water surface may also occur in the event of minor hydrocarbon spills. Importantly, these hydrocarbon compounds (lower molecular weight polycyclic aromatic hydrocarbons) are also volatile and will be rapidly be lost due to natural processes of evaporation during early stages of a spill. For this reason and given the minor volumes of hydrocarbons spilled, mortality of organisms due to lethal concentrations of dissolved hydrocarbons is expected to be rare, with contact with sensitive marine habitats (>40 km) or the shoreline also predicted to be highly unlikely.

5.18.3 Control measures

Table 5-23: Ancillary hydrocarbon or chemical spills - summary of hazards and controls

Source of Risk (Hazard)	Control Preventative Measures
Hydrocarbon (including diesel and lube oil) or chemical spill due to materials handling and storage.	IBCs are transferred to/from vessel using a chemical cradle.
	IBCs, including lifting lugs, are certified.
	All chemicals are stored in bunded areas.
	All liquid waste containers will be closed to prevent loss overboard.
	Hydrocarbon and chemical spill containment and clean-up material.
	Only chemicals selected in accordance with the VOGA chemical assessment process are used.
Control Mitigation Measures	
Wandoo Emergency Response Plan [VOG-2000-RD-0017].	
Oil Spill Response arrangements.	

5.19 Physical presence of infrastructure

5.19.1 Activity

The ‘physical presence’ refers to all aspects of the Wandoo facilities including subsea and surface facilities at WNA, WNB and the CALM Buoy and offloading system. It also includes the physical presence of vessels, tankers, ROVs and divers associated with Wandoo operations.

5.19.2 Assessment

Disturbance to marine habitats (benthic), fish, marine mammals, marine reptiles and seabirds

The Permit Area is not known to support any critical breeding, feeding or calving areas for EPBC listed marine mammals. However, the humpback whale may pass through the Permit Area during southward migration. Potential impacts associated with the presence of surface and subsea infrastructure on migrating whales in the area is considered minimal as the infrastructure is stationary. Similarly, a potential impact to other marine species, including sea snakes and turtles which may also pass through the Permit Area, is considered minimal as the infrastructure is stationary.

Provision of an artificial habitat for benthic and pelagic organisms

The physical presence of subsea infrastructure will act as artificial habitat or hard substrate, resulting in the settlement of marine organisms that would not otherwise be successful in colonising the area.

Impacts associated with the provision of artificial habitat from subsea infrastructure are increased biological productivity and diversity, which can result in a localised influence on marine communities. Given the small scale of the artificial habitat created, the potential impacts are expected to be localised.

Interaction with commercial and recreational fishing and shipping

The physical presence of subsea and surface infrastructure, support vessels and tankers may pose a potential risk to commercial and recreational fishing in the area.

A 500 m restriction zone exists around the Facility where fishing and vessels are not permitted. As there are no State or Commonwealth fisheries within the Permit Area, loss of access to the area will not impact on commercial fishing activities or recreational fishermen.

Changes to visual amenity

Changes to visual amenity are considered to pose a negligible impact due to the distance of the platform from the shore.

5.19.3 Control measures

Table 5-24: Physical presence of infrastructure - summary of hazards and controls

Source of Risk (Hazard)	Control Preventative Measures
Presence of hydrocarbon production subsea and surface infrastructure consisting of subsea pipelines/risers/ conductors, CGS and export system including CALM Buoy, mooring system and floating hose.	Emergency communications.
	Consultation/notification with relevant stakeholders including AusCoast/AMSA notification as required.
	For potential impact of disturbance to cetaceans and marine reptiles, no controls were identified as infrastructure is stationary and unlikely to have a major impact.
	For potential impact of provision of an artificial habitat for benthic and pelagic organisms, no controls were identified as no negative impact has been identified.
	For potential impact of changes to visual amenity, no controls were identified due to distance from shore.
Presence of topside hydrocarbon production facilities.	500 m restriction zone surrounding the facility.
	Bird deterrents are used on WNA.
Temporary presence of subsea equipment associated with project, campaigns, surveys, etc.	Emergency communications.
	Consultation/notification with relevant stakeholders including AusCoast/AMSA notification as required.
Control Mitigation Measures	
None identified.	

5.20 Seabed disturbance

5.20.1 Activity

The physical presence of the Wandoo Facility subsea infrastructure may alter the seabed due to the creation of benthic habitats and sea floor scour along the seabed.

5.20.2 Assessment

The physical presence of subsea infrastructure such as subsea flow lines and the CGS facility, combined with the action of altered current speed and direction around the infrastructure, can cause scour of soft sediments. At the Wandoo Facility, the seabed is characterised by soft unconsolidated sediments of no notable habitat value. Losses of soft substrata habitat due to seafloor scour represent a very small proportion of the widespread available habitat and associated impacts to the benthic habitat or productivity are considered localised and minimal.

The removal and replacement of subsea assets and wet storing may also cause temporary seabed disturbance due to the present of divers and associated equipment in the area. As this activity is temporary in nature and the benthic habitat in the area is similar to that through the region, potential impacts to benthic habitat are considered localised and minimal.

5.20.3 Control measures

Table 5-25: Seabed disturbance - summary of hazards and controls

Source of Risk (Hazard)	Control Preventative Measures
Cleaning and marine growth removal. ROV and diving. Installation of pipeline stabilisation and free span supports. Installation of scour protection. Anchoring and mooring. Removal and replacement of subsea assets. Wet storing.	There are no controls identified for these causes as there are no significant benthic habitats in the Permit Area, and impacts are local to the Facility.
Seabed scour around CGS.	Presence of scour protection around CGS.
Control Mitigation Measures	
None identified.	

5.21 Tanker and vessel biosecurity

5.21.1 Activity

Ballast water is held by offtake tankers and support vessels. Ballast water is seawater carried in a vessel or tanker's ballast tanks to improve its stability. As a vessel is unloaded, it takes on additional ballast water to compensate for the reduced weight. The ballast water is seawater drawn from the surrounding ocean and contains planktonic biota, including holoplankton, gametes, spores and larvae. As the vessel is loaded, the ballast water is discharged, along with the contained biota and any contaminants from the vessel's ballast tanks, resulting in the potential introduction of invasive marine species and changes to the local habitat structure.

5.21.2 Assessment

Due to the deep water, open-ocean environment at the Wandoo facilities, it is anticipated there will be little potential for pest organisms to accumulate and multiply due to lack of habitat. The greatest potential for the introduction of a marine pest species is the colonisation of subsea infrastructure by fouling organisms, particularly sessile invertebrates or marine algae closer to the sea surface, where light availability is greater. Due to the relative isolation of the Facility, any introduction is likely to remain localised.

5.21.3 Control measures

Table 5-26: Tanker and vessel biosecurity - summary of hazards and controls

Source of Risk (Hazard)	Control Preventative Measures
Export operations (tanker).	Tankers are required to meet quarantine guidelines.
	Compliant antifouling coatings on tankers.
	A tanker arriving from an overseas port having taken on ballast at that port is requested to change the ballast water prior to arrival at the Permit Area.
Diving and supply vessel movements.	Domestic and low risk goods transported to and from Australian ports only and free from pests.
	Compliant antifouling coatings on vessels from outside Australian waters.
Control Mitigation Measures	
None identified.	

5.22 Liquid hydrocarbon release from flow lines and risers

5.22.1 Activity

Well fluids from WNA are supplied to WNB via a production riser and flow line. After the oil is being processed, the oil is then stored in the CGS before being exported to a tanker via an export riser and pipeline from WNB.

Several causes that could lead to loss of liquid hydrocarbon from the risers and flow lines in the Wandoo Field have been identified as:

- Corrosion/erosion;
- Human error during pigging;
- Structural failure of platform due to fatigue/aging asset;
- Vessel collision with riser; and
- Dropped object/swinging load.

5.22.2 Assessment

Due to the small potential spill volume (0.8 m^3), any impacts are anticipated to be localised and short term in nature. The closest sensitive habitats to the Permit Area are located in the Dampier Archipelago and Montebello Islands, 40 km and 90 km from the Permit Area respectively. As a significantly larger instantaneous spill of 10,000 m^3 has only a low probability of impacting these habitats, it is considered highly unlikely that crude from the above spill scenarios would reach these habitats.

Minor impacts could occur on fauna in the immediate vicinity of the spill, including plankton, fish, marine mammals, reptiles and seabirds. A detailed description of the environmental impact of a hydrocarbon spill is provided in Section 5.1.

5.22.3 Control measures

Table 5-27: Liquid hydrocarbon release from flow lines and risers - summary of hazards and controls

Source of Risk (Hazard)	Control Preventative Measures
Loss of integrity of hydrocarbon containing equipment.	Flow lines and risers are designed and tested to maximum allowable operating pressure.
	Instrumentation initiators, alarms and final elements.
	Asset integrity management.
	Process and procedures for managing process system.
Incorrect operation of valves during pigging operation.	Pigging procedure specifies correct valve sequence.
Structural failure of the platform due to fatigue/aging asset.	Codes and standards as per facilities' Basis of Design.
Vessel collision with riser.	Emergency communications.
	Navigation aids.
	Structural integrity of the risers.
	Platform location published on Marine Charts.
	500 m restriction zone surrounding the facility.
	Vessel operations restricted in adverse weather.
Dropped objects/swinging load onto riser or flow lines.	Lifting management procedures.
	Crane maintenance.
Control Mitigation Measures	
Platform ESD will close riser shutdown valve.	
Wandoo Emergency Response Plan [VOG-2000-RD-0017].	
Oil Spill Response arrangements.	

VOGA carried out an assessment of alternative arrangements and additional controls to reduce the risk of loss of hydrocarbons from flow lines and risers. VOGA considered:

- Pigging processes outlined in the Platform Operations Manual [VOG-7000-MN-0001] were reviewed and improvements implemented; and
- Protection of flow lines (in areas which can be impacted by dropped objects or anchor drag). This item is not considered necessary as the crane has limited reach over the flow lines.

6 Implementation strategy

6.1 Overview

The operations of the WPF will be managed in compliance with the Wandoo Facility EP, under the OPGGS(E)R, other relevant environmental legislation and VOGAs Management System (e.g. VOGAs HSE Policy).

The objective of the Wandoo Facility EP is to ensure that any potentially adverse impacts on the environment associated with the operation of the WPF are identified and managed, and that in instances where the residual risk associated with any activity is not eliminated, it is reduced to ALARP.

The Wandoo Facility EP details the proposed performance outcomes, standards and measurement criteria, and identifies the preventative and recovery controls (where appropriate) in place for each potential impact. The overall level of residual risk is evaluated based on the assumption that these measures have been implemented.

VOGA has prepared a series of environmental performance standards for all risks, analogous to the safety performance standards prepared within Safety Case documents for managing safety critical equipment and systems. These performance standards detail the outcomes, requirements, assurance processes and criteria by which environmentally significant equipment and systems shall be maintained.

The implementation strategy detailed in the Wandoo Facility EP identifies the management systems in place, communications network, required training and competencies and key roles and responsibilities of all personnel in relation to implementing controls, managing non-conformances, routine environmental monitoring and auditing of operations, and emergency response including the implementation of oil spill response activities. The reporting requirements for recordable and reportable incidents and reporting requirements on overall compliance of the activities are described within the Wandoo Facility EP.

6.1.1 Monitoring and reporting

Table 6-1 provides a summary of routine environmental monitoring protocols and reporting that are currently undertaken at Wandoo.

Table 6-1: Summary of routine environmental monitoring and reporting

Parameter measured	Frequency	Monitoring strategy	Reporting
Ballast water and PFW discharge			
PFW overboard discharge volume	Continuously by flow meter.	Verify that PFW daily discharge flow rate remains within acceptable levels.	Wandoo Daily Report provides 24-hour flow.
PFW and ballast water OIW	OIW is trended continuously by an inline OIW analyser and twice daily laboratory analysis.	Verify that OIW content remains within acceptable levels.	Wandoo Daily Report provides 24-hour average.

Parameter measured	Frequency	Monitoring strategy	Reporting
PFW chemistry An end-of-pipe PFW sample is taken on a monthly basis and analysed in a National Association of Testing Authorities (NATA) accredited laboratory. Parameters tested will include: • Hydrocarbons (oil and grease, total recoverable hydrocarbons); and • Ammonia.	Monthly assay.	Verify that offshore OIW monitoring and onshore laboratory testing is aligned and ammonia levels from the reservoir remain within the defined threshold.	Monthly laboratory report.
PFW components An end of pipe PFW sample is taken and analysed in a NATA accredited laboratory. Parameters tested for include: • Metals (dissolved and total metals); • Inorganics (ammonia, etc.); • Radionuclides; and • Ecotoxicity screening test.	Annual assay.	Verify that concentrations are within Australian and New Zealand Environment and Conservation Council (ANZECC) Water Quality Guidelines 95% species protection guideline values where available or background levels.	Annual laboratory report.
Direct Toxicity Assessment The toxicity of an end of pipe PFW sample is assessed on a two yearly basis.	Two-yearly.	A revised No Observed Effect Concentration and potential mixing zone will be calculated based on direct toxicity assessment results. This mixing zone will be assessed to ensure it is within the mixing zone defined in the Wandoo Facility EP.	Two-yearly laboratory report.
Chemical dosing rates	Daily and weekly.	Appropriate dosing ratios of chemicals are confirmed by continuous metering and weekly stock-taking of all production chemicals.	Weekly stocktake records.
Biocide	Three- to five-weekly intervals (with pigging).	Biociding procedure ensures that tetrakis (hydroxmethyl) phosponium sulphate (biocide) is depleted to background levels prior to discharge to sea.	Records of pigging activity in the Pigging Report.

Parameter measured	Frequency	Monitoring strategy	Reporting
Atmospheric emissions			
Flaring volume	Daily.	Flaring volumes are recorded daily to ensure that any significant increase in flaring is identified. Atmospheric emissions from flaring are reviewed annually against stewardship targets.	Wandoo Daily Report. Annual review of flaring rate against stewardship targets. Emissions reporting, e.g. National Greenhouse and Energy (NGERS) and National Pollutant Inventory (NPI) reporting.
Diesel fuel usage	Daily.	Diesel fuel usage is monitored and contained within daily report figures.	Diesel usage records.
Waste			
Volumes of hazardous and non-hazardous waste removed from Facility	Frequency as removed from Facility for disposal at a licensed waste disposal facility.	Documentation volumes of waste removed from the Facility. The discharge of waste is recorded as per MARPOL Annex V requirements.	Waste manifest records.

6.1.2 Auditing

The VOGA audit procedure is outlined in the Performance Assessment Manual [VOG-1000-MN-0003]. The audit process comprises:

- Audit scheduling;
- Preparation and planning;
- The audit;
- Reporting; and
- Follow up and action item close-out.

To support compliance monitoring, the audit plan is set out each year as part of the VOGA Audit Schedule [VOG-2000-RY-0031. The audit findings will be outlined in an audit report submitted to the Operations Manager.

Following receipt of the audit report, the Operations Manager should undertake a review and develop an action plan. The action plan will finalise:

- Action items;
- Action parties;
- Timeframe for completing action items; and

- Approver.

The appropriate actions need to be taken by the designated action parties within the agreed timeframe. The process for closing out actions is detailed in the Performance Assessment Manual [VOG-1000-MN-0003].

6.1.3 Management of non-conformances

Non-conformances include near-misses, incidents or other events or information that indicate a lack of conformance with specified objectives or compliance requirements (i.e. an audit action).

VOGA utilises the Vermilion global incident recording and action tracking system 'iTrak'. This system is used for capturing and following up on near-misses and incidents including their associated corrective and preventive actions, ensuring that any lessons are learned in the interests of continual improvement.

In addition to iTrak and, on behalf of the VOGA Managing Director, the VOGA Administration Assistant maintains logs of outstanding actions arising from audits or other actions that do not require entry on iTrak, but which nevertheless require some form of follow-up action and confirmation of closure.

6.1.4 Management of Change

MoC is a critical management system process as it ensures that all modifications associated with the Wandoo facilities are subjected to appropriate scrutiny, review and assessment. The MoC form/checklist and the Change Management Process within the Work Management Manual [WPA-7000-YG-0021] are used to ensure that changes are evaluated, approved and documented prior to implementation. Field changes are initiated to resolve an operational problem or to improve safety, environmental performance or efficiency. They include modifications to facilities, changes to operating conditions and procedures, non-routine critical operations and major plant and equipment testing.

6.1.5 Environment Plan revisions

A formal review and revision of the Wandoo Facility EP will be undertaken every five years (Regulation 19), after a significant modification or new stage of an activity or any new or increased environmental impact or risk has been identified under Regulations 17 or 18.

The review will include an assessment of:

- The compliance with the Commitments Register (containing environmental performance outcomes and standards);
- Any changes to the Wandoo Well Operations Management Plan [VOG-1000-YG-0006] which may impact on well integrity;
- The continued relevance of environmental performance outcomes and standards;
- Effectiveness of the implementation strategy within the Wandoo Field EP; and
- The adequacy of auditing and monitoring.

6.1.6 Oil Spill Contingency Plan revisions

The review schedule and triggers are outlined in the Wandoo Field OSCP [WAN-2000-RD-0001]. The triggers include:

- Timing of well construction activities;
- Significant changes in oil spill response capability or spill risk profile; and
- Following spill response event.

If these reviews are not triggered, then a review of the Wandoo Field OSCP [WAN-2000-RD-0001] will occur no less frequently than once per year.

7 Oil spill response arrangements

7.1.1 Wandoo Field Oil Spill Contingency Plan

A Wandoo Field OSCP [WAN-2000-RD-0001] for the WPF detailing the arrangements in place for dealing with any potential spills and minimising the potential effects of a spill on the environment has been developed and accepted by NOPSEMA. The Wandoo Field OSCP details the roles and responsibilities of all involved and includes interfaces with third parties who may be affected by or involved in responding to a spill. For example, by supplying response equipment, such as the Australian Marine Oil Spill Centre (AMOSC) and Oil Spill Response Ltd (OSRL).

The Wandoo Field OSCP has been developed in consultation with State and Commonwealth Statutory Agencies including the WA Department of Transport and Australian Maritime Safety Authority (AMSA). The Wandoo Field OSCP outlines:

- VOGA's incident response structure and function and interfaces with external response agencies;
- The incident notification requirements for the relevant State and Federal agencies;
- The potential spill scenarios, trajectory modelling and zones of potential impact;
- The response options, including net environmental benefit analysis, response constraints and logistics arrangements; and
- The testing and monitoring arrangements to ensure the performance standards for the plan and equipment are maintained.

In the event of a spill, immediate notifications will be made as detailed in the Wandoo Field OSCP. All resources for the spill category will be activated as per the Wandoo Field OSCP. In the event of a spill, the incident action planning formally documents and communicates the:

- Incident objectives;
- Effectiveness of the response strategies;
- Status of assets;
- Operational period objectives; and
- Response strategies defined by the Incident Commander during response planning.

The Incident Command Team (ICT) will evaluate the response strategies provided in the Wandoo Field OSCP based on the actual circumstances of the spill to ensure the response is appropriate to the nature and scale of the risks and to demonstrate that the risks are reduced to ALARP. The ICT will use monitoring and evaluation data to understand the behaviour and likely trajectory of the oil spill to evaluate the appropriate spill response strategy. To ensure the spill strategy is achieving the desired environmental outcomes, performance measures are established to support the assessment of the response strategy. If the review process determines that a strategy is not 'effective', the incident action planning process provides the flexibility to adjust the response strategy or reallocate resources if necessary.

Feasible oil spill response strategies include:

- Source control;

- Monitoring and evaluation;
- Chemical dispersion;
- Containment and recovery;
- Mechanical dispersion;
- Protection and deflection; and
- Shoreline clean-up.

The potential impacts of each spill response strategy have been assessed to demonstrate the strategies are acceptable and reduce the consequences of the spill to ALARP. Equipment and capability requirements were also defined and reviewed to ensure that spill response resources were supporting the management of the spill risks to ALARP. The results are documented in the Oil Spill Capability Review [VOG-7000-RH-0009].

7.1.1.1 Operational and Scientific Monitoring Plan

The Wandoo Field Operational and Scientific Monitoring Plan (OSMP) [WAN-2000-RD-0001.03] has been designed as part of an integrated package of the environmental management documentation including the Wandoo Facility EP and the Wandoo Field OSCP. The OSMP is informed by the EP through the identification of the sensitive receptors in the Wandoo Field operating environment that could be impacted during an oil spill. The monitoring activities detailed in the Wandoo Field OSMP may also provide a basis for:

- Determining if and/or when the goals set for environmental protection are achieved;
- 'Testing' the efficacy of predictions of impact presented in the Wandoo Facility EP; and
- 'Testing' the effectiveness of the oil spill response within the Wandoo Field OSCP.

The Wandoo Field OSMP would be activated at the same time as the Wandoo Field OSCP. The following details regarding the activation and undertaking of the OSMP include:

- Values and receptors to be monitored;
- Integration of operational and scientific monitoring;
- Operational monitoring plans;
- Scientific monitoring plans;
- Data governance;
- Roles and responsibilities; and
- Resourcing and capabilities.

7.1.2 Source control plans

7.1.2.1 Wandoo Source Control Contingency Plan

The Source Control Contingency Plan [VOG-5000-PD-0001] is focused on source control for wells. The plan provides campaign-specific details relating to reservoir conditions, blowout taskforce team structure and logistics. The purpose of the document is to have as much planning as possible conducted upfront to minimise the response time of remedial measures.

There are several generic phases to bring an uncontrolled hydrocarbon release under control:

- Phase 1: Initial response, convene well construction ICT and gather information;
- Phase 2: Determine most efficient well kill method;
- Phase 3: Detailed planning of the well kill operation;
- Phase 4: Execute well kill operation;
- Phase 5: Clean-up operation; and
- Phase 6: Incident Investigation.

7.1.2.2 Concrete Gravity Structure Source Control Plan

The CGS Source Control Plan [VOG-3000-YH-0001] provides a response framework to implement to minimise the volume of oil spill originating from CGS. The response is under the Wandoo Facility Emergency Response Plan [VOG-2000-RD-0017] and runs in parallel to the oil spill ICT. Both teams interface at the incident command level of the emergency response structure.

8 Stakeholder consultation

8.1 Overview

For the activity defined in the Wandoo Facility EP, Regulations 11A, 14(9) and 16(B) of the OPGGS(E)R require consultation with relevant authorities, persons and organisations. VOGA conducted an extensive range of consultation during the development of Wandoo Facility EP and also during the development of the Well Construction EP [WPA-7000-YH-0001] in 2012. VOGA is committed to ongoing consultation with relevant stakeholders to ensure concerns associated with the company's activities are mitigated through the management of the activity where practicable.

The method VOGA uses to identify relevant stakeholders is outlined in Section 8.3.

8.2 Objectives

The key objectives of VOGA's stakeholder consultation process are to:

- Initiate and maintain open communications between stakeholders and VOGA;
- Ensure stakeholders are kept informed of VOGA's activities;
- Provide stakeholders with an opportunity to provide feedback on VOGA's activities;
- Establish an open and transparent process for engagement;
- Manage any concerns raised by stakeholders regarding VOGA's activities; and
- Provide a means for recording all communication and/or consultation, issues raised and responses.

8.3 Stakeholder identification and classification

Regulation 14(9) of the OPGGS(E)R specifies a requirement for consultation with relevant authorities of the Commonwealth, State, and other relevant interested persons or organisations. Stakeholders associated with VOGA's activities were identified by:

- Reviewing records of previous stakeholder consultation undertaken;
- Engaging with government and non-government organisations, as well as commercial fishing operators licensed/administered through the WA Department of Fisheries (DoF);
- Workshop sessions with both internal and external parties, including regulators; and
- Reviewing the regional context in which VOGA operates and the ZPI associated with the campaigns to identify which, if any, businesses, organisations, councils, landowners and traditional owners may be affected by the activities, including oil spill response.

Following the stakeholder identification process, VOGA is able to determine the level stakeholder consultation required for each planned activity. Definitions for these consultation protocols are detailed in Table 8-1.

Table 8-1: Stakeholder category definitions and consultation protocol

Category	Definition
Relevant	A relevant stakeholder is defined as a person or organisation whose functions, interests or activities may be affected by planned activities associated with the EP.
Interested	Stakeholder is indirectly impacted by the petroleum activity.

The stakeholders identified as being either relevant or interested in the Wandoo Field activities and future activities (not limited to) via the stakeholder identification process are identified in Table 8-2.

Table 8-2: Stakeholders, functions, interest or activities, and relevant receptor categories

Stakeholders	Functions, interest or activities	Relevant receptor categories
Government Regulators/Agencies		
WA Department of Mines and Petroleum (DMP)	Consultation undertaken as per the DMP Consultation Guidance Note (for the OPGGS(E)R).	All State petroleum infrastructure.
Pilbara Port Authority	Oversees operations of the Port of Dampier. Oil spill response.	Nearshore marine infrastructure (ports, boat ramps, jetties, etc.).
Australian Petroleum Production and Exploration Association (APPEA)	Coordinate and enhance industry oil spill response planning and capability.	N/A
Oil Spill Response		
AMOSC	Oil spill response (via the AMOS Plan).	N/A
AMSA	Oil spill response (Statutory and combat agency for vessels in Commonwealth waters). Oil spill response (coordinates national pollution prevention and response strategy, with oversight of the National Plan to Combat Pollution of the Sea by Oil and Other Noxious and Hazardous Substances)	Shipping.
Department of Transport (DoT)	Oil spill response (State waters).	All State environmental receptors.
WA Department of Parks and Wildlife (DPaW)	Interest in oil spill response (oiled wildlife).	All State environmental receptors.
City of Karratha	Oil spill response (in the event of an oil spill affecting the Dampier coastline, the City will have to provide emergency access to temporary accommodation and approve the disposal of oily waste).	Terrestrial infrastructure (shopping centres, local amenities, roads and access, etc.). Nearshore marine infrastructure (ports, boat ramps, jetties, etc.).
State Emergency Service (SES) Karratha	Oil spill response (likely to be involved in oil spill response activities).	Terrestrial infrastructure (shopping centres, local amenities, roads and access, etc.). Nearshore marine infrastructure (ports, boat ramps, jetties, etc.).
Fisheries and Fishing Agencies		
Department of Fisheries (DoF)	Consultation undertaken as per DoF Guidance Statement for Oil and Gas Industry Consultation.	Offshore vessels/platforms/MODUs. Nearshore marine infrastructure (ports, boat ramps, jetties, etc.).

Stakeholders	Functions, interest or activities	Relevant receptor categories
	Sustainable management and development of State fisheries Protection of brand (i.e. pristine environment).	Marine habitats. Fish and sharks. Fisheries (and aquaculture).
Australian Fisheries Management Authority (AFMA)	Sustainable management and development of State fisheries Protection of brand (i.e. pristine environment).	Offshore vessels/platforms/MODUs. Nearshore marine infrastructure (ports, boat ramps, jetties, etc.). Marine habitats. Fish and sharks. Fisheries (and aquaculture).
Commerical fisheries	Accessing their lease areas. Accessing/exploiting commercial fish species. Protection of brand (i.e. quality product).	Offshore vessels/platforms/MODUs. Nearshore marine infrastructure (ports, boat ramps, jetties, etc.). Marine habitats. Fish and sharks. Fisheries (and aquaculture).
Western Australian Fishing Industry Council (WAFIC)	Represents the interested State fishers. Accessing/exploiting commercial fish species. Protection of brand (i.e. quality product, responsible fishing).	Nearshore marine infrastructure (ports, boat ramps, jetties, etc.). Marine habitats. Fish and sharks. Fisheries (and aquaculture).
Pearl Producers Association	Represents the interests of WA's pearling industry. Accessing/exploiting commercial marine species. Protection of brand (i.e. quality product, responsible fishing).	Nearshore marine infrastructure (ports, boat ramps, jetties, etc.). Fisheries (and aquaculture).
Recfishwest/ recreational fishers	Represents the interests of recreational fishers in WA. Accessing recreational fishing areas. Accessing recreational fish species.	Nearshore marine infrastructure (ports, boat ramps, jetties, etc.). Marine habitats. Fish and sharks.
Other		
Cultural heritage holders	Shipwrecks.	Shipwrecks.
Local eNGOs	Protection of local environmental receptors.	Local environmental receptors.
Petroleum titles holders	Accessing petroleum titles (onshore and offshore). Operating petroleum titles.	All petroleum infrastructure.

VOGA maintains all stakeholders and contact details via a stakeholder matrix. Prior to engagement, the stakeholder matrix is reviewed and relevant and interested stakeholders are determined.

8.4 Summary of stakeholder consultation

During the period November 2013 to June 2014, VOGA engaged with the key stakeholders by telephone and email, and held briefing meetings (when applicable) to present an overview of its current and planned operations, the Wandoo Field OSCP [WAN-2000-RD-0001] and spill

modelling, and seek feedback and comment (as detailed in Appendix A). Stakeholders were also engaged prior to the 2015 and 2016 well construction campaigns, as per the Well Construction EP [WPA-7000-YH-0001].

In July 2016 VOGA met with WAFIC, to brief them on the modifications to the PFW and review current engagement arrangements with licence holders. WAFIC confirmed that postal contact was the only available means of contact with relevant licence holders. WAFIC advised that they were currently considering undertaking more of a coordinating role for engagement between the oil and gas industry and fisheries licence holders in the future to help deliver more effective engagement outcomes for both the industry and licence holders.

WAFIC also provided feedback on the communication materials to ensure the information was presented in a format best suited for the fishing stakeholders.

In July 2016, VOGA provided licence holders, DoF and AFMA with a fact sheet and frequently asked questions on the production and release of PFW including contact details for enquiries and feedback. The names and postal addresses of licence holders were provided by DoF. To date VOGA has not received any contact from licence holders in response to the letter.

In October 2016 VOGA provided a second letter to AFMA and DoF, summarising stakeholder consultation and providing them with a further opportunity to comment on the proposal. A response was provided by DoF to VOGA in December 2016. DoF requested that DPaW, Pearl Producers Association and Recfishwest also be consulted. VOGA provided a response to DoF and letters to the requested stakeholders in December 2016.

Appendix A presents a summary of the responses from key stakeholders and the actions by VOGA. A full copy of the VOGA briefing packages, correspondence and full text of the stakeholder replies are held in the VOGA's Document Control System.

In summary, no change to the proposed activity were identified as a result of the consultation process, although ongoing consultation will be maintained to ensure any new issues or concerns are promptly identified and addressed as per Section 8.5.

8.5 Ongoing stakeholder consultation

Ongoing stakeholder consultation will be maintained by as outlined in Table 8-3.

Table 8-3: Ongoing consultation

Consultation Trigger	Stakeholders	Frequency	Media (i.e. email, post, meetings)
Vermilion Environmental Report - summarising Vermilion's environmental performance and activities.	Available to all stakeholders.	Annual.	Report available on the Vermilion website.
Significant change to the potential or actual environmental impacts detailed in the Wandoo Facility EP for any given operation or activity.	All stakeholders identified as relevant or interested.	Prior to revised EP submission.	To be determined at the time of consultation.
Triggered consultation project or activity updates.	Consulted stakeholders, as appropriate.	As required.	To be determined at the time of consultation.

Stakeholders are able to access information on VOGA's activities via the EP Summary (on NOPSEMA's website; http://www.nopsema.gov.au) and additional information on Vermilion's website (http://www.vermilionenergy.com/operations/australia/environment.cfm).

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APPENDICES

Appendix A. Stakeholder consultation summary report

Table A-1: Summary of stakeholder consultation

Stakeholder	Engagement outcome(s) sought	Engagement actions taken	Objections Yes/No/NA	Key issues raised in consultation to-date	VOGA response to stakeholder feedback	Future steps
WA DMP	Provide DMP with information and opportunity to comment proposed operations activities in accordance with the requirements of the DMP Consultation Guidance Note (for the OPGGS(E)R). Notification of well construction activities.	VOGA sent a letter on 27 January 2014 regarding the Wandoo Facility and Well Construction EPs and activities. A mail response from DMP on 11 February requested additional information on the proposed activity. VOGA issued copy of EP summary and covering letter to DMP on 20 February, addressing DMP's information request from 11 February 2014. DMP confirmed via email (on 6 March 2014) that no additional information was required. VOGA sent a letter on 10 August 2015 regarding the 2015 Wandoo Infill Well Construction campaign. DMP confirmed via email (on 21 August 2015) that no additional information was required. VOGA sent a letter on 19 February 2016 regarding the 2016 Wandoo Infill Well Construction campaign. DMP acknowledged the 19 February 2016 letter with a reminder to notify the DMP of commencement and cessation notifications. VOGA sent an email on 22 April 2016 informing the DMP of the commencement of the 2016 well construction activities. DMP acknowledged the commencement email on 20 May 2016 with no comments. VOGA sent an email on 15 June 2016 informing the DMP of the cessation of the 2016 well construction activities. DMP acknowledged the commencement email on 20 July 2016 with no comments.	No	DMP requested additional information on: • the activities particularly drilling that is planned; • the potential impacts of the activity; • spill modelling data; and • potential for any impacts to State Waters/coast?	VOGA provided the DMP with details on the planned activity; spill modelling data; and the potential impacts of the activities to State Waters and the WA coast. DMP reviewed the notification and in their response did not require any further information.	Ongoing engagement as required, as outlined in Section 8.5.
Pilbara Port Authority	Ongoing DPA participation in exercises. Notification of well construction activities.	VOGA sent a letter on 27 January 2014 regarding the Wandoo Facility and Well Construction EPs and activities. VOGA sent follow-up email on 26 February 2014 giving then Dampier Port Authority (DPA) further opportunity to provide input. VOGA sent a letter on 10 August 2015 regarding the 2015 Wandoo Infill Well Construction campaign. VOGA sent a letter on 19 February 2016 regarding the 2016 Wandoo Infill Well Construction campaign. The Pilbara Port Authority acknowledged the 19 February 2016 letter with no comments	No	No response to consultation to date.	N/A – No feedback received from DPA to date.	Continue to engage DPA through the Pilbara Critical Infrastructure Security Forum and regional spill response activities. Seek DPA participation in exercises with VOGA and other industry members.
APPEA	Improve collective industry spill response capability through engagement with other APPEA member companies. Notification of well construction activities.	VOGA sent a letter on 27 January 2014 regarding the Wandoo Facility and Well Construction EPs and activities. VOGA followed up during participation in APPEA Safety, Environment and Oil Spill Response forums and through its attendance at twice yearly oil spill planning and capability workshops. VOGA sent a letter on 10 August 2015 regarding the 2015 Wandoo Infill Well Construction campaign. VOGA sent a letter on 19 February 2016 regarding the 2016 Wandoo Infill Well Construction campaign.	No	No issues raised at forums to date.	Review and support actions within the industry on an ongoing basis.	Continued attendance at relevant forums and working groups.

Stakeholder	Engagement outcome(s) sought	Engagement actions taken	Objections Yes/No/NA	Key issues raised in consultation to-date	VOGA response to stakeholder feedback	Future steps
AMOSC	Confirmation of oil spill resources, capability and command as per OSCP. Ongoing AMOSC participation in emergency response/oil spill scenario exercises. Obtain confirmation that AMOSC has a copy of an executed agreement for the provision of emergency response services to VOGA. AMOSC to have opportunity to comment on revised OSCP. Ensure MOU is in place allowing VOGA to access AMOSC equipment. Notification of well construction activities.	VOGA sent a letter on 27 January 2014 regarding the Wandoo Facility and Well Construction EPs and activities. VOGA sent request to AMOSC to provide its spill response resource list on 14 February 2014. AMOSC spill response resource list confirmed as part of OSCP preparations (14 and 20 February 2014). AMOSC issued update to VOGA (and other members) regarding its oiled wildlife response capability in the event of a spill (6 March 2014). VOGA representative participated in an AMOSC Oiled Wildlife Plans Presentation and Discussion Session on 8 July 2014 – to agree that a common WA Oiled Wildlife Response Plan be adopted. VOGA sent a letter on 10 August 2015 regarding the 2015 Wandoo Infill Well Construction campaign.	No	No issues raised in consultation to date.	VOGA included AMOSC resources and capability as part of OSCP review.	Ongoing engagement as required, as outlined in Section 8.5. Issue revised OSCP to AMOSC once accepted.
AMSA	Confirmation of oil spill resources, capability and command as outlined in OSCP. Clarify AMOSC and AMSA MoU. Confirmation of emergency contacts within AMSA. Confirm AMSA's ongoing participation in emergency response/oil spill scenario exercises. Notification of well construction activities.	VOGA sent a letter on 27 January 2014 regarding the Wandoo Facility and Well Construction EPs and activities. VOGA called and emailed AMSA 31 Jan 2014 re MOU between AMSA and offshore petroleum operators AMSA clarified arrangements relating to its involvement in an offshore oil spill, as detailed in its industry level MOU. AMSA confirmed industry level MOU has replaced need for individual operator consultation with AMSA. AMSA has provided MOU for VOGA signing and this is being reviewed by VOGA Corporate. VOGA has requested a meeting with AMSA to discuss spill risks from the Wandoo asset and to confirm responsibilities and command transition arrangements for marine spill events under the National Plan – requests issued to AMSA on 18 and 24 February and 27 August 2014. MOU signed by VOGA and sent to AMSA for signature on 15 October 2014. VOGA sent a letter on 10 August 2015 regarding the 2015 Wandoo Infill Well Construction campaign. VOGA sent a letter on 19 February 2016 regarding the 2016 Wandoo Infill Well Construction campaign.	No	No issues raised in consultation to date.	VOGA included AMSA resources and capability as part of OSCP review.	Ongoing engagement as required, as outlined in Section 8.5. Issue revised OSCP to AMSA once accepted.

Stakeholder	Engagement outcome(s) sought	Engagement actions taken	Objections Yes/No/NA	Key issues raised in consultation to-date	VOGA response to stakeholder feedback	Future steps
WA DoT	Provide briefing/overview of OSCP. Confirmation of oil spill resources, capability and command with DoT as per OSCP. Confirmation of approval process for dispersant use. Ongoing DoT participation in emergency response/oil spill scenario exercises. Notification of well construction activities.	VOGA sent an email 24 January 2014 requesting a meeting in February to discuss the spill scenarios in the Wandoo Field OSCP. VOGA sent a letter on 27 January 2014 regarding the Wandoo Facility and Well Construction EPs and activities. DoT confirmed WA Government's role in marine oil spill response. DoT confirmed WestPlan Marine Oil Pollution only requires confirmation that an operator's OSCP is aligned with State and National response frameworks. DoT provided information on dispersant quantities and access (14 February 2014) and the dimensions of boom required for single vessel side sweep operations (26 February 2014). Meeting held with DoT on 25 February 2014 regarding oil spill scenarios and response plans. DoT confirmed its role as hazard management agency in the event of a spill and advised no MOU was required to access resources. VOGA sent a letter on 10 August 2015 regarding the 2015 Wandoo Infill Well Construction campaign. Meetings held with WA DoT 15 December 2015 and 20 January 2016 to discuss changes to the WestPlan Marine Oil Pollution and State water arrangements. VOGA sent a letter on 19 February 2016 regarding the 2016 Wandoo Infill Well Construction campaign.	No	No issues raised in consultation to date.	VOGA provided a copy of OSCP and confirmed alignment with State and National response frameworks.	Issue revised OSCP to DoT once approved. Ongoing engagement as required, as outlined in Section 8.5.
WA DPaW	Establish greater understanding of the Western Australian Government's coordinated oiled wildlife response planning. Notification of well construction activities. Consultation on the proposed modifications to the PFW process.	VOGA sent a letter on 27 January 2014 regarding the Wandoo Facility and Well Construction EPs and activities. DPaW advised, via email on 10 February 2014, that VOGA Operations Activities were unlikely to affect ecologically sensitive receptors in general area. VOGA participated in an AMOSC-led Oiled Wildlife Plans Presentation and Discussion Session on 8 July 2014 - to agree that a common WA Oiled Wildlife Response Plan be adopted. The session was attended by DPaW representatives. VOGA emailed DPaW on 19 November 2014 to provide clarification on our available baseline data and to enquire about accessing known DPaW data. DPaW responded on 9 January 2015. VOGA sent a letter on 10 August 2015 regarding the 2015 Wandoo Infill Well Construction campaign. VOGA sent a letter on 19 February 2016 regarding the 2016 Wandoo Infill Well Construction campaign. VOGA sent a letter and fact sheet on 16 December 2016 regarding the modification to the PFW process.	No	DPaW sought confidence that VOGA has undertaken investigations and has access to information on baseline ecological condition of sensitive receptors within the ZPI. DPaW recommended that VOGA develops and maintains a baseline understanding of shallow water (<2m) and intertidal benthic habitat, sediment and water characteristics, turtle and seabird nesting and roosting sites within a suitable radius of any future activities (as determined in consultation with DPaW). In the absence of current baseline data for any areas affected by future incidental hydrocarbon release, DPaW would assume the baseline state of affected marine and coastal onshore and offshore areas to be pristine and would expect VOGA to return affected areas to their natural state within a period acceptable to regulators and the community.	VOGA has undertaken a gap analysis of baseline data within the worst-case ZPI (Astron 2014). A key function of the review was to link the most reliable and relevant baseline data collection with their methodological approaches so that post spill data collection is carried out with the highest likelihood of effectively informing management decisions. Additionally, VOGA has committed to further marine monitoring within the Wandoo Field in the Wandoo Field EP [WPA-7000-YH-0007]. In the absence of required data, the Operational and Scientific Monitoring Plan [WAN-2000-RD-0001.03] has identified methodologies for obtaining relevant baseline data at the time of a spill. During the development of the gap analysis, DPaW was identified as having established marine monitoring programs for sediment quality at Shark Bay, Montebello Islands and Barrow Island, as well as water quality monitoring at various locations. VOGA has contacted the DPaW Environmental Management Branch to determine whether this data contains hydrocarbon analysis, as well as how this data could be accessed in the event of a spill. No feedback from DPaW has been received to date.	Ongoing engagement as required, as outlined in Section 8.5.

Stakeholder	Engagement outcome(s) sought	Engagement actions taken	Objections Yes/No/NA	Key issues raised in consultation to-date	VOGA response to stakeholder feedback	Future steps
				DPaW advised that implementation of its oiled wildlife response must be mandated by regulatory decision makers as part of whole-of-government response.	VOGA advised DPaW of the process for implementation of the Oiled Wildlife Response Measures, which are detailed in the EP, and acknowledged DPaW's valuable input to the development of these measures.	
				DPaW advised that in the event of an oil spill occurring in State waters, the DER Environmental Hazard Branch should be notified as soon as practicable in accordance with the requirements of the *Environmental Protection Act 1986*. If a site within State jurisdiction is potentially contaminated VOGA must report the area to the DER Contaminated Sites Branch in accordance with the requirements of the *Contaminated Sites Act 2003*.	Within the Wandoo Field OSCP [WAN-2000-RD-0001], VOGA has identified that DPaW will be invited to participate in the VOGA Incident Command Team during a spill to ensure that the response is reasonable and proportionate and to ensure that resources that may assist DPaW to undertake its function are supplied.	
				DPaW advised that the EP must consider the method of disposal of oily waste within State sea or land areas.	Within the Wandoo Field OSCP [WAN-2000-RD-0001] the VOGA waste management plan identifies companies and resources necessary for the offshore/shoreline temporary storage, marine transport, onshore final disposal, and auditing requirements, to ensure acceptable cradle-to-grave disposal practices are in place for all oily wastes.	
City of Karratha	Provide City of Karratha with information on proposed well construction activities and an opportunity to comment on spill response activities and logistics. Notification of well construction activities.	VOGA sent a letter on 27 January 2014 regarding the Wandoo Facility and Well Construction EPs and activities. VOGA sent follow-up email 26 February 2014 providing further opportunity for input; and outlined that a summary of the approved EP would be available on the NOPSEMA and VOGA websites. VOGA sent a letter on 10 August 2015 regarding the 2015 Wandoo Infill Well Construction campaign. VOGA sent a letter on 19 February 2016 regarding the 2016 Wandoo Infill Well Construction campaign.	No	City of Karratha (then Shire of Roebourne) confirmed via email on 26 February that it had no comments regarding the project at this stage. The City would like to continue to be engaged through the Pilbara Critical Infrastructure Security Forum.	No immediate response required.	Keep updated on emergency response coordination.
SES Karratha	Notification of well construction activities.	VOGA sent a letter on 10 August 2015 regarding the 2015 Wandoo Infill Well Construction campaign. VOGA sent a letter on 19 February 2016 regarding the 2016 Wandoo Infill Well Construction campaign.	No	N/A - no issues raised.	No immediate response required.	Keep updated on emergency response coordination.
WA DoF	Provide DoF with information on operations activities. Notification of well construction activities. Consultation on the proposed modifications to the PFW process.	VOGA sent a letter on 27 January 2014 regarding the Wandoo Facility and Well Construction EPs and activities. VOGA sent a follow-up email on 25 February 2014. DoF advised it considered itself a 'relevant person' for the proposed activity. VOGA sent a letter on 11 August 2015 regarding the 2015	No	DoF recommended VOGA consult with WAFIC, Recfishwest and commercial fishers directly with regard to proposed well construction activities.	VOGA sent letters to WAFIC, Recfishwest and commercial fisheries on 4 July 2014 outlining the proposed activities. No feedback has been received to date. VOGA will engage directly with WAFIC, Recfishwest and commercial fisheries as appropriate.	Follow-up letters will be sent to WAFIC, Recfishwest and commercial fisheries within two months of commencement of well construction

Stakeholder	Engagement outcome(s) sought	Engagement actions taken	Objections Yes/No/NA	Key issues raised in consultation to-date	VOGA response to stakeholder feedback	Future steps
		Wandoo Infill Well Construction campaign. VOGA sent a letter on 19 February 2016 regarding the 2016 Wandoo Infill Well Construction campaign. VOGA sent a letter and fact sheet on 25 October 2016 regarding the modification to the PFW process. VOGA sent a letter and risk assessment on 19 December 2016 responding to the questions raised by DoF on the modification to the PFW process.		DoF requested that VOGA collect baseline marine data to compare against any post-spill monitoring to determine the nature and extent of any impacts, and specific strategies are developed in EP and/or OSCP to mitigate the risks of spills on fish spawning areas.	VOGA has undertaken a gap analysis of baseline data within the worst-case ZPI (see DPaW response). Strategies to mitigate the impact of a hydrocarbon spill on sensitive environmental receptors, including impacts on fish and fisheries, have been detailed in the Wandoo Field OSCP [WAN-2000-RD-0001].	activity outlining specific dates of activity. Details of the DoF's biosecurity policy will be forwarded to vessel operators associated with well construction activities within two months of commencement of the activity.
				DoF requested that the risk of translocating pests and diseases via immersible equipment be minimised.	VOGA has identified and risk assessed the potential for introducing invasive marine species and developed appropriate controls. These controls include vessels obtaining quarantine clearance prior before entering Australian waters and current International Anti-fouling System Certificate for all support vessels.	
				DoF requested that affected fishers are consulted prior to the commencement of the proposed PFW modifications. DoF recommended that VOGA maintains ongoing consultation with WAFIC, the Pearl Producers Association of WA, Recfishwest, DPaW and directly with fishers (acknowledging that VOGA had already undertaken consultation with WAFIC and fishers). DoF also requested that the paper by Bakke et al. (2013) be considered in the PFW impact assessment and notified if mortality of individual "fish" is likely.	VOGA sent letters and the fact sheet regarding the proposed modifications to the PFW process to Recfishwest, DPaW and the Pearl Producers Association at the request of DoF. Pearl Producers Association were acknowledged as interested due to their Zone 1 fishing zone surrounding the Wandoo Permit Area (currently inactive). VOGA provided a summary copy of the PFW risk assessment to DoF and provided context of our risk assessment to the results of the Bakke et al. (2013) paper. It was noted that drill cuttings are not included within the scope of the Wandoo Facility Environment Plan and are therefore outside the scope of the submission. Vermilion will review this information as part of our Well Construction Environment Plan annual review. VOGA confirmed that no mortality to individual 'fish' was assessed as likely.	

Stakeholder	Engagement outcome(s) sought	Engagement actions taken	Objections Yes/No/NA	Key issues raised in consultation to-date	VOGA response to stakeholder feedback	Future steps
AFMA	Confirm Permit Area does not overlap with any Commonwealth fisheries. Notification of well construction activities. Consultation on the proposed modifications to the PFW process.	VOGA sent a letter on 27 January 2014 regarding the Wandoo Facility and Well Construction EPs and activities. AFMA confirmed via email on 29 January that it has developed new guidelines and a Fishing Consultation Directory to assist the petroleum industry. AFMA had no further comments on these specific activities as the area does not appear to overlap with any Commonwealth fisheries. AFMA would appreciate further consultation when there is any change to VOGA activities. VOGA sent a letter on 11 August 2015 regarding the 2015 Wandoo Infill Well Construction campaign. VOGA sent a letter on 19 February 2016 regarding the 2016 Wandoo Infill Well Construction campaign. AFMA acknowledged the 19 February 2016 letter with no comments other than to ensure that VOGA continue to consult with affected fishers in the area, and requested that all future correspondence be sent to petroleum@afma.gov.au. VOGA sent a letter and fact sheet on 25 October 2016 regarding the modification to the PFW process.	No	AFMA recommended engaging directly with fishers ahead of drilling.	Letters were issued to fishing licence holders in the vicinity of the Wandoo facility and the WA Pearl Producers Association, which distributed the letter to its members. VOGA will engage directly with fishers as appropriate ahead of drilling.	Ongoing engagement as required, as outlined in Section 8.5. AFMA contact details updated.
Commercial fisheries	Confirm Permit Area does not overlap with Commercial fisheries. Notification of well construction activities. Consultation on the proposed modifications to the PFW process.	VOGA sent letters to licence holders on 4 July 2014 regarding the Wandoo Facility and Well Construction EPs and activities. VOGA sent letters to licence holders on 12 August 2015 regarding the 2015 Wandoo Infill Well Construction campaign. VOGA sent letters to licence holders on 19 February 2016 regarding the 2016 Wandoo Infill Well Construction campaign. VOGA sent letters to licence holders and the fact sheet on 25 July 2016 regarding the modification to the PFW process.	No	N/A - no issues raised.	N/A	Continue to keep stakeholders informed during operations.
WAFIC	Provide information on proposed operations activities. Notification of well construction activities. Consultation on the proposed modifications to the PFW process.	VOGA sent a letter on 27 January 2014 regarding the Wandoo Facility and Well Construction EPs and activities. VOGA sent a follow-up email on 25 February 2014. VOGA sent a letter on 11 August 2015 regarding the 2015 Wandoo Infill Well Construction campaign. VOGA sent a letter on 19 February 2016 regarding the 2016 Wandoo Infill Well Construction campaign. Meeting with WAFIC on 21 July 2016 regarding the modification to the PFW process.	No	N/A - no issues raised.	VOGA sent a letter to WAFIC on 4 July 2014 outlining a description of proposed operations activities as requested by DoF.	Continue to keep stakeholders informed during operations.
Pearl Producers Association	Provide information on operational activities. Consultation on the proposed modifications to the PFW process.	VOGA sent a letter on 18 August 2014 regarding the VOGA Wandoo Field Activities. VOGA sent a response email on 18, 19, 21 and 27 August 2014. VOGA sent a letter and fact sheet on 16 December 2016 regarding the modification to the PFW process.	No	Pearl Producers Association requested on 19 August 2016 clarification on whether the VOGA operations are new or existing.	VOGA confirmed via email on 19 August 2014 that the operations and well construction activated are existing.	Continue to keep stakeholders informed during operations.
				Pearl Producers Association requested on 21 August 2014 an improved map to include the water depth contours of the operational area.	VOGA provided updated maps to Pearl Producers Association, including depth contours via email on 27 August 2014.	
				Pearl Producers Association requested clarification on 21 August 2014 whether seismic survey activity formed part of the proposed operational activities.	VOGA confirmed with Pearl Producers Association via email on 21 August 2014 that no seismic survey activity is contained within the proposed operational activities.	

Stakeholder	Engagement outcome(s) sought	Engagement actions taken	Objections Yes/No/NA	Key issues raised in consultation to-date	VOGA response to stakeholder feedback	Future steps
Recfishwest	Provide information on operational activities. Notification of well construction activities. Consultation on the proposed modifications to the PFW process.	VOGA sent letters on 4 July 2014 regarding the Wandoo Facility and Well Construction EPs and activities. VOGA sent a letter on 10 August 2015 regarding the 2015 Wandoo Infill Well Construction campaign. VOGA sent a letter on 19 February 2016 regarding the 2016 Wandoo Infill Well Construction campaign. VOGA sent a letter and fact sheet on 19 December 2016 regarding the modification to the PFW process.	No	N/A - no issues raised.	N/A	Continue to keep stakeholders informed during operations.