Santos

Reindeer Wellhead Platform and Offshore Gas Supply Pipeline Operations Environment Plan WA-41-L and WA-18-PL

PROJECT / FACILITY	Reindeer Wellhead Platform and Pipeline
REVIEW INTERVAL (MONTHS)	60 Months
SAFETY CRITICAL DOCUMENT	NO

Rev	Owner	Reviewer/s *Managerial/Technical/Site*	Approver
	Operations Superintendent	HSE Team Lead - Production	Manager – Gas Assets
2			

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Rev	Rev Date	Author / Editor	Amendment
A	06/09/2013	Quadrant Energy	Draft issued for internal review
0	11/09/2013	Quadrant Energy	Submission to NOPSEMA
1	30/05/2014	Quadrant Energy	Addressed comments from NOPSEMA (Opportunity to Modify: dated 9/10/14)
1.1	05/08/2014	Quadrant Energy	Revised to incorporate MoC-056, which includes content of RFFWI accepted by NOPSEMA (31/07/14).
1.2	08/07/2015	Quadrant Energy	Revised to incorporate MoC-95
1.3	07/09/2016	Quadrant Energy	Update to Section 5.3 (atmospheric emissions) and Table 7-3 to accurately describe the potential sources and measurement of atmospheric emissions from Reindeer WHP (risk assessed in MOC-155).
1.3A	13/05/19	Santos WA	Revision A draft five year revision issued for internal review
1.3B	13/06/19	Santos WA	Revision B draft five year revision issued for internal review
2	16/07/19	Santos WA	Issued to NOPSEMA.

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Abbreviations

AFMA	Australian Fisheries Management Authority
ALARP	as low as reasonably practicable
AMOSC	Australian Marine Oil Spill Centre
AMSA	Australian Maritime Safety Authority
APPEA	Australian Petroleum Production and Exploration Association
AUV	autonomous underwater vehicle
BIA	biologically important area
CAMBA	China Australia Migratory Bird Agreement (1986)
CH_4	methane
CMMS	Computerised Maintenance Management System
CO_2	carbon dioxide
CTD	conductivity, temperature, and depth
DAH	dissolved aromatic hydrocarbon
DBCA	The Department of Biodiversity, Conservation and Attractions (Formerly Department of Parks and Wildlife)
DC	Devil Creek
DCGP	Devil Creek Gas Plant
DEWHA	Commonwealth Department of the Environment, Water, Heritage and the Arts
DMIRS	Department of Mines, Industry Regulation and Safety
DoEE	Department of the Environment and Energy
DoF	Department of Fisheries (now DPIRD)
DoT	Department of Transport
DPaW	Department of Parks and Wildlife
DPIRD	Department of Primary Industry and Regional Development (Formerly Department of Fisheries)
DWER	Department of Water and Environmental Regulation
EMBA	environment that may be affected
EP	environment plan
EPBC Act	Environment Protection and Biodiversity Conservation Act 1999
EPO	environmental performance outcome
EPS	environmental performance standard
ESD	emergency shutdown
GDA	Geocentric Datum of Australia
GHG	greenhouse gas
H_2S	hydrogen sulphide
HSE	Health, Safety and Environment

Hz	hertz
IAPP	International Air Pollution Prevention
IMO	International Maritime Organisation
IMT	Incident Management Team
JAMBA	Japan-Australia Migratory Birds Agreement (1974)
KEF	key ecological feature
kHz	kilohertz
km	kilometre
KP	kilometre point
L	litre
LAT	lowest astronomical tide
µm	micrometre or micron
µPa	micropascal
m	metre
m/s	metre per second
m^2	square metre
m^3	cubic metre
MARPOL	International Convention for the Prevention of Pollution from Ships
MBES	multi-beam echo sounder
MNES	matters of national environmental significance
MoC	management of change
MOP	Marine Oil Pollution
MPNMP	Marine Parks Network Management Plan
nm	nautical mile
NOPSEMA	National Offshore Petroleum Safety and Environmental Management Authority
NOx	nitrogen oxides
NRT	National Response Team
NT	Northern Territory
OPEP	oil pollution emergency plan
OPGGS(E)R 2009	Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009
OPGGS Act	Offshore Petroleum and Greenhouse Gas Storage Act 2006
OSRL	Oil Spill Response Limited
ppb	parts per billion
ppm	parts per million
ROTV	remotely operated (underwater) towed vehicle
ROV	remotely operated (underwater) vehicle

SA	South Australia
SBES	single-beam echo sounder
SMPEP	shipboard marine pollution emergency plan
SO_x	sulphur oxides
SOLAS	Convention on Safety of Life at Sea, 1974
SOPEP	shipboard oil pollution emergency plan
SSS	side-scan sonar
UNCLOS	United Nations Convention on the Law of the Sea (1982)
VOC	volatile organic compound
WA	Western Australia
WHP	wellhead platform
WOMP	well operations management plan

1 Introduction

1.1 EP Summary

OPGGS(E)R 2009 Requirements
Regulation 11(3)
Within 10 days after receiving notice that the Regulator has accepted an environment plan (whether in full, in part or subject to limitations or conditions), the titleholder must submit a summary of the accepted plan to the Regulator for public disclosure.
Regulation 11(4)
The summary: (a) must include the following material from the environment plan: (i) the location of the activity; (ii) a description of the receiving environment; (iii) a description of the activity; (iv) details of environmental impacts and risks; (v) a summary of the control measures for the activity; (vi) a summary of the arrangements for ongoing monitoring of the titleholder's environmental performance; (vii) a summary of the response arrangements in the oil pollution emergency plan; (viii) details of consultation already undertaken, and plans for ongoing consultation; (ix) details of the titleholder's nominated liaison person for the activity; and (b) must be to the satisfaction of the Regulator.

EP Summary material requirement	Relevant section of EP containing EP Summary material
The location of the activity	**Section 2.1**
A description of the receiving environment	**Section 3** and **Appendix C**
A description of the activity	**Section 2**
Details of the environmental impacts and risks	**Sections 6** and **7**
The control measures for the activity	**Sections 6** and **7 and Table 8-3**
The arrangements for ongoing monitoring of the titleholder's environmental performance	**Section 8**
The response arrangements in the oil pollution emergency plan	**Section 6.7** and **OPEP**
Details of consultation already undertaken and plans for ongoing consultation	**Section 4**
Details of the titleholder's nominated liaison person for the activity	**Section 1.6.2**

1.2 Background

On 27 November 2018, Santos completed its acquisition of Quadrant Energy. This has the effect that Santos Limited is now the ultimate holding company of Quadrant Energy Holdings Pty Ltd and its subsidiaries. It has also resulted in most of the Quadrant group of entities changing their name. For example, Quadrant Energy Australia Limited has changed its name to Santos WA Energy Limited and Quadrant Northwest Pty Limited has changed its name to Santos WA Northwest Pty Limited. Each entities ABN has remained the same. Santos WA Energy Limited on behalf of Santos WA Northwest Pty Ltd (hereafter referred to as Santos WA or the Company) will be responsible for all commitments and obligations in this EP.

1.3 Activity Overview

The scope of this EP comprises all activities described in this EP that are associated with the operation of the Reindeer wellhead platform (WHP) and associated wells within permit area WA-41-L and the offshore section of the Devil Creek Gas Supply Pipeline (DC supply pipeline; WA-18-PL) in Commonwealth waters. These are collectively referred to as the Reindeer facilities. The Reindeer facilities are located in Commonwealth waters and comprise:

+ The WHP infrastructure approximately 80 km offshore north-west of Dampier (**Figure 2-2**);
+ An offshore section of the DC supply pipeline approximately 43 km long (from kilometre points (KPs) 91.27 at the WHP to KPs 48.3 where the DC supply pipeline crosses into State waters);
+ Three wells tied back to the WHP; and
+ An open ocean well (Reindeer-1), which is temporarily abandoned and not connected to the WHP.

Although the Reindeer facilities are associated with the operation of the Devil Creek Gas Plant (DCGP) and the portion of the DC supply pipeline that is in State waters, this infrastructure is outside of the scope of this EP and is managed under the Devil Creek Gas Supply Pipeline and Sales Gas Pipeline Operations EP (EA-14-RI-10001/01) and Devil Creek Operations Environmental Management Plan (DC-40-RI-00021), respectively, under WA State jurisdiction.

1.4 Purpose of this Environment Plan

OPGGS(E)R 2009 Requirements
Regulation 19(1)
A titleholder must submit to the Regulator a proposed revision of the environment plan for an activity at least 14 days before the end of each period of 5 years, commencing on the latest of the following: (a) the day on which the environment plan is first accepted under regulation 10 by the Regulator; (b) the day on which a revised environment plan submitted under this regulation is accepted under regulation 10 by the Regulator; (c) for a revision of an environment plan submitted under regulation 17 or 18, the day (if any) notified by the Regulator under subregulation (2).
Regulation 19(2)
For paragraph (1)(c), the Regulator may notify the titleholder that the effect of a revision of an environment plan submitted under regulation 17 or 18 is that the period of 5 years mentioned in subregulation (1) starts on the date specified in the notification.

The operation of the Reindeer facilities has been managed under the Reindeer Wellhead Platform and Offshore Gas Supply Pipeline Operations Environment Plan (EA-14-RI-10002) accepted by the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) on 31 July 2014. As the five-year validity period of this EP is due to expire on 31 July 2019, Santos WA has revised the EP in accordance with Regulation 19 of the Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009 (OPGGS(E)R 2009). This revision has been informed by NOPSEMA's information paper, Considerations for Five-Year Environment Plan Revisions (N-04750-IP1764). Santos WA has submitted this revised EP within 14 days of the five-year period from the date the original EP was accepted by NOPSEMA, as required under Regulation 11.

This EP details the environmental impacts and risks associated with the activity and demonstrates how these will be reduced to as low as reasonably practicable (ALARP) and to an acceptable level. The EP reflects the updated existing implementation strategy used to measure and report on environmental performance during planned activities and unplanned events to ensure impacts and risks are continuously reduced to ALARP and are at an acceptable level. The environmental management of the activity described in the EP complies with the Company Environmental Management Policy (**Appendix A**) and with all relevant legislation. This EP documents and considers all relevant stakeholder consultation.

1.5 Environment Plan Validity

In accordance with Regulation 19, this EP remains valid from NOPSEMA acceptance for a period of five years, or until NOPSEMA has accepted an end-of-activity notification under Regulation 25A, or until Santos WA revises this EP.

1.6 Titleholder

1.6.1 Details for the Titleholder

OPGGS(E)R 2009 Requirements
Regulation 15(1)
The environment plan must include the following details for the titleholder: (a) name; (b) business address; (c) telephone number (if any); (d) fax number (if any); (e) email address (if any); (f) if the titleholder is a body corporate that has an ACN (within the meaning of the Corporations Act 2001)—ACN.
Regulation 15(2)
The environment plan must also include the following details for the titleholder's nominated liaison person: (a) name; (b) business address; (c) telephone number (if any); (d) fax number (if any); (e) email address (if any).

Table 1-1 lists the two titleholders of WA-41-L and WA-18-PL and their contact details.

Table 1-1: Titleholder Details for WA-41-L and WA-18-PL

Permit	Titleholder	ACN	% Interest	Address
WA-41-L	Santos WA Northwest Pty Ltd (Operator)	009 140 854	55	Level 7, 100 St Georges Terrace, Perth WA 6000
	Santos Offshore Pty Ltd	005 475 589	45	
WA-18-PL	Santos WA Northwest Pty Ltd (Operator)	009 140 854	55	
	Santos Offshore Pty Ltd	005 475 589	45	

1.6.2 Details for Nominated Liaison Person

Details for Santos WA Northwest Pty Ltd's nominated liaison person for the activity are as follows:

Name: Gareth Bamford (Manager – Gas Assets)

Business address: Level 7, 100 St Georges Terrace, Perth, WA 6000

Telephone number: (08) 6218 7100

Email address: offshore.hse.regulatory@santos.com

1.6.3 Notification Procedure in the Event of Changed Details

If there is a change in the titleholder, the titleholder's nominated liaison person, or the contact details for the titleholder or liaison person, Santos WA will notify NOPSEMA in writing and provide the updated details.

Additional information regarding Santos WA's operations can be obtained from the Santos WA website at: www.santos.com.

1.7 Environmental Management Framework

OPGGS(E)R 2009 Requirements
Regulation 13(4)
The environment plan must: (a) describe the requirements, including legislative requirements, that apply to the activity and are relevant to the environmental management of the activity; and (b) demonstrate how those requirements will be met.
Regulation 16
The environment plan must contain the following: (a) a statement of the titleholder's corporate environmental policy; (b) a report on all consultations under regulation 11A of any relevant person by the titleholder, that contains: (i) a summary of each response made by a relevant person; and (ii) an assessment of the merits of any objection or claim about the adverse impact of each activity to which the environment plan relates; and (iii) a statement of the titleholder's response, or proposed response, if any, to each objection or claim; and (iv) a copy of the full text of any response by a relevant person; (c) details of all reportable incidents in relation to the proposed activity.

1.7.1 Environmental Management Policy

The activity will be conducted in accordance with the Environmental Management Policy (**Appendix A**) and relevant legislative requirements presented in **Appendix B**, inclusive of the relevant EP sections where the legislation may prescribe or control how an activity is undertaken.

Sections 6, 7 and 8 reflect the Environmental Management Policy, detailing and evaluating impacts and risks from planned and unplanned events and providing control measures with set performance outcomes, standards, and measurement criteria to ensure environmental performance is achieved.

1.7.2 International Legislation

Australia is signatory to numerous international conventions and agreements that obligate the Commonwealth government to prevent pollution and protect specified habitats, flora and fauna. Those that have been considered during development of this EP are detailed in **Appendix B**.

1.7.3 Commonwealth Legislation

The petroleum activity described in this EP (**Section 2**) takes place within the Commonwealth jurisdictional boundary and therefore is subject to Commonwealth legislation.

All activities conducted as part of this EP will comply with legislative requirements established under relevant Commonwealth legislation. These are further detailed in **Appendix B.**

1.7.4 State Legislation

In the event of a WHP or pipeline loss of integrity or a vessel collision, there is the potential for the spill to impact on State waters and shorelines. Relevant State legislation is detailed in **Appendix B.**

2 Activity Description

OPGGS(E)R 2009 Requirements
Regulation 13(1)
The environment plan must contain a comprehensive description of the activity including the following: (a) the location or locations of the activity; (b) general details of the construction and layout of any facility; (c) an outline of the operational details of the activity (for example, seismic surveys, exploration drilling or production) and proposed timetables; (d) any additional information relevant to consideration of environmental impacts and risks of the activity. Note: An environment plan will not be capable of being accepted by the Regulator if an activity or part of the activity, other than arrangements for environmental monitoring or for responding to an emergency, will be undertaken in any part of a declared World Heritage property—see regulation 10A.

In accordance with OPGGS(E)R 2009, this section provides a description of the Reindeer facilities, their location and the activities undertaken to support operations.

2.1 Location

The Reindeer gas field is located within permit area WA-41-L, approximately 80 km northwest of Dampier, in the Barrow Sub-basin on the North West Shelf, offshore of Western Australia, as presented in **Figure 2-2**. The DC supply pipeline is located within pipeline licence WA-18-PL.

The coordinates for the WHP and DC supply pipeline are provided in **Table 2-1**. The pipeline crosses the Pluto pipeline approximately 20 km from the WHP.

Table 2-1: Coordinates for the Reindeer Facilities

Infrastructure Locations	Coordinates (Datum/Projection: GDA 94 Zone 50)		Water depth (m) LAT
	Latitude (South)	Longitude (East)	
Reindeer WHP	20°01'26.738"	116°18'35.021"	58.7
Pluto pipeline crossing	20°13'1"	116°19'20"	50.5
DC supply pipeline State/Commonwealth boundary interception	20°24'39.442"	116°20'08.562"	38.0

2.2 Operational Area

The operational area is defined as the area shown in **Figure 2-1** and **Figure 2-2**, comprising:

+ A 250-m buffer either side of the Commonwealth waters section of the DC supply pipeline (from the WHP to the State waters limit); and
+ A 2-km x 1-km buffer around the WHP and Reindeer-1 well.

The operational area includes a charted 500-m petroleum safety zone around the WHP. A cautionary area designated by the Australian Maritime Safety Authority (AMSA) with a radius of 2.5 nautical miles (nm) is charted around the WHP.

The extent of the operational area has been defined based on the physical footprint of the activities detailed in this EP associated with the operation of the Reindeer facilities.

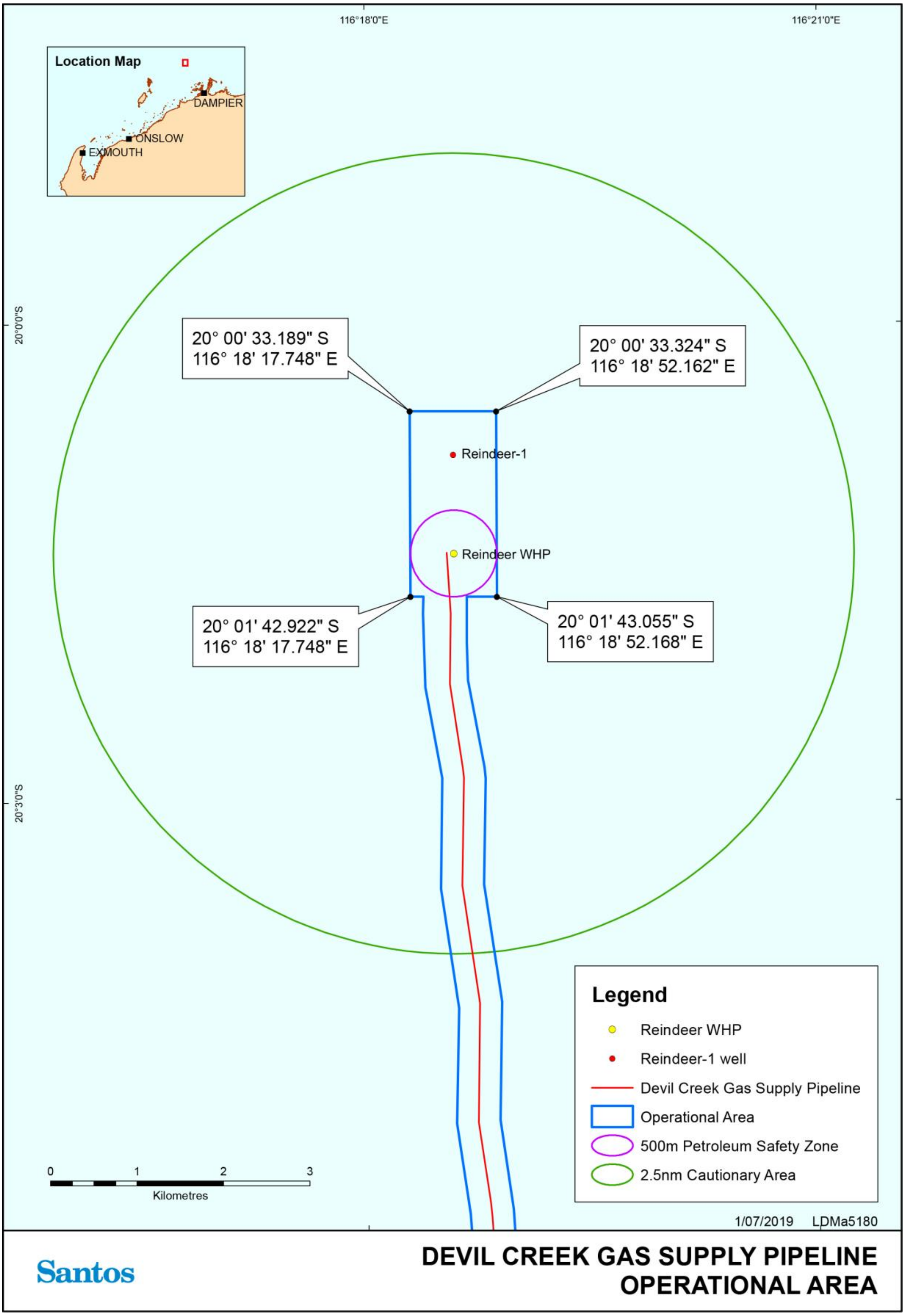

Figure 2-1: Location of Operational Area around Reindeer WHP and Reindeer-1

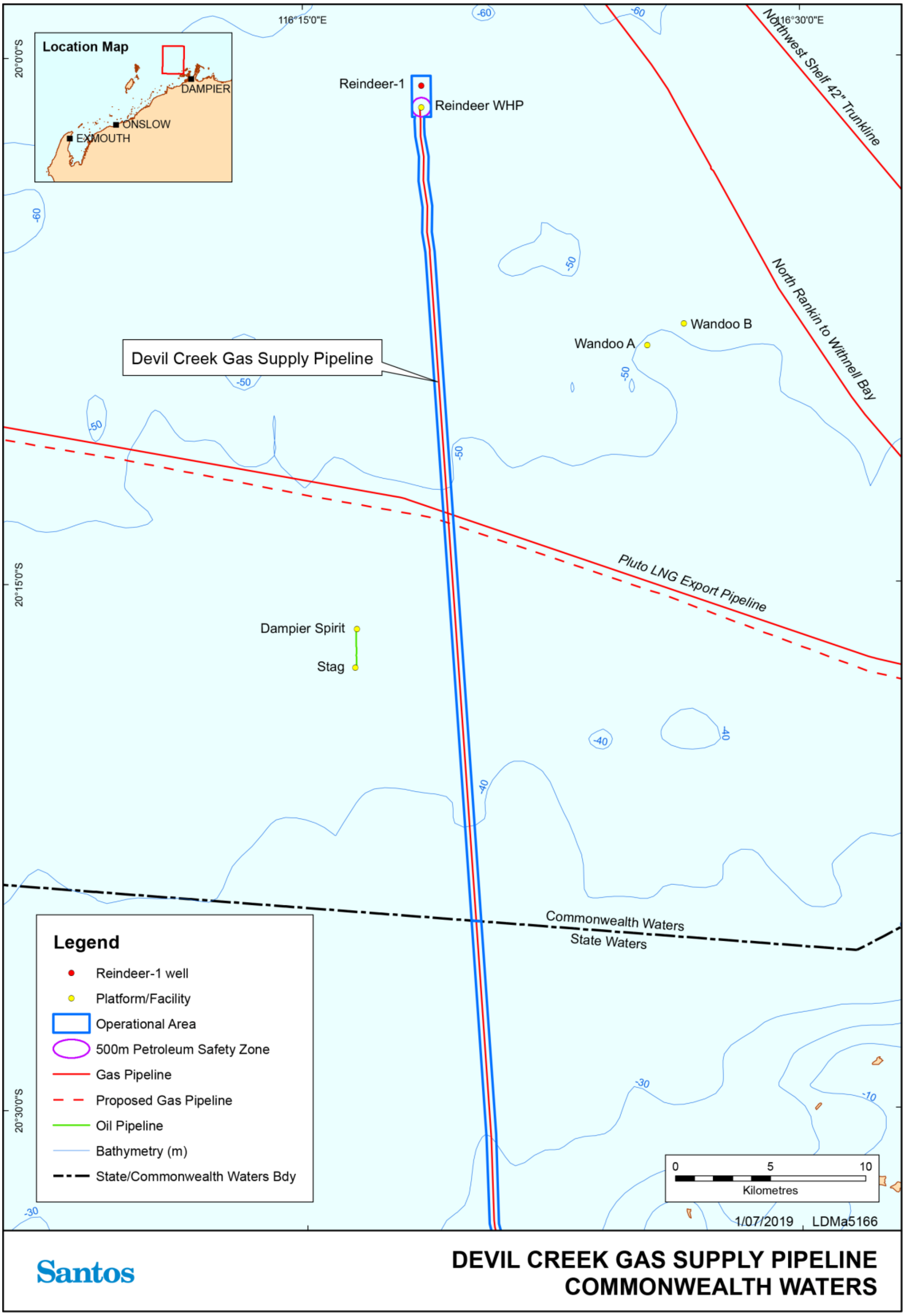

Figure 2-2: Reindeer WHP and Offshore Gas Pipeline Locations

2.3 Timing

The Reindeer facilities operate 24 hours a day, every day of the year; and routine activities may occur at any time during any season.

2.4 Overview of the Facilities

The Reindeer facilities comprise:

+ An unmanned, minimum-facilities wellhead platform (Reindeer WHP) with three conventional production wells remotely controlled from the onshore DCGP. The substructure is a four-legged jacket with one skirt pile per leg and four levels topsides with an integrated helideck located on the upper deck;
+ An open ocean well (Reindeer-1), which is temporarily abandoned and not connected to the WHP; and
+ A single 406-mm (16") subsea and offshore gas pipeline (DC supply pipeline) linking the WHP to an onshore gas treatment plant (the DCGP).

A 500-m-radius petroleum safety zone surrounds the WHP. Vessels operating within this zone must not exceed a speed of five knots. A cautionary area designated by the Australian Maritime Safety Authority (AMSA) with a radius of 2.5 nautical miles (nm) is charted around the WHP. The Reindeer facilities are all marked on nautical charts.

2.4.1 Topsides Infrastructure

The topsides module has four levels, specifically (highest to lowest):

+ Upper deck, including the helideck;
+ Mezzanine deck;
+ Main deck; and
+ Cellar deck.

2.4.1.1 Upper Deck

This is the top level of the topsides and contains a crane, a laydown area, and hatches to access the six well slots (three currently operational). The upper deck is completely bunded and is level with the helideck.

Three Christmas trees on the operational wells are located between the main deck and upper deck and hence straddle the central section of the mezzanine deck.

A crane is available to transfer supplies from support vessels onto the WHP laydown area and facilitate well intervention operations. Supplies consist of bulky chemical containers, diesel containers, potable water, replacement parts and other materials. Chemicals (**Section 2.4.1.13**) and diesel (**Section 2.4.1.12**) are not bunkered onto the platform but are moved across in bulk containers and transferred from these containers into the designated storage containers using hoses. The chemical storage tanks and water tank are located on the underside of the upper deck. The diesel tank is located in the crane pedestal. The deck is steel plated and fitted with piping to the open drainage system (**Section 2.4.1.11**).

2.4.1.2 Helideck

The helideck is located on the eastern end of the upper deck and is used to access the WHP for routine maintenance and inspection. It is suitable for helicopters up to and including D values of 16 m and T values of 5.3 tonnes, as well as AW139 helicopters. The design incorporates an atmospheric drainage system to collect runoff, which is piped overboard (**Section 2.4.1.11**). The helideck is not bunded.

2.4.1.3 Mezzanine Deck

The mezzanine deck is located below the upper deck and contains the equipment room, wellhead control panel, hydraulic power unit and crane power pack. There is also a laydown area for materials handling. A pig launcher is also located on the mezzanine deck for inline inspections of the pipeline. The deck is mostly covered with steel grating and is not bunded; however, there is localised bunding around the hydraulic power unit pump, the equipment room and the wellhead control panel, which drains to the atmospheric drainage system (**Section 2.4.1.11**).

2.4.1.3.1 Equipment Room

The equipment room accommodates the electrical and control equipment for the platform, including the local controls such as the emergency shutdown (ESD) system, as well as all other electrical equipment and communications.

2.4.1.3.2 Pig Launcher

The pig launcher, capable of launching a standard complement of foam, brush, scraper or intelligent pigs, is located above the export pipeline riser to afford crane access. Liquids from the pig launcher are directed into the closed drainage system (**Section 2.4.1.11**).

2.4.1.4 Main Deck

The main deck, located below the mezzanine deck, contains the production manifold and manual isolation valve for the wellheads.

The main deck also contains the fuel gas equipment and back-up diesel generator. There is a laydown area for materials handling. The main deck is completely bunded, and the bunding feeds into the atmospheric drainage system (**Section 2.4.1.11**).

2.4.1.5 Cellar Deck

The cellar deck contains the closed drainage system sump, atmospheric drainage system (**Section 2.4.1.11**), riser ESD valve, and fuel gas microturbines. There is a laydown area provided for materials handling. The cellar deck is mostly covered with steel grating, except under the two microturbine generators, which are bunded. Bunding is also located around the atmospheric drainage system.

2.4.1.6 Production Manifold and Online Telemetry Systems

The production manifold consists of flow meters for monitoring gas production, electrically actuated choke valves for controlling the quantity of gas being produced and online corrosion detection probes.

All production data are continuously monitored via telemetry by the DCGP control room where adjustments are made to the operation of the WHP to meet optimal performance. The telemetry system also allows some testing and checks to be made remotely. The production system and testing can also be controlled from personnel on the WHP, accessed using the wellhead control panel located on the mezzanine deck.

2.4.1.7 Shutdown Valves

Shutdown valves are located at various points along the gas supply system to allow the separation and isolation of the gas process systems from other parts of the system. The Christmas trees also have master and wing valves that provide isolation if required.

The shutdown valves include an ESD valve located on the export riser, and all wells also incorporate a surface-controlled subsurface safety valve in the subsea production tubing as an additional barrier to isolate the platform from the reservoir. There is also a subsea isolation valve on the DC supply pipeline (**Section 2.4.3**).

2.4.1.8 Description of Safeguards and Emergency Shutdown and Emergency Blowdown Systems

Safeguarding systems are in place to automatically detect any abnormal process or upset condition, to alert the operator or control interface, and to execute actions (such as process inventories or initiation of blowdown and shutdown of equipment as outlined in this section).

2.4.1.8.1 Safeguards Overview

Safeguarding systems form part of the overall emergency support system installed on a facility and will be used in conjunction with Santos WA's Health, Safety and Environment Management System. The safeguarding systems are required in an emergency to:

+ Provide protection for personnel;
+ Minimise the release of hydrocarbons;
+ Prevent damage to equipment, plant and structure;
+ Remove or isolate hydrocarbon inventory; and
+ Prevent escalation of a single incident to other areas.

The safeguards measures fall into the following general categories:

+ Control systems: to maintain operating parameters within prescribed limits;
+ Process alarms: to alert operators if operating parameters move outside prescribed limits; and
+ Depressurisation and automated ESD: to isolate and blowdown sections of the facility to bring it to safe condition.

The emergency shutdown and emergency blowdown activities for the Reindeer facilities are outlined below

2.4.1.8.2 Automated Emergency Shutdown

When the facilities shutdown is activated, the pipeline is also shut-in. The wells are shut-in along with the shutdown of the equipment on the platform. All safety systems on the platform are designed as fail safes, with the well and platform isolated. Automatic shutdown is preceded by a pre-alarm relayed to the onshore control room. In addition, if an ESD at the onshore DCGP occurs, the Reindeer WHP and associated wells will also automatically shut in.

2.4.1.8.3 Emergency Blowdown Activities

There is no automatic depressurisation for the WHP. The production system remains pressurised after shutdown. The overpressure protection system protects the pipeline from overpressure conditions. Pressure safety valves are provided on the WHP and relieve at set pressure as specified on the process and instrumentation diagrams and pressure safety valve datasheets.

2.4.1.9 Power Generation

Electrical power for platform equipment and machinery is generated by two gas-fuelled microturbines (sourced from the platform supply) that have their own protection and detection systems incorporated into the package. Entrained water in the fuel gas is removed through coalescers and collected in the closed drainage system (**Section 2.4.1.11**).

Hydraulic power required for the platform equipment is provided by an electrically driven hydraulic power unit, while hydraulic power for the crane is supplied by a separate diesel-driven power pack.

A diesel generator is also provided for black start. This starts automatically on loss of both gas-fuelled microturbines. The diesel generator can also be started remotely for routine maintenance or test runs and has a dedicated battery for starting.

Diesel is stored in a 3.1-m^3 diesel storage tank located in the crane pedestal and fed by an electrically driven diesel transfer pump into the diesel generator day tank.

Diesel is supplied to the WHP via bulk containers lifted onto the upper deck from offshore support vessels and decanted into the crane pedestal via hose.

2.4.1.10 WHP Lighting

The platform is designed for unmanned operation; hence, only minimal permanent operational lighting is provided, consisting of safety and navigation lighting using flashing amber lights. Additional fluorescent lighting is available in the event of an emergency. In the event night-time activities are scheduled, any additional lighting required will be provided by portable lighting supplied by personnel visiting or working on the platform.

2.4.1.11 Drain Systems

A closed drainage system (sump, process vent to atmosphere and electric pumps) is present on the WHP to capture liquids from the following sources:

+ Liquid separated in the fuel gas system;
+ Drainage and depressurisation of topsides production piping prior to maintenance;
+ Drainage of the pig launcher; and
+ Pressure relief valves.

The closed drainage system has a maximum storage capacity of 2,100 L, sized to contain the contents of a single flowline, the production manifold or the pig launcher. Liquids collected in the closed drainage system sump are returned intermittently to the production manifold by the sump pumps.

An atmospheric drainage system (with atmospheric venting) is provided for the collection of rainwater, wash-down water and spillage from the bunded upper and main decks. The open drainage system sump (referred to as the atmospheric sump) is built into the cellar deck and has a capacity of 7,240 L. The atmospheric sump enables the separation of hydrocarbon liquids from water collected through the atmospheric drainage system and the reinsertion of the hydrocarbon liquids into the production line via the atmospheric sump pump.

2.4.1.12 Hydrocarbon Storage

Approximately 3.1 m^3 of diesel is stored on the WHP. A small amount (approximately 200 L) of hydraulic fluid is required during operation of the wellhead control panel. Prior to use, additional diesel and hydraulic fluid is stored in a self-bunded storage cabinet and protected by the WHP structure.

High-pressure process hydrocarbons contained within the process systems on the platform can be released (cold vented) during maintenance activities or in the event of an incident. The maximum total volume from all process areas and systems would be approximately 40 m^3. The wellstream hydrocarbons are mainly methane. Cold venting of a process area is done through the closed drainage system (**Section 2.4.1.11**).

There are also hydrocarbon inventories within the subsurface reservoir (isolated from the platform via the Christmas tree master and wing valves, surface-controlled subsurface safety valve and within the gas supply pipeline, downstream of the subsea isolation valve.

2.4.1.13 Chemical Storage

The main chemical used on the platform is corrosion inhibitor, which is injected into the wellstream. This is used to prevent internal corrosion of the DC supply pipeline. The chemical injection system includes three chemical injection tanks (1 x 3,800 L, 2 x 1,600 L), which are filled from bulk containers lifted onto the platform via the crane as required. A chemical injection point has also been provided in the same location for injection of methanol or monoethylene glycol, which is used as a hydrate inhibitor or scale inhibitor, if required.

2.4.1.14 Corrosion Prevention

The WHP and its substructure are painted as part of corrosion management. The submerged zone is painted and also protected by sacrificial anodes with a design life of 20 years.

2.4.1.15 Miscellaneous

The following general items are provided on the WHP:

+ Bird deterrent device to stop bird infestation and nesting and associated guano hazards;
+ Flushing toilet; and
+ 2,500-L potable water tank with two stainless-steel hand wash basins.

Water from the flushing toilet and hand wash basins are directed into the ocean.

2.4.2 Subsea Infrastructure

There are three production wells operational on the WHP. There are Christmas tree master and wing valves provided for isolation. All wells also incorporate a downhole surface-controlled subsurface safety valve in the production tubing as an additional barrier.

The WHP also has four legs concreted into the seabed.

The Reindeer-1 well is located north of the WHP. It is an open ocean well that is temporarily abandoned, with a cap installed (approximately 3 m high), and not connected to the WHP.

2.4.3 DC Supply Pipeline

The DC supply pipeline extends approximately 103 km from the WHP to the DCGP. It runs in a southerly direction from the WHP to the mainland, crossing over the Pluto pipeline approximately 21 km south of the WHP and passing from the Commonwealth waters boundary into State waters approximately 48.3 km seaward from the mean low water mark, reaching the shoreline at Gnoorea Point. A subsea isolation valve is located approximately 60 m west of the platform on the pipeline, and an ESD valve is located at the DCGP.

Concrete coating has been applied to the pipeline for primary stabilisation. Secondary stabilisation (gravity anchors) has been installed at the Pluto pipeline crossing and at the riser tie-in spool. An external anti-corrosion coating has been applied, and sacrificial anodes are used to protect against external corrosion. The gas export riser connecting the DC supply pipeline to the WHP is located within the WHP substructure bracing to provide protection against vessel impact.

2.5 Operational Activities

2.5.1 WHP Visits

The WHP is a normally unmanned facility; as such, inspections and maintenance activities are conducted on a scheduled and as-needed basis. Inspections and maintenance of the WHP and DC supply pipeline are managed using a Computerised Maintenance Management System (CMMS).

Site safety and general maintenance inspections of the WHP are conducted routinely. These routine inspections are undertaken to maintain the integrity of structures and production systems. Visits to the WHP are generally conducted via helicopter, utilising the helideck, but may also be conducted via vessels. Replenishment of chemicals, diesel fuel and potable water will be performed during visits conducted using an offshore support vessel.

Maintenance activities that may be undertaken during these visits are described in relation to their potential impacts in **Sections 6** and **7**.

2.5.2 Subsea and Pipeline Integrity and Corrosion Management

Inspections of the subsea infrastructure and DC supply pipeline are scheduled through the CMMS and carried out in accordance with routine work orders. Maintenance activities can also be conducted on an as-needed basis depending on the results of the inspections through corrective work orders.

Offshore external inspection of all Santos WA subsea assets is based on asset class, as outlined in the Subsea Inspection Procedure (QE-35-IS-00001). This procedure covers inspection of all subsea infrastructure, including structural, riser, pipeline, conductor and subsea system assets. The offshore inspection requirements of the WHP risers and pipelines are described in the Reindeer Offshore Facilities Reindeer WHP Performance Standard Assurance Plan: PS-03 Hydrocarbon Containment: Risers and Pipelines (RE-00-RG-00044) and require autonomous underwater vehicles (AUV) and cathodic protection and general visual inspection surveys. .

Additional inspections may be performed following physical events (e.g., extreme weather, sea conditions, third-party interactions), integrity assessments or other triggers that indicate further inspection is required. Post-cyclone inspection by remotely operated vehicle (ROV) may be able to provide additional surveillance of anomalies or areas of interest flagged by inspections or analysis.

Inspections require a dedicated equipment-specific vessel, such as a diving support vessel or ROV support vessel, or a support vessel equipped with a remotely operated towed vehicle (ROTV), AUV or side-scan sonar (SSS) equipment.

2.5.3 Subsea, Pipeline and Seafloor Imaging Surveys

Subsea, pipeline and seafloor imaging surveys may be undertaken using methods and technologies such as single-beam echo sounders, multibeam echo sounders, side scan sonars and AUVs to identify:

+ Freespans;
+ Lateral and upheaval buckling;
+ Severe scour or other seabed disturbance;
+ Gross variation from as-laid positions; and
+ Debris.

These surveys will provide input to integrity assessments and will assist in planning of future inspection campaigns, if required.

2.5.3.1 Single-Beam Echo Sounders and Multi-Beam Echo Sounders

Single-beam echo sounders (SBESs) use a hydrographic technique that provides the water depths and an image of the seabed and pipeline by measuring the two-way travel time of a high-frequency sound pulse emitted by a transducer. The transducer, generally mounted on a vessel or to an AUV, also tracks the motion of the unit it is mounted on in order to allow for correction for the motion. Multi-beam echo sounders (MBESs) work in the same way but produce a swath or acoustic fan-shaped pulses of sound made up of many single beams.

2.5.3.2 Side Scan Sonar Surveys

SSS is a marine geophysical technique that is used to produce an image of the seafloor. SSS transducers may be mounted on AUVs, vessel hulls or, more commonly, operated using an ROTV.

2.5.3.3 Autonomous Underwater Vehicles

AUVs may be used to conduct a number of geophysical and inspection activities, including sub-bottom profiles; MBESs; SBESs; SSS; cameras; and conductivity, temperature, and depth (CTD) profilers.

AUVs travel underwater on a predefined ‘flight path’ without requiring navigation from an operator and are fitted with various payloads for data acquisition. The size of the vessel required to deploy an AUV depends on the size of the AUV and the launch and recovery system. The AUV is typically deployed from a vessel using a crane or an A-frame and is recovered using a winch or net.

2.5.4 Subsea, Pipeline and Seafloor Visual Surveys

General visual inspection surveys are used to identify the following:

+ Integrity of the pipeline system, including all subcomponents;
+ Location of all features detailed on alignment sheets or as-built records;
+ Pipeline crossings for pipeline separation and integrity of any support structures and/or stabilisation;
+ Seabed topography, scour, pipeline settlement and extent of burial;
+ Freespan lengths, locations, heights and shoulder conditions (shoulders buried, partially buried, resting on seabed);
+ Concrete weightcoat condition;
+ Coating condition, where visible, and indications of corrosion;
+ Pipeline protection, stabilisation, scour remediation and span rectification for condition and effectiveness;
+ Marine growth type and extent;
+ Debris in contact with or adjacent to the pipeline;
+ Excessive pipe movements, including expansion effects and lateral and upheaval buckling; and
+ Other items or anomalies identified following previous inspections.

General visual inspection surveys are generally conducted by ROV. In some circumstances, divers will be used to conduct general visual inspections and other inspections or works.

2.5.4.1 Remotely Operated Vehicle Surveys

An ROV is typically used to conduct subsea visual inspections. The ROV is tethered to a vessel via an umbilical cable that provides power and control to an operator on the vessel. Thrusters are used to provide propulsion. The ROV is also fitted with a real-time feedback visual monitoring system and lights that provide video relay to the operator on the vessel to allow the operator to subsequently manoeuvre the ROV into position to inspect the pipeline. ROVs can be fitted with a mechanical arm that can also be controlled from the surface to undertake some maintenance activities.

ROVs are usually deployed using an A-frame or winch from a dedicated vessel. ROVs are linked to the vessel by a neutrally buoyant tether; or, often when working in rough conditions or in deeper water, a load-carrying umbilical cable is used along with a tether management system.

2.5.4.2 Diver Surveys

Visual inspection by divers is undertaken from a dedicated diving support vessel. Divers are tethered to a vessel via an umbilical, which provides communication, air and a video relay from a camera and lights on the diver’s helmet. Divers may also be used for maintenance activities. A Diving Project Plan is developed for each program, and all diving operations are carried out in accordance with the Offshore Petroleum and Greenhouse Gas Storage (Safety) Regulations 2009.

2.5.4.3 Cathodic Protection Surveys

Cathodic protection surveys are typically carried out concurrently with general visual inspections. Cathodic protection, such as galvanic anodes and coatings, are applied to the pipeline and subsea infrastructure for corrosion control. The cathodic protection survey forms part of the general visual inspection, which generally covers the following:

- Galvanic anodes are inspected for depletion and security;
- Direct contact cathodic protection potentials of the anodes are taken using a cathodic protection probe;
- Continuity strap integrity and effectiveness is tested by measurement of potentials at each end;
- Welds are inspected;
- Ultrasonic wall thickness is tested; and
- Coating is removed for inspection access.

Cathodic protection is measured using an underwater cathodic protection probe and/or contactless cathodic protection survey method (field gradient method). Ultrasonic wall thickness testing is undertaken using an underwater ultrasonic wall thickness tester. Both are non-destructive test instruments.

2.5.5 Maintenance Activities

Maintenance of the Reindeer facilities is managed using a CMMS with consideration given to results from the general WHP visits and subsea and pipeline inspections.

Maintenance activities may include corrective (e.g., repair of equipment) and non-routine maintenance, undertaken in accordance with routine or corrective work orders. Generally, these activities may involve additional personnel and the use of ROVs, divers and work vessels, which may require anchoring at or near the work location.

Ongoing operations and maintenance-related activities include:

- Plant inspection and maintenance;
- Plant modifications;
- Marine growth removal;
- Corrosion control;
- Pipeline route maintenance;
- Inline inspections of the offshore pipeline (pigging);
- Well intervention; and
- Well suspension or abandonment.

2.5.5.1 Plant Inspection and Maintenance

The exterior of the WHP may be inspected using unmanned aerial vehicles. Unmanned aerial vehicles may be used to conduct aerial surveys in the operational area. Unmanned aerial vehicles are autonomous aircraft that will use the WHP or a vessel as a launch platform to execute surveys and inspections of the structure to inform the Planned Maintenance System.

Routine maintenance activities, such as valve change out, pump servicing, electrical hazardous area maintenance, cleaning, corrosion control (blasting/painting), visual and non-destructive testing inspections, and pipe spool replacement, are carried out as required.

2.5.5.2 Plant Modifications

Demolition and installation of new equipment on the WHP is occasionally required due to changes in recovery rates or other operational modifications and upgrades. Any modifications to plant are covered under a change management control process (QE-91-IQ-00007) that ensures any environment impact is considered and addressed prior to modifications occurring. Such alterations can include:

- Removing pipework and process units;

+ Extensions to the platform;
+ Upgrading the various components and equipment on the platform;
+ Flushing, draining and recovery of residual liquids from pipes; and
+ Piping, process and electrical alterations to accommodate operational changes to the field, such as new wells.

2.5.5.3 Marine Growth Removal

Marine growth on the substructures of offshore platforms and on subsea pipelines must be maintained at levels that do not compromise the structural integrity of the platform or pipeline. The WHP substructure provides attachment points for a variety of marine organisms that, over time, add significantly to the drag and weight on the substructure. As part of the maintenance of the facility, marine growth on the substructure is inspected in accordance with the Subsea Inspection Procedure (QE-35-IS-00001) using ROV and/or divers; if determined to be beyond the allocated depth, marine growth is periodically removed. This is carried out on an as-required basis.

As part of ongoing maintenance and to facilitate inspections, the removal of marine growth from subsea infrastructure may be required. Marine growth is regularly monitored against design limits. Removal of marine growth is typically only required for inspection purposes and is conducted on localised areas using high-pressure water cleaning or brushing or a combination of these:

+ Water-jetting: conducted by ROV or divers, water is pressurised to above hydrostatic pressure. Generally, water-jetting activities are through small-diameter water jets that act locally on the pipe or structure. Wash out or induced currents are typically not experienced during this activity due to the nature of the operation.
+ Brushing: typically a coarse brush would be applied to the pipeline or structure on a localised area only. This is a less common technique.

2.5.5.4 Corrosion Control

A program of ongoing fabric maintenance of the offshore platform is undertaken as part of the corrosion control program. Prior to painting, offshore structures are cleaned with mechanical cleaning, ultra-high-pressure water or grit blasted with garnet (a natural coastal sand product).

Other corrosion control and monitoring activities may involve anode replacements on the Reindeer facilities, cathodic protection monitoring, weld inspections, ultrasonic wall thickness testing, freespan inspection of the pipeline, coating removal for inspection access, pipeline repair clamp installation, leg wrap maintenance and installation, non-destructive testing, and general inspections and maintenance of subsea valves and other subsea equipment. This work is usually undertaken by ROV, AUV or divers operating on a diving support vessel, which may also involve the use of additional support vessels such as an anchor-handling vessel.

2.5.5.5 Pipeline Route Maintenance

Maintenance activities may require alteration of the seabed in the immediate vicinity of subsea infrastructure such as movement of sediment from around the area to be worked on.

Where span rectification is required, various methods may be considered. The most common is grout bag installation. An empty grout bag is positioned under the pipeline by ROV or divers and pumped full of a measured volume of grout from the support vessel. Depending on the span height, several bags may be used at a single location to support the pipeline. A field support vessel or diving support vessel is used to support this activity. Where burial is observed, sediments will be jetted or airlifted to displace them from the top of the pipeline.

2.5.5.6 In-line Inspection Activities

In-line inspection of the pipeline, referred to as pigging, is a routine practice that is undertaken, as required, as part of ongoing pipeline integrity management. This practice may involve both the use of intelligent pigs, used for evaluating pipeline integrity and wall thickness, and standard brush and foam pigs, used for operational or corrosion control purposes. Pig launchers and receivers are permanently installed on the DC supply pipeline (at the WHP and DCGP respectively). Pigs are launched on the WHP and received at the DCGP. The disposal of pigging waste is outside of the scope of this EP and is managed in accordance with the DCGP Operations EP (DC-40-RI-00021).

2.5.5.7 Well Intervention

Well intervention is a collective term for deployment of tools, fluids, and equipment in pressurised or dead completed wells. A range of activities undertaken through well intervention are completed from the Reindeer WHP. These may include but are not limited to:

+ Plug and abandon, kill and cement or suspend old wells in preparation for a drill rig to re-enter a well and undertake a side track (mobile offshore drilling unit activities are not covered by this EP);
+ Isolate subsea valves to the WHP or pipeline prior to the commencement of drilling or other topsides activities;
+ Remove plugs and perforate wells whether new wells or new intervals of old wells;
+ Bottom hole pressure surveys (for reservoir modelling and management), production logging tools to determine gas and water contact, installing bridge plugs to isolate water zones and perforating new zones in the well;
+ Trouble shooting of wells in terms of down hole subsea safety valves;
+ Pumping: bullhead well kill, lubricate bleed, annulus top ups, corrosion treatment, scale treatment, spotting cement at reservoir;
+ Well servicing including Christmas tree maintenance and removal (from the WHP only) and wireline logging in the well bores; and
+ Commissioning new wellheads.

During well intervention work, a dedicated crew undertakes the required intervention work, either from the platform (day shift) or from a vessel (day and night shift) as required.

2.5.5.8 Abandonment or Suspension

During the field life, wells may be temporarily suspended or plugged and abandoned in accordance with the requirements of the Offshore Petroleum and Greenhouse Gas Storage Act 2006 (OPGGS Act). This process usually involves placing cement plugs within the casing of the well at various intervals and flooding the casing with fluids containing corrosion inhibitor and/or biocide. Well intervention equipment used for these activities will either be lifted aboard and operated on the WHP or operated from a support vessel. Any activities involving the use of a mobile offshore drilling unit, such as the drilling of new wells or permanent abandonment of wells, are not covered in this EP.

Depending upon the specific well activity requirements at the time, flushing and purging the pipelines and process equipment of any residual hydrocarbons may be required, including leaving the pipeline in situ until a final abandonment program has been developed.

2.5.5.9 Cold Venting

There is no flare on the WHP; therefore, any gas emissions are cold vented. Fugitive emissions can also occur during cold venting.

Cold venting will typically occur under the following circumstances:

+ Manual depressurisation of the production system for maintenance;
+ Following an emergency shutdown; and
+ Depressurisation and draining of the pig launcher after each use.

2.5.6 Bird Deterrent Activities

Safety of aircraft and passengers visiting the WHP is paramount. Management of birds for the safe landing and take-off of helicopters is critical. In addition, the platform needs to be clear of guano on both the top deck and helideck surfaces to avoid the potential for slips, trips and falls.

Due to potential bird strikes on helicopters when approaching the platform to land, various bird deterrent systems are used. They include intermittent loud noise, vibration and light.

Note that previous experience has shown that birds may become desensitised to specific bird deterrents over time. Therefore, during the life of this EP, there may be a requirement to investigate further deterrent options, which may use noise, vibration or light emissions.

2.6 Vessel Operations

As-required, visits to the WHP utilising a support vessel for replenishment of chemicals, diesel fuel and potable water will be undertaken routinely. The support vessel will also be used to backload any equipment, waste and materials that require offloading.

Dedicated equipment-specific vessels that may be used include diving support vessel, ROV support vessel, or a support vessel equipped with ROTV, AUV or SSS equipment. Maintenance or well intervention activities may require more than one support vessel.

Vessel-to-vessel refuelling is not normally required for routine activities associated with the Reindeer facilities as these activities usually have a limited duration and scope. Similarly, equipment transfers are rarely required. However, depending on the nature and scale of a non-routine activity, a material or fuel transfer may be needed in rare instances. Therefore, the impacts and risks associated with these activities are included in this EP.

Similarly, anchoring of vessels in not likely to be required for routine activities; however, there are circumstances where anchoring could be required. Therefore, the impact and risks associated with anchoring, including appropriate management controls, are included in this EP.

Support vessels are usually locally based (e.g., Port of Dampier). However, there may be instances where non-local vessels are considered due to availability or task specification requirements. Therefore, the impact and risks associated with sourcing non-local vessels, including appropriate management controls, are included in this EP.

2.7 Decommissioning

A stand-alone environmental approval to undertake decommissioning of the Reindeer facilities will be sought from NOPSEMA (or the equivalent agency at the time) and other government authorities under the relevant legislation closer to the time of the activity.

3 Description of the Environment

OPGGS(E)R 2009 Requirements
Regulation 13(2)
The environment plan must: a) describe the existing environment that may be affected by the activity; and b) include details of the particular relevant values and sensitivities (if any) of that environment. Note: The definition of *environment* in regulation 4 includes its social, economic and cultural features.
Regulation 13(3)
Without limiting paragraph (2)(b), particular relevant values and sensitivities may include any of the following: (a) the world heritage values of a declared World Heritage property within the meaning of the EPBC Act; (b) the national heritage values of a National Heritage place within the meaning of that Act; (c) the ecological character of a declared Ramsar wetland within the meaning of that Act; (d) the presence of a listed threatened species or listed threatened ecological community within the meaning of that Act; (e) the presence of a listed migratory species within the meaning of that Act; (f) any values and sensitivities that exist in, or in relation to, part or all of: (i) a Commonwealth marine area within the meaning of that Act; or (ii) Commonwealth land within the meaning of that Act.

3.1 Environment that May Be Affected

This section summarises the key physical, biological, socio-economic and cultural characteristics of the existing environment that may be affected by the activity, both from planned and unplanned events associated with the activity. The description of the environment applies to two areas:

- The operational area, which includes the Reindeer facilities within Commonwealth waters.
- The environment that may be affected (EMBA), shown in **Figure 3-1.**

The Reindeer facilities are located approximately 80 km offshore, northwest of Dampier, in the Barrow Sub-basin on the Northwest Shelf Province in the North-west Marine Region (DEWHA, 2008). The Reindeer facilities are situated in water depths of 58 m LAT. The operational area as defined in **Section 2.2** lies wholly within Commonwealth waters (**Figure 2-1** and **Figure 2-2**).

A detailed and comprehensive description of the environment in the operational area and broader EMBA is available in **Appendix C,** with copies of the Department of Environment and Energy (DoEE) Protected Matters Search Tool outputs for the operational area and the EMBA.

The EMBA encompasses the environment that may be affected by planned and unplanned events.

Most planned and unplanned events associated with the operation of the Reindeer facilities may affect the environment up to a few hundred metres around the Reindeer facilities (as identified in each relevant event description in **Sections 6** and **7**). A large unplanned hydrocarbon spill, however, would extend substantially beyond the boundaries of the operational area.

3.1.1 Determining the Environment that May Be Affected

Stochastic hydrocarbon dispersion and fate modelling, applied to credible spill scenarios identified as relevant to the activity, was undertaken to determine the extent of the EMBA. The modelling used defined hydrocarbon contact thresholds for the various hydrocarbon phases (floating, entrained, and dissolved) at which potential impacts to fauna or habitats could result. To consider the widest range of potential environmental impacts associated with all identified credible spill scenarios, each scenario was modelled under environmental conditions representative of each season. The outputs of each model were combined to create an area that delineates the extent of the EMBA under all scenarios, whereby the outer extent of the EMBA was determined by the spatial extent of four key physical and/or chemical phases of hydrocarbons that pose differing environmental risks to receptors: surface hydrocarbons, entrained oil, dissolved aromatic hydrocarbons (DAHs) and shoreline accumulated hydrocarbons.

The actual area affected from any single spill event would be considerably smaller than the extent of the EMBA; **Figure 3-1** shows one example of a single spill event (a deterministic run). The EMBA represents the areal extent of the combined hydrocarbon phases predicted for both the diesel spill (from a vessel collision) and WHP loss of containment spill scenarios. The worst-case diesel spill scenario is assessed on all hydrocarbon phases combined, and the assessment of a hydrocarbon spill from a loss of containment at the WHP is based on each of the shoreline oil, floating oil, entrained oil and dissolved aromatic hydrocarbon phases. **Section 7.5** discusses specific scenarios, controls, standards and performance criteria used to reduce the risk of these events occurring to ALARP.

The figures presented in this section of the EP have been zoomed to the extent of the data boundaries present within the EMBA to ensure all data presented are relevant and legible. Some data layers that sit in the map area but are not present in the EMBA are not displayed.

3.1.2 High Environmental Values

Areas of high environmental value within the EMBA were used to define priority protection areas in relation to responding to a hydrocarbon spill. Preplanning has identified shoreline protection priority areas that have high environmental value and that modelling indicates could receive floating oil and shoreline loading (**Figure 3-2**), those ranked as highest value (1-3) are listed below.

+ Ningaloo Coast South;
+ Outer Ningaloo Coast North;
+ Ningaloo Coast North;
+ Outer NW Ningaloo;
+ Exmouth Gulf Coast;
+ Muiron Islands;
+ Barrow-Montebello Surrounds;
+ Barrow Island;
+ Lowendal Islands;
+ Montebello Islands; and
+ Dampier Archipelago

The values and sensitivities associated with these high environmental values have been described in **Appendix C**.

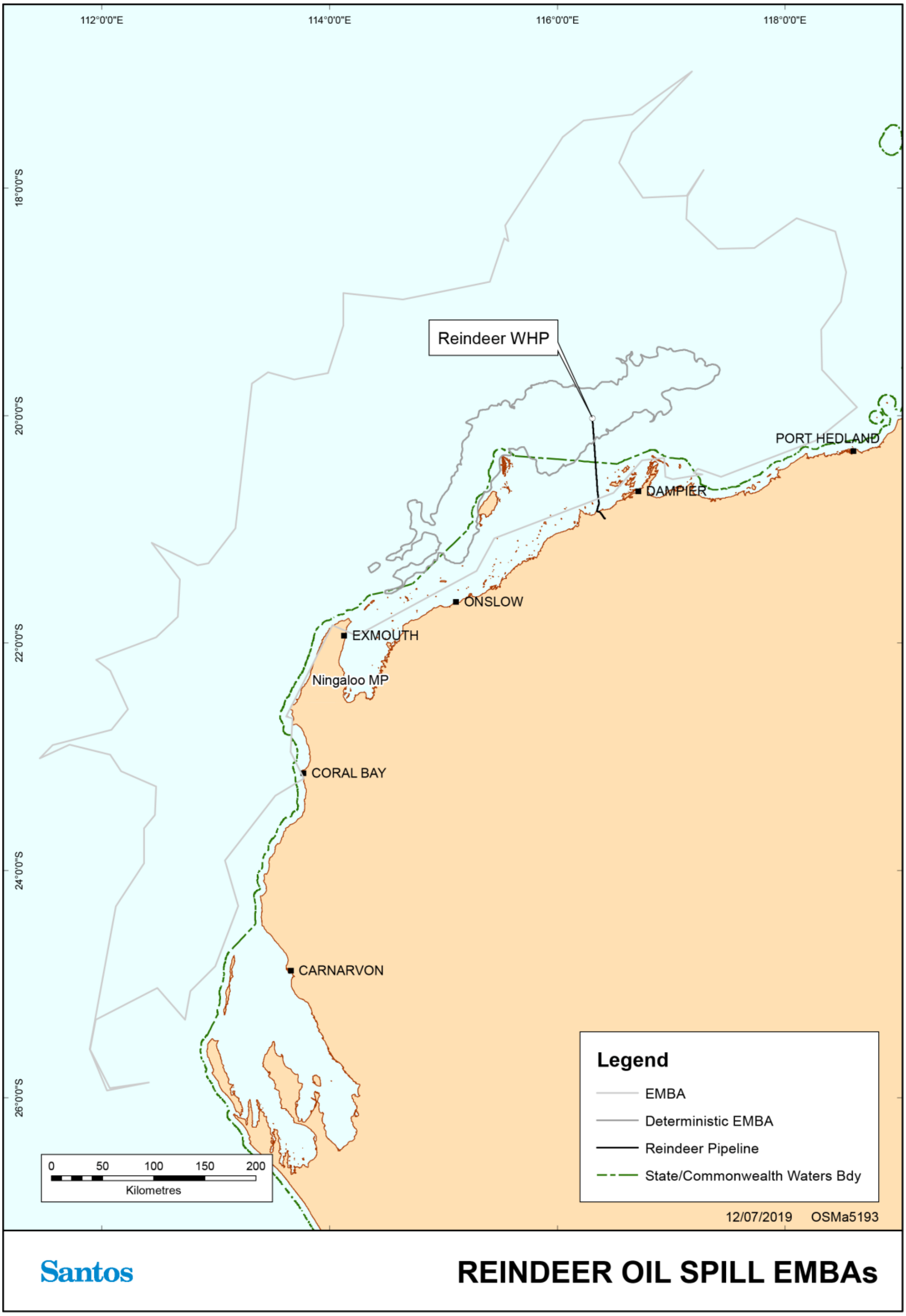

Figure 3-1: Reindeer Oil Spill EMBAs

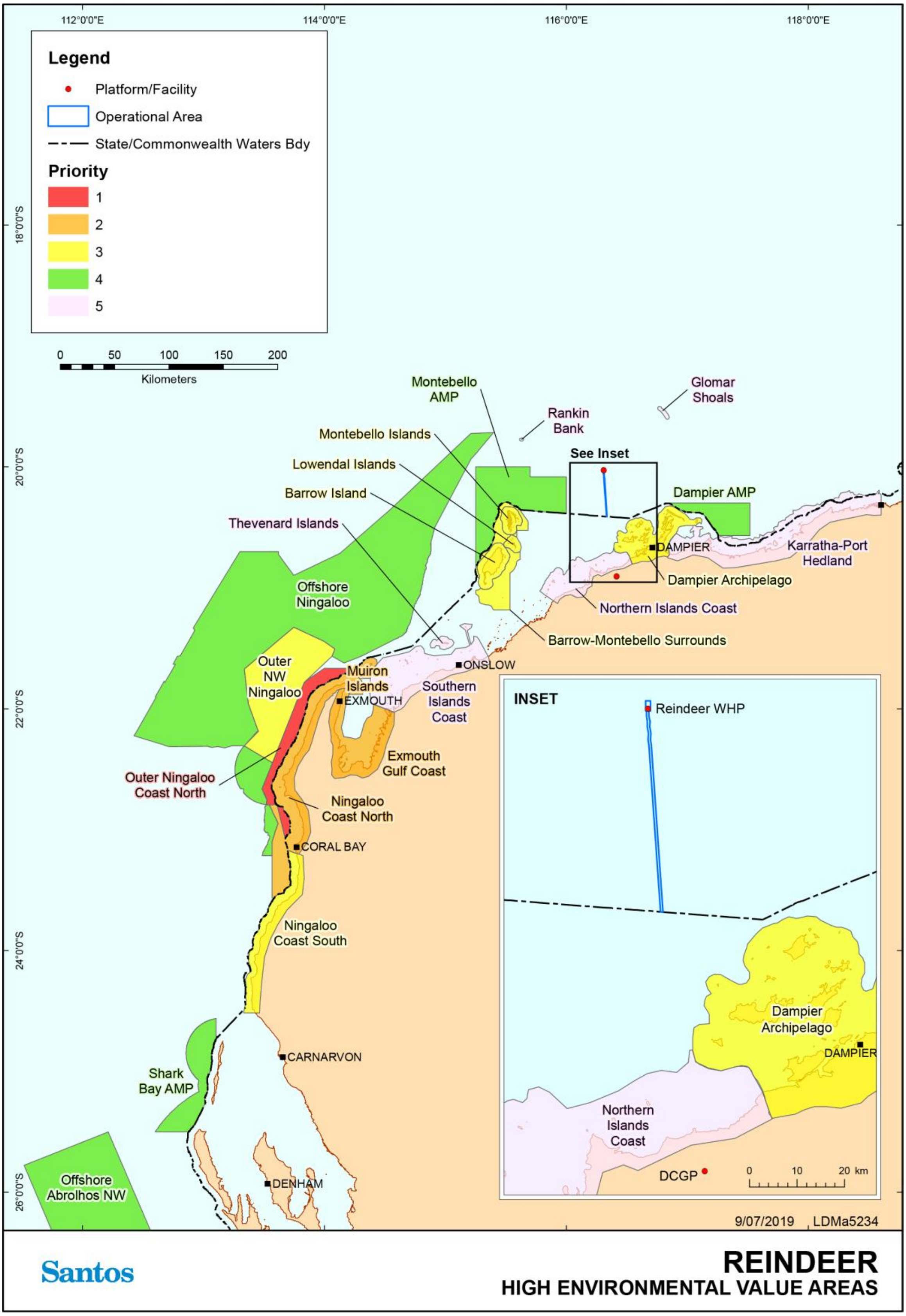

Figure 3-2: High Environmental Value Areas

3.2 Environmental Values and Sensitivities

Desktop searches of the operational area and the EMBA were undertaken in April 2019, using the DoEE Protected Matters Search Tool for the purpose of identifying matters of national environmental significance listed under the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act). The results of these searches are provided in **Appendix C**.

A comprehensive description of the environmental values and sensitivities present in the existing environment, operational area and EMBA is provided in this chapter and **Appendix C** (required by OPGGSR 13(2)). This draws upon existing knowledge and a comprehensive review of information on the marine environmental values and sensitivities in the region.

Sensitive receptors that may be impacted by the operation of the Reindeer facilities are outlined in **Table 3-1** and sections below.

3.2.1 Bioregions

The Reindeer facilities are located approximately 80 km offshore, northwest of Dampier, in the Barrow Sub-basin on the Northwest Shelf Province in the North-west Marine Region (DEWHA, 2008), in water depths of ~58 m LAT. The DC supply pipeline extends from the Reindeer WHP to the Commonwealth/State waters boundary (**Figure 2-2**), in water depths ranging from 58 m to 38 m.

Based on the Integrated Marine and Coastal Regionalisation of Australia (IMCRA), Version 4.0 (DEH, 2006), the bioregion overlapped by the operational area is the Northwest Shelf Province, and the EMBA overlaps the following bioregions (**Figure 3-3**):

+ Northwest Shelf Province;
+ Northwest Province;
+ Northwest Transition;
+ Central Western Transition;
+ Central Western Shelf Transition; and
+ Central Western Shelf Province.

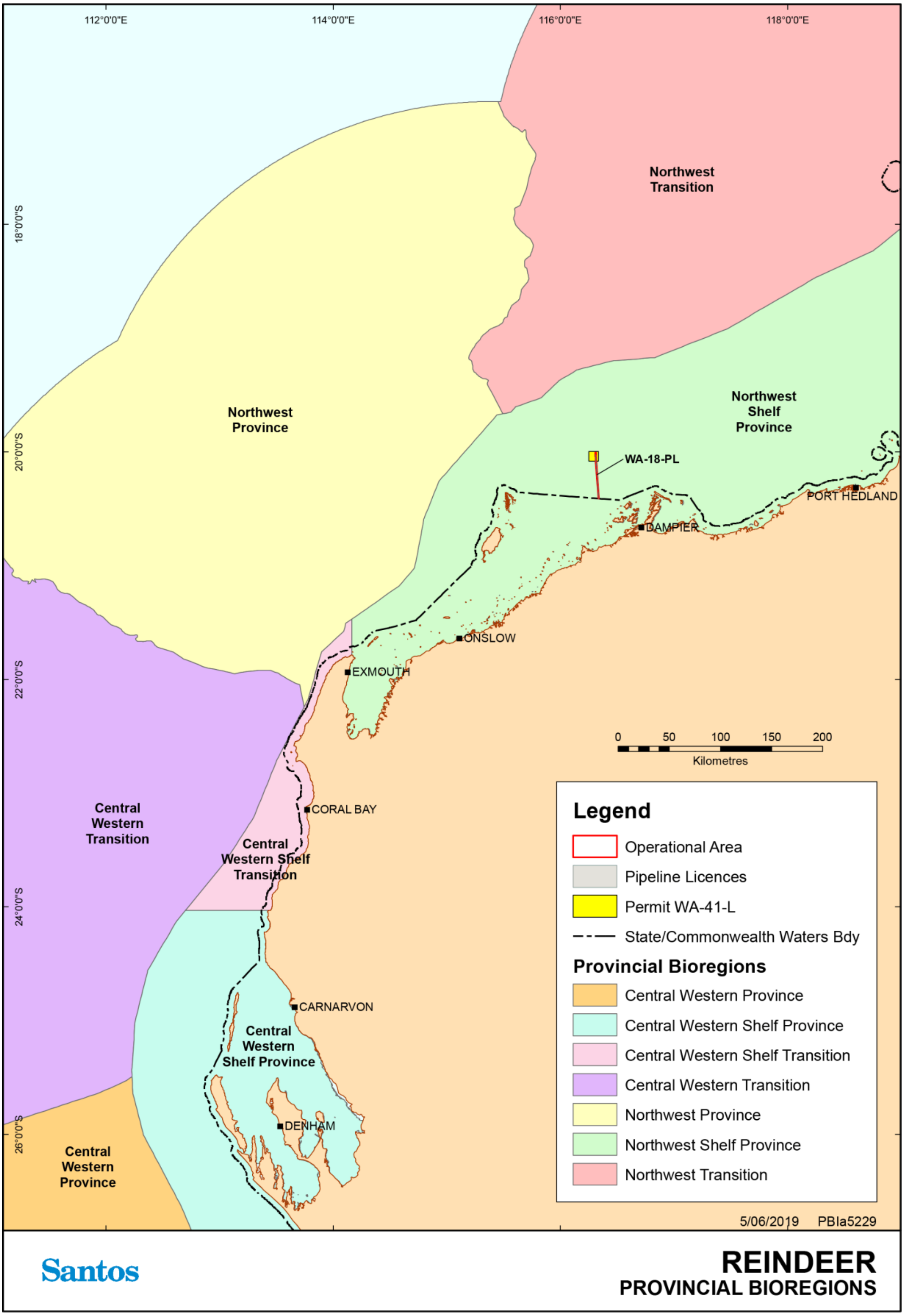

Figure 3-3: Provincial Bioregions within the EMBA

3.2.2 Benthic Habitats

3.2.2.1 Operational Area

The operational area does not contain any shoreline habitat. The nearest landmasses are the Montebello Islands, Dampier Archipelago and Barrow Island located approximately 55 km, 30 km and 80 km from the operational area respectively.

The predominant habitat type in the operational area is soft unconsolidated sediments (RPS, 2008). Benthic primary producer habitat (e.g., areas of hard corals, seagrass or macroalgae) are unlikely to be present in the operational area, given that the water depths range between approximately 38 and 58 m (NGI, 2018). Benthic primary production at these depths are limited due to insufficient light availability (RPS, 2008).

A detailed marine survey of the seabed along the pipeline alignment and at the WHP location was carried out in October 2007 (RPS, 2008). This survey described the benthic communities at the seabed at a number of sites spanning the Reindeer facilities.

The deepest areas investigated, approximately between 60 and 45 m water depth, comprised mainly medium-to-coarse sands and generally supported low-diversity communities, with sparse benthic and epibenthic (living on the surface of sediments) organisms that included sea pens (sometimes quite dense), heart urchins, and very occasional crinoids and bryozoans. The fine-to-medium sand habitats were characterised by a higher level of bioturbation than was evident in the coarser sediments. The epibenthic fauna characteristics of the deep areas suggest the presence of a deep sand layer without pavement close to the surface.

Between 43 and 47 m water depth, the substrate was again dominated by mostly bare medium-to-coarse sands, with limited benthic (living on the seafloor) faunal communities. There were occasional emergent areas of rock pavement. The hard substrates were colonised by a more diverse community, including occasional sea whips, sponges, gorgonians, sea pens and crinoids in low densities. Species diversity and density appeared to relate mainly to sediment stability and seabed profile, with the higher profile features supporting more abundant and diverse communities than the lower pavements and bare sandy areas. Bare sands were bioturbated (mixed) by infauna (living within the sediment), but very few organisms were seen over pavement areas other than the occasional schooling fish and a sea snake.

Further exposed rock pavement, isolated small surface rocks and pavement overlain with thin sand veneers were identified between 51 and 50 km offshore in 41 m water depth. This area was mostly bare rock and sand apart from occasional sponges and fish near the rocks. The rock pavement extended into areas previously described as medium-to-coarse and coarse gravelly sands. These areas were characterised by occasional sponges, crinoids, hydroids, sea whips, ascidians, isolated patches of gorgonian fans, very occasional sea stars and bare bioturbated sands.

3.2.2.2 EMBA

The subtidal benthic habitats in the wider Northwest Shelf Province Bioregion include coral reefs, macroalgae, seagrasses, hard substrates and supported assemblages, and soft sediments and associated benthic fauna. Habitats along the DC supply pipeline route described by RPS (2008) are likely to be representative of areas at similar depths within the EMBA (**Section 3.2.1**) and are discussed below.

Bare bioturbated sands extend inshore along the pipeline route and are the dominant feature between 44 and 33 km offshore (37 and 30 m water depth). Very occasional crinoids and hydroids were observed, with occasional macroalgae in the shallower water.

Multiple large rock and coral bomboras (isolated reef structure), surrounded by exposed rock pavement with sand veneers and areas of bare sand, were identified between 33 and 29 km offshore (30 to 26 m water depth), mainly west of the centreline of the pipeline corridor. The coral bomboras ranged in height from 1 m to 6 m and were dominated by large plating *Pachyseris* species (**Plate 3-1)**. Dense schooling reef fish and pelagic (found in open water) fish were associated with areas of high coral cover.

Rock pavement areas surrounding the coral bomboras support medium-to-high density sponges and macroalgae, including the algae genera *Dictyopteris* and *Caulerpa*. Bare sand areas support the growth of low-to-medium density seagrass (*Halophila*), *Caulerpa* and *foraminiferans*.

A low-profile rock pavement ridge was identified running approximately east–west between 21 and 23 km offshore (Approximately 26 m to 22 m water depth). This ridge area was characterised by exposed limestone rock pavement dominated by macroalgae, with sponges, corals and gorgonians. The corals included *Porites* and *Turbinaria*. Small numbers of ascidians and sea whips were also present. An additional area containing coral bomboras up to 1.5 m high was identified east of the corridor centreline between 22 and 20 km offshore. The dominant feature at this site was the surrounding rock pavement with sand veneers, macroalgae and minor small corals, including *Acropora*, *Turbinaria* and *Porites*.

The dominant substrate from 20 to 15 km offshore (approximately 22 to 9 m depth) was bare coarse sand of unknown depth. Between 15 and 10 km offshore (approximately 22 to 9 m depth), rock pavement with sand veneers was again the dominant feature, the pavement supporting the growth of macroalgae (mostly *Asparagopsis* and *Dictyopteris*), minor sponges, sea whips, gorgonians, and occasional crinoids, ascidians and corals, including *Turbinaria* and *Porites* (**Plate 3-2**). Occasional sea stars and heart urchins were also observed.

The zone between 10 and 2 km offshore (9 m to 4 m) was a mixture of bare sand patches with medium-to-coarse grains and exposed pavement with sand veneers. The bare sand areas supported medium to dense patches of heart urchins and areas of minor bioturbation. The pavement areas had minor to moderate macroalgal cover, including *Dictyopteris*, *Asparagopsis* and occasional patches of *Padina*, and *Udotea*, as well as small corals, gorgonians and occasional sponges. The number of coral species and coral cover increased slightly as the depth decreased towards the shore, along with the occurrence of isolated coral bomboras and coral patches (**Plate 3-1** to **Plate 3-3**). Medium-density patches of seagrass were also observed between the areas of pavement (**Plate 3-4**).

Plate 3-1: Plating *Pachyseris* on large coral bombora

Plate 3-2: Sandy pavement with *Asparagopsis* and sponges

Plate 3-3: Patch coral reef with macroalgae

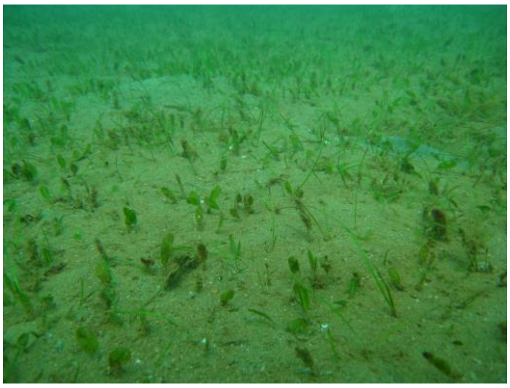

Plate 3-4: Medium- to high-density seagrass meadow

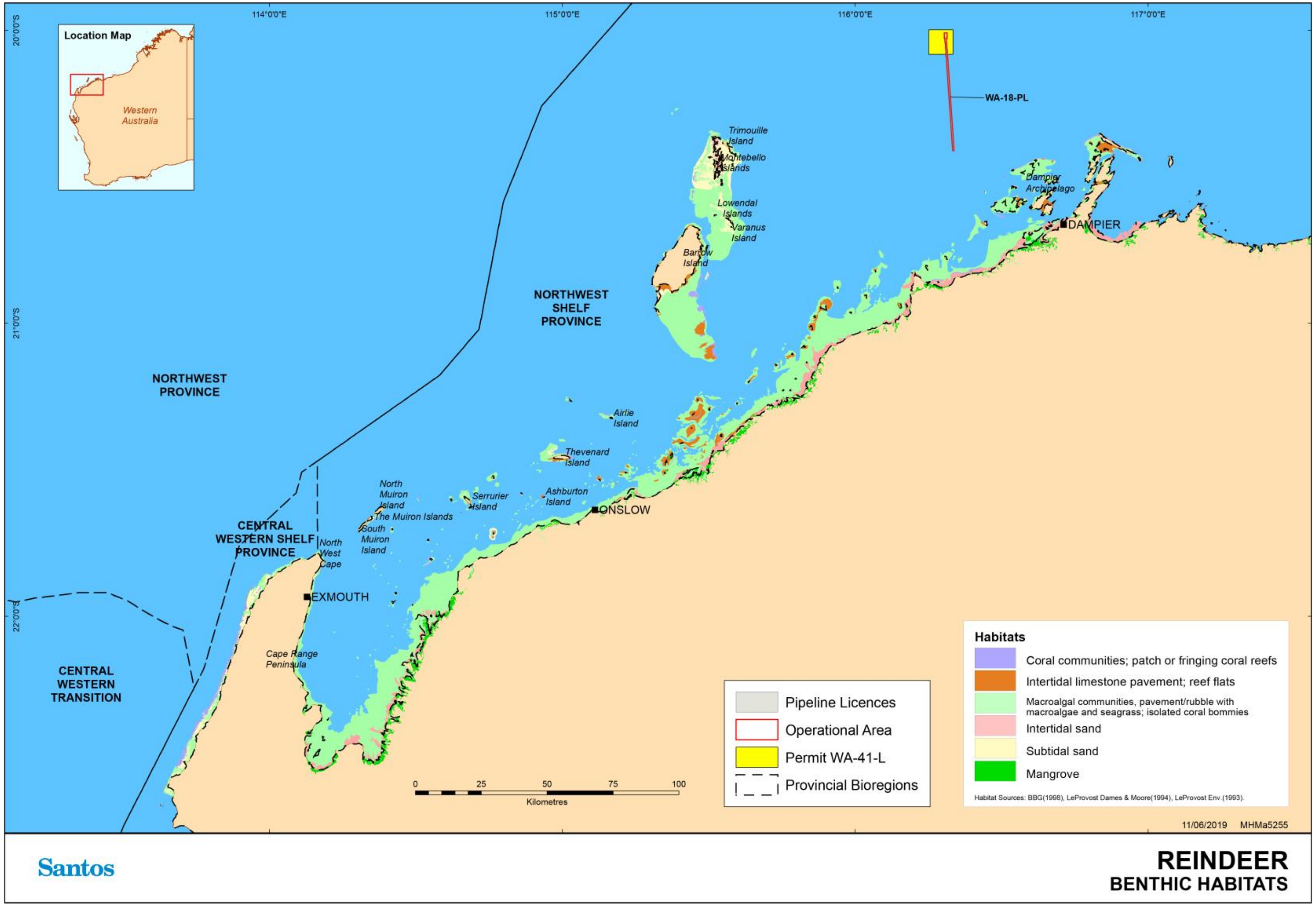

Figure 3-4: Benthic Marine Habitats within the EMBA

Table 3-1: Habitats Associated with Receptors and Receptors Identified within the EMBA

Receptors	Subtidal/Intertidal Habitats					Shoreline Habitats			EMBA					
											Loss of Well Control			
	Soft Sediments	Coral Reefs	Macroalgal Beds	Seagrass Beds	Hard Substrate (Flora/Fauna)	Rocky Shorelines	Sandy Beaches	Mangroves	Operational Area	Diesel Spills	Floating Oil (1 g/m^2) Contact	Entrained Oil (100 ppb) Contact	Dissolved Aromatic Hydrocarbons (6 ppb) Contact	Shoreline Oil (≥100 g/m^2) Contact
Barrow Island	✔	✔	✔	✔	✔	✔	✔	✔	×	✔	×	×	✔	✔
Barrow-Montebello Surrounds (offshore)	✔	✔	✔	✔	✔	×	×	×	×	✔	×	×	✔	×
Dampier Archipelago	✔	✔	✔	✔	✔	✔	✔	✔	×	x	×	×	✔	×
Lowendal Islands	✔	✔	✔	✔	×	✔	✔	×	×	✔	×	×	×	✔
Montebello Islands	✔	✔	✔	✔	✔	✔	✔	✔	×	✔	×	×	✔	✔
Muiron Islands	✔	✔	✔	✔	✔	✔	✔	×	×	✔	×	×	×	×
Ningaloo Region (mainland)	✔	✔	✔	✔	✔	✔	✔	✔	×	✔	×	×	×	×
Onslow Region (mainland)	✔	✔	✔	✔	✔	✔	✔	✔	×	✔	×	×	×	×
Thevenard Island	✔	✔	✔	✔	×	×	✔	x	×	x	×	×	×	×
Glomar Shoals	✔	✔	✔	✔	✔	x	x	x	×	✔	×	×	✔	×
Rankin Bank	✔	✔	✔	✔	✔	x	x	x	×	✔	×	×	✔	×

3.2.3 Protected and Significant Areas

3.2.3.1 Operational Area

The operational area does not intercept any marine protected areas, the closest being the Murujuga National Park and the Montebello Australian Marine Park (AMP), which are located approximately 53.6 km and 72.5 km respectively from the nearest boundary of the operational area.

Key ecological features (KEFs) that are components of the marine ecosystem that are considered to be important for biodiversity or ecosystem function and integrity of the Commonwealth Marine Area are also included in the DoEE EPBC Act Protected Matters Search Tool results (**Appendix C**). No KEFs intercept the operational area. The closest KEFs to the operational area are the Ancient Coastline at 125-m Depth Contour KEF (located 44.8 km north from the closest edge of the operational area) and Glomar Shoals KEF (44.3 km NE).

3.2.3.2 EMBA

Protected or significant areas identified in the EMBA are detailed in **Table 3-2**. The EMBA overlaps the Montebello Australian Marine Park, the Montebello Islands Marine Park (State), the Barrow Island Marine Park (State) and some of the Gascoyne Australian Marine Park, Ningaloo Australian Marine Park, Shark Bay Australian Marine Park, Argo-Rowley Terrace Australian Marine Park and Dampier Australian Marine Park. These areas are further discussed in **Appendix C**.

Australian marine parks are recognised under the EPBC Act for protecting and maintaining biological diversity and contributing to a national representative network of marine protected areas. Management plans for Australian marine parks have been developed and came into force on 1 July 2018. Under these plans, Australian marine parks are allocated conservation objectives (IUCN Protected Area Category) based on the Australian IUCN reserve management principles in Schedule 8 of the EPBC Regulations 2000. The management zones associated with the Australian marine parks identified in the EMBA and the relevant objectives are detailed in **Table 3-3.** The Proposed Dampier Archipelago Marine Park and Proposed Regnard Marine Management Area are not gazetted; they are therefore not considered protected areas and are not carried through in the assessment for this EP.

The EMBA overlaps several KEFs (**Figure 3-6**), including the Ancient Coastline at 125-m Depth Contour, Glomar Shoals, the Continental Slope Demersal Fish Communities, Exmouth Plateau, Commonwealth waters adjacent to Ningaloo Reef and Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula.

Table 3-2: Key Values and Sensitivities within the EMBA

Value/Sensitivity	Name of Protected or Significant Area	Zone or IUCN Classification	Within Operational Area	Distance to Operational Area
World heritage areas	Ningaloo World Heritage Area		No	238 km
Commonwealth heritage place	Commonwealth waters of the Ningaloo Marine Park	-	No	260 km
National heritage place	The Dampier Archipelago	-	No	24 km
	The Ningaloo Coast Heritage Area		No	238 km
Australian marine park (AMP)	Ningaloo AMP	Recreational Use Zone (IUCN IV)	No	260 km

Value/Sensitivity	Name of Protected or Significant Area	Zone or IUCN Classification	Within Operational Area	Distance to Operational Area
		National Park Zone (IUCN II)		
	Montebello AMP	Multiple Use Zone (IUCN VI)	No	32 km
	Gascoyne AMP	Habitat Protection Zone (IUCN IV) National Park Zone (IUCN II) Multiple Use Zone (IUCN VI)	No	271 km
	Dampier AMP	Habitat Protection Zone (IUCN IV) National Park Zone (IUCN II) Multiple Use Zone (IUCN VI)	No	52 km
	Eighty Mile Beach AMP	Multiple Use Zone (IUCN VI)	No	Not within the EMBA
State marine reserves	Proposed Dampier Archipelago Marine Park	Sanctuary Zone Special Purpose Zone Recreation Zone General Use Zone	No	15 km
	Montebello/Barrow Islands Marine Conservation Reserve	Sanctuary Zone	No	68 km
	Ningaloo Marine Park	National Park Zone (IUCN II) Sanctuary Zone Special Purpose Zone Recreation Zone	No	258 km

Value/Sensitivity	Name of Protected or Significant Area	Zone or IUCN Classification	Within Operational Area	Distance to Operational Area
		General Use Zone		
	Muiron Island Marine Management Area	Sanctuary Zone Special Purpose Zone Recreation Zone General Use Zone	No	238 km
	Eighty Mile Beach Marine Park	Sanctuary Zone Special Purpose Zone Recreation Zone General Use Zone	No	Not within the EMBA
Key ecological features	Ancient Coastline at 125-m Depth Contour	-	No	45 km
	Commonwealth water adjacent to Ningaloo Reef	-	No	260 km
	Continental Slope Demersal Fish Communities	-	No	95 km
	Exmouth Plateau	-	No	205 km
	Glomar Shoals	-	No	43 km
	Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula	-	No	213 km

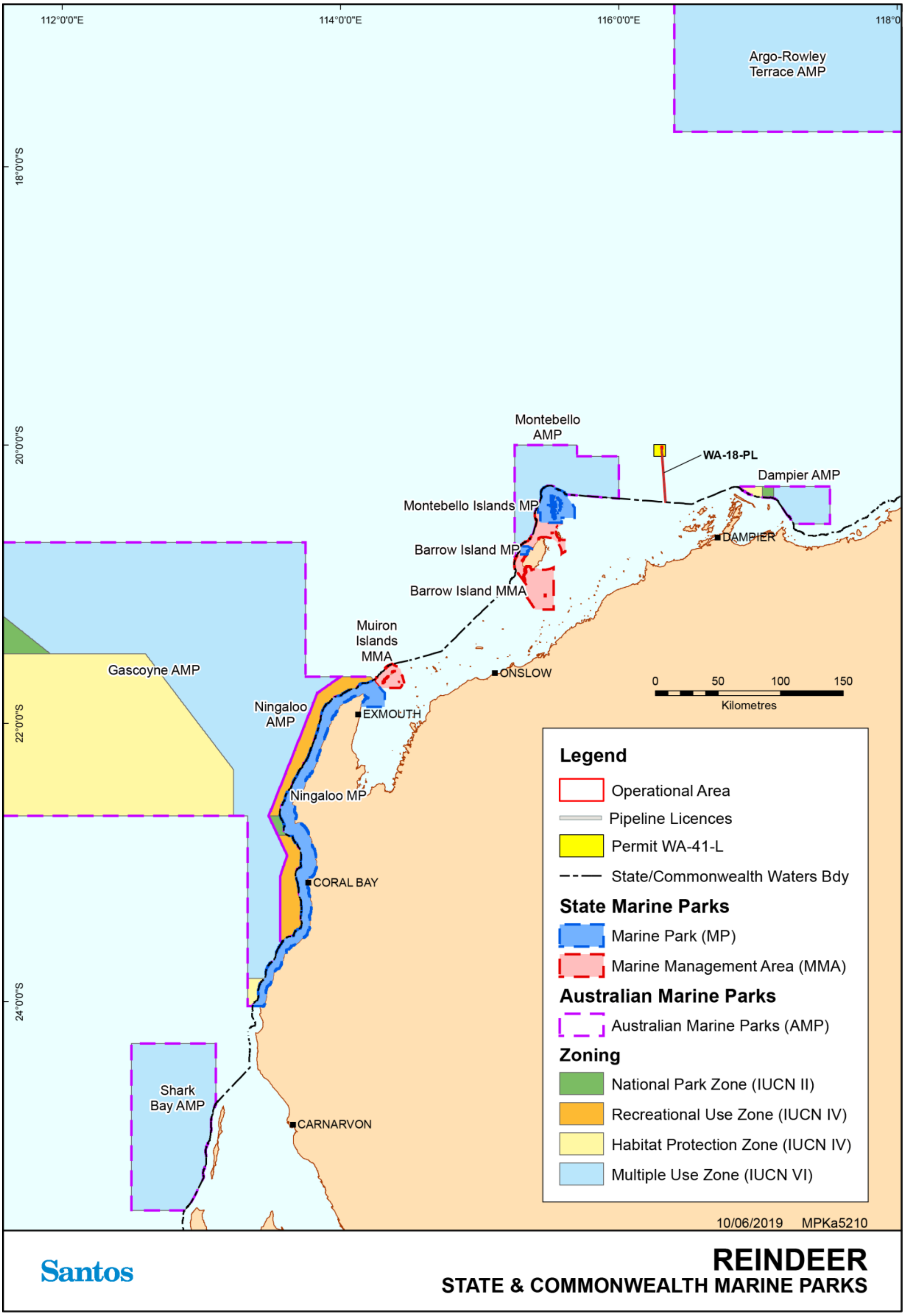

Figure 3-5: Marine Parks within the EMBA

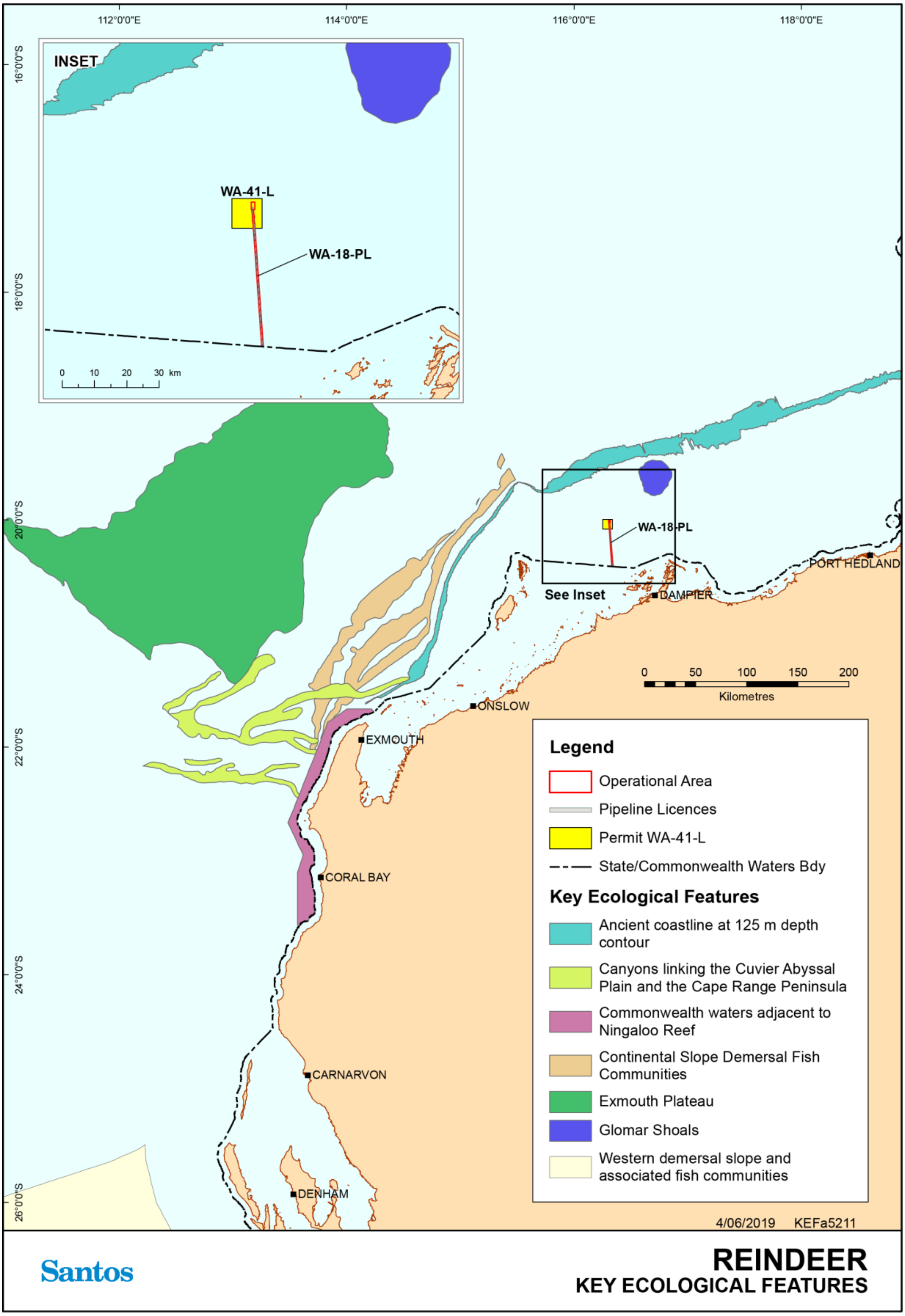

Figure 3-6: Key Ecological Features (KEF) within the EMBA

Table 3-3: Management Zones for the Australian Marine Parks Found within the EMBA and the Associated Objectives

Management Zones	Objective
Australian Marine Parks	
Multiple Use (IUCN VI)	The objective is to provide for ecologically sustainable use and the conservation of ecosystems, habitats and native species. The zone allows a range of sustainable uses, including commercial fishing and mining where they are authorised and consistent with park values. Mining operations are defined in the EPBC Act and include oil spill response.
Recreational Use (IUCN IV)	The objective is to provide for the conservation of ecosystems, habitats and native species in as natural a state as possible, while providing for recreational use.
Habitat Protection Zone (IUCN IV)	The objective is to provide for the conservation of ecosystems, habitats and native species in as natural a state as possible, while allowing activities that do not harm or cause destruction to seafloor habitats.
National Park Zone (IUCN II)	The objective is to protect natural biodiversity with its underlying ecological structure and supporting environmental processes and to promote education and recreation.
Special Purpose Zone (IUCN VI)	The objective is to protect natural ecosystems and use natural resources sustainably, when conservation and sustainable use can be mutually beneficial.
State Marine Parks	
Sanctuary Zones	The primary purpose of sanctuary zones is to protect and conserve marine biodiversity. Sanctuary zones are 'no-take' areas managed solely for nature conservation and low-impact recreation and tourism.
Special Purpose Zones	*Special purpose (benthic protection) zone*: This zone has the priority purpose of conservation of benthic habitat. *Special purpose (shore-based activities) zone*: Special purpose zones in marine parks are managed for a priority purpose or use, such as a seasonal event (e.g., wildlife breeding, whale watching) or a commercial activity (e.g., pearling).
Recreation Zones	Recreation zones have the primary purpose of providing opportunities for recreational activities, including fishing, for visitors and for commercial tourism operators, where these activities are compatible with the maintenance of the values of the zone.
General Use Zones	Conservation of natural values is still the priority of general use zones, but activities such as sustainable commercial and recreational fishing, aquaculture, pearling and petroleum exploration and production may be permitted provided they do not compromise the ecological values of the marine park.

Oil and gas operations and associated oil spill response may be conducted in a Multiple Use Zone (IUCN VI) subject to the class approval and prescriptions within the North-West Marine Parks Network Management Plan (MPNMP) (Director of National Parks, 2018). The 'Class Approval – Mining Operations and Green House Gas Activities' for the North-West MPNMP, which is applicable to petroleum-related activities, came into effect on 1 July 2018. Prescriptions or conditions of the North-

West MPNMP and Class Approval for the North-West MPNMP that are considered relevant to the scope of this EP are provided in **Table 3-4**.

Table 3-4: Prescriptions/Conditions from the North-West MPNMP 2018 and associated Class Approval – Mining Operations and Green House Gas Activities relevant to the Activities in this EP

Prescription/ Condition Number	Prescription/Condition	Relevant Section of EP
North-west MPNMP (Director of National Parks, 2018)		
4.2.9.8	Notwithstanding Section 4.2.9.1 (of the North-West MPNMP), actions required to respond to oil pollution incidents, including environmental monitoring and remediation in connection with mining operations authorised under the OPGGS Act, may be conducted in all zones without an authorisation issued by the Director, provided that: + The actions are taken in accordance with an environment plan that has been accepted by NOPSEMA; and + The Director is notified in the event of oil pollution within a marine park or where an oil spill response action must be taken within a marine park, so far as reasonably practicable, prior to response action being taken.	This EP **Section 4** Stakeholder Consultation), reporting under **Section 8** and the oil pollution emergency plan (OPEP)
Class Approval – Mining Operations and Green House Gas Activities – for North-west MPNMP (Director of National Parks, 2018)		
1	Approved action must be conducted in accordance with: + An environment plan accepted under the Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations (2009);	OPEP (some proposed response activities in the event of an oil pollution incident may be undertaken within the North-West Marine Park Network).
	+ The EPBC Act;	**Appendix B** (Legislation)
	+ The EPBC regulations;	This EP
	+ The North-West MPNMP;	**Table 3-4** (this table)
	+ Any prohibitions, restrictions or determinations made under the EPBC Regulations by the Director of National Parks; and	Not applicable
	+ All other applicable Commonwealth and state and territory laws (to the extent those laws are capable of operating concurrently with the laws and instruments described in the preceding paragraphs.	**Appendix B**(Legislation), and the OPEP

Prescription/ Condition Number	Prescription/Condition	Relevant Section of EP
2	If requested by the Director of National Parks, an Approved Person must notify the Director prior to conducting Approved Actions within Approved Zones. Note: the timeframe for prior notice will be agreed to by the Director of National Parks and the Approved Person.	**Section 8.9 and 8.10** (Reporting) and the OPEP.
3	If requested by the Director of National Parks, an Approved Person must provide the Director with information relating to undertaking the Approved Actions (or gathered while undertaking the Approved Actions) that is relevant to the Director's management of the Approved Zones. Note: the information required and timeframe within which it is required will be agreed to by the Director of National Parks and the Approved Person.	Not applicable

3.2.4 Marine Fauna

3.2.4.1 Threatened and migratory species

Table 3-5 presents the threatened and migratory species within the operational area and the EMBA. These include all relevant matters of national environmental significance protected under the EPBC Act as identified in the protected matters search for the operational area and the EMBA. For each species identified, the extent of likely presence is provided, including any overlap with designated biologically important areas (BIAs). BIAs such as an aggregation, breeding, resting, nesting or feeding area or known migratory route for these species are shown in **Figure 3-7**, **Figure 3-8** and **Figure 3-9** and are described in **Appendix C**.

The protected matters search identified 20 marine fauna species listed as 'threatened' and 35 marine fauna species listed as 'migratory' within the operational area, and 34 marine fauna species listed as 'threatened' and 56 marine fauna species listed as 'migratory' within the EMBA (**Table 3-5**). Other listed marine species that may occur within the operational area and the EMBA are provided in **Appendix C**. Note that terrestrial species that occur in the EPBC searches of the EMBA have been excluded where not relevant with respect to hydrocarbon concentrations of floating oil, entrained oil and dissolved aromatic hydrocarbons and shoreline accumulations used to define the EMBA. Species that may occur on shorelines include shorebirds. Terrestrial mammals, reptiles (such as pythons) and bird species that do not have habitats along shorelines are excluded from **Table 3-5**. It should also be noted that seabirds and shorebirds are classified as marine fauna for the purposes of impact assessment within this EP.

Table 3-5: Protected Species and Communities within the Operational Area and the EMBA

Value/Sensitivity		EPBC Act Status CE = Critically Endangered E = Endangered V = Vulnerable M = Migratory CD = Conservation Dependent	Operational Area Presence	Particular Values or Sensitivities within Operational Area	EMBA Presence	Particular Values or Sensitivities Within EMBA	Relevant Events
Common Name	Scientific Name						
Protected Species and Communities: Fish and Sharks							
Whale shark	*Rhincodon typus*	V, M	✓	Foraging, feeding or related behaviour known to occur within area Overlap with foraging BIA	✓	Foraging, feeding or related behaviour known to occur within area. Overlap with foraging BIA	<u>Planned</u> Light emissions Acoustic disturbance Operational discharges Spill response operations <u>Unplanned</u> Hydrocarbon releases Non-hydrocarbon releases Marine fauna interaction Introduction of invasive marine species
Grey nurse shark (west coast population)	*Carcharias taurus* (west coast population)	V	✓	Species or species habitat likely to occur within area	✓	Species or species habitat known to occur within area	
Great white shark	*Carcharodon carcharias*	V, M	✓	Species or species habitat may occur within area	✓	Species or species habitat known to occur within area	
Dwarf sawfish	*Pristis clavata*	V, M	✓	Species or species habitat known to occur within area	✓	Species or species habitat known to occur within area	

Value/Sensitivity		EPBC Act Status CE = Critically Endangered E = Endangered V = Vulnerable M = Migratory CD = Conservation Dependent	Operational Area Presence	Particular Values or Sensitivities within Operational Area	EMBA Presence	Particular Values or Sensitivities Within EMBA	Relevant Events
Common Name	Scientific Name						
Green sawfish	*Pristis zijsron*	V, M	✓	Species or species habitat known to occur within area	✓	Species or species habitat known to occur within area	
Narrow sawfish	*Anoxypristis cuspidata*	M	✓	Species or species habitat likely to occur within area	✓	Species or species habitat known to occur within area	
Shortfin mako	*Isurus oxyrinchus*	M	✓	Species or species habitat likely to occur within area	✓	Species or species habitat likely to occur within area	
Longfin mako	*Isurus paucus*	M	✓	Species or species habitat likely to occur within area	✓	Species or species habitat likely to occur within area	
Porbeagle, mackerel shark	*Lamna nasus*	M	x	N/A	✓	Species or species habitat may occur within area	
Reef manta ray	*Manta alfredi*	M	✓	Species or species habitat	✓	Species or species habitat	

Value/Sensitivity		EPBC Act Status CE = Critically Endangered E = Endangered V = Vulnerable M = Migratory CD = Conservation Dependent	Operational Area Presence	Particular Values or Sensitivities within Operational Area	EMBA Presence	Particular Values or Sensitivities Within EMBA	Relevant Events
Common Name	Scientific Name						
				known to occur within area		known to occur within area	
Giant manta ray	*Manta birostris*	M	✓	Species or species habitat likely to occur within area	✓	Species or species habitat known to occur within area	
Blind gudgeon	*Milyeringa veritas*	V	**x**	N/A	✓	Species or species habitat known to occur within area	
Blind cave eel	*Ophisternon candidum*	V	**x**	N/A	✓	Species or species habitat known to occur within area	
Protected Species and Communities: Marine Mammals							
Humpback whale	*Megaptera novaeangliae*	V, M	✓	Species or species habitat known to occur within area Overlap with BIA for migration	✓	Congregation or aggregation known to occur within area Overlap with BIA for migration	<u>Planned</u> Noise emissions Operational discharges Spill response operations

Value/Sensitivity		EPBC Act Status					
Common Name	**Scientific Name**	CE = Critically Endangered E = Endangered V = Vulnerable M = Migratory CD = Conservation Dependent	**Operational Area Presence**	**Particular Values or Sensitivities within Operational Area**	**EMBA Presence**	**Particular Values or Sensitivities Within EMBA**	**Relevant Events**
Blue whale	*Balaenoptera musculus*	E, M	✓	Species or species habitat likely to occur within area	✓	Migration route known to occur within area Overlap with BIA for migration	<u>Unplanned</u> Hydrocarbon releases Non-hydrocarbon releases Marine fauna interaction
Sei whale	*Balaenoptera borealis*	V, M	✓	Species or species habitat may occur within area	✓	Foraging, feeding or related behaviour likely to occur within area	
Fin whale	*Balaenoptera physalus*	V, M	✓	Species or species habitat may occur within area	✓	Foraging, feeding or related behaviour likely to occur within area	
Bryde's whale	*Balaenoptera edeni*	M	✓	Species or species habitat may occur within area	✓	Species or species habitat likely to occur within area	
Orca, killer whale	*Orcinus orca*	M	✓	Species or species habitat may occur within area	✓	Species or species habitat may occur within area	
Spotted bottlenose dolphin	*Tursiops aduncus* (Arafura/Timor	M	✓	Species or species habitat	✓	Species or species habitat	

Value/Sensitivity		EPBC Act Status CE = Critically Endangered E = Endangered V = Vulnerable M = Migratory CD = Conservation Dependent	Operational Area Presence	Particular Values or Sensitivities within Operational Area	EMBA Presence	Particular Values or Sensitivities Within EMBA	Relevant Events
Common Name	**Scientific Name**						
	Sea populations)			likely to occur within area		known to occur within area	
Sperm whale	*Physeter macrocephalus*	M	X	N/A	✓	Species or species habitat may occur within area	
Indo-Pacific humpback dolphin	*Sousa chinensis*	M	✓	Species or species habitat may occur within area	✓	Species or species habitat known to occur within area	
Dugong	*Dugong dugon*	M	✓	Species or species habitat likely to occur within area	✓	Breeding known to occur within area Overlap with BIA for breeding	
Southern right whale	*Eubalaena australis*	E, M	X	N/A	✓	Species or species habitat likely to occur within area	
Antarctic minke whale	*Balaenoptera bonaerensis*	M	X	N/A	✓	Species or species habitat likely to occur within area	

Value/Sensitivity		EPBC Act Status CE = Critically Endangered E = Endangered V = Vulnerable M = Migratory CD = Conservation Dependent	Operational Area Presence	Particular Values or Sensitivities within Operational Area	EMBA Presence	Particular Values or Sensitivities Within EMBA	Relevant Events
Common Name	**Scientific Name**						
Protected Species and Communities: Marine Reptiles							
Short-nosed seasnake	*Aipysurus apraefrontalis*	CE	✓	Species or species habitat may occur within area	✓	Species or species habitat known to occur within area	<u>Planned</u> Light emissions Acoustic disturbance Operational discharges Spill response operations <u>Unplanned</u> Hydrocarbon releases Non-hydrocarbon releases Marine fauna interaction
Loggerhead turtle	*Caretta caretta*	E, M	✓	Species or species habitat known to occur within area	✓	Breeding known to occur within area Overlap interesting BIA	
Green turtle	*Chelonia mydas*	V, M	✓	Species or species habitat known to occur within area	✓	Breeding known to occur within area Overlap interesting BIA	
Leatherback turtle	*Dermochelys coriacea*	E, M	✓	Species or species habitat likely to occur within area	✓	Foraging, feeding or related behaviour known to occur within area Breeding likely to occur within area	

Value/Sensitivity		EPBC Act Status					
Common Name	Scientific Name	CE = Critically Endangered E = Endangered V = Vulnerable M = Migratory CD = Conservation Dependent	Operational Area Presence	Particular Values or Sensitivities within Operational Area	EMBA Presence	Particular Values or Sensitivities Within EMBA	Relevant Events
Hawksbill turtle	*Eretmochelys imbricata*	V, M	✓	Species or species habitat known to occur within area	✓	Breeding known to occur within area	
Flatback turtle	*Natator depressus*	V, M	✓	Congregation or aggregation known to occur within area Overlap with internesting BIA	✓	Breeding known to occur within area Overlap with breeding BIA	
Protected Species and Communities: Marine Birds							
Curlew sandpiper	*Calidris ferruginea*	CE, M	✓	Species or species habitat may occur within area	✓	Species or species habitat known to occur within area	<u>Planned</u> Light emissions Acoustic disturbance Operational discharges Atmospheric emissions Spill response operations
Red knot	*Calidris canutus*	E, M	✓	Species or species habitat may occur within area	✓	Species or species habitat known to occur within area	
Southern giant petrel	*Macronectes giganteus*	E, M	✓	Species or species habitat	✓	Species or species habitat	

Value/Sensitivity		EPBC Act Status CE = Critically Endangered E = Endangered V = Vulnerable M = Migratory CD = Conservation Dependent	Operational Area Presence	Particular Values or Sensitivities within Operational Area	EMBA Presence	Particular Values or Sensitivities Within EMBA	Relevant Events
Common Name	Scientific Name						
				may to occur within area		may occur within area	<u>Unplanned</u> Hydrocarbon releases Non-hydrocarbon releases Marine fauna interaction
Northern giant petrel	*Macronectes halli*	V	**X**	N/A	✓	Species or species habitat may to occur within area	
Abbott's booby	*Papasula abbotti*	E	**X**	N/A	✓	Species or species habitat may to occur within area	
Eastern curlew	*Numenius madagascar-iensis*	CE, M	✓	Species or species habitat may occur within area	✓	Species or species habitat known to occur within area	
Common noddy	*Anous stolidus*	M	✓	Species or species habitat may occur within area	✓	Species or species habitat likely to occur within area	
Streaked shearwater	*Calonectris leucomelas*	M	✓	Species or species habitat likely to occur within area	✓	Species or species habitat likely to occur within area	

Value/Sensitivity		EPBC Act Status					
Common Name	Scientific Name	CE = Critically Endangered E = Endangered V = Vulnerable M = Migratory CD = Conservation Dependent	Operational Area Presence	Particular Values or Sensitivities within Operational Area	EMBA Presence	Particular Values or Sensitivities Within EMBA	Relevant Events
Lesser frigatebird	*Fregata ariel*	M	✓	Species or species habitat likely to occur within area	✓	Species or species habitat likely to occur within area	
Common sandpiper	*Actitis hypoleucos*	M	✓	Species or species habitat may occur within area	✓	Species or species habitat known to occur within area	
Sharp-tailed sandpiper	*Calidris acuminata*	M	✓	Species or species habitat may occur within area	✓	Species or species habitat known to occur within area	
Pectoral sandpiper	*Calidris melanotos*	M	✓	Species or species habitat may occur within area	✓	Species or species habitat may occur within area	
Osprey	*Pandion haliaetus*	M	✓	Species or species habitat may occur within area	✓	Breeding known to occur within area	
Bar-tailed godwit	*Limosa lapponica baueri*	V, M	**X**	N/A	✓	Species or species habitat known to occur within area	

Value/Sensitivity		EPBC Act Status CE = Critically Endangered E = Endangered V = Vulnerable M = Migratory CD = Conservation Dependent	Operational Area Presence	Particular Values or Sensitivities within Operational Area	EMBA Presence	Particular Values or Sensitivities Within EMBA	Relevant Events
Common Name	**Scientific Name**						
Northern Siberian bar-tailed godwit	*Limosa lapponica menzbierii*	CE, M	**X**	N/A	✓	Species or species habitat may occur within area	
Australian fairy tern	*Sternula nereis nereis*	V	✓	Foraging, feeding or related behaviour likely to occur within area	✓	Breeding known to occur within area	
Fork-tailed swift	*Apus pacificus*	M	**X**	N/A	✓	Species or species habitat likely to occur within area	
Wedge-tailed shearwater	*Ardenna pacifica*	M	**X**	N/A	✓	Breeding known to occur within area	
Greater frigatebird	*Fregata minor*	M	**X**	N/A	✓	Species or species habitat may occur within area	
Caspian tern	*Hydroprogne caspia*	M	**X**	N/A	✓	Breeding known to occur within area	

Value/Sensitivity		EPBC Act Status	Operational Area Presence	Particular Values or Sensitivities within Operational Area	EMBA Presence	Particular Values or Sensitivities Within EMBA	Relevant Events
Common Name	**Scientific Name**	CE = Critically Endangered E = Endangered V = Vulnerable M = Migratory CD = Conservation Dependent					
Bridled tern	*Onychoprion anaethetus*	M	**X**	N/A	✓	Breeding known to occur within area	
Roseate tern	*Stern dougallii*	M	✓	Foraging, feeding or related behaviour likely to occur within area	✓	Breeding known to occur within area	
White-tailed tropicbird	*Phaethon lepturus*	M	**X**	N/A	✓	Foraging, feeding or related behaviour likely to occur within area	
Oriental plover	*Charadrius plover*	M	**X**	N/A	✓	Species or species habitat may occur within area	
Oriental pratincole	*Glareola maldivarum*	M	**X**	N/A	✓	Species or species habitat may occur within area	
Common greenshank	*Tringa nebularia*	M	**X**	N/A	✓	Species or species habitat	

Value/Sensitivity		EPBC Act Status CE = Critically Endangered E = Endangered V = Vulnerable M = Migratory CD = Conservation Dependent	Operational Area Presence	Particular Values or Sensitivities within Operational Area	EMBA Presence	Particular Values or Sensitivities Within EMBA	Relevant Events
Common Name	Scientific Name						
						likely to occur within area	
White-winged fairy-wren (Barrow Island), Barrow Island black-and-white fairy-wren	*Malurus leucopterus edouardi*	V	X	N/A	✓	Species or species habitat likely to occur within area	
Soft-plumaged petrel	*Pterodroma mollis*	V	X	N/A	✓	Foraging, feeding or related behaviour likely to occur within area	
Indian yellow-nosed albatross	*Thalassarche carteri*	V, M	X	N/A	✓	Foraging, feeding or related behaviour may occur within area	
Tasmanian shy albatross	*Thalassarche cauta*	V, M	X	N/A	✓	Species or species habitat may occur within area	
White-capped albatross	*Thalassarche cauta steadi*	V, M	X	N/A	✓	Foraging, feeding or related behaviour likely to occur within area	

Value/Sensitivity		EPBC Act Status CE = Critically Endangered E = Endangered V = Vulnerable M = Migratory CD = Conservation Dependent	Operational Area Presence	Particular Values or Sensitivities within Operational Area	EMBA Presence	Particular Values or Sensitivities Within EMBA	Relevant Events
Common Name	**Scientific Name**						
Campbell albatross	*Thalassarache impavida*	V, M	**X**	N/A	✓	Species or species habitat may occur within area	
Black-browed albatross	*Thalassarche impavida*	V, M	**X**	N/A	✓	Species or species habitat may occur within area	
Flesh-footed shearwater	*Ardenna carneipes*	M	**X**	N/A	✓	Species or species habitat likely to occur within area	
Australian painted snipe	*Rostratula Australis*	E	**X**	N/A	✓	Species or species habitat may occur within area	

Source: EPBC Act Protected Matters Search (2019).

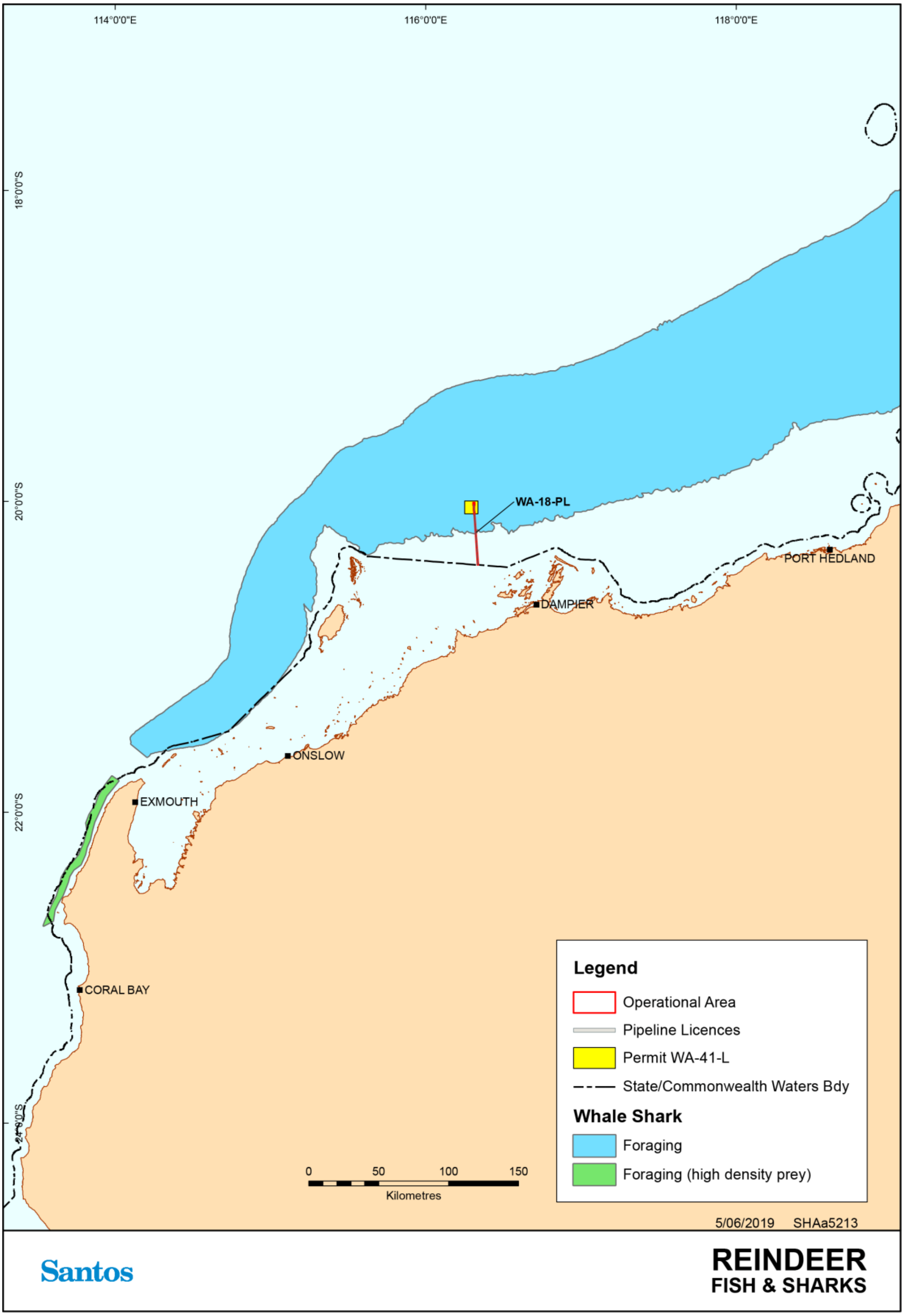

Figure 3-7: Fish and Sharks BIA within the EMBA

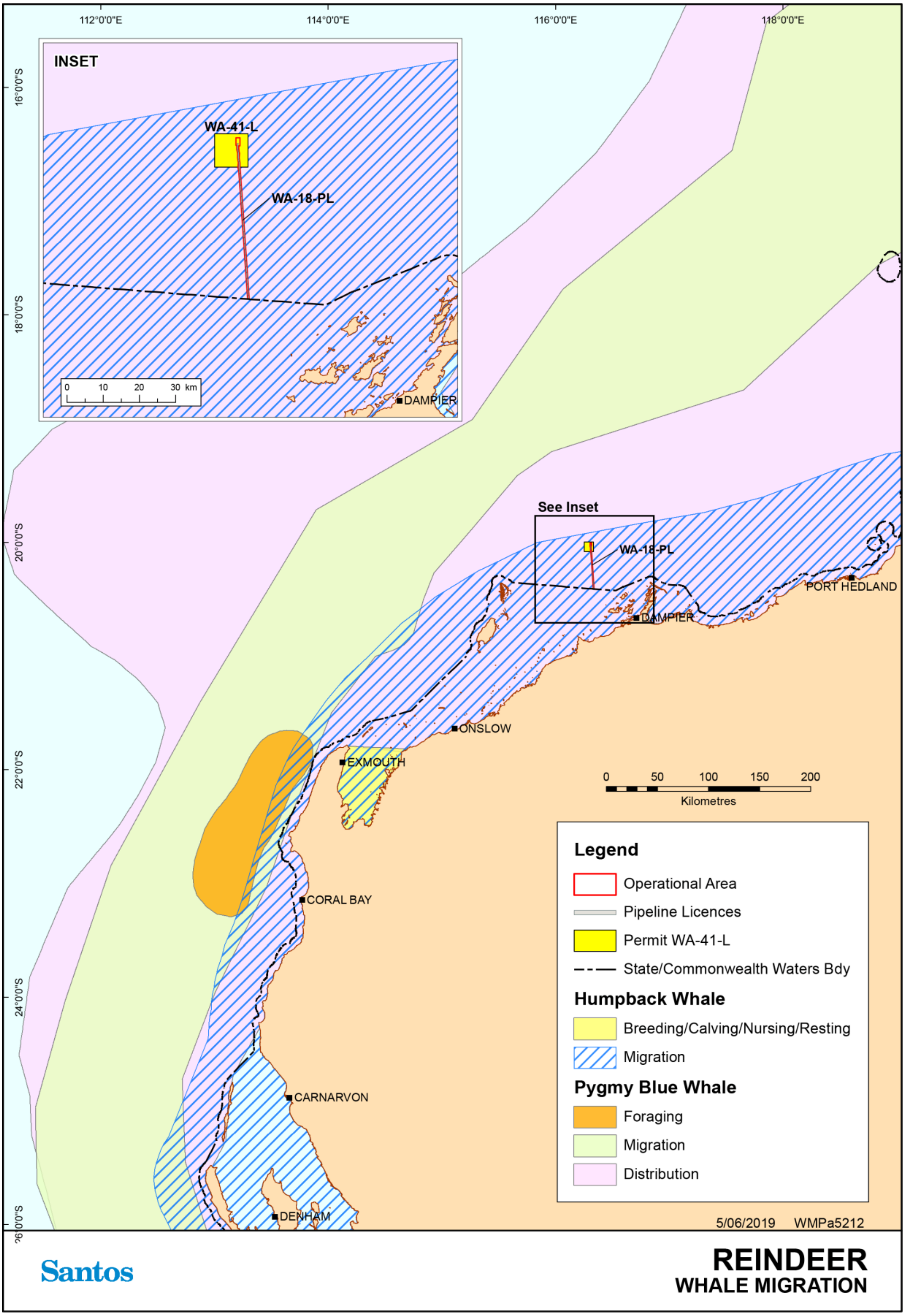

Figure 3-8: Whale Migration and BIA within the EMBA

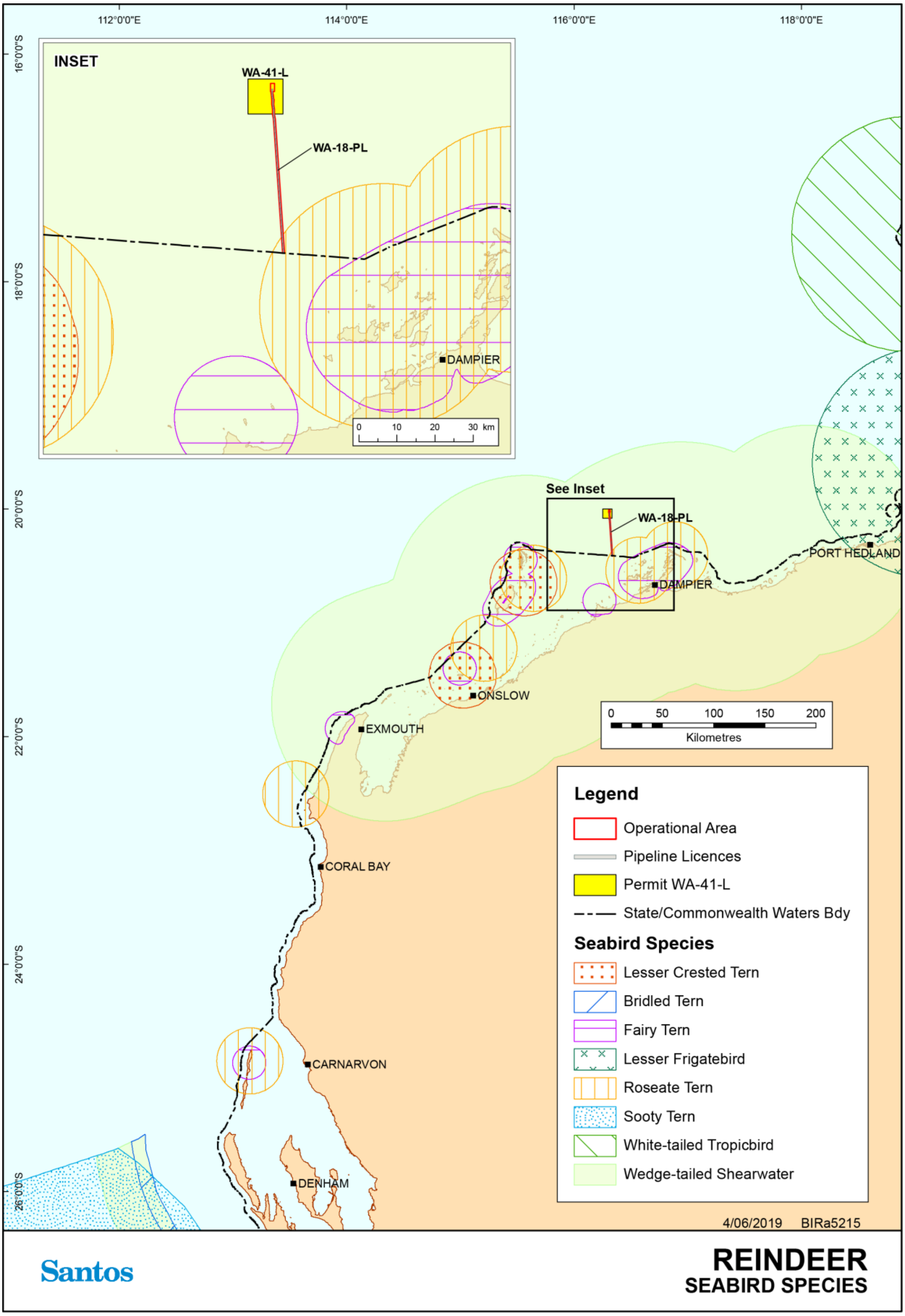

Figure 3-9: Seabird Species BIA within the EMBA

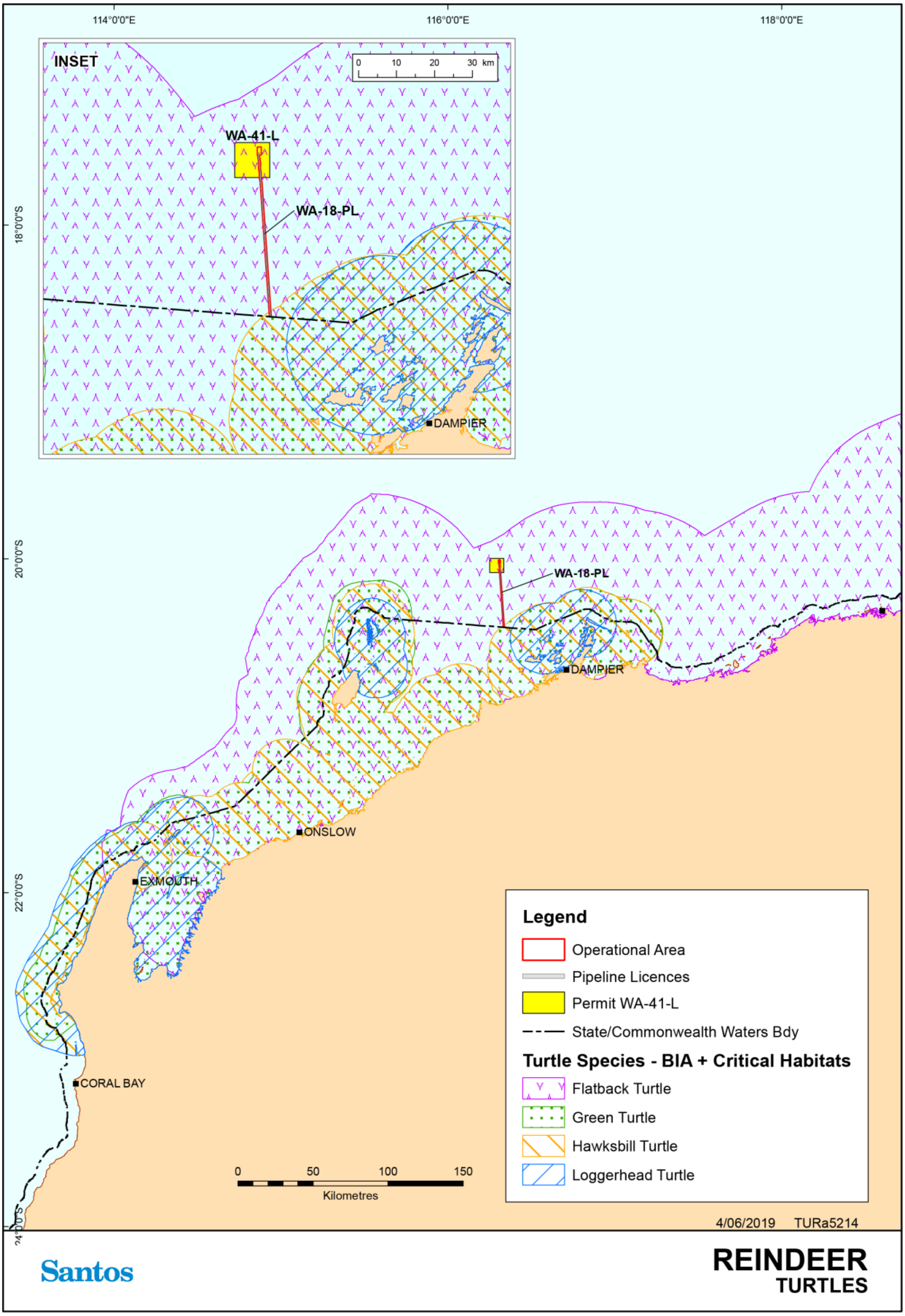

Figure 3-10: Turtle Species BIA within the EMBA

3.2.4.2 Recovery Plans

Recovery plans set out the research and management actions necessary to stop the decline and support the recovery of listed threatened species.

Table 3-6 summarises the actions relevant to the activity, details the specific requirements of the relevant plans of management (including conservation advice and conservation management plans) that would be applicable to the Reindeer facilities, and demonstrates how current management requirements have been taken into account.

Table 3-6: Threats and Strategies from Recovery Plans, Conservation Advice and Management Plans Relevant to the Activity

Name	Recovery Plan, Conservation Advice or Management Plan	Threats and Strategies Identified as Relevant to the Activity	Addressed in EP Section
Cetaceans			
Blue whale	Conservation Management Plan for the Blue Whale 2015-2025 (2015) Threat Abatement Plan for Impacts of Marine Debris on Vertebrate Wildlife of Australia's Coasts and Oceans (2018)	Noise interference	**6.1**
		Habitat modification	**7.2, 7.3**
		Vessel disturbance	**7.2**
Fin whale	Approved Conservation Advice for *Balaenoptera physalus* (fin whale) (2015) Threat Abatement Plan for Impacts of Marine Debris on Vertebrate Wildlife of Australia's Coasts and Oceans (2018)	Anthropogenic noise and acoustic disturbance	**6.1**
		Pollution (persistent toxic pollutants)	**6.3, 6.4, 7.3, 7.4, 7.5, 7.6, 7.7, 7.8**
		Vessel strike	**7.2**
Sei whale	Approved Conservation Advice for *Balaenoptera borealis* (sei whale) (2015) Threat Abatement Plan for Impacts of Marine Debris on Vertebrate Wildlife of Australia's Coasts and Oceans (2018)	Anthropogenic noise and acoustic disturbance	**6.1**
		Habitat degradation including pollution (persistent toxic pollutants)	**7.2, 7.3, 7.4, 7.5, 7.6, 7.7, 7.8**
		Marine debris	**7.3**
		Vessel strike	**7.2**
Humpback whale	Approved Conservation Advice for *Megaptera novaeangliae* (humpback whale) (2015). Threat Abatement Plan for Impacts of Marine Debris on Vertebrate Wildlife of Australia's Coasts and Oceans (2018)	Noise interference	**6.1**
		Marine debris	**7.3**
		Vessel strike	**7.2**
Southern right whale	Conservation Management Plan for the Southern Right Whale 2011 – 2021 (2012)	Habitat modification	**7.2, 7.3**
		Vessel disturbance	**7.2**
		Noise interference	**6.1**

Name	Recovery Plan, Conservation Advice or Management Plan	Threats and Strategies Identified as Relevant to the Activity	Addressed in EP Section
Marine Reptiles			
Short-nosed seasnake	Commonwealth Conservation Advice on *Aipysurus apraefrontalis* (short-nosed seasnake) (2011)	Degradation of reef habitat	**7.4, 7.5, 7.6, 7.7, 7.8**
Loggerhead turtle	Recovery Plan for Marine Turtles in Australia 2017-2027 (2017) Threat Abatement Plan for Impacts of Marine Debris on Vertebrate Wildlife of Australia's Coasts and Oceans (2018)	Noise interference	**6.1**
		Marine debris	**7.3**
		Deteriorating water quality	**6.6, 7.4, 7.5, 7.6, 7.7, 7.8**
		Vessel disturbance	**7.2**
		Loss of habitat and/or habitat modification	**7.2, 7.3**
		Light pollution	**6.2**
Green turtle	Recovery Plan for Marine Turtles in Australia 2017-2027 (2017) Threat Abatement Plan for Impacts of Marine Debris on Vertebrate Wildlife of Australia's Coasts and Oceans (2018)	Noise interference	**6.1**
		Deteriorating water quality	**6.6, 7.4, 7.5, 7.6, 7.7, 7.8**
		Marine debris	**7.3**
		Vessel disturbance	**7.2**
		Light pollution	**6.2**
Leatherback turtle, leathery turtle	Commonwealth Conservation Advice on *Dermochelys coriacea* (2008)	Boat strike	**7.2**
		Changes to breeding sites	**6.4, 7.1, 7.2, 7.3**
		Marine debris	**7.3**
	Recovery Plan for Marine Turtles in Australia 2017-2027 (2017)	Noise interference	**6.1**
		Deteriorating water quality	**6.6, 7.4, 7.5, 7.6, 7.7, 7.8**
		Marine debris	**7.3**

Name	Recovery Plan, Conservation Advice or Management Plan	Threats and Strategies Identified as Relevant to the Activity	Addressed in EP Section
	Threat Abatement Plan for Impacts of Marine Debris on Vertebrate Wildlife of Australia's Coasts and Oceans (2018)	Loss of habitat	**7.2, 7.3**
		Vessel disturbance	**7.2**
		Light pollution	**6.2**
Hawksbill turtle	Recovery Plan for Marine Turtles in Australia 2017-2027 (2017) Threat Abatement Plan for Impacts of Marine Debris on Vertebrate Wildlife of Australia's Coasts and Oceans (2018)	Noise interference	**6.1**
		Deteriorating water quality	**6.6, 7.4, 7.5, 7.6, 7.7, 7.8**
		Marine debris	**7.3**
		Loss of habitat	**7.2, 7.3**
		Vessel disturbance	**7.2**
		Light pollution	**6.2**
Flatback turtle	Recovery Plan for Marine Turtles in Australia 2017-2027 (2017) Threat Abatement Plan for Impacts of Marine Debris on Vertebrate Wildlife of Australia's Coasts and Oceans (2018)	Noise interference	**6.1**
		Deteriorating water quality	**6.6, 7.4, 7.5, 7.6, 7.7, 7.8**
		Marine debris	**7.3**
		Loss of habitat	**7.2, 7.3**
		Vessel disturbance	**7.2**
		Light pollution	**6.2**
Fish and Sharks			
Whale shark	Approved Conservation Advice for *Rhincodon typus* (whale shark) (2015)	Marine debris	**7.3**
		Boat strike from large vessel	**7.2**
Grey nurse shark (west coast population)	Recovery Plan for the Grey Nurse Shark (*Carcharias taurus*) (2014)	Ecosystem effects as a result of habitat modification and pollution effects	**7.2, 7.3**

Name	Recovery Plan, Conservation Advice or Management Plan	Threats and Strategies Identified as Relevant to the Activity	Addressed in EP Section
	Threat Abatement Plan for Impacts of Marine Debris on Vertebrate Wildlife of Australia's Coasts and Oceans (2018)	Marine debris	**7.3**
Great white shark	Recovery Plan for the White Shark (*Carcharodon carcharias*) (2013)	Ecosystem effects as a result of habitat modification	**7.2, 7.3**
Dwarf sawfish	Commonwealth Conservation Advice on *Pristis clavata* (dwarf sawfish) (2009)	Habitat degradation and modification	**7.2, 7.3**
	Sawfish and River Sharks Multispecies Recovery Plan (2015)		
Green sawfish	Commonwealth Conservation Advice on *Pristis zijsron* (green sawfish) (2008)	Habitat degradation and modification	**7.2, 7.3**
	Sawfish and River Sharks Multispecies Recovery Plan (2015)		
Birds			
Red knot	Approved Conservation Advice for *Calidris canutus* (red knot) (2016)	Habitat loss and degradation	**7.2, 7.3**
		Pollution/contamination impacts	**7.2, 7.3, 7.4, 7.5, 7.6, 7.7, 7.8**
Southern giant-petrel	National Recovery Plan for Threatened Albatrosses and Giant Petrels 2011-2016 (2011) Background paper, population status and threats to albatrosses and giant petrels listed as threatened under the EPBC Act 1999 (2011)	Marine pollution	**7.2, 7.3, 7.4, 7.5, 7.6, 7.7, 7.8**
Northern giant-petrel	National Recovery Plan for Threatened Albatrosses and Giant Petrels 2011-2016 (2011)	Marine pollution	**7.2, 7.3, 7.4, 7.5, 7.6, 7.7, 7.8**

Name	Recovery Plan, Conservation Advice or Management Plan	Threats and Strategies Identified as Relevant to the Activity	Addressed in EP Section
	Background paper, population status and threats to albatrosses and giant petrels listed as threatened under the EPBC Act 1999 (2011)		
Curlew sandpiper	Approved Conservation Advice for *Calidris ferruginea* (curlew sandpiper) (2015)	Habitat loss and degradation from pollution	**7.2, 7.3, 7.4, 7.5, 7.6, 7.7, 7.8**
Eastern curlew	Approved Conservation Advice for *Numenius madagascariensis* (eastern curlew) (2015)	Habitat loss and degradation from pollution	**7.4, 7.5, 7.6, 7.7, 7.8**
Western Alaskan bar-tailed godwit	Approved Conservation Advice for *Limosa lapponica baueri* (bar-tailed godwit western Alaskan) (2016)	Habitat loss and degradation	**7.4, 7.5, 7.6, 7.7, 7.8**
		Pollution/contamination impacts	**7.4, 7.5, 7.6, 7.7, 7.8**
Northern Siberian bar-tailed godwit	Approved Conservation Advice for *Limosa lapponica menzbieri* (bar-tailed godwit northern Siberian) (2016)	Habitat loss and degradation	**7.4, 7.5, 7.6, 7.7, 7.8**
		Pollution/contamination impacts	**7.4, 7.5, 7.6, 7.7, 7.8**
Australian fairy tern	Commonwealth Conservation Advice on *Sternula nereis nereis* (fairy tern) (2011)	Oil spills	**7.5, 7.6, 7.7, 7.8**
Campbell albatross	National Recovery Plan for Threatened Albatrosses and Giant Petrels 2011-2016 (DSEWPaC, 2011)	Marine pollution	**7.2, 7.3, 7.4, 7.5, 7.6, 7.7, 7.8**
Indian yellow-nosed albatross	National Recovery Plan for Threatened Albatrosses and Giant Petrels 2011-2016 (DSEWPaC, 2011)	Marine pollution	**7.2, 7.3, 7.4, 7.5, 7.6, 7.7, 7.8**
Shy albatross	National Recovery Plan for Threatened Albatrosses and Giant Petrels 2011-2016 (DSEWPaC, 2011)	Marine pollution	**7.2, 7.3, 7.4, 7.5, 7.6, 7.7, 7.8**

Name	Recovery Plan, Conservation Advice or Management Plan	Threats and Strategies Identified as Relevant to the Activity	Addressed in EP Section
White-capped albatross	National Recovery Plan for Threatened Albatrosses and Giant Petrels 2011-2016 (DSEWPaC, 2011)	Marine pollution	**7.2, 7.3, 7.4, 7.5, 7.6, 7.7, 7.8**
Black-browed albatross	National Recovery plan for Threatened Albatrosses and Giant Petrels 2011-2016 (DSEWPaC, 2011)	Marine pollution	**7.2, 7.3, 7.4, 7.5, 7.6, 7.7, 7.8**
White-winged fairy wren	Approved Conservation Advice for *Malurus leucopterus edouardi* (White-winged Fairy-wren (Barrow Island))	Habitat loss, disturbance and modification	**7.2, 7.4, 7.5, 7.6, 7.7, 7.8**

3.2.5 Socio-Economic

Socio-economic activities that may occur within the operational area include commercial fishing, oil and gas exploration and production, and, to a lesser extent, recreational fishing and tourism as summarised in **Table 3-7**.

Table 3-7: Socio-Economic Activities in the Operational Area and the EMBA

Value/ Sensitivity	Description	Operational Area presence	Relevant Events within Operational Area	Relevant Events within the EMBA
Commercial fisheries - Commonwealth (**Figure 3-11**)	Three Commonwealth fisheries overlap the operational area: the Western Tuna and Billfish Fishery, the Southern Bluefin Tuna Fishery, and the Western Skipjack Tuna Fishery. Since 2005, fewer than five vessels have been active in the Western Tuna and Billfish Fishery, down from 50 active vessels in 2000 (ABARES Fishery Status Reports, 2010). The Southern Bluefin Tuna Fishery is only active in waters offshore of south and south-eastern Australia, confirmed in consultation with the Australia Southern Bluefin Tuna Association in consultation for previous company offshore activities (ABARES Fishery Status Reports, 2018). There has been no fishing effort in the Western Skipjack Tuna Fishery since the 2009 season, and in that season activity concentrated off South Australia (ABARES Fishery Status Reports, 2018).	✓	<u>Planned</u> Interaction with other users (**Section 6.5**)	<u>Unplanned</u> Unplanned hydrocarbon spills (**Section 7.5**)
Commercial fisheries - State	State fisheries active within the operational area are the Pilbara Trap, Line and Fish Trawl Managed Fisheries and the Mackerel Managed Fishery Area 2 (**Figure 3-12** and **Table 3-8**). A number of fisheries are open within the operational area and the EMBA; however, they do not have activity in this area. These are the Marine Aquarium Fish Managed Fishery, West Coast Deep Sea Crab (Interim)	✓	<u>Planned</u> Interaction with other users (**Section 6.5**)	<u>Unplanned</u> Unplanned hydrocarbon spills (**7.5**)

	Managed Fishery and Specimen Shell Managed Fishery.			
Shipping	Shipping using North West Shelf waters includes iron ore carriers, oil tankers and other vessels proceeding to or from the ports of Dampier, Port Walcott and Port Hedland; however, these are predominantly heading north from these ports. The operational area does not overlap any major shipping lanes (>20 km away), although vessel traffic may be encountered throughout the operational area as commercial vessels transit around the Montebello Islands and support vessels conduct operations with the offshore infrastructure (**Figure 3-13**).	✓	<u>Planned</u> Interaction with other users (**6.5**)	<u>Unplanned</u> Unplanned hydrocarbon spills (**7.5**)
Recreational fishing	Within the operational area there are no known natural seabed features that would aggregate fishes and that are typically targeted by recreational fishers. Given the water depths and distance from the nearest mainland, it is unlikely recreational fishing would occur in the vicinity. Recreational fishing does occur within the EMBA and therefore could be impacted by a loss of well control.	-	N/A	<u>Unplanned</u> Unplanned hydrocarbon spills (**7.5**)
Defence	In consultation, Defence has advised no concerns with this proposed activity (**Section 4**).	-	N/A	N/A
Shipwrecks	Twelve shipwrecks are found within the EMBA.	-	N/A	<u>Unplanned</u> Unplanned hydrocarbon spills (**7.5**)
Oil and gas	Various petroleum exploration and production activities have been undertaken within the North West Shelf; however, there are none in the vicinity of the operational area. Outside of the operational area but within the permit area, the Pluto gas pipeline transects the southwest	-	N/A	<u>Unplanned</u> Unplanned hydrocarbon spills (**7.5**)

	corner (~5 km from the operational area). Vessels servicing oil and gas operations in the region may pass through the area en-route to facilities; however, since vessel transit is not classed as a petroleum activity, potential impacts to vessels are discussed under 'Shipping' above. Oil and gas facilities occur within the EMBA as do permits operated by other titleholders. As such, oil and gas activities could be impacted by unplanned events.			
Tourism	Owing to the water depths of the operational area, planned events are not predicted to have an impact on tourism. There are sources of marine-based tourism within the EMBA. Aquatic recreational activities such as boating, diving and fishing occur near the coast and Montebello Islands. These activities are concentrated in the vicinity of the population centres such as Exmouth, Dampier and Onslow. The EMBA encompasses the Montebello Islands Marine Park, Montebello Islands Sanctuary Zone and also the Barrow Island Marine Park and Marine Management Area; shoreline accumulation of oil may also occur within the Ningaloo Marine Park and Muiron Islands Marine Management Area (**Figure 3-5**) as such eco-tourism based on specific local values (game fish, nearshore reef snorkelling and diving) could be impacted by unplanned events.	-	N/A	Unplanned Unplanned hydrocarbon spills (**7.5**)
Cultural Heritage	No known sites of Aboriginal Heritage significance occur within the operational area or EMBA.	-	N/A	N/A

3.2.5.1 Commercial Fisheries

Offshore and coastal waters in the North-west Marine Region support a valuable and diverse commercial fishing industry. The major fisheries in the Pilbara region target tropical finfish, large pelagic fish, crustaceans (prawns and scampi) and pearl oysters (AEL, 2010; AFMA, 2018; DoF, 2012).

These North West Shelf region fisheries are managed either by the Department of Primary Industries and Regional Development (DPIRD) (State fisheries) with specific management plans, regulations and a variety of subsidiary regulatory instruments under the Fish Resources Management Act 1994 or by the Australian Fisheries Management Authority (AFMA), which manages Commonwealth fisheries (within the 200-nm Australian Fishing Zone).

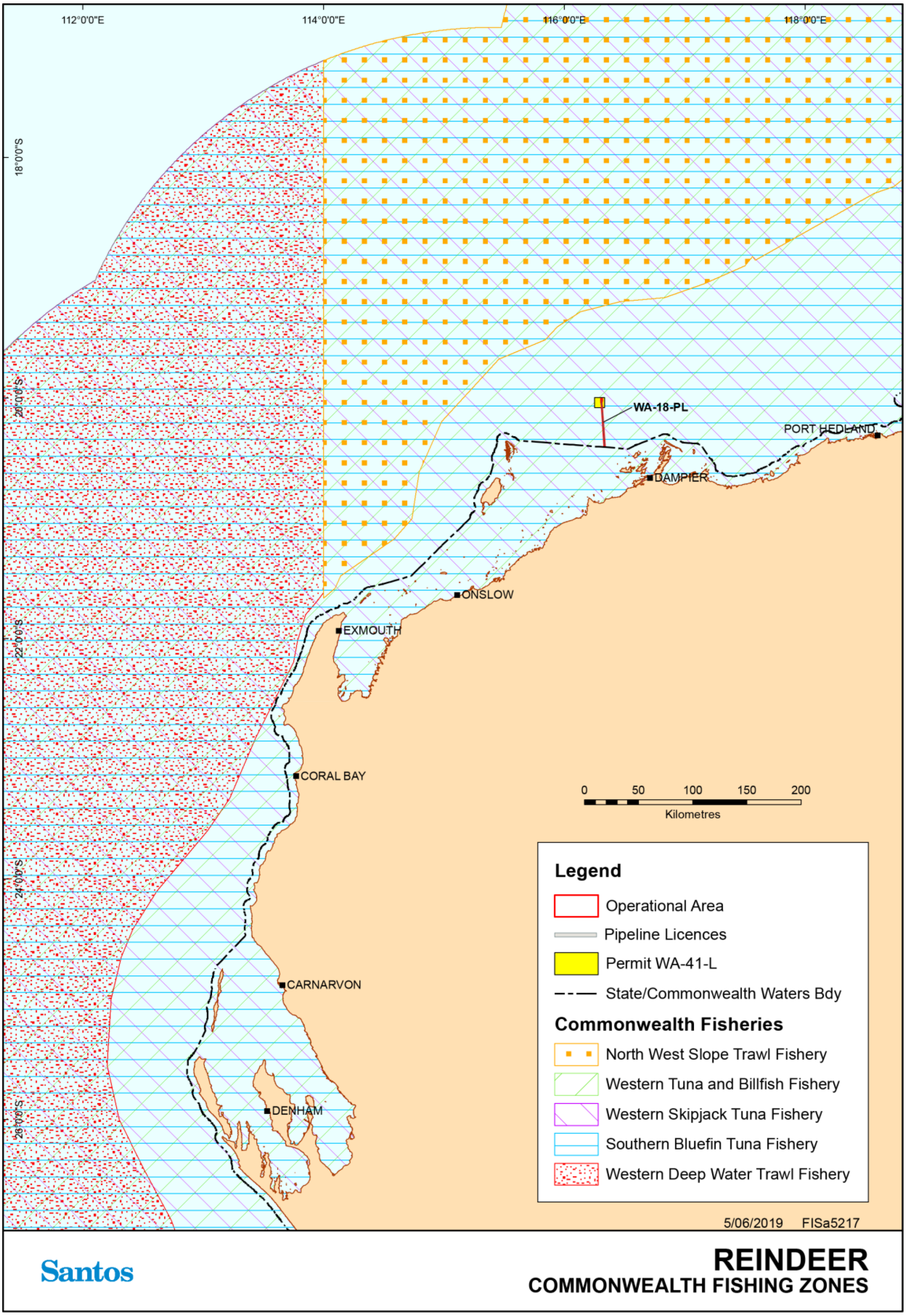

Figure 3-11: Commonwealth Fishing Zones within the EMBA

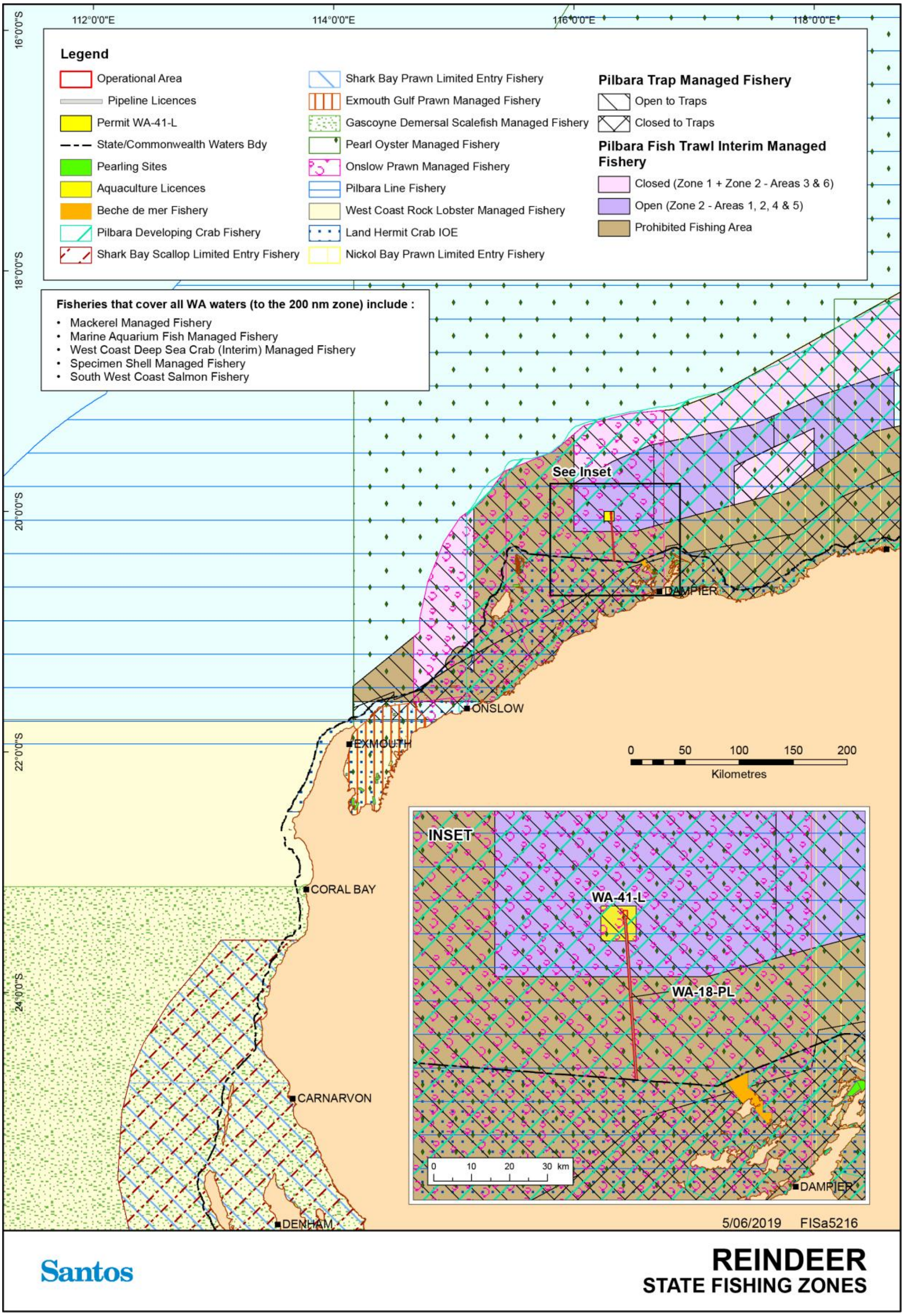

Figure 3-12: State Fishing Zones within the EMBA

Table 3-8: State and Commonwealth Fisheries in the Vicinity of the Operational Area and the EMBA

Value/Sensitivity	Description	Operational Area Presence	EMBA Presence	Relevant Events within the Operational Area and the EMBA
Commonwealth Managed Fisheries				
Southern Bluefin Tuna Fishery	Southern Bluefin Tuna Fishery is only active in waters offshore south and south-eastern Australia as confirmed in consultation with the Australia Southern Bluefin Tuna Association in consultation for previous company offshore activities, also illustrated in the ABARES Fishery Status Reports 2018.	✓	✓	No active commercial fishing within the operational area in the past years; however, fisheries overlap the EMBA, and therefore fishing vessels could be encountered in low density.
Western Tuna and Billfish Fishery	Extends westward from Cape York Peninsula (142°30' E) off Queensland to 34° S off the WA west coast. It also extends eastward from 34° S off the west coast of WA across the Great Australian Bight to 141° E at the South Australian–Victorian border. Since 2005, fewer than five vessels have been active in the Western Tuna and Billfish Fishery, down from 50 active vessels in 2000 (ABARES Fishery Status Reports 2018). Fishing activity in the Western Tuna and Billfish Fishery concentrates in West Australian waters South of Carnarvon, and off South Australia (ABARES Fishery Status Reports 2018).	✓	✓	
Western Skipjack Tuna Fishery	There has been no fishing effort in the Skipjack Tuna Fishery since the 2009 season, and in that season activity concentrated off South Australia (ABARES Fishery Status Report 2018).	✓	✓	
State Managed Fisheries (North Coast Bioregion)				
Pearl Oyster Managed Fishery	Mostly operates March to June.	✓	✓	Operational area does occur within the boundaries of the fishery, but fishery activity is

Value/Sensitivity	Description	Operational Area Presence	EMBA Presence	Relevant Events within the Operational Area and the EMBA
				restricted to shallow diving depths below 35 m.
Onslow Prawn Limited Entry Fishery (Area 3)	The boundaries of the Onslow Prawn Managed Fishery are 'all the Western Australian waters between the Exmouth Prawn Fishery and the Nickol Bay prawn fishery east of 114º39.9' on the landward side of the 200-m depth isobath. Prawn trawling activities focus on inshore areas between Onslow and Karratha.	✓	✓	As prawn trawling activities focus on inshore, shallow waters, planned events will not impact fishing activities; however, unplanned events may affect fishing activities in the inshore areas of the EMBA.
Mackerel Managed Fishery (Area 2)	Surface trolling or handline. Near-surface trolling gear from vessels in coastal areas around reefs, shoals and headlands.	✓	✓	The operational area for this activity does intersect the Mackerel Managed Fishery Area 2.
Pilbara Demersal Scalefish Fisheries – Pilbara Fish Trawl (Interim) Managed Fishery (Zone 2), Pilbara Crab Managed Fishery (Area A), the Pilbara Trap Managed Fishery and the Pilbara Line Managed Fishery	These fisheries use a combination of vessels, effort allocations (time), gear limits, plus spatial zones (including extensive trawl closures) as management measures. The trawl fishery lands the largest component of the catch of demersal finfish in the Pilbara (and North Coast Bioregion) comprising more than 50 scalefish species. In comparison, the trap fishery retains a subset of about 45 to 50 scalefish species; and while the line fishery catch comprises a similar number, it also includes some deeper offshore species.	✓	✓	The operational area for this activity does intersect line, trap and trawl fisheries.
State Managed Fisheries (Whole of State)				
Marine Aquarium Fish Fishery	The Marine Aquarium Fish Fishery license area extends into Commonwealth waters, spanning the coastline from the NT border to the SA border. Operators may fish year-round below the high tide water mark on the landward side of the 200-m isobath. The fishery is most active in waters from	✓	✓	Disruption to fishing activities will not occur within the operational area from planned events given the water depths these

Value/Sensitivity	Description	Operational Area Presence	EMBA Presence	Relevant Events within the Operational Area and the EMBA
	Esperance to Broome, with popular areas being around the Capes, Perth, Geraldton, Exmouth and Dampier. Harvest is primarily dive-based.			fisheries operate within; however, sites of the fishery within inshore areas of the EMBA may be affected by unplanned events.
Specimen Shell Managed Fishery	The Specimen Shell Managed Fishery spans the entire WA coastline, with efforts concentrated in areas adjacent to population centres such as Broome, Exmouth, Perth, Mandurah, the Capes area and Albany. The main harvesting methods are by hand by divers operating from small vessels in shallow coastal waters or by wading along coastal beaches below the high water mark.	✓	✓	
West Coast Deep Sea Crustacean Managed Fishery	This fishery extends seaward from the 150-m isobath, north of Augusta to the NT border, which is outside the operational area but within the EMBA. Catch effort is concentrated in areas south of Exmouth; therefore, it will not interact with planned and unplanned events for this activity.	✓	✓	Disruption to this fishery will not result from planned or unplanned events.
South West Coast Salmon Fishery	Although permitted to fish within the operational area and the EMBA, the fishery is biogeographically limited to the southwest coast.	✓	✓	
Abalone Managed Fishery (Areas 4 and 8)	The commercial fishery harvest method is a single diver working off a ‘hookah’ (surface-supplied breathing apparatus) using an abalone ‘iron’ to prise the shellfish off rocks.	✓	✓	Disruption is unlikely to occur in the operational area due to depths and method of collection. Unplanned events that may occur in the EMBA are also unlikely to disrupt fishing activities.

3.2.5.2 Shipping

The Reindeer facilities reside between two shipping fairways, located approximately 50 km to the east and west of the boundary of the WHP (AMSA 2012). There is also a shipping fairway approximately 25 km south of the Reindeer WHP which crosses the offshore gas pipeline (**Figure 3-12**). Additional shipping routes are located within the wider region and it is expected that local vessel traffic will pass through the area. Shipping fairways for the NWS, relative to the project location, are illustrated in **Figure 3-12.**

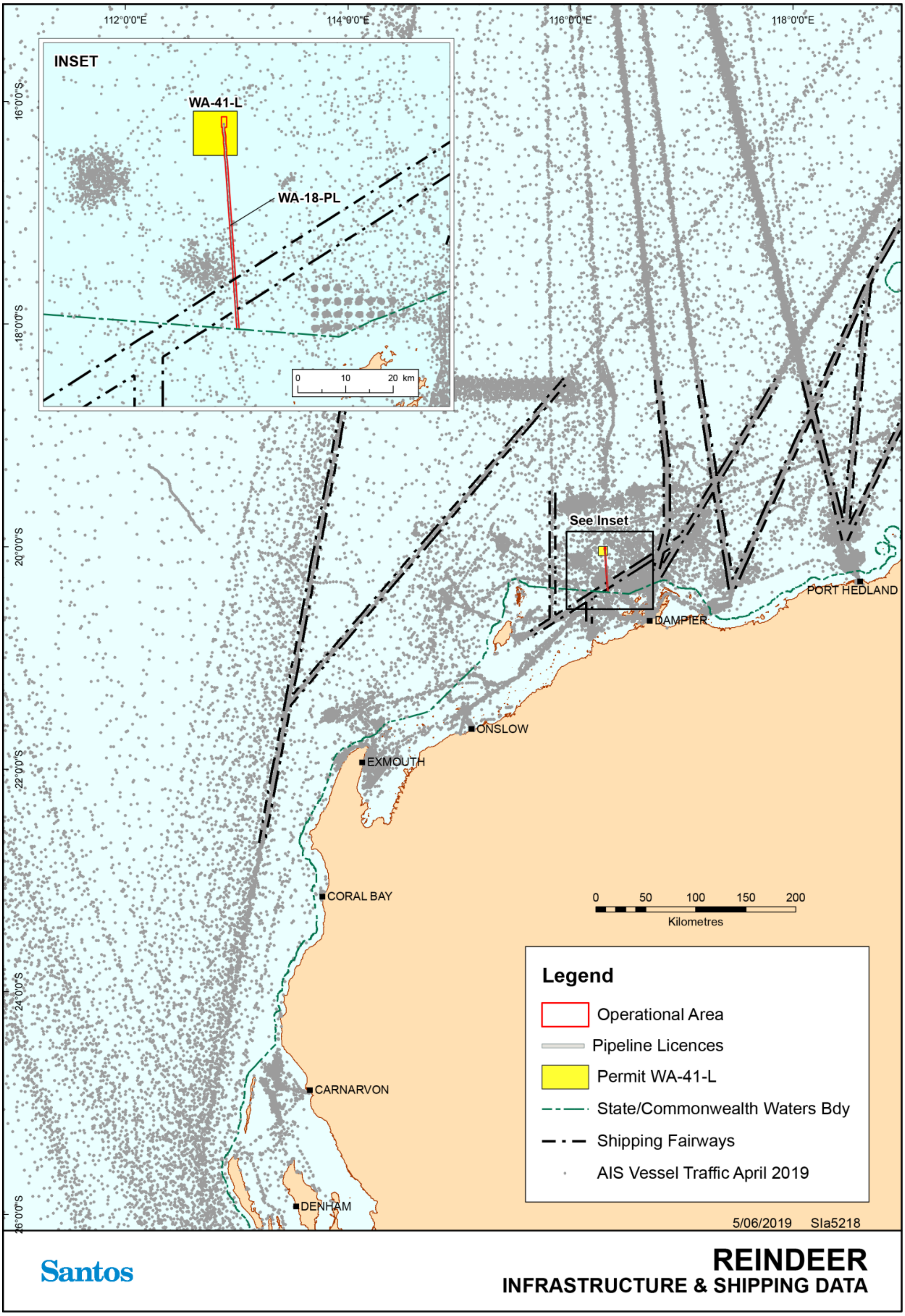

Figure 3-13: Shipping Traffic and AMSA Shipping Routes within the EMBA

3.2.6 Windows of Sensitivity

Timing of peak activity for threatened and migratory species and other relevant, significant sensitivities is given in **Table 3-9.**

Table 3-9: Windows of Sensitivity in the Vicinity of the EMBA

Categories	Receptors (Critical Life Cycle Stages)	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Physical Environment and Habitats	Non-coral benthic invertebrates												
	Coral (spawning periods)												
	Macroalgae	growing				shedding fronds				growing			
	Other benthic habitats												
Marine Fauna (incl. Threatened/ Migratory Species)	**Fish/ Sharks and Fisheries Species**												
	Whale sharks			Aggregations at Ningaloo Coast									
	Fisheries species spawning/aggregation times:[1]												
	Baldchin groper												
	Blacktip shark												
	Crystal crab												
	Goldband snapper												
	King George whiting												
	Pink snapper												
	Rankin cod												
	Red Emperor												
	Spangled Emperor												
	Sandbar shark												
	Spanish mackerel												

Categories	Receptors (Critical Life Cycle Stages)	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
	Marine Mammals												
	Dugong (breeding)	breeding								breeding			
	Humpback whale (migration)						northern			southern			
	Blue whale (migration)					northern						southern	
	Marine Reptiles												
	Hawksbill turtle (resident adult and juveniles[2])	Widespread throughout North West Shelf waters; highest density of adults and juveniles over hard bottom habitat (coral reef, rocky reef, pipelines etc.)											
	Hawksbill turtle (mating aggregations[2])												
	Hawksbill turtle (nesting and internesting[2])												
	Hawksbill turtle (hatching[1])												
	Flatback turtle (resident adult and juveniles[2])	Widespread throughout North West Shelf waters; increased density over soft bottom habitat 10 to 60 m deep; post hatchling age classes and juveniles spread across shelf waters											
	Flatback turtle (mating aggregations[2])												
	Flatback turtle (nesting and internesting[2])												
	Flatback turtle (hatching[2])												
	Flatback turtle (nesting[2])												
	Green turtle (resident adult and juveniles[2])	Widespread throughout the North West Shelf waters; highest density associated with seagrass beds and macroalgae communities; high density juveniles in shallow waters off beaches, among mangroves and in creeks											
	Green turtle (mating aggregations[2])												

Categories	Receptors (Critical Life Cycle Stages)	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
	Green turtle (nesting and internesting[2])												
	Green turtle (hatching[2])												
	Loggerhead turtle (resident adult and juveniles[2])	Widespread throughout the North West Shelf waters; increased density associated with soft bottom habitat supporting their bivalve food source; juveniles associated with nearshore reef habitat											
	Loggerhead turtle (mating aggregations[2])												
	Loggerhead turtle (nesting and internesting[2])												
	Loggerhead turtle (hatching[2])												
	Leatherback turtle	Can occur at low density across the North West Shelf year round											
	Short-nosed seasnake	Can occur at low density across the North West Shelf year round											
	Seabirds												
	Terns, shearwaters, petrels (nesting)												
	Commercial Managed Fisheries												
	Oil and Gas												
	Shipping												
	Tourism/Recreational	None applicable											

KEY / NOTES			
	(blue)	Peak activity, presence reliable and predictable.	[1] Information provided from Department of Fisheries consultation.
	(yellow)	Lower level of abundance/activity/presence.	[2] Information provided by K. Pendoley.

Categories	Receptors (Critical Life Cycle Stages)	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
	Very low activity/presence.												
	Activity can occur throughout the year.												
	Proposed timing of activity.												

4 Stakeholder Consultation

OPGGS(E)R 2009 Requirements
Regulation 9AB
If the Regulator's provisional decision under regulation 9AA is that the environment plan includes material apparently addressing all the provisions of Division 2.3 (Contents of an environment plan), the Regulator must publish on the Regulator's website as soon as practicable: (a) the plan with the sensitive information part removed; and (b) the name of the titleholder who submitted the plan; and (c) a description of the activity or stage of the activity to which the plan relates; and (d) the location of the activity; and (e) a link or other reference to the place where the accepted offshore project proposal (if any) is published; and (f) details of the titleholder's nominated liaison person for the activity. Note: If the plan is a seismic or exploratory drilling environment plan, the Regulator must also publish an invitation for public comment on the plan: see regulation 11B.
Regulation 16
The environment plan must contain the following: (a) a statement of the titleholder's corporate environmental policy; (b) a report on all consultations under regulation 11A of any relevant person by the titleholder, that contains: (i) a summary of each response made by a relevant person; and (ii) an assessment of the merits of any objection or claim about the adverse impact of each activity to which the environment plan relates; and (iii) a statement of the titleholder's response, or proposed response, if any, to each objection or claim; and (iv) a copy of the full text of any response by a relevant person; (c) details of all reportable incidents in relation to the proposed activity.

4.1 Summary

Stakeholders (**Table 4-1**) were provided a Reindeer WHP Operations Consultation Package via email in May 2019 to ensure they were aware the EP was being revised. In addition, Santos WA's wider stakeholder group is regularly updated on Santos WA's activities through Quarterly Consultation Update documents, which list the Reindeer WHP as a key operating facility for the company.

Outside of the regulatory approval process, Santos WA continuously engages with regional stakeholders to ensure they are informed of the company's operational, development and planning activities, and to seek input on issues of relevance and concern to them. Santos WA maintains relationships with community partners, focusing on Karratha and Exmouth, allowing the business to align community investments with the strategic objectives of the communities in which Santos WA operates. Other interested stakeholders are able to find information regarding the Reindeer operations on Santos' external website.

Santos WA considers that consultation with regulators and key stakeholders (further detailed in **Table 4-2**) has been adequate for activities covered under this EP. No stakeholder has objected to activities covered under this EP nor claimed that the environmental impacts or risks are unacceptable. Given the long-term presence of the Reindeer facilities, Santos WA anticipates all relevant stakeholders are familiar with the associated activities.

Consultation about development of Santos WA oil spill strategies and tactics is outlined in **Section 4.4**.

4.2 Stakeholder Identification

Santos WA maintains a comprehensive stakeholder list, with stakeholders identified through the following mechanisms:

+ Regular review of all legislation applicable to petroleum and marine activities;
+ Identification of marine user groups and interest groups active in the area (e.g., recreational and commercial fisheries, other oil and gas producers, and merchant shipping);
+ DPIRD fishing license holder database, sourced annually;
+ The Australian Government Guidance on Offshore Petroleum and Greenhouse Gas Activities Consultation;
+ Active participation in industry bodies (e.g., Australian Petroleum Production and Exploration Association and Australian Marine Oil Spill Centre); and
+ Records from previous consultation activities in the area.

Additionally ongoing consultation methods planned for the OPEP include:

+ Consultation conducted in accordance with regulatory guidelines;
+ Engagement with stakeholder (service providers and regulatory agencies) through Santos WA's spill response exercise, training and assurance activities;
+ Regular briefings and meetings as requested or required with stakeholders and two-way communication with stakeholders, including project briefings regarding all Santos WA projects.

In addition, new stakeholders who visit Santos's external facing website may contact the company via details provided online, and information about Santos WA's activities is published on the website for new stakeholders to review. The EP is also published in full on the NOPSEMA website upon submission, allowing stakeholders to review and comment.

For the activities undertaken under this EP, a standardised approach is applied to identify key stakeholders for the activity in question, beginning with a review of Santos WA's stakeholder list and of the stakeholders consulted over other recent activities in the area. In particular, the operational area for the activity (refer **Section 2.2**) is used to identify relevant persons and will be used throughout the duration of this EP.

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Table 4-1: Stakeholders Engaged With for Reindeer WHP Operations EP

Group	Stakeholder
Fishers and representative bodies	Australian Fisheries Management Authority (AFMA) Commonwealth Fisheries Association Recfishwest Western Australian Fishing Industry Council Marine Tourism WA
Marine conservation	Department of Primary Industries and Regional Development (DPIRD) Department of Biodiversity, Conservation and Attractions (DBCA)
Shipping safety and security	Australian Maritime Safety Authority (AMSA) Department of Defence Department of Transport (DoT) Pilbara Port Authority
Adjacent regulator	Department of Mines, Industry Regulation and Safety (DMIRS)
Commonwealth Government departments	Department of Agriculture and Water Resources – Biosecurity Department of Agriculture and Water Resources – Fisheries
Indigenous stakeholder groups	The Yaburara and Coastal Mardudhnuera Aboriginal Corporation (YACMAC)

4.3 Environment Plan Consultation

A high-level overview of the Reindeer WHP Operations EP, including activity summary, coordinates, location map and petroleum safety zone details were distributed to stakeholders in a detailed consultation package, via email in May and June 2019. This consultation package outlined potential risks and impacts, together with a summary of control measures proposed, to ensure stakeholders could adequately assess potential impacts to their activities.

No concerns with the activity were raised during this consultation period. Consultation material is summarised in **Table 4-2** and evidenced in **Appendix D**.

Full text responses and contact information for all stakeholder consultation undertaken is provided as a separate document to NOPSEMA in accordance with their policy guidance note N-04750-PL1347: Environment Plan Assessment.

Table 4-2: Consultation Summary for Activity

Stakeholder	Assessment of Consultation Undertaken
Fishers and Representative Bodies – fishers identified by Santos WA as potentially being active in the area and/or their representative bodies.	
Australian Fisheries Management Authority (AMFA)	This stakeholder was provided the Reindeer WHP Operations Consultation Package by email on 23 May 2019 and receives all Santos WA's Quarterly Consultation Update documents. No response regarding the activity has been received to date. No action arising from this consultation for this EP.

Stakeholder	Assessment of Consultation Undertaken
Commonwealth Fisheries Association	This stakeholder was provided the Reindeer WHP Operations Consultation Package by email on 23 May 2019 and receives all Santos WA's *Quarterly Consultation Update* documents. No response regarding the activity has been received to date. No action arising from this consultation for this EP.
Recfishwest	This stakeholder was provided the Reindeer WHP Operations Consultation Package by email on 23 May 2019 and receives all Santos WA's Quarterly Consultation Update documents. No response regarding the activity has been received to date. No action arising from this consultation for this EP.
Western Australian Fishing Industry Council (WAFIC)	This stakeholder was provided the Reindeer WHP Operations Consultation Package by email on 12 June 2019 and receives all Santos WA's *Quarterly Consultation Update* documents. Below is a summary of the stakeholder comments received on 28 June 2019 and Santos' response of 4 July 2019: + General feedback on content of Consultation Pack *Santos to meet with WAFIC to discuss improvements to the presentation of material in the consultation packs and Quarterly Consultation Updates.* + Fisheries consulted as part of this EP *In the revision of these EPs, Santos has consulted with the relevant peak fishery bodies, including WAFIC and Recfishwest. Santos is currently in the process of reviewing and updating its FishCube data to identify any individual commercial fishers who fish in the affected areas, and commit to ongoing consultation with these fishers as required. Santos welcomes WAFIC input on relevant commercial fishers to include in this ongoing consultation.* + Santos' communications strategy to ensure staff, contractors and sub-contractors are aware of the difference between exclusion zones and cautionary zones, noting the Reindeer WHP is located in a pre-existing 500 metre radius exclusion zone with a 2.5nm cautionary zone. *A designated platform Person in Charge (PIC) is present on the WHP whenever works are occurring and is responsible for the activity. This dedicated role is staffed by personnel who have a full understanding of rules and regulations regarding access and is clear on the difference between cautionary zones and PSZ.* + Acknowledgment that WAFIC appreciates there is no exclusion zone for Reindeer-1 (which is temporarily abandoned), as this provides a potential fish aggregation site; *Acknowledged.* + Santos' communication policy with all staff and vessel crew, contractors and sub-contractors regarding interacting and protecting the rights of active commercial fishers on the water; *Santos WA contracts reputable and experienced vessel contractors to undertake its offshore vessel based activities. These operators meet all of the relevant maritime legislation requirements and responsibly manage*

Stakeholder	Assessment of Consultation Undertaken
	their interactions with other marine users, including commercial fishers, when undertaking activities. + A request that the Table referring to interactions with other marine users also include reference to commercial fishing activities. *The Table appearing on page three of the Consultation Pack does not appear in the final EP and is used for consultation purposes only. However Santos will revise this Table in future consultation packs to ensure it also includes reference to commercial fishing activities.* + Santos confirm that the *"No fishing from support/commercial vessels"* policy is abided by all at operator / proponent level and also strictly enforced and communicated with contractors and subcontractors? What is Santos's audit / compliance policy / process regarding recreational fishing on support/commercial vessels? *There is no change to Santos WA's policy on fishing from support vessels. All vessel contractors are required to acknowledge and sign a statement of conformance which includes the requirement for no fishing from vessels. This is undertaken both pre-mobilisation and post-mobilisation to confirm adherence to Santos requirements.* WAFIC responded on 4 July 2019 thanking Santos for addressing points raised by WAFIC and requesting Santos update them once the FishCube data has been revised. Santos WA commits to ongoing consultation with WAFIC for all offshore activities which may impact fishers.
Marine Tourism WA	This stakeholder was provided the Reindeer WHP Operations Consultation Package by email on 4 July 2019 and receives all Santos WA's *Quarterly Consultation Update* documents. No response regarding the activity has been received to date. No action arising from this consultation for this EP.
Marine Conservation – relevant government departments	
Department of Primary Industry and Regional Development (DPIRD) (Fisheries)	This stakeholder was provided the Reindeer WHP Operations Consultation Package by email on 23 May 2019, and receives all Santos WA's *Quarterly Consultation Update* documents. Below is a summary of the stakeholder comments received on 20 June 2019 and Santos' response of 4 July 2019. + Santos consults relevant representative bodies as appropriate to the proposed activities, and with individual commercial fishers and charter operators who fish in the affected area. *In the revision of these EPs, Santos has consulted with the relevant peak fishery bodies, charter operators and Traditional Owner groups, and commits to ongoing consultation with these groups as well as individual commercial fishers and charter operators who fish in the affected areas. Santos is currently reviewing and updating its FishCube data to verify individual commercial fishers who fish in the affected areas, and commits to ongoing consultation with these fishers as required*.

Stakeholder	Assessment of Consultation Undertaken
	+ Certain actions for inclusion in the Oil Pollution Emergency Plan (OPEP). *A summary of Santos' OPEP consultation for this EP is contained in **Section 4.4.*** Santos commits to ongoing consultation with DPIRD on these matters, as required.
Department of Biodiversity, Conservation and Attractions (DBCA)	This stakeholder was provided the Reindeer WHP Operations Consultation Package by email on 14 May 2019 and receives all Santos WA's *Quarterly Consultation Update* documents. This stakeholder responded on 27 June 2019 advising the department had no comments to make at this stage of the plan. No action arising from this consultation for this EP
Shipping Safety and Security – stakeholders who provide information on shipping and vessel traffic or may be involved in a response to an unplanned event.	
Australian Maritime Safety Authority (AMSA)	This stakeholder was provided the Reindeer WHP Operations Consultation Package by email on 23 May 2019, and receives all Santos WA's *Quarterly Consultation Update* documents. The stakeholder responded on 30 May 2019 advising: + The Master to notify AMSA's JRCC at least 24-48 hrs before operations commence; + Contact AHO no less than 4 working weeks before operations. Santos's response of 4 July 2019 proposes that as this is an operations EP it pertains to ongoing activities at the wellhead platform within the PSZ and along the pipeline. This infrastructure is already marked on nautical charts and therefore the Notice to Mariners and Radio Navigation Warnings are not required prior to activities commencing. Activities occur on approximately a weekly basis using vessels that adhere to maritime legislation. AMSA responded on 9 July, advising the proposed approach is appropriate, and if there is any deviation from the normal activities then Santos WA is to follow the steps provided in AMSA's original response. Santos commits to ongoing consultation with AMSA as required.
Department of Defence	This stakeholder was provided the Reindeer WHP Operations Consultation Package by email on 23 May 2019, and receives all Santos WA's *Quarterly Consultation Update* documents. No response regarding the activity has been received to date. No action arising from this consultation for this EP.
Department of Transport (DoT)	This stakeholder was provided the Reindeer WHP Operations Consultation Package by email on 23 May 2019, and receives all Santos WA's *Quarterly Consultation Update* documents. Consultation with DoT regarding spill response arrangements and the OPEP for the activity is provided in **Section 4.4**. Santos commits to ongoing consultation, as required, with DoT.
Pilbara Port Authority	This stakeholder was provided the Reindeer WHP Operations Consultation Package by email on 23 May 2019, and receives all Santos WA's *Quarterly Consultation Update* documents.

Stakeholder	Assessment of Consultation Undertaken
	No response regarding the activity has been received to date. No action has arisen from the consultation process for this EP.
Adjacent Regulators	
State Department of Mines, Industry Regulation and Safety (DMIRS)	This stakeholder was provided the Reindeer WHP Operations Consultation Package by email on 23 May 2019, and receive all Santos WA's *Quarterly Consultation Update* documents. This stakeholder responded on 27 June 2019 advising no further information was required. No action arising from this consultation for this EP.
Commonwealth Government Departments	
Department of Agriculture and Water Resources – Biosecurity	This stakeholder was provided the Reindeer WHP Operations Consultation Package by email on 23 May 2019. The stakeholder responded on 28 May 2019 advising of changes to the DAWR regulatory framework that may impact the EP. These changes relate to offshore installation biosecurity guidelines. Santos responded on 4 July 2019 advising Santos is working through the information provided and would welcome the opportunity to meet with DAWR. A meeting is scheduled for August 2019. Santos commits to ongoing discussions with DAWR as required to ensure compliance with relevant legislation.
Department of Agriculture and Water Resources – Fisheries	This stakeholder was provided the Reindeer WHP Operations Consultation Package by email on 23 May 2019. No response regarding the activity has been received to date. No action arising from this consultation for this EP.
Indigenous stakeholder groups	
The Yaburara and Coastal Mardudhnuera Aboriginal Corporation (YACMAC)	This stakeholder was provided the Reindeer WHP Operations Consultation Package by email on 4 July 2019. No response regarding the activity has been received to date. No action arising from this consultation for this EP.

4.4 OPEP Consultation

In preparing the Devil Creek Pipeline and Reindeer Well Head Platform Oil Pollution Emergency Plan (EA-14-RI-10007.02), a number of external relevant parties were identified which would be engaged in a spill response either as a service provide or a relevant regulatory authority. These stakeholders were originally identified through evaluation of the activity and spill potential, with arrangements continually reviewed through Santos WA spill preparedness activities.

Where required, specific agreements or contracts have been put into place with agencies and organisations so that roles, responsibilities and service requirements are understood. However, some services provided by organisations nominated in this OPEP are business as usual services (for example helicopter and vessel support) that support Santos' ongoing offshore activities.

Stakeholders providing a regulatory function or support service in a spill response for Devil Creek Pipeline and Reindeer WHP operations are outlined in **Table 4-3**. These stakeholders are relevant to spill response arrangements supporting other Santos WA activities, including other operations which, like Devil Creek Pipeline and Reindeer WHP operations, are continual throughout the year. For that reason engagement with these stakeholders is continual and is largely achieved through Santos WA's ongoing spill response testing, exercising and assurance activities as detailed in **Section 8.8.** However, where noted in **Table 4-3**, consultation specific to the revision of this document has been undertaken.

Santos WA seeks to establish and maintain two-way lines of communication between itself and all potential relevant persons throughout the life of all activities across the North West Shelf. Consultation is continuous and ongoing so as to maintain best practice in the field of oil spill response. The OPEP will continue to be reviewed, and updated as required, in light of any identified improvement opportunities or changes in a stakeholder's position.

Table 4-3: OPEP Stakeholder Consultation Summary

Engaged With		Assessment of Consultation Undertaken
Function	**Stakeholder**	
Australian Marine Oil Spill Centre (AMOSC)		Historically, AMOSC reviewed oil spill contingency plans and OPEPs and has been satisfied with the description of their support. AMOSC now requests to only view OPEPs once they are accepted by the regulator and before the activity commences. Roles and responsibilities defined in the OPEP reflect the arrangements established under contract conditions as a Participating Member of AMOSC under the AMOSPlan, a cooperative arrangement for response to oil spills by Australian oil and associated industries. Continuous consultation with AMOSC occurs through the implementation of Santos WA's exercise and training program and through industry engagement events throughout the year, including AMOSC member forums.
Oil Spill Response Limited (OSRL)		OSRL operates under contract conditions with Santos. All arrangements defined in the OPEP nominating OSRL reflect contracted services. Continuous consultation with OSRL occurs through the implementation of Santos WA's exercise and training program and through industry engagement events throughout the year.
Australian Marine Safety Authority (AMSA)		Historically, AMSA reviewed OPEPs and has been satisfied with the description of their support. AMSA now requests to only view OPEPs once they are accepted by the regulator and before the activity commences. Roles and responsibilities defined in the OPEP reflect the arrangements established in a memorandum of understanding between AMSA and Santos WA.
Logistics providers		Santos WA maintains local logistics and global freight forwarding service under contract conditions. All arrangements defined in the OPEP reflecting freight forwarding services reflect contracted services. These services are business as usual services, however arrangements specific to supporting spill response are tested and exercised as part of Santos WA training and exercise schedule.
Vessel providers		Vessel providers operate under contract conditions to provide day to day services to Santos WA's offshore operations. These arrangements will be used to support spill response

Engaged With		Assessment of Consultation Undertaken
Function	**Stakeholder**	
		activities included in this OPEP. Specific engagement, training and testing related to spill response operations is included in Santos WA training and exercise schedule.
Aircraft providers		Aircraft providers operate under contract conditions to provide day to day services to Santos WA's offshore operations. These arrangements will be used to support spill response activities included in this OPEP. Specific engagement, training and testing related to spill response operations is included in Santos WA training and exercise schedule.
Department of Water and Environmental Regulation (DWER), Waste Management Division		The DWER Waste Management Division, has reviewed and has had input into defining the Waste Management Plan contained in Santos WA oil spill contingency plans or OPEPs. The waste management processes do not change between OPEPs, so the original consultation is sufficient for the OPEP.
Department of Biodiversity, Conservation and Attractions (DBCA)		DBCA contributed to development of the WA Oiled Wildlife Response Plan defined in the OPEP. Descriptions of the Santos WA interface with the WA Oiled Wildlife Response Plan contained within the OPEP are consistent with the intent of DBCA (and AMOSC) for oiled wildlife response. No further consultation is required. Santos WA invited DBCA to comment on its Devil Creek Pipeline and Reindeer WHP OPEP, including its scientific monitoring plan on 4 July 2019. At the time of submission Santos WA has not received a response however will continue to consult with DBCA as required.
Department of Transport (Hazard Management Authority) (DoT)		All roles and responsibilities defined in the OPEP for DoT reflect the arrangements for the Westplan – Marine Oil Pollution (MOP) as further defined by the DoT Offshore Petroleum Industry Guidance Note, Marine Oil Pollution: Response and Consultation Arrangements (DoT, 2018). Santos WA provided a consultation package to DoT on the Devil Creek Pipeline and Reindeer Platform EP on 23 May 2019. DoT, in their response dated 4 June 2019, requested that if there have been any changes to the corresponding OPEP, or change to spill risk, that they be consulted with in accordance with the DoT Offshore Petroleum Industry Guidance Note, Marine Oil Pollution: Response and Consultation Arrangements (DoT, 2018). Santos responded on 4 July 2018 advising that it did not believe there have been any significant changes to the spill response strategies and spill risks since the last revision of the OPEP provided to DoT. However, offered that a copy of the revised OPEP be provided to DoT prior to submission to NOPSEMA.

Engaged With		Assessment of Consultation Undertaken
Function	**Stakeholder**	
		DoT replied on 5 July 2019 and advised that as long as the OPEP aligns with the DoT Offshore Petroleum Industry Guidance Note, Marine Oil Pollution: Response and Consultation Arrangements (DoT, 2018) they are happy with this approach.
Department of Primary Industries and Regional Development – Fisheries (DPIRD Fisheries)		Santos WA provided a consultation package to DPIRD Fisheries on the Devil Creek Pipeline and Reindeer Platform EP on 23 May 2019. In their reply dated 20 June 2019 DPIRD advised of certain actions that it expects Santos WA to undertake in the event of an oil spill. This included notifications to DPIRD, collection and maintenance of marine baseline data and consideration of strategies to mitigate risk to fish spawning grounds and nurseries. On 4 July 2019, Santos WA advised DPIRD that it had included DPIRD notification details in the OPEP and that the OPEP details processes and strategies that would mitigate and monitor impacts to fish spawning grounds and nurseries in the event of a spill.
Spill modelling provider		A spill modelling provider operates under specific contract conditions with Santos WA to provide forecast spill modelling. All arrangements defined in the OPEP nominating spill modelling reflect contracted services. Engagement and testing of this service is included in Santos WA training and exercise schedule.
Waste contractor		A waste service provider operates specific contract conditions with Santos WA for oil spill response waste service provision. All arrangements defined in the OPEP nominating waste services reflect contracted services. Engagement and testing of this service is included in Santos WA training and exercise schedule.
Emergency response services	Local emergency management committee (Karratha)	Devil Creek Person in Charge participates as a member of the Karratha Emergency Management Committee and through this forum maintains communications with committee stakeholders in relation to incident or emergency response requirements at DC and Reindeer facilities.

4.5 Ongoing Consultation

Santos WA provides relevant stakeholders with ongoing consultation for regulatory purposes and to ensure community stakeholders are engaged and informed of Santo WAs' activities in the region. Santos WA will work with stakeholders to address any future concerns if they arise throughout the duration of this EP. Should any new stakeholders be identified throughout the lifecycle of the asset through methods outlined in **Section 4.2**, they will be added to Santos WA's stakeholder list and included in all future correspondence as required, including any specific activity notifications and quarterly updates.

4.5.1 Stakeholder Notifications

Stakeholders will be notified of any activities relating to the Reindeer facilities that may impact upon their interests. These activities may include maintenance or ongoing monitoring activities and may include temporarily increased vessel activity. Notifications will be provided to relevant stakeholders when required only, to combat stakeholder fatigue; and while Santos WA does not expect concerns to be raised regarding activities at the Reindeer facilities, if additional comments do arise, Santos WA will allow an appropriate amount of time to respond and address these comments.

4.5.2 Quarterly Consultation Update

Santos WA distributes the Quarterly Consultation Update, a high-level, summary document, by email quarterly in approximately March, June, September and December. The purpose of this document is to give an overview of Santos WA's current and proposed activities and to encourage stakeholders to contact Santos WA if they wish to receive more information regarding a particular activity.

The Reindeer facilities are listed in all Santos WA Quarterly Consultation Updates. Any planned activities relating to the Reindeer facilities that may be of interest to stakeholders will be included in a brief operational update in the document.

If stakeholders request additional information or raise concerns on any activity listed in a Quarterly Consultation Update, a dialogue with these stakeholders can continue during or after the preparation of an EP and will be recorded for future reference. Santos WA commits to respond and address any comments and to keep any consultation on file during and after acceptance of an EP. Examples of Quarterly Consultation Update documents are evidenced in **Appendix D**.

4.6 Addressing Consultation Feedback

Santos WA's Consultation Coordinator is available before, during and after the activity to ensure opportunities for stakeholders to provide feedback are available. Consultation material is provided to relevant internal activity personnel to ensure the Santos WA business has a thorough understanding of how the activity is being received by relevant persons.

If as a result of stakeholder consultation a change to any control measure or activity outlined in this EP is required, Santos WA would undertake an internal assessment using the management of change (MoC) process (**Section 8.11.2**).

4.6.1 Environmental Performance Standards and Outcomes

Control measures, environmental performance outcomes and measurement criteria for stakeholder consultation are provided in **Table 8-3**.

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5 Environmental Impact and Risk Assessment

Environmental impact and risk assessment refers to a process whereby planned and unplanned events that may or will occur during an activity are quantitatively and/or qualitatively assessed for their impacts on the environment (physical, biological, and socio-economic) at a defined location and specified period of time. In addition, unplanned events are assessed based on their likelihood of occurrence, which contributes to their level of risk.

Santos WA has undertaken environmental impact and risk assessments for the operational activities' planned events (including any routine, non-routine and contingency activities) and unplanned events in accordance with the OPGGS(E)R 2009.

Provided in this section of the EP is the following information relating to the environmental impact and risk assessment approach:

+ Terminology used; and
+ Summary of the approach.

A full description of the process applied in identifying, analysing and evaluating the impacts and risks relating to the planned activity is documented in the company's Environmental Hazard Identification and Assessment Procedure (EA-91-IG-00004).

5.1 Impact and Risk Assessment Terminology

Common terms applied during the impact and risk assessment process and used in this EP are defined in **Table 5-1**. For a more comprehensive listing of the terms and definitions used in environmental impact and risk assessment, refer to Santos WA's Environmental Hazard Identification and Assessment Procedure (EA-91-IG-00004).

Table 5-1: Impact and Risk Assessment Terms and Definitions

Term	Definition
Acceptability	Determined for both impacts and risks. Acceptability of a planned impact is in part determined by the severity (consequence) of the impact after control measures have been implemented. Acceptability of an unplanned impact is in part determined by its risk ranking after control measures have been implemented. For both impacts and risks, acceptability is also determined by a demonstration of the ALARP principle (see next table row), consistency with the Santos WA's Environmental Management Policy (**Appendix A**), consistency with all applicable legislation, and consideration of relevant stakeholder consultation when determining control measures.
ALARP principle	The ALARP principle is that the residual impacts and risk shall be 'as low as reasonably practicable'. It has particular connotations as a route to reduce risks when considering law, regulation and standards. For an impact or risk to be ALARP, it must be possible to demonstrate that the sacrifices (cost and effort) involved in reducing the impact or risk further would be grossly disproportionate to the environmental benefit gained. The ALARP principle arises from the fact that infinite time, effort and money could be spent on the attempt to reduce a risk to zero. It should not be understood as simply a quantitative measure of benefit against detriment. It is more a best common practice of judgement of the balance of impact or risk and societal benefit.
EMBA	Environment that may be affected by planned or unplanned events.

Term	Definition
Receptor	A feature of the environment that may have environmental, social and/ or economic values.
Planned activity	The activity to be undertaken under an environmental plan or oil pollution emergency plan, including the services, equipment, products, assets, personnel, timing, duration and location.
Planned event	An attribute of the planned activity that results in some level of environmental impact and will occur continuously or frequently throughout the duration of the planned activity.
Non-routine planned event	An attribute of the planned activity that results in some level of environmental impact and may occur or will occur infrequently during the planned activity.
Unplanned event	An event that results in some level of environmental impact and may occur despite preventive safeguards in place. An unplanned event is not intended to occur during the activity.
Environmental impact	Any change to the environment, whether adverse or beneficial, wholly or partly resulting from the planned activity.
Environmental consequence	The severity of an impact in terms of its adverse or beneficial effects on the environment.
Likelihood of impact	Probability of an impact occurring (used for risk assessment only).
Environmental risk	Applies to unplanned events. Risk is a function of the likelihood of the impact from an unplanned event occurring and the severity (consequence) of that impact.
Grossly disproportionate	Where the sacrifice (cost and effort) of implementing a control measure to reduce impact or risk grossly exceeds the environmental benefit to be gained.

5.2 Summary of the Environmental Impact and Risk Assessment Approach

5.2.1 Overview

Santos WA operates under an overarching Risk Management Policy (QE-91-IF-10050). The company Risk Management Framework (QE-91-IF-10051) underpins the Risk Management Policy and is consistent with the requirements of AS/NZS ISO 31000:2018, Risk Management – Guidelines (ISO, 2018).

The key steps to risk management are illustrated in **Figure 5-1**.

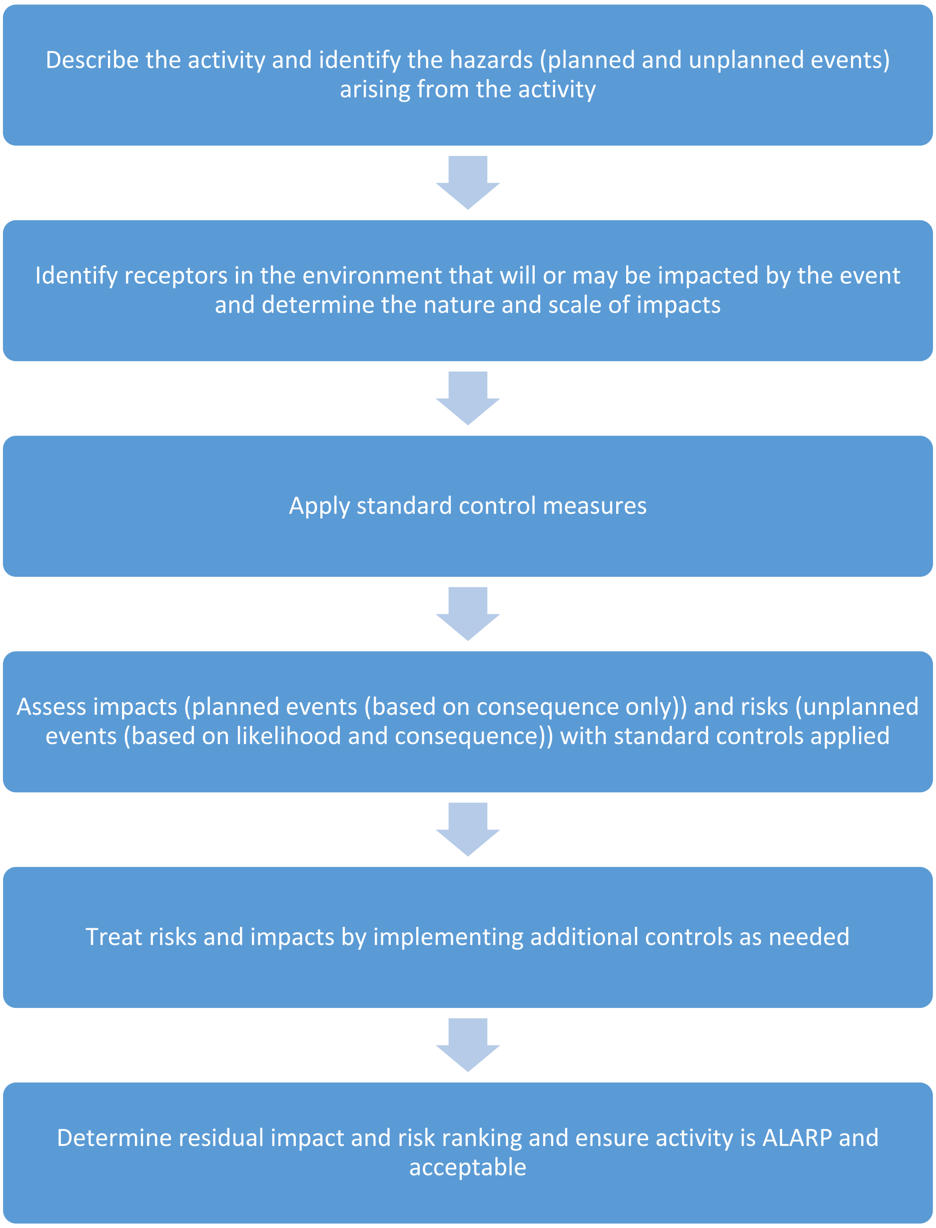

Figure 5-1: Environmental Impact and Risk Assessment Process

Santos WA's Environmental Hazard Identification and Assessment Procedure (EA-91-IG-00004) includes consideration of the following key areas in an impact and risk assessment:

- Description of the activity (including location and timing);
- Description of the environment (potentially affected by both planned and unplanned events);
- Identification of relevant persons;
- Identification of legal requirements ('legislative controls') that apply to the activity;
- Santos WA's Environmental Management Policy and standards;
- Principles of ecologically sustainable development; and
- Company-defined acceptable levels of impact and risk.

These factors were considered in three environmental impact and risk assessment workshops held on 4 April 2019, 9 April 2019 and 10 April 2019 covering both the Reindeer and Devil Creek facilities. The risk workshops involved participants from Santos WA as well as specialist environmental consultants with knowledge of the proposed activity, existing environment and the activity.

The workshop actions are distributed to relevant personnel, and there is continual liaison with the business units to refine activity description and consequence assessments and to determine suitable control measures.

5.2.2 Describe the Activity and Associated Planned and Unplanned Events

The petroleum activity is described in **Section 1.3** of this plan. An assessment against the activity was undertaken, and the planned and unplanned events were identified. The outcome of this assessment is detailed in the relevant subsections of **Sections 6** and **7**.

5.2.3 Determine the Nature and Scale of Impacts and Identify Receptors that Have the Potential to be Impacted

The extent of actual or potential impacts from each planned or unplanned event is assessed using, where required, modelling (e.g., hydrocarbon spills) and scientific reports. The duration of the event is also described, including the potential duration of any impacts should they occur. Receptors identified as potentially occurring within an impacted area or areas are detailed in **Section 3**.

5.2.4 Describe the Control Measures, Environmental Performance Outcomes, Standards, and Measurement Criteria

For each planned and unplanned event, a set of control measures, environmental performance outcomes, environmental performance standards and measurement criteria is identified. The definitions of these terms are consistent with the OPGGS(E)R 2009.

5.2.5 Determine the Impact Consequence Level and Risk Rankings (on the basis that all control measures have been implemented)

This step looks at the causal effect between the event and the identified receptor. Impact mechanisms and any thresholds for impacts are determined and described, using scientific literature and modelling where required. Impact thresholds for different critical life stages are also identified where relevant.

The consequence level of the impact is then determined for each planned and unplanned event based on the severity of the impact to relevant receptors in the following categories:

+ Threatened, migratory, or local fauna;
+ Physical environment or habitat;
+ Threatened ecological communities;
+ Protected areas; and
+ Socio-economic receptors.

The level of information required to determine the impact or risk assessment depends on the nature and scale of the impact or risk. This process determines a consequence level based on set criteria for each receptor category and takes into consideration the duration and extent of the impact, receptor recovery time and the effect of the impact at a population, ecosystem or industry level. Impacts to social and economic values are also considered based on existing knowledge and feedback from stakeholder consultation. As the result of historic consultation with stakeholders, the social and economic values in the region that are of interest are evident.

A description of the consequence levels is provided in **Table 5-2**.

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Table 5-2: Consequence Level Description

Consequence Level		Consequence Level Description
A	Negligible	No impact or negligible impact. Environmental impact lasting days up to 1 week.
B	Minor	Detectable but insignificant change to local population, industry or ecosystem factors. Environmental impact lasting weeks up to 12 months.
C	Moderate	Significant impact to local population, industry or ecosystem factors. Environmental impact lasting 1 to 10 years.
D	Major	Major long-term effect on local population, industry or ecosystem factors. Environmental impact lasting 10 to 20 years.
E	Critical	Complete loss of local population, industry or ecosystem factors AND/ OR major widespread regional impacts with slow recovery to no full recovery. Environmental impact lasting more than 20 years to no recovery.

Note: Injury or mortality to a protected species is included as a moderate consequence level (refer to **Appendix E**).

For unplanned events, in addition to the consequence level of the impact, a risk ranking is also determined using an assessment of the likelihood (likelihood ranking) of the impact occurring from an unplanned event. For oil spill events, potential impacts to environmental receptors are assessed where they occur within the EMBA using results from modelling. The risk matrix is provided in **Figure 5-3**.

Table 5-3: Likelihood Description

No.	Matrix	Description
5	Probable	1. Event has occurred frequently within the Company. 2. Between 1 and 10 incidents every 10 years (i.e., up to a frequency of 1/year).
4	Likely	1. Event has occurred frequently within the Industry. 2. Between 1 and 10 incidents every 100 years (i.e., up to a frequency of 10^{-1}/year).
3	Unlikely	1. Event has occurred occasionally within the Company. 2. Between 1 and 10 incidents every 1,000 years (i.e., up to a frequency of 10^{-2}/year).
2	Very Unlikely	1. Event has occasionally occurred within the Industry. 2. Between 1 and 10 incidents every 10,000 years (i.e., up to a frequency of 10^{-3}/year).
1	Rare	1. Event could happen under exceptional circumstances only. 2. Between 1 and 10 incidents every 100,000 years (i.e., up to a frequency of 10^{-4}/year).

		Consequence				
		Negligible	Minor	Moderate	Major	Critical
		A	B	C	D	E
Likelihood	5. Probable					
	4. Likely					
	3. Unlikely					
	2. Very Unlikely					
	1. Rare					

Key:

High Risk	Reduction of risk required
Medium Risk	Reduction of risk required based on ALARP principle
Low Risk	Deemed acceptable based on standard risk controls in place

Figure 5-2: Santos WA's Risk Matrix

5.2.6 Evaluate Whether Impacts and Risks are ALARP

For planned and unplanned events, an ALARP assessment is undertaken to demonstrate that the standard control measures adopted reduce the impact (consequence level) or risk to as low as reasonably practicable (ALARP). This process relies on demonstrating that further potential control measures would require a disproportionate level of cost or effort to reduce the level of impact or risk. If this cannot be demonstrated, then further control measures are adopted. The level of detail included in the ALARP assessment is based on the nature and scale of the potential impact or risk. For example, more detail is required for a risk ranked as Medium compared to a risk ranked as Low.

5.2.7 Evaluate Impact and Risk Acceptability

Santos WA considers an impact or risk associated with the proposed activity to be acceptable if the following criteria are met:

+ The consequence of a planned event is ranked as A or B; or a risk of impact from an unplanned event is ranked Low to Medium;
+ An assessment has been completed to determine whether further information or studies are required to support or validate the consequence assessment;
+ Assessment and management of risks have addressed the principles of ecologically sustainable development;
+ That the acceptable levels of impact and risks have been informed by relevant species recovery plans, threat abatement plans and conservation advice can be demonstrated;
+ Performance standards are consistent with legal and regulatory requirements;
+ Performance standards are consistent with the Santos WA's Environmental Management Policy;

- Performance standards are consistent with industry standards and best practice guidance (e.g., National Biofouling Management Guidelines for the Petroleum Production and Exploration Industry (Marine Pest Sectoral Committee, 2018));
- Performance outcomes and standards are consistent with stakeholder expectations; and
- Performance standards have been demonstrated to reduce the impact or risk to ALARP.

6 Environmental Assessment for Planned Events

OPGGS(E)R 2009 Requirements
Regulation 13(5)
The environment plan must include: (a) details of the environmental impacts and risks for the activity; and (b) an evaluation of all the impacts and risks, appropriate to the nature and scale of each impact or risk; and (c) details of the control measures that will be used to reduce the impacts and risks of the activity to as low as reasonably practicable and an acceptable level.
Regulation 13(6)
To avoid doubt, the evaluation mentioned in paragraph (5)(b) must evaluate all the environmental impacts and risks arising directly or indirectly from: (a) all operations of the activity; and (b) potential emergency conditions, whether resulting from accident or any other reason.
Regulation 13(7)
The environment plan must: (a) set environmental performance standards for the control measures identified under paragraph (5)(c); and (b) set out the environmental performance outcomes against which the performance of the titleholder in protecting the environment is to be measured; and (c) include measurement criteria that the titleholder will use to determine whether each environmental performance outcome and environmental performance standard is being met.

Santos WA's environmental assessment identified seven potential sources of environmental impact associated with the planned activities to be undertaken in the operational area. The results of the impact assessments are summarised in **Table 6-1**. Given the risk of a planned event occurring is 100% likelihood (i.e., it will occur), the residual risk ranking is not assessed (as explained in **Section 5**). The potential impact assessment for each planned event and the subsequent control and management measures proposed by Santos WA to reduce the extent of the impacts are detailed in the following subsections.

Table 6-1: Summary of the Consequence Level Rankings for Hazards Associated with Planned Events

EP Section	Hazard	Residual Consequence Level
6.1	Acoustic disturbance to marine fauna	A – Negligible
6.2	Light emissions	A – Negligible
6.3	Atmospheric emissions	A – Negligible
6.4	Seabed and benthic habitat disturbance	B – Minor
6.5	Interaction with other marine users	A – Negligible
6.6	Operational discharges	A – Negligible
6.7	Spill response operations	B – Minor

6.1 Acoustic Disturbance to Marine Fauna

6.1.1 Description of Event

Event	During the operational life of the activity, anthropogenic noise emissions will be generated by the operation of the Reindeer facilities in the operational area. There is little noise generating equipment on the platform since processing of hydrocarbons occurs at the DCGP and the platform is unmanned. The main sources of acoustic disturbance during operational activities include noise from: + The operation of the wellhead platform (low-level noise from gas-driven microturbine generator, pumps for chemical injection and hydraulics on the platform); + Operation of a diesel generator (only used as emergency power supply); + Inspection, maintenance, monitoring and repair activities of the platform and other subsea infrastructure (e.g., use of ROV, SBES, MBES, SSS, AUV, diving operations, marine growth cleaning, pigging, modification and replacement of components); + Support vessel activities (e.g., vessel engines, thrusters and other machinery); + Operation of a noise-emitting device on the Reindeer WHP to deter birds to allow safe helicopter landings and take-offs; and + Use of unmanned aerial vehicles and helicopter activities in the operational area. Noise originating from these sources could potentially have a negative physiological or behavioural effect on marine fauna.
Extent	Localised: A support vessel using main engines and bow thrusters to maintain position will become inaudible above background noise within an approximately 20-km radius. Localised: A conservative estimate for the use of geophysical equipment (SBESs, MBESs and SSS) is within a 1.5-km radius depending on the activity characteristics. Localised: Helicopter and unmanned aerial vehicle noise will be highly localised as the majority of the noise will not transfer into the water. Localised: Production equipment noise will be inaudible within 1 to 2 km of the platform. Localised: ROV, AUV and diving operations will occur in the area of the Reindeer activity and adjacent to subsea infrastructure. Localised: Bird deterrent
Duration	Intermittently around the subsea infrastructure and Reindeer WHP within the operational area.

6.1.1.1 Noise Generated from Support Vessels

Vessel operational noise consists of machinery noise (e.g., engine noise) and hydrodynamic noise (e.g., water flowing past the hull and propeller singing). All machinery on a ship radiates sound through the hull into the water.

For support vessels, the noisiest anticipated activity is when the vessel uses thrusters to maintain its position. McCauley (1998) measured underwater sound pressure levels equivalent to approximately 182 dB re 1 µPa @ 1 m with a frequency range of 20 Hz to 10 kHz from a support vessel holding station in the Timor Sea. The thruster noise dropped below 120 dB re 1 µPa within 3 to 4 km and was audible above ambient noise up to 20 km away (McCauley, 1998). This has been taken as the greatest noise-generating activity for assessment purposes, as other vessel activities will require the vessel to be idle or moving, e.g., pipeline inspection and maintenance activities will typically require the vessel to be moving slowly at approximately 4 knots. McCauley (1998) recorded the noise of a support vessel underway audible up to 10 km away, with the intensity dropping below 120 dB re 1 µPa at around 0.5 to 1 km away from the vessel.

6.1.1.2 Single-Beam and Multi-Beam Echo Sounders and Side Scan Sonar

SBESs, MBESs and SSS are used to develop a high-resolution image of the seafloor and of objects on the seafloor such as the pipeline and subsea infrastructure. Sound pressure levels for SBESs and MBESs typically range from 210 to 245 dB re 1 µPa @ 1 m, and SSS typically range from 220 to 226 dB re 1 µPa @ 1 m (DECC, 2011).

A modelling study completed in 2013 (JASCO, 2013) indicated the maximum distances at which sound pressure levels were reduced to just above background level (120 dB re 1 µPa) from different equipment types. These were:

+ MBES: Approximately 1 km from the sound source;
+ SBES: Approximately 350 m from the sound source; and
+ SSS: 1.5 km from the sound source.

6.1.1.3 Noise Generated from a Helicopter and UAV

Sound traveling from a source in the air (e.g., a helicopter) to a receiver underwater is affected by both in-air and underwater propagation processes, which are further complicated by processes occurring at the air-seawater surface interface (e.g., wind and waves). The level of noise received underwater depends on source altitude and lateral distance, receiver depth, water depth, and other variables.

Helicopter engine noise is emitted at various frequencies; however, the dominant tones are generally of a low frequency below 500 Hz (Richardson *et al.*, 1995). Sound pressure in the water directly below a helicopter is greatest at the surface and diminishes with increasing receiver depth. Noise also reduces with increasing helicopter altitude, but the duration of audibility often increases with increasing altitude. The noise from the flyover of a Bell 214 helicopter (stated to be one of the noisiest) has been recorded underwater (Richardson *et al*., 1995). The sound source was 162 dB re 1 µPa @ 1 m at its peak and had a frequency of 155 Hz**.**

Noise generated by the use of UAV’s will be generated above the sea surface. The noise emitted by UAVs and which penetrates the sea surface is less than the noise generated by support vessels which the UAV is launched from and the UAV operators will be on. In this way the impacts of noise from the UAV underwater are considered negligible comparatively. The noise (and presence) of the UAV is likely to result in short term intermittent behavioural responses from seabirds.

6.1.1.4 Noise Generated from Machinery Equipment on the WHP

Noise is also generated by equipment such as generators and pumps on the topsides infrastructure. Noise from WHP operations, maintenance or well intervention or suspension activities, such as plant modifications, is expected to be low as all operating equipment, including generators, engines and machinery, and is above sea level. The frequency and level of noise received underwater from the WHP topsides will depend on a number of variables, including the type of infrastructure; the types and sizes of engines, and the local hydroacoustic and geoacoustic environment (Erbe, 2011).

An estimate of underwater noise from a wellhead platform’s machinery has been drawn from a study by McCauley (1998) of noise from a drilling rig when it is working but not drilling, with the rig tender at anchor. The comparison is considered conservative, thus overestimating the sound being produced from a wellhead platform. The highest level encountered by McCauley (1998) was recorded at the wellhead, with 117 dB re 1 µPa at 125 m. This noise was audible up to 1 to 2 km away.

Impacts to marine fauna from noise, generated by bird deterrent devices, will depend on the frequency range and intensity of the noise produced. As sounds increase in wavelength with distance from the source, higher frequencies experience rapid loss. The noise generated by bird deterrent devices is high frequency which is outside the sensitive range for marine fauna. The bird deterrent system will be operated in a band width of approximately 118 – 137 MHz. The acoustic footprint of the audio device is estimated to be 1500m above water based on a maximum potential noise level at source of 148 dB. As the system will be installed on the helideck well above the waterline, the level of noise penetrating underwater will be significantly lower.

Any impacts to birds will be short term intermittent local avoidance only to a small proportion of local populations. In addition, the device will be operated in accordance with the Santos WA Bird Management Plan for the Reindeer Offshore Platform (EA-00-RI-10191), which includes optimisation of the maximum noise level emitted based on bird response to the noise as it is gradually increased.

6.1.2 Nature and Scale of Environmental Impacts

Potential receptors: marine mammals, marine turtles, fish and sharks, seabirds

Noise generated from operational activities may result in physiological or behavioural impacts to fauna including marine mammals, marine turtles, fish and sharks, and seabirds. The generated noise is short in duration and is expected to be reduced to background levels within kilometres to tens of kilometres, therefore any impact to fauna is expected to be temporary and short-ranged.

Noise may impact on marine fauna in the following ways:

+ Attraction to the noise source;
+ Localised avoidance;
+ Increased stress levels;
+ Disturbance, leading to behavioural changes or displacement from areas;
+ Secondary ecological effects that may occur as a result of an effect on one (or more) species influencing another species, e.g., by alteration of a predator–prey relationship; and
+ Physical injury to hearing or other organs.

The use of sound in the underwater environment is important for some marine animals, particularly cetaceans, which use it to navigate, communicate and forage effectively. The following additional impacts to marine fauna may result from underwater noise:

+ Disruption to underwater acoustic cues; and
+ Masking or interference with other biologically important sounds such as communication or echolocation (used by certain cetaceans for location of prey and other objects).

Impacts to marine fauna will depend on the frequency range and intensity of the noise produced, distance from the noise source, and species sensitivity. As noise propagates away from the source, it reduces in intensity, which is caused by the spreading of sound into an ever-increasing space, known as spherical spreading loss (Swan *et al.*, 1994). The rate of noise attenuation, however, depends on the frequency of the sound source, as well as such environmental factors as temperature, water depth and composition of the sea floor. As sounds increase in wavelength with distance from the source, higher frequencies experience rapid loss (e.g., SBES, MBES, and SSS dissipate within approximately 1.5 km), while low frequencies continue to propagate over longer distances (e.g., vessels dissipate within approximately 20 km) (Swan *et al.*, 1994; MCC, 2007) as described above.

Direct studies of underwater noise effects on marine animals are difficult to undertake, and comprehensive studies concentrate on the species that are known to be sensitive to sound. These are mainly marine mammals, fish and some invertebrates, as well as sea turtles and potentially aquatic birds (OSPAR Commission, 2009).

6.1.2.1 Marine Mammals

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

Sound levels sufficient to cause physical injury (defined as the onset of permanent threshold shift, PTS) and sub-lethal responses (such as temporary threshold shift, TTS) have been the subject of many studies. Southall *et al*. (2007), Finneran and Jenkins (2012) Wood *et al*. (2012), Finneran (2015) and more recently NMFS (2018) reviewed available literature to determine noise exposure criteria, determined based on the onset levels of non-recoverable permanent hearing loss (PTS) and temporary hearing threshold shift (TTS) in cetaceans. The NMFS (2018) criteria incorporate the best available science to inform assessment of PTS and TTS. Thresholds for PTS (for impulsive sounds) are between 202 and 230dB (depending on the species), and thresholds for TTS are between 196 and 224dB.

PTS and TTS in marine mammals has the potential to occur in close range to operations activities. However, marine mammals potentially affected by underwater noise are expected to exhibit avoidance behaviour prior to PTS or TTS occurring. Behavioural responses, such as avoidance, are typically expected at 160dB (NMFS, 2018). Avoidance behaviour is likely to be localised within the operational area and for the duration of the helicopter/vessel presence only. Acoustic disturbances to marine fauna due to operational activities are expected to be minimal as the activities are temporary and intermittent in an open ocean environment.

The EPBC Act–listed species expected to be within or move through the operational area or a 20-km radius (largest area of possible influence from the activity) and therefore potentially be impacted by underwater noise are listed in **Section 3.2.4**. These include the Bryde’s whale, blue whale, humpback whale, killer whale and spotted bottlenose dolphin, which are likely to be present in the operational area in increased numbers during migration windows. Conservation Management Plan for the Blue Whale, 2015-2025 (Commonwealth of Australia, 2015) and Conservation Advice: *Megaptera novaeangliae* (Humpback Whale) (DoE, 2015) identify noise interference as a risk. They require that risk of noise interference is evaluated and, if required, appropriate mitigation measures are implemented.

Observed disturbance responses to anthropogenic sound in cetaceans include altered swimming direction; increased swimming speed, including pronounced ‘startle’ reactions; changes to surfacing, breathing and diving patterns; avoidance of the sound source area; and other behavioural changes (NRC, 2003). The occurrence and intensity of such responses, however, are highly variable and depend on a range of factors relating to the animal and situation (NRC, 2003). Noise produced by operational activities and associated vessel operations may interfere with the ability of marine animals to detect natural sounds. This effect is termed auditory masking and has the potential to interfere with animals’ communication and socialisation, the detection of predators and prey, and navigation and orientation.

JASCO (2013) undertook an acoustic modelling study in order for the findings to be used as a preliminary assessment of the acoustic impact of geophysical surveys in coastal waters on cetaceans and pinnipeds. The report indicated that low-frequency cetaceans and pinnipeds would not be affected by MBES or SSS at any distance, while mid-frequency and high-frequency cetaceans may result in injury or behavioural modification within a 1.5-m radius around the sound source for either activity, with a 95% confidence distance of less than 1 km (JASCO, 2013).

Reactions of whales to circling aircraft (fixed wing or helicopter) are sometimes conspicuous if the aircraft is below an altitude of 300 m, uncommon at 460 m and generally undetectable at 600 m (NMFS, 2001). The effects on whales seem transient, and occasional overflights probably have no long-term consequences on cetaceans (NMFS, 2001). Observations by Richardson and Malme (1993) indicate that, for bowhead whales, most individuals are unlikely to react significantly to occasional single helicopter passes by low-flying helicopters ferrying personnel and equipment to offshore operations at altitudes above 150 m. Leatherwood *et al.* (1982) observed that minke whales responded to helicopters at an altitude of 230 m by changing course or slowly diving.

Behavioural response is expected close to (within 3 to 4 km) of the WHP during vessel thruster use; however, the sound intensity from the noise associated with vessel thrusters is highly unlikely to exceed the threshold peak impulse sound pressure that could result in direct physical trauma in cetaceans. This threshold is generally considered to be greater than 200 dB re 1 μPa (McCauley, 1994; Richardson *et al*., 1995; Southall *et al.*, 2004). Therefore, behavioural response may be seen, such as avoidance, but no long-term or significant impacts are expected.

6.1.2.2 Marine Turtles

Marine turtle hearing is most sensitive to sounds between 100 to 700 Hz (Bartol & Musick, 2003). Studies infer that turtles may begin to show behavioural responses to received sound levels of approximately 166 dB re 1 μPa and show avoidance at around 175 dB re 1 μPa (McCauley *et al*., 2000). This frequency range can be generated from vessels but is not likely from survey equipment (medium to high frequency). Temporary impairment from operational sounds to marine turtles due to TTS is expected to only occur at close ranges (within tens of metres) (JASCO 2016). Behavioural impacts may occur at close to intermediate ranges (within hundreds or metres). Considering the open ocean location of the operational area, only individual turtles may be affected as they transit the area.

The Recovery Plan for Marine Turtles in Australia: 2017-2027 (DoEE, 2017) highlights noise interference from anthropogenic activities as a threat to marine turtles. The plan refers to vessel noise and the operation of some oil and gas infrastructure as sources of chronic (continuous) noise in the marine environment, exposure to which may lead to avoidance of important turtle habitat. As described in **Table 3-5**, BIAs for marine turtles occur within the operational area, including the green, flatback and hawksbill turtles (internesting and critical nesting habitat). A study that investigated flatback turtle internesting behaviour found that the 30 m depth contour encompassed the vast majority of internesting activities (i.e. resting on the seabed) (Pendoley 2017). Another study by Whittock *et al*. (2016) identified suitable internesting habitat for flatbacks to be between 0 – 16 m deep and within 5 – 10 km off the coastline. These studies demonstrate that while marine turtles may be present in offshore waters during the internesting period, they are typically freely moving through these areas before they return to shallow waters to rest in the days leading up to re-nesting activity. Therefore, it is likely that marine turtles will occur in increased numbers as they traverse through the operational area during the peak internesting period.

6.1.2.3 Sharks, Fish and Rays

All fish species can detect noise sources, although hearing ranges and sensitivities vary substantially between species (Dale *et al.* 2015). Sensitivity to sound pressure seems to be functionally correlated in fishes to the presence and absence of gas-filled chambers in the sound transduction system. These enable fishes to detect sound pressure and extend their hearing abilities to lower sound levels and higher frequencies (Ladich and Popper 2004; Braun and Grande 2008). Based on their morphology, Popper *et al*. (2014) classified fishes into three animal groups comprising:

+ Fishes with swim bladders whose hearing does not involve the swim bladder or other gas volumes;
+ Fishes whose hearing does involve a swim bladder or other gas volume; and
+ Fishes without a swim bladder that can sink and settle on the substrate when inactive.

Thresholds for PTS and recoverable injury are between 207dB PK and 213dB PK (depending on the presence or absence of a swim bladder), and the threshold for TTS is 186dB SEL_{cum} (Popper *et al.*, 2014).Given there is no exposure criteria for sharks ad rays, the same criteria are adopted, though typically sharks and rays do not possess a swim bladder. As discussed above, sources of noise have the potential to reach these levels during vessel activities, however, this is an upper limit that is expected to be temporary and localised.

Whale sharks could potentially be impacted from operational noise, especially around the time of aggregating events off the Ningaloo coast since whale sharks could potentially migrate through the operational area while transiting to these aggregations. As described in **Section 3**, a BIA for whale shark foraging occurs within the operational area.

Whale sharks would be expected to show avoidance to vessel noise although are likely to tolerate low level noise, because whale sharks have been observed swimming close to oil and gas platforms on the NWS. Santos WA marine fauna records have previously reported the presence of whale sharks in proximity to the operational area.

6.1.2.4 Seabirds

Seabirds are unlikely to be directly affected by underwater noise generated during the operational activities. The wedge-tailed shearwater and Roseate Tern BIA's overlap the operational area. Noise emitted by the bird deterrent device aims to have a short term, intermittent behavioural impact on birds to prevent them breeding and nesting on the Reindeer WHP. By encouraging them to stay away, this will protect birds from helicopter strike and make the platform safe for helicopters to land on/take-off from. If the regular but intermittent use of the bird deterrent system does not deter birds from using the platform, then it will also be used prior to helicopter take-off and landing to minimise the risk of bird strike and provide safe conditions for take-off and landing manoeuvres. Detrimental impacts to seabirds from bird deterrent devices are not expected at an individual or population level.

6.1.2.5 Plankton and Invertebrates

Benthic invertebrates are unlikely to be negatively impacted from noise generated from operational activities due to their distance from the WHP and other vessels (i.e., water depth is greater than 50 m). Plankton, including fish eggs and larvae, and pelagic invertebrates could drift into close proximity to high-energy noise sources (e.g., bow thrusters). Any negative impacts that could occur would be restricted to within metres of the sound source. At such a localised extent, impacts would be negligible at an ecosystem or population level.

6.1.3 Environmental Performance and Control Measures

The environmental performance outcome (EPO) relating to this event includes:

+ No injury or mortality to EPBC Act–listed marine fauna during operational activities [EPO-RE-01].

The control measures considered for this event are shown in **Table 6-2**, and environmental performance standards (EPSs) and measurement criteria for the EPO are described in **Table 8-3.**

Table 6-2: Control Measures Evaluation for Acoustic Disturbance to Marine Fauna

Control Measure Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
Standard Controls				
RE-CM-01	Procedure for interacting with marine fauna.	Reduces risk of physical and behavioural impacts to marine fauna from vessels, helicopters and UAV's because if they are sighted, then vessels can slow down, or move away, and helicopters and	Operational costs to adhere to marine fauna interaction restrictions, such as vessel, helicopter and UAV speed and direction are based on legislated requirements and must be accepted.	**Adopted** – Benefits in reducing impacts to marine fauna outweigh the costs incurred by Santos WA.

Control Measure Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
		UAV's can increase distances from sighted fauna if required.		
Additional Controls				
N/A	Dedicated Marine Fauna Observer on vessels.	Improved ability to spot and identify marine fauna at risk of impact from vessel noise (that may cause harm).	Additional cost of contracting several specialist Marine Fauna Observers while the risk to all EPBC Act–listed marine fauna cannot be reduced due to variability in timing of environmentally sensitive periods and unpredictable presence of some species. Vessel masters are keeping watch for potential hazards.	**Rejected –** Cost disproportionate to increase in environmental benefit.
N/A	Structure operational activities to avoid coinciding with sensitive periods for marine fauna present in the operational area.	Potential reduction in impact of noise to some sensitive receptors.	Impracticable to schedule operational activities to a limited time of the year as this would affect the maintenance program and integrity of the assets, leading to potential critical safety and environment impacts.	**Rejected** – Cost and residual safety risk is disproportionate to increase in environmental benefit.
N/A	Elimination of vessels.	May reduce the amount of noise emissions from vessels, although acoustic disturbances to marine fauna due to vessel activities are expected to be negligible as the number of vessel activities required are minimal.	Elimination of support vessels from the field would not achieve Santos WA's legal requirements for petroleum production or its work-plan objectives for oil and gas production and may compromise safety	**Rejected** – Cost disproportionate to increase in environmental benefit.

Control Measure Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
			standards for other marine users.	
N/A	Elimination of bird deterrent usage.	Would eliminate potential impacts associated with this intermittent noise source.	Limits the type of bird deterrent devices able to be used and potentially prohibits landings because the helideck integrity may be affected by bird guano and the landing of helicopters would be at risk of bird strike, which creates safety issues. Would also require mobilisation of personnel via vessel to the platform to clean the decks, introducing safety and health risks to personnel who would be required to climb the platform and would potentially inhale guano.	**Rejected** – Given the intermittent use and minimal risk of impacts to birds occurring, safety risk associated with personnel and helicopter use outweigh the environmental benefit.

6.1.4 Environmental Impact Assessment

Receptor	Consequence Level
Acoustic Disturbance	
Threatened, migratory, or local fauna	While the level of noise expected from temporary and intermittent operational activities has the potential to cause physical injury to marine fauna, most species which may transit through the area are expected to demonstrate avoidance behaviour if noise levels approach those that could cause pathological effects. The potential for physical injuries and behavioural impacts to marine fauna will be managed through the procedure for interacting with marine fauna. Any unavoidable behavioural impacts to fauna are expected to be temporary and short-ranged, and are not expected to lead to long term changes in individual

	behaviour (e.g. migration or internesting) or lead to changes at the population level. Bird deterrent devices aim to produce avoidance behaviour in seabirds and are not expected to result in detrimental impacts to seabirds at an individual or population level. The consequence level for fauna is considered to be A - Negligible.
Overall worst-case consequence level	A – *Negligible*

6.1.5 Demonstration of ALARP

Elimination of support vessels from the field would not achieve Santos WA's legal requirements for petroleum production or its work-plan objectives for oil and gas production and may compromise safety standards for other marine users. Therefore, the elimination of vessels and vessel activities is not considered to be a practicable alternative on this basis.

Reducing the frequency or size of support vessels is possible but would introduce disproportionate operational and safety risks; for example, the support vessel is required to be of sufficient size and power to be able to supply the necessities or services in an efficient and timely manner to maintain effective operation of the WHP and to provide support in an emergency, e.g., man overboard or fire incidents. Similarly, reducing or removing vessel and helicopter activities, particularly during known migration periods of marine fauna, is not a viable option as these activities are necessary for the safe and efficient operation of the facility, year round. The deterrent device is required to be used regularly (such as daily) but intermittently and for a short duration, to deter birds from nesting on the platform.

Note also that marine fauna affected in varying degrees by acoustic noise (i.e., cetaceans, turtles, sharks and fish) are all expected to avoid the source of noise. This avoidance is likely to be from a small area (due to the small spatial extent of required activities) and to be temporary, i.e., for the duration of the vessel activity only.

The support vessels are also expected to produce similar noise emissions to other marine vessels that frequent or transit through the vicinity of the operational area (i.e., oil and gas industry vessels). Management controls are in place to reduce operating noise including vessel, UAV and helicopter operational protocols, through adherence to the Santos WA Protected Marine Fauna Interaction and Sighting Procedure (EA-91-11-00003) which requires compliance with Part 8 of the Environment Protection and Biodiversity Conservation Regulations 2000, and includes controls to reduce the risk of disturbance or collision to EPBC listed marine fauna. Santos WA has considered the actions prescribed in the Recovery Plan for Marine Turtles in Australia (2017) when developing this control to minimise noise impacts on marine turtles.

Any behavioural impact caused by acoustic disturbance is likely to be localised and temporary, with marine species expected to resume normal behavioural patterns in the open oceanic waters surrounding the operational area in a short time frame.

It is considered that there are no additional practicable risk reduction measures to those described that would not provide a grossly disproportionate benefit to the environment. It is therefore considered that the legislated and industry standard control measures identified for vessel movements, which Santos WA will implement, will reduce the impact and risk to ALARP.

6.1.6 Acceptability Evaluation

Is the consequence ranked as A or B?	Yes – Maximum consequence from acoustic disturbance is A (Negligible).

Is further information required in the consequence assessment?	No – Potential impacts and risks are well understood through the information available.
Are risks and impacts consistent with the principles of ecologically sustainable development?	Yes – Activity evaluated in accordance with Santos WA's Environmental Hazard Identification and Assessment Procedure, which considers principles of ecologically sustainable development.
Are risks and impacts consistent with relevant legislation, international agreements and conventions, guidelines and codes of practice (including species recovery plans, threat abatement plans, conservation advice and Australian marine park zoning objectives)?	Yes - IUCN principles of nearby reserves are met (**Table 3-4**). EPBC Regulations Part 8. Controls implemented will minimise the potential impacts from the activity to species identified in Recovery Plans as having the potential to be impacted by noise emissions. Relevant species Recovery Plans, Conservation Management Plans and management actions including but not limited to: + Recovery Plan for Marine Turtles in Australia (2017) + Approved Conservation Advice for *Megaptera novaeangliae* (humpback whale) + Conservation Management Plan for the Blue Whale, 2015-2025 + Approved Conservation Advice for *Balaenoptera physalus* (fin whale) (2015) + Conservation Management Plan for the Southern Right Whale 2011 – 2021 (2012)
Are risks and impacts consistent with the Santos WA's Environmental Management Policy?	Yes – Aligns with Santos WA's Environmental Management Policy.
Are risks and impacts consistent with stakeholder expectations?	Yes – No concerns raised.
Are performance standards such that the impact or risk is considered to be ALARP?	Yes – See ALARP above.

Minimal behavioural changes are expected from operational activities based on the duration and scale of the activities and elimination of the risk such as restrictions on vessel operations within close proximity to cetaceans (and whale sharks). Therefore, the consequence has been assessed as negligible. Through adherence to Santos WA's Protected Marine Fauna Interaction and Sighting Procedure (EA-91-11-00003) which requires compliance with Part 8 of the EPBC regulations (specifically Vessels and aircraft), the activity is considered acceptable to undertake in the area, in addition, no concerns from stakeholders (including fisheries) have been raised to indicate that the operational activities will have any unacceptable impacts to socio-economic receptors. The activity is managed in accordance with the relevant actions described in the Recovery Plans and conservation advices listed above and no impacts to other Marine Park values are expected. The impacts of noise in the receiving environment are ALARP and considered environmentally acceptable.

6.2 Light Emissions

6.2.1 Description of Event

Event	The WHP is an unmanned facility; therefore, navigational lighting is permanently provided for safety and navigational purposes. This consists of pulsating amber navigation lights. Whilst carrying out a maintenance activity on the WHP or DC supply pipeline or a well intervention, abandonment or suspension activity, night-time operation may be required. While WHP visits are generally undertaken during daylight hours, a night-time visitation may occur intermittently. In all of these cases lighting for safe work conditions and navigational purposes at night would be required at the location of the activity. Night operations on the WHP would be supported by portable lighting brought to the platform that can be run off the power on the platform (**Section 2**) or supplied by lighting found on the support vessel being used. Lighting for night-time activities, either on the WHP or on the support vessel, will typically consist of bright white (i.e., either sodium vapour, halogen or fluorescent) lights.
Extent	Localised: 5 km from the light source.
Duration	Permanent: Navigational lighting will be present (as a minimum) on the facility for the life of the operation, approximately 10 to 14 years. Temporary: If required, lighting on the WHP or support vessels will be used for night-time activities temporarily (approximately 5 nights for routine activities and intermittently (typically occurring less than once a year). However, non-routine activities may require lighting for longer periods.

6.2.2 Nature and Scale of Environmental Impacts

<u>Potential receptors: Fish and sharks, marine turtles and seabirds</u>

Artificial lighting has the potential to affect marine fauna that use visual cues for orientation, navigation, or other purposes, resulting in behavioural responses that can alter foraging and breeding activity in marine reptiles, seabirds, fish and zooplankton; create competitive advantage for some species; and reduce reproductive success and/or survival in others.

Potential impacts to marine fauna from artificial lighting associated with the Reindeer WHP or DC supply pipeline maintenance activities are:

+ Disorientation, attraction or repulsion; and
+ Disruption to natural behavioural patterns and cycles.

These potential impacts depend on:

+ Density and wavelength of the light and the extent to which light spills into areas that are significant for breeding and foraging;
+ Timing of overspill relative to breeding and foraging activity; and
+ Resilience of the fauna populations that are affected.

The WHP is designed as an unmanned facility; therefore, minimal lighting is provided, and it consists of a safety navigational aid system (flashing amber lights) to comply with International Association of Marine Aids to Navigation and Lighthouse Authorities' Recommendations on The Marking of Man-Made Offshore Structures (IALA-AISM, 2013). Routine inspections of the Reindeer WHP are planned to be conducted during daylight hours. However, during the lifetime of the infrastructure, some routine activities may be required to be carried out on a continuous 24-hour basis at the Reindeer WHP or from a support vessel along the offshore DC supply pipeline.

Night-time lighting will typically consist of fluorescent lighting using bright white lights, such as sodium vapour, halogen or fluorescent lights. On the platform, these will be used to illuminate walkways and the area around which the maintenance activity is being undertaken, while on the support vessel this lighting will be used on the deck.

Lighting from the WHP and support vessels that are on location at the well site may result in alterations to normal marine fauna behaviour, as discussed below for each fauna group. The combination of colour, intensity, closeness, direction and persistence of a light source are key factors in determining the magnitude of environmental impact (EPA, 2010). The most sensitive environmental receptors to light emissions are marine turtles.

6.2.2.1 Fish and Plankton

The response of fish to light emissions varies according to species and habitat. Experiments using light traps have found that some fish and zooplankton species are attracted to light sources (Meekan *et al*., 2001), with traps drawing catches from up to 90 m away (Milicich *et al*., 1992). Lindquist *et al*. (2005) concluded from a study that artificial lighting associated with offshore oil and gas activities resulted in an increased abundance of clupeids (herring and sardines) and engraulids (anchovies). These species are known to be highly photopositive: the artificial light serves to focus their marine plankton prey and consequently leads to enhanced foraging success.

6.2.2.2 Seabirds

Seabirds are known to be attracted to artificial light from platforms or to potential food sources attracted to light (e.g., invertebrates, fish). However, due to the WHP being unmanned and therefore having only navigational lights present, the attraction would be more likely due to the aggregation of marine life at all trophic levels due to the presence of the structure, which creates food sources and shelter for seabirds (Surman, 2002).

6.2.2.3 Sea Snakes

Sea snakes can occur in the vicinity of the WHP and may potentially be affected by artificial light sources. Due to the scarcity of information, the direct effect of artificial light on sea snakes is largely unknown. Sea snakes may experience indirect effects, such as changes in predator–prey relationships, and disorientation, attraction or repulsion may occur, although no data are currently available for further assessment.

6.2.2.4 Marine Turtles

Marine turtles are particularly sensitive to artificial lighting, which is known to disrupt breeding adult turtles and post-emergent hatchlings (Limpus, 1971; Salmon & Wyneken, 1994; Limpus, 2007, 2008a, 2008b, 2009a, 2009b).

The Recovery Plan for Marine Turtles in Australia: 2017-2027 (DoEE, 2017) highlights artificial light as one of several threats to marine turtles. Specifically, the plan indicates that artificial light may reduce the overall reproductive output of a stock, and therefore recovery of the species, by:

+ Inhibiting nesting by females;
+ Creating pools of light that attract swimming hatchlings and increase their risk of predation; and
+ Disrupting hatchling orientation and sea-finding behaviour.

This disruption can occur because hatchlings orient themselves to the lowest-elevation light horizon and away from high silhouettes when moving from the nest to the sea. When the direction of the lowest-elevation light horizon is not clear, hatchlings move towards the brightest, lowest horizon (Limpus & Kamrowski, 2013).

Therefore, while onshore lights (i.e., landward side of dunes) are of particular concern, offshore bright lights also have the potential to attract hatchlings, which have been shown to orient towards light sources close to the horizon (Witherington & Martin, 2003). This generally would not pose a problem if hatchlings are attracted directly to the surf zone, for once in the surf zone, turtle hatchlings are believed to be less influenced by light and to navigate using sea-wave and magnetic cues (Witherington & Martin, 2003). However, hatchlings may also orient along the beach, depending on the location of the light source relative to the beach. This can lead to fatigue, increase the hatchlings exposure to predators, and reduce the success of hatching turtles entering the ocean.

Once in the ocean, hatchlings are thought to remain close to the surface, orient by wave fronts and swim into deep offshore waters for several days to escape the more predator-filled shallow inshore waters. During this period, light spill from coastal port infrastructure and ships may 'entrap' hatchling swimming behaviour, reducing the success of their seaward dispersion and potentially increasing their exposure to predation via silhouetting (Salmon *et al.*, 1992).

Although the operational area is a known aggregation area for adult turtles, some impacts may be expected, including behavioural responses. However, behavioural responses are not expected to significantly disturb long-distance movements, reproductive or feeding activities of turtles transiting the operational area.

6.2.2.5 Cetaceans

There is no evidence to suggest that artificial light sources adversely affect the migratory, feeding or breeding behaviours of cetaceans. Cetaceans predominantly use acoustic senses to monitor their environment rather than visual sources (Simmonds *et al*., 2004). Therefore, light from the WHP navigational lights or from the WHP or support vessel night-time activity is not expected to have an impact on marine mammal behaviour.

6.2.3 Environmental Performance and Control Measures

During the evaluation of the potential impacts of light emissions as a result of the activity, it was determined that no control measures were required as the inherent consequence of light emissions is expected to be negligible and does not compromise any recovery plans, management plans or conservation advice in place for protected fauna.

As no control measures have been identified to manage light emissions during the activity, there is no requirement for EPOs or EPSs to be set in accordance with Regulation 13(7)(a) of the OPGGS(E)R 2009. Control measures considered and rejected for this activity regarding light emissions are described in **Table 6-3**.

Table 6-3: Control Measures Evaluation for Light Emissions

Control Measure Ref. No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
Standard Controls				
None	No controls.	Light emissions are considered to be ALARP.	N/A	N/A
Additional Control Measures				
N/A	Review lighting to replace with a type (colour) that has less potential to impact.	Reduce potential for impacts on certain sensitive receptors from light emissions.	High cost to complete lighting change out on all vessels in area of low sensitivity. Navigational lighting colours are stipulated by law.	**Rejected** – Cost considered disproportionate compared to the incremental environmental benefit and is a legislative requirement.
N/A	Limit or exclude night-time operations.	Reduce potential for impacts on certain sensitive receptors from light emissions during hours of darkness when light sources are more apparent and potential impacts are greatest.	Would double duration of activity; would increase impacts or potential impacts in other areas, including increase in waste, air emissions, and risk of vessel collision; and would be a navigational hindrance. The risk to all EPBC Act–listed marine fauna cannot be reduced due to variability in timing of environmentally sensitive periods and unpredictable presence of some species.	**Rejected** – Given the minimal risk of impacts to EPBC Act–listed marine species (e.g., turtles) occurring due to lighting, the financial and environmental costs incurred by requiring all works to be undertaken during daylight hours only (therefore disrupting operational activities) is unfeasible. Although the operational area overlaps with the internesting turtle BIA, impacts are not expected on a population level or on turtle habitat.
N/A	Select a bird deterrent device that does not include a light emitting component.	Would eliminate potential impacts associated with this intermittent light source during hours of darkness.	Limits the type of bird deterrent devices able to be used and potentially prohibits landings because the helideck integrity may be affected by bird guano, which creates safety issues.	**Rejected** – Given the intermittent use and minimal risk of impacts to birds occurring, the financial and environmental costs by limiting helicopter use to only daylight hours (thereby disrupting emergency response abilities) is unfeasible.

6.2.4 Environmental Impact Assessment

Receptor	Consequence Level
Light Emissions	
Threatened, migratory, or local fauna	Sensitive receptors that may be impacted by light emissions in the same location for an extended period of time include fish at the surface, marine turtles and seabirds. Light emissions may be visible to turtles transiting or internesting in surrounding areas, but they are unlikely to affect nesting or hatchling sea-finding and dispersal activity. The Reindeer facilities are located a considerable distance from the closest known significant turtle nesting beaches. At the closest point, which would be a support vessel working on the DC supply pipeline at the State–Commonwealth waters boundary, the closest nesting beaches are Rosemary Island (in the Dampier Archipelago, approximately 24 km away) and Montebello, Barrow and Lowendal islands, approximately 69 km away) (**Section 3**). The WA Environmental Protection Authority (EPA) conservatively estimates there is only a light influence on marine turtles if the light source is within 1.5 km of the nesting beach (EPA, 2010). Therefore, night-time activity lighting from the support vessels is expected to have a negligible impact on breeding or hatchling turtles, given any maintenance activities are of relatively short duration too. In addition, permanent navigational lights or night-time activity lighting on the platform is not expected to have an impact as the WHP is 240 km away from the nearest significant nesting beach (Rosemary Island). Although the operational area overlaps with the internesting turtle BIA, impacts are not expected on a population level or on turtle habitat. Cetaceans and marine mammals are not known to be significantly attracted to light sources at sea; therefore, disturbance to behaviour is unlikely. Indirect impacts on food sources or habitats also unlikely (see below). Fish, sharks and birds have been shown to be attracted to artificial light sources; however, the short duration of any maintenance activities on the Reindeer WHP is unlikely to lead to large-scale changes in species abundance or distribution. Impacts to transient fish, sharks and seabirds will therefore be limited to short-term behavioural effects with no decrease in local population size or area of occupancy of species, loss or disruption of critical habitat, or disruption to the breeding cycle.
Overall worst-case consequence level	A – *Negligible*

6.2.5 Demonstration of ALARP

Elimination of lighting for night-time activities is not considered practicable as activities on the WHP and DC supply pipeline are often undertaken within good weather windows, which means that sometimes it is essential to work at night. The alternative to working at night is spending longer periods at a location to achieve the operational objectives during daylight hours or mobilising over a number of good weather windows; this would be of no net environment benefit due to extra fuel use and increased presence at the location.

The potential to disorient or misorient turtles (nesting adults and hatchlings) through night-time lighting for 24-hour maintenance activities is considered unlikely as the closest that night-time activities may be required to occur from known turtle rookeries is on the offshore DC supply pipeline at the State–Commonwealth waters boundary. This is located more than 20 km from the nearest known significant turtle rookeries (i.e., Rosemary Island). Therefore, the environmental risk to hatching turtles and nesting adults is considered negligible.

The activity will not compromise the objectives set out in the Recovery Plan for Marine Turtles in Australia (DoEE, 2017) as biologically important behaviours of nesting adults and emerging or dispersing hatchlings can continue given the distance of operational activities from the nearest nesting beaches (24 km off Montebello Islands and from Dampier Archipelago). The light on the WHP is not expected to negatively impact individuals transecting the WHP operational area.

The assessed residual consequence for this impact is negligible and cannot be reduced further. Additional control measures were considered but rejected since the associated cost or effort was grossly disproportionate to any benefit, as detailed in **Section 6.1.3**. It is considered therefore that the impact of the activities conducted are acceptable and ALARP.

6.2.6 Acceptability Evaluation

Is the consequence ranked as A or B?	Yes – Maximum consequence from light emissions is A (Negligible).
Is further information required in the consequence assessment?	No – Potential impacts and risks are well understood through the information available.
Are risks and impacts consistent with the principles of ecologically sustainable development?	Yes – Activity evaluated in accordance with Santos WA's Environmental Hazard Identification and Assessment Procedure, which considers principles of ecologically sustainable development.
Are risks and impacts consistent with relevant legislation, international agreements and conventions, guidelines and codes of practice (including species recovery plans, threat abatement plans, conservation advice and Australian marine park zoning objectives)?	Yes – Management consistent with International Convention of the Safety of Life at Sea (SOLAS) 1974 and the Navigation Act 2012. Consistent with relevant species recovery plans, conservation management plans and management actions set out in **Table 3-6**, including but not limited to: + Recovery Plan for Marine Turtles in Australia (2017) + Recovery Plan for Threatened Albatrosses and Giant Petrels (DSEWPaC, 2011)
Are risks and impacts consistent with Santos WA's Environmental Management Policy?	Yes – Aligns with Santos WA's Environmental Management Policy.
Are risks and impacts consistent with stakeholder expectations?	Yes – No concerns raised.
Are performance standards such that the impact or risk is considered to be ALARP?	Yes – See ALARP above.

Lighting of the Reindeer WHP and vessels is industry standard and required to meet relevant maritime and safety regulations.

The potential consequences of the anthropogenic light sources in the operational area are considered to be insignificant in nature and restricted to short-term behavioural impacts on low numbers of individual fauna that may be present in the operational area.

Significant impacts are not expected on fauna, including nesting turtles or hatchlings. The separation of the light sources associated with the activity from nesting beaches is consistent with the relevant actions described in the Recovery Plan for Marine Turtles in Australia (DoEE, 2017).

Although a flatback turtle aggregation area is known to occur within the operational area, lighting from the Reindeer facilities and associated vessels is not expected to impact aggregating adults. Constant navigational lighting at the WHP is not likely to impact transient turtles. Turtles are more sensitive to light when feeding, mating or nesting or as hatchlings when transitioning from nest to ocean. Given the distance of the operational area from the shoreline, little to no effect is expected.

The event is consistent with the relevant actions described in the recovery plans listed above.

No impacts to marine park values are expected, and the event is consistent with the management principles for the Montebello Australian Marine Park. No stakeholder concerns have been raised regarding lighting for the activity.

The impacts of lighting to the receiving environment are ALARP and considered environmentally acceptable.

6.3 Atmospheric Emissions

6.3.1 Description of Event

Event	Greenhouse gas (GHG) emissions, such as carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O), along with non-GHGs, such as sulphur oxides (SO_x) and nitrous oxides (NO_x), will be discharged to the atmosphere during operation of the WHP, contributing to a localised reduction in air quality. Atmospheric emissions from Reindeer facilities operations are derived from: + The use of gas- and diesel-powered turbines and equipment on the WHP; + The use of fuel to power vessel engines and equipment during maintenance and operational activities; + Venting of: – Volatile organic compounds (VOCs) (primarily CH_4) from drain systems on the platform, fugitive emissions from relief valves and sumps, and also their actuation; – Pigging operations, process equipment maintenance, and well maintenance, servicing, suspension and abandonment; or – Fugitive emissions from the process control system. + Vessels may also use: – An incinerator to manage wastes; or – Ozone-depleting substances in closed-system rechargeable refrigeration systems
Extent	Localised: The quantities of gaseous emissions are relatively small and will, under normal circumstances, quickly dissipate into the surrounding atmosphere.
Duration	Air emissions generated during the operational life of the field.

6.3.1.1 Combustion Emissions

The operation of the gas- and diesel-powered equipment on the WHP, as well as the use of fuel to power vessel engines and vessel equipment, results in the release of atmospheric emissions of GHGs and other combustion wastes. These emissions include CO_2, and CH_4 and the non-GHGs SO_x and NO_x. Specific equipment that produces emissions under normal operating conditions include:

+ Two gas-powered microturbines for power generation;
+ A diesel-powered deck crane; and
+ A diesel standby generator (automatically started upon loss of both microturbines).

The volume of gases released from this equipment is not metered; the volume is calculated using the fuel gas and diesel usage as a proxy. A conversion factor is applied to this volume to convert it into tonnes of CO_2 equivalent. This factor is an accepted method used in annual reporting for the National Greenhouse and Energy Reporting Scheme. Note that NO_x is not contained in the gas stream and is therefore not considered further in the assessment of atmospheric emissions from the WHP.

6.3.1.2 Cold Venting and Fugitive Emissions

During cold venting, gas discharges are likely to contain methane, ethane, propane and carbon dioxide. The closed drain sumps separate the liquid from the gas in the inlet stream and then discharge the gas to atmosphere through a flame arrestor. Minor amounts of fugitive emissions are expected to occur on the WHP due to potential leak paths from the production equipment.

6.3.1.3 Ozone-depleting Substances

Ozone-depleting substances are used in closed refrigeration systems on board vessels. Ozone-depleting substances have the potential to contribute to ozone-layer depletion if accidentally released to the atmosphere. Ozone-depleting substances are not used, generated or discharged by vessel activity other than what is incidentally located and used in closed systems on board vessels.

6.3.2 Nature and Scale of Environmental Impacts

Potential receptors: Seabirds and humans

Hydrocarbon combustion may result in a temporary, localised reduction of air quality in the environment immediately surrounding the discharge point during the activity, which could affect seabirds and humans in the immediate vicinity.

6.3.2.1 Combustion Emissions

The combustion emission of GHGs can lead to a reduction in local air quality and add to the national GHG loading, which could in turn contribute to climate change. Non-GHGs may be toxic, odoriferous or aesthetically unpleasing.

6.3.2.2 Cold Venting and Fugitive Emissions

VOCs can be harmful to human health and also to the environment, as they can be toxic; however, this is generally for high concentrations of VOCs in closed environments. VOCs are not expected to be in large enough volumes to be harmful. The typically windy region will also dissipate and disseminate any VOCs, reducing their impacts.

The circumstances leading to cold venting include both planned and unplanned maintenance activities. These planned maintenance activities are scheduled to occur infrequently, at most annually (e.g., pigging). The volumes of hydrocarbons, including GHGs and non-GHGs, are small.

Minor amounts of fugitive emissions are expected to occur on the WHP due to potential leak paths from the production equipment. Hydrocarbon vapours, including VOCs, are released from storage tanks and equipment on filling of the diesel tanks and continuous minor venting, although emissions from storage tanks are expected to be minimal as the tanks themselves are very small (approximate tank size is 3.1 m^3). Air emissions will be similar to other facilities operating in the region for both petroleum and non-petroleum activities.

6.3.3 Environmental Performance and Control Measure

Environmental performance outcomes (EPOs) relating to this event include:

+ Emissions or discharges to sea or air meet legislative requirements and are ALARP and acceptable [EPO-RE-02].

The control measures considered for this activity are shown in **Table 6-4**, and EPS and measurement criteria for the EPOs are described in **Table 8-3**.

Table 6-4: Control Measures Evaluation for Atmospheric Emissions

Control Measure Ref. No	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
Standard Controls				
RE-CM-02	Facilities Planned Maintenance System	Reduces emissions from the WHP because equipment is operating within its parameters.	Operational costs and labour or access requirements of undertaking facility maintenance.	**Adopted** – Benefits of operating equipment within operational parameters to help control emissions created by equipment outweighs the cost.
RE-CM-03	Vessels Planned Maintenance System	Reduces emissions from vessels because equipment is operating within its parameters.	Operational costs and labour or access requirements of undertaking vessels maintenance.	**Adopted** - Benefits of operating equipment within operational parameters to help control emissions created by equipment outweighs the cost.
RE-CM-04	Fuel Oil Quality	Reduces emissions through use of low-sulphur fuel in accordance with Marine Order 97.	Operational costs of refuelling.	**Adopted** - Environmental benefit outweighs cost, and it is a legislated requirement.
RE-CM-05	International Air Pollution Prevention Certificate (IAPP)	Reduces probability of potential impacts to air quality due to ozone-depleting substance	Personnel cost of ensuring vessel has current IAPP certificate or equivalent during vessel contracting procedure and during	**Adopted** – Benefits of ensuring vessels are compliant outweighs the minimal cost of personnel time,

Control Measure Ref. No	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
		emissions and high NO_x and SO_x emissions.	premobilisation audits or inspections.	and it is a legislated requirement.
RE-CM-06	Ozone-depleting Substance Handling Procedures	Reduces probability of potential impacts to air quality due to ozone-depleting substance emissions.	Personnel cost of maintaining ozone-depleting substance record book or recording system.	**Adopted** - Benefit of ensuring no ozone-depleting substance release outweighs the minimal cost.
RE-CM-07	Waste Incineration Management	Reduces the potential for emissions or particulates by ensuring only permissible waste is incinerated as per Marine Order 97.	Personnel cost of maintaining waste records and training of staff.	**Adopted** – Benefit to air quality outweighs the costs and it is a legislated requirement.
Additional Control Measures				
N/A	No incineration during vessel-based operations activities.	Eliminate the potential for emissions due to waste incineration to impact air quality.	Increase in health risk from storage of wastes. Increase in risk due to transfers (increased fuel usage, potential increase in collision risk, disposal on land).	**Rejected** – Health and safety risks outweigh the benefit given the offshore location. Cost associated with transporting waste to shore for landfill and/or incineration outweighs costs of on-board incineration.
N/A	Removal of all ozone-depleting substance-containing equipment.	Eliminates potential of ozone-depleting substance emissions occurring and impacting on air quality.	Lack of refrigeration systems on board the vessels would lead to unacceptable workplace conditions (i.e., air conditioning) and	**Rejected** – Based on cost to replace all equipment, and there is only a low potential for ozone-depleting substance– releases.

Control Measure Ref. No	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
			poor food hygiene standards, limiting the vessels' ability to undertake the activity. Therefore, there is no practicable alternative to the use of refrigeration. It is noted that ozone-depleting substances are rarely found on vessels.	
N/A	Alternative fuel type (non-hydrocarbon based) selected for all vessels and helicopters.	Could reduce level of pollutants released to the environment during fuel combustion.	Practicable and reliable alternative fuel types and power sources for the helicopters and support vessels have not been identified. If an alternative was available, vessels have fuel specification for equipment, and change of fuel may require further modifications to equipment.	**Rejected –** Not feasible.
N/A	Use incinerators and engines with higher environmental efficiency.	Improves air quality by more efficient burning or fuel combustion.	Significant cost in changing unknown vessel equipment.	**Rejected –** Cost grossly disproportionate to low environmental benefit (impact rated negligible).
N/A	Contain and re-inject gas to export pipeline.	Prevents cold venting.	Significant costs and effort in the augmentation of the facilities/processes on the WHP.	**Rejected** - The cost of implementing and maintaining these alternative controls are considered grossly dis-

Control Measure Ref. No	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
				proportionate to the environmental benefits that they could provide given the platform location, the low volumes of gas to reclaim/flare and the infrequent releases.
N/A	Flaring of cold vented gases.	Flaring would convert methane to carbon dioxide and minimise greenhouse gas risk.	Significant costs and effort in the augmentation of the facilities/processes on the WHP.	The cost of implementing and maintaining these alternative controls are considered grossly dis-proportionate to the environmental benefits that they could provide given the platform location, the low volumes of gas to reclaim/flare and the infrequent releases.

6.3.4 Environmental Impact Assessment

Receptor	Consequence Level
Atmospheric Emissions	
Threatened, migratory, or local fauna	Short-term behavioural impacts to seabirds could be expected if they overfly the location; they may avoid the area. No decrease in local population size or area of occupancy of species, loss or disruption of critical habitat, disruption to the breeding cycle or introduction of disease.
Physical environment or habitat	Not applicable – No impacts to physical environments or habitats from atmospheric emissions are expected.

Receptor	Consequence Level
Atmospheric Emissions	
Threatened ecological communities	Not applicable – No threatened ecological communities identified in the area over which atmospheric emissions are expected.
Protected areas	Negligible effects – Potential impacts to fauna that contribute to marine park values addressed above. No impacts to other sensitive values identified in the Montebello Marine Park Management Plan (DNP, 2018).
Socio-economic receptors	As the activity occurs in offshore waters, the combustion of fuels, venting and ozone-depleting substance releases in the remote location will not impact on air quality of mainland human receptors. The quantities of gaseous emissions are relatively small and will, under normal circumstances, quickly dissipate into the surrounding atmosphere. The highly dispersive nature of local winds (i.e., strong and consistent) is expected to reduce potentially harmful or 'noticeable' gaseous concentrations within a short distance from the WHP and vessels and therefore not impact on other marine users in the vicinity and not influence local human receptors, such as Barrow Island, Dampier and Onslow. Atmospheric emissions will add to the global inventory of GHGs; however, they and non-GHGs are not expected to have any local environmental consequences.
Overall worst-case consequence level	A – *Negligible*

6.3.5 Demonstration of ALARP

Air emissions are unavoidable during the production operation process on the WHP, as alternative power sources (such as solar or wind) to reduce emissions are not a guaranteed source. This would introduce a compromise of safety that would be disproportionate to the volume of emissions released.

There are no alternatives to combustion of fuels on support vessels to adequately maintain the WHP and pipeline. Emissions from support vessels are unavoidable since supply trips and personnel transfers to the WHP are required for routine maintenance. To date, there are no support vessels that offer any less environmentally harmful alternative fuel options. Where practicable, Santos WA will group activities into a single campaign to improve efficiency and reduce emissions, as well as to improve cost effectiveness of the activities, such as combining routine WHP visits with routine maintenance activities and WHP supply trips.

It is noted that the open drain system may capture unplanned spills of hydrocarbons, leading to some emissions; however, these are not considered cold venting activities and are captured as unplanned spills, described in **Section 7** of the EP.

Santos WA has adopted best practice industry standards as the primary measures for reducing the extent and degree of air quality impacts to ALARP. This includes managing and maintaining all WHP production equipment in accordance with the CMMS designed for the WHP. Vessels and on-vessel combustion equipment will be maintained in accordance with the Contractor's planned maintenance system to ensure these are in good working order.

Maintenance, modification and inspection of the WHP, subsea infrastructure and DC supply pipeline are performed relatively infrequently. Further reducing the frequency of trips to the operational area may compromise the safe and efficient operating of the facility, which could increase the risk of greater environmental impacts (e.g., release of hydrocarbon to the marine environment).

The MARPOL standards and AMSA marine orders are considered to be the most appropriate standards for support vessels to adhere to in this environment, given the nature and scale of the activities, and they are widely used by the industry. These include regulations controlling the level of NO_x and SO_x from vessel engines. Compliance with these requirements together with implementation of the controls listed above reduces the environmental impacts associated with air emissions to ALARP.

Furthermore, the WHP and DC supply pipeline are located in oceanic waters where air emissions will disperse and rapidly assimilate in the North West Shelf air shed.

It is considered that there are no additional practicable risk reduction measures to those described that would not provide a grossly disproportionate benefit to the environment. Therefore, with the control measures listed in **Section 6.3.3** in place, the risks and impacts from atmospheric emissions resulting from the activities are considered to be ALARP.

6.3.6 Acceptability Evaluation

Is the consequence ranked as A or B?	Yes – Maximum consequence from atmospheric emissions is A (Negligible).
Is further information required in the consequence assessment?	No – Potential impacts and risks are well understood through the information available.
Are risks and impacts consistent with the principles of ecologically sustainable development?	Yes – Activity evaluated in accordance with Santos WA's Environmental Hazard Identification and Assessment Procedure, which considers principles of ecologically sustainable development.
Are risks and impacts consistent with relevant legislation, international agreements and conventions, guidelines and codes of practice (including species recovery plans, threat abatement plans, conservation advice and Australian marine park zoning objectives)?	Yes – Management consistent with Convention of the Safety of Life at Sea (SOLAS) 1974, *Navigation Act 2012*. Consistent with relevant species recovery plans, conservation management plans and management actions set out in **Table 3-6** including but not limited to: + Recovery Plan for Threatened Albatrosses and Giant Petrels (DSEWPaC, 2011)
Are risks and impacts consistent with Santos WA's Environmental Management Policy?	Yes – Aligns with Santos WA's Environmental Management Policy.
Are risks and impacts consistent with stakeholder expectations?	Yes – No concerns raised.
Are performance standards such that the impact or risk is considered to be ALARP?	Yes – See ALARP above.

Atmospheric emissions from vessels are permissible under the Protection of the Sea (Prevention of Pollution from Ships) Act 1983, which is enacted in Australian waters by Marine Order 97 (Marine pollution prevention – air pollution) (which also reflects MARPOL Annex VI requirements). This is an internationally accepted standard that is utilised industry wide, and compliance with MARPOL standards is considered to be an appropriate management measure in this case.

The overall impacts to the atmosphere and sensitive receptors are expected to be negligible (A) if the emissions management is adhered to, and impacts from emissions that are generated by the various operational activities are considered to be ALARP and environmentally acceptable.

6.4 Seabed and Benthic Habitat Disturbance

6.4.1 Description of Event

Event	A description of the activities associated with Reindeer WHP operational activities is provided in **Section 2**. Disturbance to the seabed and benthic habitats could potentially occur due to: + Vessel anchoring (non-routine); + Cleaning of subsea infrastructure; + Sedimentation as infrastructure is placed or relocated on the seabed; + Temporary subsea storage of equipment (e.g., ROV basket or clump weight); + Subsea maintenance and repair activities (e.g., diving, AUV survey activities, ROV operations, cutting, welding, pigging, installation, replacement or modification of subsea equipment, freespan rectification and stabilisation etc.); + Initial placement of solid structures, deployment, retrieval or movement of equipment and ROV operations; and + Creation of artificial habitat because of the physical presence of infrastructure (and from currents altered by the presence of subsea infrastructure). This may result in minor seabed disturbance, sedimentation or water quality impacts (i.e., increased turbidity).
Extent	Localised**:** within the operational area.
Duration	For the operational life of the activity.

6.4.2 Nature and Scale of Environmental Impacts

Potential receptors: Benthic habitats

The potential impacts are discussed below. The predominant habitat type in the operational area is soft unconsolidated sediments and commercial fisheries habitat.

6.4.2.1 Artificial Habitat Creation

The presence of subsea infrastructure has the potential to act as artificial habitat or hard substrate for the settlement of marine organisms that would not otherwise be successful in colonising the area. Over time, the colonisation of subsea infrastructure can lead to the development of a ‘fouling’ community, which subsequently provides predator or prey refuges, foraging resources for pelagic fish species, and artificial reefs potentially supporting fish aggregations (Gallaway *et al*., 1981).

The presence of seabed and fixed platform structures may result in a minor increase in diversity and abundance of reef-associated species, such as cods and snappers, which prefer habitat of structural complexity. Similarly, near-surface infrastructure can support pelagic species that are commonly attracted to fixed and drifting surface structures in areas of open ocean (Lindquist *et al*., 2005).

6.4.2.2 Damage or Loss of Benthic Habitat and Biota

Previous surveys of the substrate (RPS, 2008) indicate that the seabed around the infrastructure is mostly soft sediments that support sparse benthic and epibenthic organisms, such as infauna (**Section 3**). Should the habitat be disturbed from any of the above-mentioned activities, the soft sediment communities will rapidly return to their pre-disturbance state due to the continuously moving nature of the seabed sediments, which act to fill depressions and other disturbed areas. Sediments are then expected to be recolonised by infauna and to regain ecological function.

Temporary or permanent direct loss of benthic habitat and associated biota may occur during maintenance, repair and intervention activities. During inspection or repair activities on the DC supply pipeline, vessel activities could include the placement of stabilisation mattresses, rocks or grout bags on the seabed or rock-bolting activities.

6.4.3 Environmental Performance and Control Measures

Environmental performance outcomes (EPOs) relating to this event include:

+ Seabed disturbance is limited to the operational area [EPO-RE-04].

The control measures considered for this activity are shown in **Table 6-5**, with EPSs and measurement criteria for the EPOs described in **Table 8-3**.

Table 6-5: Control Measures Evaluation for Seabed and Benthic Habitat Disturbance

Control Measure Ref. No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
Standard Controls				
RE-CM-08	Planned subsea and offshore maintenance.	Preplanning of subsea and offshore maintenance activities reduces the risk of impacts to the seabed.	Personnel costs associated with preparation of planning documentation.	**Adopted** – The environmental benefits outweigh the costs of implementing measure.
RE-CM-09	Dropped object prevention procedures (LEMS).	Implementation of a dropped object prevention procedure for equipment deployment helps to protect the integrity of infrastructure on the seabed and the equipment being lowered. This in turn minimises impacts and extent of seabed disturbance through standards for lifting equipment inspection and maintenance and procedures for lifting.	No additional costs to Santos WA other than negligible personnel costs of reviewing information.	**Adopted** – Helps to protect the integrity of infrastructure on the seabed and the equipment being lowered, which in turn minimises impacts and extent of seabed disturbance.
RE-CM-10	Dropped object recovery.	Requires dropped objects to be recovered (where safe and practicable to do so unless the environmental consequences are negligible).	Additional personnel and vessel costs to plan and undertake if safe and practicable to do so.	**Adopted -** Benefits of recovering dropped objects where safe and practicable unless the environmental

Control Measure Ref. No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
				consequences are negligible to do so outweighs the costs.
RE-CM-11	Anchoring and equipment deployment management.	Requires using existing moorings or Santos WA–approved anchor locations within the operational area, except in the case of an emergency, to prevent further seabed disturbance.	No additional costs to Santos WA other than negligible personnel costs of reviewing information in an emergency situation.	**Adopted -** Benefits of using existing moorings prevents further disturbance.
Additional Control Measures				
N/A	Cessation of operations until all dropped objects are located and recovered.	Would minimise potential for further disturbance due to dropped object potentially moving around on seabed causing further disturbance or long-term impacts.	Substantial additional cost to operational activities due to downtime over and above value of equipment lost. Little benefit given water depths and sparse distribution of sensitive benthic habitats in operational area.	**Rejected** – Cost outweighs the benefit.
N/A	Elimination of vessels or use of dynamic positioning for all vessels.	Reduces impacts to seabed from anchoring.	Given vast distances, inspections can be carried out in shorter time frames, reducing campaign lengths and other associated risks, thus, the use of vessels is a lower-risk and lower-cost option for surveys.	**Rejected –** Increased (transferred) risk disproportionate to environmental benefit.

6.4.4 Environmental Impact Assessment

Receptor	Consequence Level
Seabed and Benthic Habitat Disturbance	
Threatened, migratory, or local fauna	No sensitive seabed features are expected within the operational area based on surveys completed in the area (**Section 3**). Marine invertebrates may inhabit soft sediments and can contribute to the diet of some fauna, including flatback turtles. The area of soft sediment habitat that is potentially impacted is small compared to the amount of habitat available;

Receptor	Consequence Level
Seabed and Benthic Habitat Disturbance	
	therefore, the disturbance is not expected to affect prey availability; and therefore, impacts to protected flatback turtle species will be negligible.
Physical environment or habitat	The area of physical environment and habitat that would be impacted during the event is typically soft unconsolidated sediments, is small compared to the area of similar habitat in the wider environment, and is expected to re-establish following disturbance. As such, long-term or significant impacts to habitat values or ecosystem function are not expected. The impacts to the seabed from repair and maintenance activities would also be localised to the immediate repair location. No significant benthic habitats are known to exist in the corridor of the DC supply pipeline; therefore, it is not anticipated that any maintenance activities would have a significant effect on benthic communities (**Section 3.2.2**).
Threatened ecological communities	Not applicable – No threatened ecological communities have been identified in the area over which seabed disturbance could occur.
Protected areas	Not applicable – No protected areas have been identified in the operational area where seabed disturbance could occur.
Socio-economic receptors	No stakeholder concerns have been raised regarding this event.
Overall worst-case consequence level	B – *Minor*

6.4.5 Demonstration of ALARP

Seabed disturbance (from maintenance activities) cannot be eliminated, as the alternative to anchoring is using thrusters to maintain position, which would introduce increased risks for divers or equipment in the water during such activities as diver inspections or maintenance activities and would also increase noise impacts. In addition, elimination of planned maintenance may potentially result in more severe environmental impacts (e.g., a hydrocarbon leak due to pipeline leak) and compromising with the safety requirements from the approved safety case.

However, a review of the most recent seabed survey indicates that there are no sensitive habitats in the vicinity of the WHP and DC supply pipeline, and the habitat type present is well represented habitat that will recover should a disturbance occur. If anchoring of work vessels or disturbance of the seabed is required during planned maintenance and repair activities, the anchoring and mooring procedures during such activities will ensure that the area disturbed is minimised and the risks and impacts are ALARP.

It is considered that there are no additional practicable risk reduction measures to those described that would not provide a grossly disproportionate benefit to the environment. It is therefore considered that the control measures identified for seabed disturbance, which Santos WA will implement, will reduce the impact and risk to ALARP.

6.4.6 Acceptability Evaluation

Is the consequence ranked as A or B?	Yes – Maximum consequence from seabed and benthic habitat disturbance is B (Minor).
Is further information required in the consequence assessment?	No – Potential impacts and risks are well understood through the information available.
Are risks and impacts consistent with the principles of ecologically sustainable development?	Yes – Activity evaluated in accordance with Santos WA's Environmental Hazard Identification and Assessment Procedure, which considers principles of ecologically sustainable development.
Are risks and impacts consistent with relevant legislation, international agreements and conventions, guidelines and codes of practice (including species recovery plans, threat abatement plans, conservation advice and Australian marine park zoning objectives)?	Yes – No plans identified seabed disturbance like those described above as being a threat to marine fauna or habitats.
Are risks and impacts consistent with Santos WA's Environmental Management Policy?	Yes – Aligns with Santos WA's Environmental Management Policy.
Are risks and impacts consistent with stakeholder expectations?	Yes – No concerns raised.
Are performance standards such that the impact or risk is considered to be ALARP?	Yes – See ALARP above.

Reindeer WHP operations will result in some level of seabed disturbance; however, with consideration of the control measures in place, based on Santos WA's consequence matrix (**Figure 5-2**), the worst impact is assessed as 'Minor'.

The Activity is consistent with the relevant actions described in the Recovery Plans listed above.

No impacts to other Marine Park values are expected. No stakeholder concerns have been raised regarding the activity.

The impacts of seabed disturbance to the receiving environment are ALARP and considered environmentally acceptable.

6.5 Interaction with Other Marine Users

6.5.1 Description of Event

Event	Interactions with other marine users will occur through undertaking operational activities. Support vessels will be regularly transiting the area and, at times of maintenance, inspection and repair, may need to operate 24 hours a day. The presence of vessels in the operational area could potentially inhibit marine user groups, tourism, commercial shipping, fishing and other oil and gas activities.
Extent	Localised within the operational area.
Duration	Temporary and intermittent interaction with vessels when transiting the operational area. Permanent exclusion of other marine users within the 500-m-radius petroleum

	safety zone (under Section 6 of the OPGGS Act) of the WHP for the operational life of the field.

6.5.2 Nature and Scale of Environmental Impacts

Potential receptors: Other marine users

The presence of the WHP with its 500-m-radius petroleum safety zone, the 2.5-nm-radius cautionary zone, and the movements of support vessels may be potential obstacles for commercial or recreational fisheries and shipping traffic in the region. These impacts include a loss of access to the area, navigational hazards, and a collision risk.

The presence of the support vessels associated with the DC supply pipeline could impact commercial shipping. One major shipping route crosses the pipeline in Commonwealth waters (**Figure 3-13**).

Operation of the WHP and support vessels associated with the WHP and DC supply pipeline activities could impact on commercial fisheries. For example, activities could potentially result in the temporary displacement, damage or loss of fishing equipment and indirect environmental impacts, including potential impacts to commercial species and localised impacts on water quality (e.g., increased sedimentation).

The open waters in the vicinity of the WHP and DC supply pipeline do not support significant recreational or tourist activity and therefore impact to recreational fisheries or tourism is not expected.

6.5.3 Environmental Performance and Control Measures

Environmental performance outcomes (EPOs) relating to this event include:

+ Information is available to regulatory authorities and marine users directly affected by planned activities [EPO-RE-05].

The control measures considered for this activity are shown in **Table 6-6,** with EPSs and measurement criteria for the EPOs described in **Table 8-3**.

Table 6-6: Control Measures Evaluation for Interaction with Other Marine Users

Control Measure Ref. No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
Standard Controls				
RE-CM-12	WHP petroleum safety zone	A petroleum safety zone and a cautionary area apply around the Reindeer WHP and are shown on Australian nautical charts. Reduces risk to other users.	No additional costs to Santos WA. Other marine users may be temporarily excluded from areas, disrupting their activities.	**Adopted** – Benefits considered to outweigh Costs.
RE-CM-13	Navigational charting of infrastructure.	Ensure other marine users are aware of the presence of the WHP, pipeline and subsea infrastructure.	No additional costs to Santos WA. Other marine users may be temporarily excluded from areas, disrupting their activities.	**Adopted** – Benefits considered to outweigh Costs.
RE-CM-14	Navigation lighting and aids.	Reduces risk of environmental impact from vessel collisions due	Costs of operating and maintaining	**Adopted** – Benefits

Control Measure Ref. No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
		to ensuring safety requirements are fulfilled and other marine users are aware of the presence of the WHP and vessels.	navigational equipment.	considered to outweigh Costs.
RE-CM-15	Seafarer Certification.	Requires appropriately trained and competent personnel, in accordance with Marine Order 70, to navigate vessels to reduce interaction with other marine users.	Costs associated with personnel time in obtaining qualifications.	**Adopted –** Benefits considered to outweigh costs, and it is a legislated requirement.
RE-CM-16	Constant bridge watch on support vessels	Monitoring of surrounding marine environment to identify potential collision risks with other marine users	No additional cost – industry practice and regulated by AMSA.	**Adopted** – industry practice, benefits outweigh cost.
RE-CM-17	Stakeholder consultation.	Santos WA will update relevant stakeholders on a quarterly basis. All external stakeholder communications are recorded in a database.	Costs associated with personnel time in preparing and distributing information and collating and addressing any feedback provided.	**Adopted** – Benefits considered to outweigh Costs to Santos WA.
Additional Control Measures				
N/A	Manage the timing of the operational activities to avoid peak marine user periods (e.g., fishing).	Would eliminate potential impacts to other marine users.	Not considered feasible as marine users could potentially be in the area all year round and operational activities are required all year round. The area that other marine users are excluded from is small when compared to the area available to other marine users, and there is low fishing activity in the area as evidenced through consultation.	**Rejected** – Stakeholders in the area all year round.

6.5.4 Environmental Impact Assessment

Receptor	Consequence Level
Interaction with Other Users	

Threatened, migratory, or local fauna	Not applicable – related to socio-economic receptors only.
Physical environment or habitat	
Threatened ecological communities	
Protected areas	
Socio-economic receptors	Given that the WHP has been operational since 2011 and that shipping vessels have been required to deviate slightly around it since construction began in 2010, the impacts to shipping are considered to be negligible due to the small area affected in comparison to the area available for vessels to navigate through. The impact from the pipeline is also considered to be negligible due to the small area affected in comparison to the area available for vessels to navigate through and the infrequent visits required for pipeline maintenance visits (approximately less than once a year (**Section 2.5.5.5**)). Data from DPIRD (DoF, 2012) indicates that the operational area is not likely to be used for commercial fishing as it does not represent important habitat for targeted commercial species. A lack of natural seabed features (e.g., rocky or coral reef) beneath the WHP indicates that recreational fishing is also unlikely to occur. The open waters in the vicinity of the WHP and DC supply pipeline do not support significant recreational or tourist activity therefore, impact to recreational fisheries or tourism is not expected.
Overall worst-case consequence level	A – *Negligible*

6.5.5 Demonstration of ALARP

There are no alternatives to the use of a vessel to undertake the activities. The risk of interfering with other marine users will be reduced to ALARP by informing stakeholders of the location of the WHP and pipeline and associated activities, areas and zone; implementing navigation controls; and maintaining communication during the activity.

Vessel presence is required to undertake production operation activities. Review of fisheries data, commercial shipping data and stakeholder consultation indicates that neither commercial fisheries nor commercial shipping will be significantly disrupted. Accordingly, industry standard measures (e.g., stakeholder and marine user notifications) have been adopted for the duration of Reindeer WHP operations.

Stakeholders are regularly updated on activities at DCGP through quarterly consultation (see **Section 4**). Information provided in this way is intended to afford stakeholders an opportunity to request additional information on specific activities or elements that may be of interest to them and to voice any concerns.

With the controls adopted, the assessed residual consequence for this impact is negligible and cannot be reduced further. Additional control measures were considered but rejected since the associated cost or effort was grossly disproportionate to any benefit. Therefore, it is considered that the impact is ALARP.

6.5.6 Acceptability Evaluation

Is the consequence ranked as A or B?	Yes – Maximum consequence is A (Negligible).
Is further information required in the consequence assessment?	No – Potential impacts and risks are well understood through the information available.
Are risks and impacts consistent with the principles of ecologically sustainable development?	Yes – Activity evaluated in accordance with Santos WA's Environmental Hazard Identification and Assessment Procedure, which considers principles of ecologically sustainable development.
Are risks and impacts consistent with relevant legislation, international agreements and conventions, guidelines and codes of practice (including species recovery plans, threat abatement plans, conservation advice and Australian marine park zoning objectives)?	Yes – Management consistent with the International Convention for the Safety of Life at Sea (SOLAS) 1974 and Navigation Act 2012.
Are risks and impacts consistent with Santos WA's Environmental Management Policy?	Yes – Aligns with Santos WA's Environmental Management Policy.
Are risks and impacts consistent with stakeholder expectations?	Yes – No concerns raised.
Are performance standards such that the impact or risk is considered to be ALARP?	Yes – See ALARP above.

A possibility remains that some interaction with other users will result as Reindeer WHP operations could encounter other users; however, with consideration of the control measures in place, based on Santos WA's consequence matrix (**Figure 5-2**), the worst impact is assessed as 'Negligible'.

The event is consistent with the relevant actions described in the international conventions and act listed above.

The presence of the WHP and support vessels is not expected to significantly affect other marine users, including commercial fishing operations or shipping traffic, given the small petroleum safety zone (500 m), marking of the facility on navigational charts, distance from defined shipping routes and absence of any navigation hazards.

A petroleum safety zone around the WHP is required under maritime legislation, and the controls proposed will ensure that other users are aware of its presence and readily able to navigate accordingly, such that potential impacts are ALARP and are considered to be environmentally acceptable.

6.6 Operational Discharges

6.6.1 Description of Event

Event	Planned discharges from the Reindeer WHP to the marine environment include: + Sewage/grey water; + Deck drainage/rain runoff; and + Platform maintenance. Planned discharges from support vessels within the operational area may include: + Sewage/grey water; + Food wastes; + Deck drainage; + Cooling water; + Bilge water; + Ballast water; and + Brine. Other discharges associated with planned maintenance and operations include: + Hydraulic fluid (valve operation on subsea Christmas trees and manifolds); + Discharges from cathodic protection systems on subsea pipelines; + Discharges from maintenance activities (e.g., from venting or releases during removal, replacement or repair of subsea infrastructure, pig launchers and receivers, leak testing, fabric maintenance); and + Paint and chemicals from cleaning, inspection and repair of infrastructure and pipeline.
Extent	Localised: within the area around the discharge points and in the direction of the prevailing current in surface waters.
Duration	During the operational life of the activity, localised impacts to water quality will occur.

6.6.1.1 Wellhead Platform Discharges

6.6.1.1.1 Sewage and Grey Water

A flushing toilet and hand wash basins have been provided for personnel when visiting the WHP (**Section 2**). These discharge directly overboard into the ocean. No kitchen facilities are available on the WHP; therefore no kitchen grey water (e.g., dishwater) or putrescible waste will be produced from the WHP. The volumes of sewage and washwater discharge are expected to be minimal from the WHP as it is an unmanned platform that is visited once every two months by 2 to 4 people (maximum of 10 people) (**Section 2**).

6.6.1.1.2 Washdown, Deck Drainage/Deck Washdown Water

Rainwater, wash-down water and any spillages from bunded deck areas are collected by the WHP atmospheric drain system, which drains to the atmospheric sump tank built into the cellar deck. During heavy rainfall events, the system is designed to separate hydrocarbons from the water and allow the separated water to discharge, storing the hydrocarbons, which will then be pumped back into the production header. The system is designed so that water is preferentially discharged over hydrocarbons

(**Section 2.4.1.11**). Hydrocarbons are separated in the atmospheric drain system; however, both are pumped back into the production line under normal operations.

This water may contain trace quantities of contaminants from the deck surface, such as detergents, oil and grease.

6.6.1.1.3 Platform Maintenance

Paint may be stripped from the WHP structure in order to undertake a visual inspection or preventive maintenance of the infrastructure. The removal of paint or external coating from infrastructures releases inert materials into the marine environment that will either fall to the seabed floor or be dispersed with the prevailing currents. Cleaning agents (e.g., garnet in the case of grit blasting) are transferred to the platform and are injected into the cleaning process system. Cleaning wastes (e.g., cleaning agents and cleaning residues) will be collected and transferred off the platform.

Maintenance activities may also result in planned discharges of fluids with low concentrations of hydrocarbons or chemicals. Gas or condensate may be vented or released after flushing and opening of a system, residual hydrocarbons and chemicals may also be released during these activities. Similarly leak testing would make use of a dye to detect leaks in a subsea system which may be released in small quantities.

Guano is also water blasted (using seawater) off the platform as required to maintain the helideck for safe helicopter landing. The guano and water is discharged directly to sea.

6.6.1.2 Support Vessels

6.6.1.2.1 Sewage and Grey Water

All support vessels will have toilets, laundries, showers and wash hand basins and kitchens, which will produce sewage and grey water. Depending on waste production rates and the specifications of sewage systems available, the total volume of this waste stream typically ranges between 0.04 and 0.45 m^3 per day per person (EMSA, 2016).

6.6.1.2.2 Food Waste

Putrescible waste from the WHP and its supply vessels is estimated to consist of approximately 1 L of food waste per person per day.

6.6.1.2.3 Deck Drainage

Rainwater, wash-down water and any spillages from bunded deck areas on a support vessel may potentially discharge into the ocean.

6.6.1.2.4 Cooling Water

Seawater may be used by some vessels as a heat exchange medium for the cooling of supply vessel machinery. Seawater is drawn from the ocean and pumped through heat exchangers, transferring heat from the vessel engines and machinery to the seawater. The seawater is then discharged to the ocean.

6.6.1.2.5 Bilge Water

Bilge water is an almost unavoidable product of operations vessels. Bilge water that is generated in proximity to shipboard equipment (such as in the engine room) may contain residual hydrocarbons and either is treated through an oily water filter system prior to overboard discharge or is collected and stored for discharge onshore.

6.6.1.2.6 Ballast Water

Ballast water is water confined in specially constructed compartments in a vessel's hold to serve as weight distribution and stabilisation material. Ballast water can contain marine pests (see **Section 7.1** for controls to prevent accidental introduction of marine pests).

6.6.1.2.7 Brine

The potable water supply systems available on the type of support vessels to be used for the activities are standard water-making systems. The water supply systems will be dosed with a non-toxic potable water stabiliser or a chemical of similar properties (i.e., fit for human consumption). The volume of the discharge depends on the requirement for fresh (or potable) water and would vary between the vessels and the number of people on board.

6.6.1.3 Routine Discharges from Maintenance and Operations

6.6.1.3.1 Hydraulic Fluids

Hydraulic fluid, used in the subsea equipment as a lubricant and sealant, may be released in very small quantities when subsea valves are used or tested. The estimated quantity released by the operation of a single valve is very small (less than 10 mL) (**Section 2**).

6.6.1.3.2 Metal Ions from Cathodic Protection

Use of sacrificial anodes for cathodic protection and corrosion prevention continually releases metal ions into the marine environment at an extremely low rate as most of the ions released will supply electrons to the steel surface of the pipeline to form a protective film. Santos WA uses aluminium and zinc anodes for cathodic protection.

6.6.1.3.3 Other Discharges from Maintenance and Operations Activities

Residual hydrocarbons, corrosion inhibitor, biocides and treated seawater are likely to enter the subsea marine environment from maintenance and operations activities. Small volumes of treated seawater will be released into the marine environment during these activities (approximately 10 m^3).

Leak testing of the subsea system may occur and result in small volumes (estimated at less than 50 mL) of non-toxic dye released. Integrity testing of subsea infrastructure can result in a methane gas bleed off. Brine (NaCl) may also be released during this activity in small volumes.

Non-routine work on subsea systems may require opening of the system (e.g., for the repair or replacement of equipment). This type of work occurs infrequently, typically every few years. Prior to work involving opening of the subsea system, hydrocarbons are flushed towards the DCGP with seawater containing chemicals (biocide) used to preserve the system. By opening the existing system or by replacing infrastructure during upgrade works, some treated seawater will be released to the marine environment with the potential for residual liquid hydrocarbons (condensate) to be associated with the discharge, although the flushing process is designed to reduce the amount of hydrocarbons left in the system to as low as practicable. Biocides are used at a concentration required for effective preservation of the subsea system (typically 200 to 1,000 ppm). The volume of treated seawater released will vary depending on the type of maintenance or repair being performed and the capacity of the infrastructure being worked on, but the volume is typically in the order of 2 m^3. As with replaced equipment and infrastructure, new equipment and infrastructure may also be dosed with biocide (e.g., biocide sticks) prior to hook-up to the existing facility.

Chemicals planned for use and discharge to the marine environment are selected and assessed using Santos WA's Operations Chemical Selection Evaluation and Approval Procedure (EA-91-II-10001).

6.6.1.4 Paint and Cleaning

Removing corrosion, external coating or marine growth from subsea infrastructure during cleaning releases inert materials and marine growth into the marine environment, which will either fall to the seabed floor or is dispersed with the prevailing currents. Guano is also released to sea when undertaking jet washing with seawater.

Subsea cleaning may require the use of acid wash chemicals to assist in calcareous marine growth removal. Chemicals selected for use during this activity will follow Santos WA's Operations Chemical Selection Evaluation and Approval Procedure (EA-91-II-10001).

6.6.2 Nature and Scale of Potential Environmental Impacts

<u>Potential receptors: Fish and sharks, marine mammals, marine turtles and seabirds</u>

6.6.2.1 Sewage and Grey Water

Sewage and grey water discharged to the ocean from the WHP and support vessels has the potential to cause water discolouration, localised nutrient enrichment, increase in water column productivity of phytoplankton and bacteria, or oxygen depletion from increased biological oxygen demand around the discharge. Discolouration of marine water around a sewage outlet is generally due to the release of sewage sludge with high levels of solids.

Nitrogen and phosphorus from sewage and grey water represent a nutrient source for phytoplankton populations. The accumulation of these nutrients can lead to increased primary production, which may stimulate secondary production, e.g., lead to algal blooms, which in turn could lead to changes in other algal community structures or release of toxic metabolites causing death in marine fauna.

6.6.2.2 Putrescible Waste

Discharges of macerated food scraps from the support vessels have the potential to result in localised increase in nutrient concentrations, exert biological oxygen demand on the receiving waters, and promote localised elevated levels of bacteria and phytoplankton activity.

Some fish and oceanic seabirds may be attracted to the vessel by the discharge of macerated food wastes. This attraction may either be direct, in response to increased food availability, or indirect, as a result of prey species being attracted to the vessel.

6.6.2.3 WHP Washdown Water and Deck Drainage/Deck Washdown Water

Washdown water can contain contaminants, such as cleaning detergents, oil and grease residues and trace quantities of metals, but these are typically of low concentrations. Therefore, the potential for impact is low, with dispersion and biodegradation expected to be rapid and highly localised due to typically strong prevailing currents and waves. This will not result in long-term or adverse effects on water quality or marine ecology.

6.6.2.4 Cooling Water

Most cooling water discharges on support vessels occur above the water line to reduce any potential water temperature impacts to the marine environment. As cooling water discharges occur relatively localised and intermittently to surface waters and the vessel activities are of a relatively short duration, it is not expected that these discharges will result in long-term or adverse effects upon the marine environment.

Temperature dispersion modelling undertaken by Woodside (2008) shows that cooling water temperature decreases quickly as it mixes with the receiving waters, with discharge waters being less than 1°C above background levels within less than 100 m (horizontally) of the discharge point. Vertically, modelling predicts that discharge is likely to be within background levels within 10 m from the source.

Brine discharge modelling by Woodside (2008) shows that most of the discharged brine from a jackup exploration drilling rig (12,000 m^3) remains in the upper water column (in the upper 10 metres). Results also showed that the discharge stream is reduced to approximately one per cent of its original concentration at no less than 50 m from the discharge point.

6.6.2.5 Brine

Brine from potable water supply systems on board support vessels will be of similar salinity as seawater and is not expected to have any significant impact on the marine environment. Any chance of effects will be highly temporary and localised due to the rapid dispersion expected due to the typically strong prevailing currents and waves.

Brine discharge modelling by Woodside (2008) shows that most of the discharged brine from a jackup exploration drilling rig (12,000 m^3) remains in the upper water column (in the upper 10 metres). Results also show that the discharge stream is reduced to approximately 1% of its original concentration at less than 50 m from the discharge point.

6.6.2.6 Bilge and Ballast Water

Oil and grease residue in bilge water are typically of low concentrations and the potential for impact is low, with dispersion and biodegradation expected to be rapid and highly localised due to the prevailing currents and waves, resulting in no long-term or adverse effects on water quality or marine ecology. Environmental impacts and risks associated with ballast water discharges are evaluated in **Section 7.1.**

6.6.2.7 Hydraulic Fluid

The use and testing of subsea valves releasing hydraulic fluid do not occur continuously, are of short duration, are monitored and are based upon the properties of the fluid used in an open oceanic environment. Therefore, they are not expected to affect marine fauna or water quality.

6.6.2.8 Paint, Chemicals and Residual Hydrocarbons

Removing paint or external coating from infrastructure releases inert materials into the marine environment, which will either fall to the seabed or disperse with the prevailing currents. These activities are carried out infrequently and will not significantly affect the marine environment. It is unlikely that the dispersed fines will be found in sufficient concentrations to cause toxic effects to marine fauna (e.g., from ingestion) due to the rapid dispersion and open ocean environment.

The discharges of residual hydrocarbons or chemicals in treated water are generally low and are most likely due to entrapment in pockets of subsea system gas or condensate that may be vented or released after flushing and opening of that system and chemicals in treated seawater (e.g., biocide) that are discharged during temporary opening up of subsea equipment. Similarly, leak testing would make use of a dye to detect leaks in a subsea system.

6.6.3 Environmental Performance and Control Measures

Environmental performance outcomes (EPOs) relating to this event include:

+ Emissions or discharges to sea or air meet legislative requirements and are ALARP and acceptable [EPO-RE-02].

The control measures considered for this EPO are shown in **Table 6-7**, with EPSs and measurement criteria for the EPO described in **Table 8-3**.

Table 6-7: Control Measures Evaluation for Liquid Waste

Control Measure Ref. No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
Standard Controls				
RE-CM-18	Sewage system.	Reduces potential impacts of inappropriate discharge of sewage. Provides compliance with Marine Order 96, Marine Pollution Prevention – Sewage	Personnel cost in ensuring vessel certificates are in place during vessel contracting and in premobilisation audits and inspections and in reporting discharge levels.	**Adopted** – Benefits of ensuring vessels are compliant outweigh minimal costs of personnel time, and it is a legislated requirement.
RE-CM-19	Oily mixture system.	Reduces potential impacts of planned discharge of oily water to the environment. Provides compliance with Marine Order 91, Marine Pollution Prevention – Oil.	Time and personnel costs in maintaining oil record book.	**Adopted** – Benefits of ensuring vessels are compliant outweigh the minimal costs of personnel time, and it is a legislated requirement.
RE-CM-20	Offshore platform deck drain system and bunding.	Reduces the likelihood of any oily or chemical content reaching the marine environment from the offshore platform.	Personnel and operational costs associated with construction and maintenance of offshore platform bunding and maintenance of bunding procedure.	**Adopted** – Benefit of the inspection to determine operational integrity outweigh the cost to undertake the inspection.
RE-CM-21	Garbage Management.	Reduces probability of garbage being discharged to sea, reducing potential impacts to marine fauna. Stipulates putrescible (food) waste	Personnel cost of premobilisation audits and inspections and of reporting discharge levels.	**Adopted** – Benefits of ensuring vessels are compliant outweigh the minimal costs of personnel time, and it is a legislated requirement.

Control Measure Ref. No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
		disposal conditions and limitations and AMSA Placards displayed on support vessels to provide a visual message to personnel about what wastes can be discharged where and improves waste awareness. Provides compliance with Marine Order 95, Marine Pollution Prevention – Garbage.		
RE-CM-22	Deck cleaning product selection.	Improves water quality discharge (reduces toxicity) to the marine environment. Those deck cleaning products planned to be released to sea meet the criteria for not being harmful to the marine environment according to MARPOL Annex V.	Personnel costs of implementing. Potential additional cost and delays of deck cleaning product substitution.	**Adopted** – Benefits of ensuring vessels are compliant and that those deck cleaning products planned to be released to sea meet MARPOL criteria outweigh the cost.
RE-CM-23	Chemical selection procedure.	Aids in the process of chemical management that reduces the impact of liquid discharges to sea. Only	Cost associated with implementation of procedure. Range of chemicals reduced with potentially higher costs for alternative products.	**Adopted** – Environmental benefit of using lower toxicity chemicals outweigh procedural

Control Measure Ref. No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
		environmentally acceptable products are used.		implementation costs.
RE-CM-24	Pipeline flushing prior to opening of the subsea system.	Production fluids (hydrocarbons) will be flushed through with treated water to the DCGP prior to maintenance activities. Reduces the toxicity of chemicals and residual hydrocarbons in subsea infrastructure before any release to sea during activities.	Additional costs and time taken to flush pipeline.	**Adopted** – Environmental benefits of flushing outweigh the associated costs.
Additional Control Measures				
N/A	Scupper plugs on support vessels are continuously in place to prevent deck drainage.	Would eliminate potential impacts of contaminants being discharged to sea in rainwater.	Increased health and safety risks from wet deck not draining. Large amounts of water on a vessel's deck can also cause stability issues (free-surface effect).	**Rejected** – Safety considerations outweigh the benefit given small volumes of contaminants.
N/A	Mandatory closed drain system on support vessels to prevent deck drainage discharged overboard.	Would prevent the release of deck spills to sea and therefore reduce environmental impact.	Increased cost due to treatment system required, modifications to vessels, storage space required for containment of drained liquids, increase in transfers to vessels resulting in increased potential impacts and risks. Increased transfers result in increased fuel usage, increased safety risks to personnel during transfer (e.g.,	**Rejected** – Cost outweighs the benefit given the low impact expected from planned discharges and high potential impacts from the increased transfers required.

Control Measure Ref. No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
			crushing between skips), and increase in crane movements.	
N/A	Discharge point for cooling water discharges restricted to above sea level to allow it to cool further before mixing at sea surface.	Reduce potential impacts associated with discharge of higher temperature water into the marine environment.	High costs to alter all current vessels to allow for discharge of cooling water at different height, not feasible on all vessels, and reduction in temperature would be minimal compared to cost of altering the discharge height.	**Rejected** – Cost outweighs the benefit given the low impact expected from planned discharges.
N/A	Store liquid wastes and transport to land.	No discharge to the marine environment.	This would result in an increase in environmental impacts through increased fuel consumption and increased atmospheric emissions, both by the vessel (or transport vessel) having to return to port a number of times to unload the wastes and by land transport to the nearest disposal facility. Increased energy consumption and atmospheric emissions would also result from the disposal (e.g., incineration, treatment) of the wastes.	**Rejected –** This would result in an increase in environmental impacts onshore and higher risk to the safety of personnel.

6.6.4 Environmental Impact Assessment

<table>
<tr><th>Receptor</th><th>Consequence Level</th></tr>
<tr><th colspan="2">Operational Discharges</th></tr>
<tr><td>Threatened, migratory, or local fauna</td><td rowspan="3">Impacts to water quality that will be experienced in the discharge mixing zone will be localised and will occur only as long as the discharges occur (i.e., no sustained impacts); therefore, recovery will be measured in hours to days.
Changes to water quality may result in an alteration to marine fauna behaviour. Sensitive receptors that may be impacted include fish at surface, marine turtles and mammals, and seabirds. Any effects on water quality are expected to be within the surface waters only and have no effect on seabed receptors.
Given the infrequency of discharges (approximately every two months) and the highly dispersive waters of the North West Shelf, impacts will be limited to short-term water quality impacts and possible temporary behavioural effects observed in fish, sharks and seabirds.
While marine fauna may transit through the area, there are no feeding, breeding or other aggregation areas nearby.
No physical environments or habitats are identified in the area over which operational discharges are expected to disperse other than open water.</td></tr>
<tr><td>Physical environment or habitat</td></tr>
<tr><td>Socio-economic receptors</td></tr>
<tr><td>Threatened ecological communities</td><td>Not applicable – No threatened ecological communities are identified in the area over which planned discharges are expected.</td></tr>
<tr><td>Protected areas</td><td>Not applicable – No protected areas are identified in the area where planned discharges could affect water quality.</td></tr>
<tr><td>Overall worst-case consequence</td><td>A – Negligible</td></tr>
</table>

6.6.5 Demonstration of ALARP

During operations activities, small amounts of sewage, putrescible waste and wash-down water will be generated on the WHP and support vessels, and these are unavoidable as routine maintenance is required on these facilities.

The alternative to discharging these small amounts of liquid wastes to the marine environment is to store and transport the wastes to land, where they would be disposed of in line with industry best practice. However, this would result in an increase in environmental impacts through increased fuel consumption and increased atmospheric emissions, both by the vessel (or transport vessel) having to return to port a number of times to unload the wastes and by land transport to the nearest disposal facility. Increased energy consumption and atmospheric emissions would also result from the disposal (e.g., incineration, treatment etc.) of the additional wastes. This method would also result in an increased risk of vessel-to-platform or vessel-to-vessel collision, which could lead to a marine diesel spill. Therefore, this option would be of no net environmental benefit and would increase the risk associated with the activity, so it has not been adopted.

Therefore, to reduce the impacts and risks associated with discharging liquid wastes, these wastes will be treated in line with industry best practise. Discharge of sewage and other liquid wastes from vessels in Australian waters is permissible under the Protection of the Sea (Prevention of Pollution from Ships) Act 1983, which reflects requirements of MARPOL 73/78 Annexes IV, V and I and AMSA Marine Orders 95 and 96.

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Generating oily mixture from deck drainage and machinery spaces is unavoidable for the WHP and its support vessels. Discharge of oily water from vessels in Australian waters is permissible under the Protection of the Sea (Prevention of Pollution from Ships) Act 1983, which reflects MARPOL 73/78 Annex I requirements. Support vessels must abide by this regulation, which requires oily water discharges to be no greater than 15 ppm (mg/L) and discharged en-route.

Maintenance or modification of topsides and subsea equipment is required to ensure the integrity of the hydrocarbon production and transport infrastructure. Facilities designs, together with procedures, work plans and risk assessments developed for specific jobs, help to manage the volume of chemicals, hydrocarbons and other wastes released during these interventions.

The MARPOL standard and AMSA marine orders are considered to be the most appropriate standard to adhere to in this environment, given the nature and scale of the activity, and are widely accepted and used in the industry. Compliance with these requirements, together with implementation of the controls listed above, reduces the environmental impacts and risks associated with liquid waste discharges to marine environment to ALARP.

6.6.6 Acceptability Evaluation

Is the consequence ranked as A or B?	Yes – Maximum consequence from liquid waste discharges is A (Negligible).
Is further information required in the consequence assessment?	No – Potential impacts and risks are well understood through the information available.
Are risks and impacts consistent with the principles of ecologically sustainable development?	Yes – Activity evaluated in accordance with Santos WA's Environmental Hazard Identification and Assessment Procedure, which considers principles of ecologically sustainable development.
Are risks and impacts consistent with relevant legislation, international agreements and conventions, guidelines and codes of practice (including species recovery plans, threat abatement plans, conservation advice and Australian marine park zoning objectives)?	Yes – Consistent with relevant species recovery plans, conservation management plans and management actions set out in **Table 3-6**, including but not limited to: + Recovery Plan for Marine Turtles in Australia (2017), + Recovery Plan for Threatened Albatrosses and Giant Petrels (DSEWPaC, 2011) + Approved Conservation Advice for Megaptera novaeangliae (humpback whale) + Conservation Management Plan for the Blue Whale, 2015-2025
Are risks and impacts consistent with Santos WA's Environmental Management Policy?	Yes – Aligns with Santos WA's Environmental Management Policy.
Are risks and impacts consistent with stakeholder expectations?	Yes – No concerns raised by stakeholders for this event.
Are performance standards such that the impact or risk is considered to be ALARP?	Yes – See ALARP above.

Release of non-hazardous discharges into the sea from vessels in Australian waters is permissible under the Protection of the Sea (Prevention of Pollution from Ships) Act 1983, which in Australian waters reflects MARPOL Annex I, IV, and V requirements respectively, and is enacted by:

+ Marine Order 91 (Marine pollution prevention – oil);

+ Marine Order 96 (Marine pollution prevention – sewage); and
+ Marine Order 95 (Marine pollution prevention – garbage).

The operational discharges are not expected to significantly impact the receiving environment given the management controls proposed, including compliance with all relevant Marine Orders requirements. The Marine Orders are considered to be the most appropriate standard given that the nature and scale of the events is expected to reduce the potential for environmental impacts to a level that is considered ALARP and environmentally acceptable.

Operational discharges from vessels will result in short-term and localised impacts; however, with consideration of the control measures in place, based on Santos WA's consequence matrix (**Figure 5-2**), the worst-case impact is assessed as 'Negligible'.

The activity is consistent with the relevant actions described in the recovery plans listed in **Table 3-6**.

No impacts to other marine park values are expected. No stakeholder concerns have been raised regarding the activity.

The impacts of operational discharges to the receiving environment are ALARP and considered environmentally acceptable.

6.7 Spill Response Operations

The spill response strategies that may be adopted in the event of a hydrocarbon spill have been identified in **Table 7-12** and **Table 7-19**. Potential impacts arising from the implementation of the following spill response operations and actions have been assessed as planned events in this section.

6.7.1 Description of Event

Event	In the event of a hydrocarbon spill, response strategies will be implemented to reduce environmental impacts to ALARP. The selection of strategies will be undertaken through the net environmental benefit analysis process, outlined in the OPEP. Spill response will be under the direction of the relevant Control Agency, as defined within the OPEP (Section 2.2), which may be Santos WA or another agency or both. In all instances, Santos WA will undertake a 'first-strike' spill response and will act as the Control Agency until the designated Control Agency assumes control. The response strategies selected as appropriate for the worst-case oil spill scenarios identified for the event are detailed in Table 3-5 of the OPEP and comprise: + Source control; + Monitoring and evaluation; + Mechanical dispersion; + Shoreline protection and deflection; + Shoreline clean-up; + Oiled wildlife response; + Scientific monitoring; and + Waste management. While response strategies are intended to reduce the environmental consequences of a hydrocarbon spill, poorly planned and coordinated response activities can result in a lack of or inadequate information being available, which can lead to poor decisions being made, thereby exacerbating or causing further environmental harm. An inadequate level of training and guidance during the implementation of spill response strategies can also result in environmental harm over and above that already caused by the spill.

	The greatest potential for impacts additional to those described for routine operations is from shoreline clean-up and oiled wildlife response operations where coastal and shoreline habitat damage and fauna disturbance may occur.
Extent	Extent of spill.
Duration	As required

6.7.2 Nature and Scale of Impacts

Light Emissions	
Spill response activities will involve the use of vessels that are required, at a minimum, to display navigational lighting. Vessels may operate in close proximity to shoreline areas during spill response activities. Spill response activities will also involve onshore operations, including the use of vehicles and temporary camps, both of which may require lighting.	
Potential receptors:	Fauna (including threatened, migratory, or local fauna) Protected areas Socio-economic receptors
Lighting may cause behavioural changes in fish and sharks, seabirds and marine turtles that can have a heightened consequence during key lifecycle activities, such as turtle nesting and hatching. Turtles and seabirds, which include threatened and migratory fauna (**Table 3-5**), have been identified as key fauna susceptible to lighting impacts during spill response activities. **Section 6.2** provides further detail on the nature of impacts to fish and sharks, seabirds and marine turtles. Spill response activities that require lighting may take place in protected areas important to turtles. For example, shoreline locations of the Montebello Islands, Barrow Island and Ningaloo area are seasonally important for turtles. During nesting and hatching season (primarily over summer months) lighting may cause behavioural impacts to turtles, including aborted nesting attempts and disorientation of newly hatched turtles, which may increase mortality rates. Spill response activities may also occur on shorelines used by nesting and feeding birds, including seabirds and shorebirds. Lighting can cause disorientation in flying birds, disrupt nesting and breeding behaviours and impact on the ability of birds to forage. Disturbance to feeding migratory shorebirds may reduce their ability to replenish energy reserves and alter the timing and success of migratory flights. As a consequence of impacts to fauna, lighting has the potential to directly impact supported industries, such as tourism, and indirectly impact the values of protected areas.	
Acoustic Disturbance	
Spill response activities will involve the use of aircraft and vessels that will generate noise both offshore and in proximity to sensitive receptors in coastal areas. Spill response activities will also involve the use of equipment on coastal areas during shoreline clean-up (e.g., pumps and vehicles), to access shoreline areas (e.g., vehicles) and to support temporary camps (e.g., diesel generators).	
Potential receptors:	Fauna (including threatened, migratory, or local fauna) Protected areas Socio-economic receptors
Underwater noise from the use of vessels may impact marine fauna, such as fish and sharks, marine reptiles and marine mammals, in the worst instance causing physical injury to hearing organs but more likely causing short-term behavioural changes that may impact key lifecycle processes (e.g., spawning, breeding, calving). Underwater noise can also mask communication or	

echolocation used by cetaceans. **Section 6.1** provides further detail on these impacts from vessels. Cetaceans have been identified as the key concern for vessel noise within the EMBA. Spill response activities using vessels have the potential to impact fauna in protected areas, including Montebello Marine Park. Noise and vibration from terrestrial activities on shorelines has the potential to cause behavioural disturbance to coastal fauna, including protected and migratory species of shorebirds and turtles. Shoreline activities involving the use of noise-generating equipment may take place in important nesting areas for turtles and roosting or feeding areas for shorebirds. As a consequence of impacts to fauna (including shorebirds, marine mammals, fish and sharks), noise has the potential to impact supported industries, such as tourism and commercial fishing.	
Atmospheric Emissions	
The use of fuels to power vessel engines, generators and mobile equipment used during spill response activities will result in emissions of GHGs, such as carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O), along with non-GHGs, such as sulphur oxides (SO_x) and nitrous oxides (NO_x). Emissions will result in localised decreases in air quality.	
Potential receptors:	Fauna (including threatened, migratory, or local fauna) Physical environment or habitat Protected areas Socio-economic receptors
Atmospheric emissions from spill response equipment will be localised; and while potential exists for fauna and flora impacts, the use of mobile equipment, vessels and vehicles is not considered to create emissions on a scale where noticeable impacts would be predicted. Emissions may occur in protected areas and areas where tourism is important; however, the scale of the impact relative to potential oil spill impacts is not considered great.	
Operational Discharges and Waste	
Operational discharges includes those routine discharges from vessels used during spill response and may include: + Deck drainage; + Putrescible waste and sewage; + Cooling water from operation of engines; + Bilge water; + Ballast water; and + Brine discharge. In addition, there are specific spill response discharges and waste creation that may occur, including: + Cleaning of oily equipment, vessels and vehicles; + Flushing water for the cleaning of shoreline habitats; + Sewage, putrescible waste and municipal waste at camp areas; and + Creation, storage and transport of oily waste and contaminated organics.	
Potential receptors:	Fauna (including threatened, migratory, or local fauna) Physical environment or habitat Protected areas Socio-economic receptors
Operational discharges from vessels may create a localised and temporary reduction in marine water quality. Effects include nutrient enrichment, toxicity, turbidity, and temperature and salinity	

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increases as detailed in **Section 6.6**. These may impact a different set of receptors than previously described in that section given vessel use may occur in shallower coastal waters during spill response activities. Discharge could potentially occur adjacent to such marine habitats as corals, seagrass, and macroalgae and in protected areas (i.e., receptors anywhere within the EMBA), all of which support a more diverse faunal community; however, discharges will be very localised and temporary. Cleaning of oil-contaminated equipment, vehicles and vessels has the potential to spread oil from contaminated areas to those area not impacted by a spill, potentially spreading the impact area and moving oil into a more sensitive environment. Flushing of oil from shoreline habitats is a clean-up technique designed to remove oil from the receptor that has been oiled and remobilise the oil back into the marine environment, which can result in further dispersion of the oil. The process of flushing has the potential to physically damage shoreline receptors, such as mangroves and rocky shoreline communities, increase levels of erosion; and create an additional, and potentially higher, level of impact than if the habitat was left to bioremediate. Sewage, putrescible waste and municipal waste will be generated from onshore activities at temporary camps, which may include toilet and washing facilities. These wastes have the potential to attract fauna; impact habitats, flora and fauna; and reduce the aesthetic value the environment areas, all of which may be within protected areas. The creation, storage and transport of oily waste and contaminated organics has the potential to spread impacts of oil to areas, habitats and fauna not previously contaminated.
Physical Presence and Disturbance
The movement and operation of vessels, vehicles, personnel and equipment and the set-up of temporary camp areas during spill response activities has the potential to disturb the physical environment and marine and coastal habitats and fauna, which may include those habitats and fauna within protected areas. Disturbance may also impact cultural values of an area. The movement of vessels could potentially introduce to nearshore areas invasive marine species attached as biofouling, while vehicle and equipment movement could spread non-indigenous flora and fauna. Oiled wildlife response activities may involve deliberate disturbance (hazing), capture, handling, cleaning, rehabilitation and release of wildlife, which could lead to additional impacts to wildlife.

Potential receptors:	Fauna (including threatened, migratory, or local fauna) Physical environment or habitat Protected areas Socio-economic receptors

The use of vessels may disturb benthic habitats in coastal waters, including corals, seagrass, macroalgae and mangroves. Impacts to habitats from vessels include damage through the deployment of anchors, chains, and nearshore oil containment booms and from grounding. Vessel use in shallow coastal waters also increases the chance of contact or physical disturbance with marine megafauna, such as turtles and dugongs. Booms create a physical barrier on the surface waters that has the potential to injure or entangle passing marine fauna that are either surface breathing or surface feeding. Vehicles, equipment and personnel used during shoreline response activities have the potential to damage such coastal habitats as dune vegetation, mangroves and habitats important to threatened and migratory fauna and to damage nests of turtles and birds and bird roosting or feeding areas. Shoreline clean-up may involve the physical removal of substrates that could cause impact to habitats and coastal hydrodynamics and alter erosion or accretion rates. The presence of camp areas, although relatively short-term, may disrupt normal behaviour of such coastal species as shorebirds and turtles and could potentially interfere with nesting and feeding behaviours.

Oiled wildlife response may include the hazing, capture, handling, transportation, cleaning and release of wildlife susceptible to oiling, such as birds and marine turtles. While oiled wildlife response is aimed at having a net benefit, poor response can potentially create additional stress and exacerbate impacts from oiling, interfering with lifecycle processes, hampering recovery and, in the worst instance, increasing levels of mortality. Impacts and risks from invasive marine species are described in **Section 7.1** and are not described further in this section. Impacts from invasive terrestrial species (e.g., weeds) are similar to those of invasive marine species in that the invasive species can outcompete local species and interfere with ecosystem processes. Non-native species may be transported attached to equipment, vehicles and clothing. Such an introduction would be especially detrimental to wilderness areas or protected terrestrial reserves, which may have a relatively undisturbed flora and fauna community. The disturbance to marine and coastal natural habitat, as well as the potential for disruption to culturally sensitive areas, which may occur in specially protected areas, may have flow-on impacts to socio-economic values and industry (e.g., tourism, fisheries).		
Disruption to Other Users of Marine and Coastal Areas and Townships		
Spill response activities may involve the use of vessels, equipment and vehicles and the establishment of temporary camps in areas used by the general public or industry. The mobilisation of spill response personnel into an affected area may also place increased demands on local accommodation and other businesses.		
Potential receptors:	Socio-economic receptors	
The use of vessels in the nearshore and offshore environment and the undertaking of spill response activities at shoreline locations may exclude general public and industry use of the affected environment. As well as impacting leisure activities of the general public, this may impact on revenue with respect to such industries as tourism and commercial fishing. The mobilisation of personnel to small communities has the potential to affect the local community through demands on local accommodation and business, reducing the availability of services to members of the public.		

6.7.3 Environmental Performance and Control Measures

Environmental performance outcomes (EPOs) relating to this event include:

+ Implementation of source control methods to stop the release of hydrocarbons into the marine/onshore environment. [EPO-RE-OPEP-01]
+ Implement monitor and evaluate tactics in order to provide situational awareness to inform IMT decision making. [EPO-RE- OPEP-02]
+ Implement mechanical dispersion to reduce the concentration of surface hydrocarbons to reduce contact with protection priorities. [EPO-RE- OPEP-03]
+ Implement shoreline protection and deflection tactics to reduce hydrocarbon contact with coastal protection priorities. [EPO-RE- OPEP-04]
+ Implement shoreline clean-up tactics to remove stranded hydrocarbons from shorelines in order to reduce impact on coastal protection priorities and facilitate habitat recovery. [EPO-RE- OPEP-05]
+ Assist DFES in the control of hazardous material. Remediate the site as directed by the Jurisdictional Authority. [EPO-RE- OPEP-06]

+ Implement tactics in accordance with the Western Australian Oiled Wildlife Response Plan (WAOWRP) to prevent or reduce impacts, and to humanely treat, house, and release or euthanase wildlife. [EPO-RE- OPEP-07]

+ Comply with waste treatment, transport and disposal regulations and prevent secondary contamination while reducing, reusing and recycling waste where possible. [EPO-RE- OPEP-08]

+ Implement monitoring programs to assess and report on the impact, extent, severity, persistence and recovery of sensitive receptors contacted by a spill. [EPO-RE- OPEP-09]

The control measures considered for this activity are shown in **Table 6-6,** with EPSs and measurement criteria for the EPOs described in **Table 8-4.**

Environmental Performance Standards (EPSs) and measurement criteria for spill response control measures are provided within the relevant strategy sections of the OPEP.

Table 6-8: Control Measures Evaluation for Spill Response Operations

Control Measure Ref. No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
Standard Controls				
RE-OPEP-CM-01	Competent Incident Management Team (IMT) and oil spill responder personnel.	Ensures that spill response strategy selection and operational activities consider the potential for additional environmental impacts.	Personnel and operational costs associated with maintaining competent IMT team and responder personnel.	**Adopted –** Considered a standard spill response control.

6.7.4 Environmental Impact Assessment

Receptor	Consequence Level
Spill Response Operations – Light Emissions	
Threatened, migratory, or local fauna Physical environment or habitat Threatened ecological communities Protected areas Socio-economic receptors	The receptors considered most sensitive to lighting from vessel and shoreline operations are seabirds, shorebirds and marine turtles, particularly over summer months with respect to marine turtles where emerging hatchlings are sensitive to light spill onto beaches. Following restrictions on night time operations by spill response vessels, which will demobilise to mooring areas offshore with safety lighting only, impacts from vessels are considered to be A (*Negligible*). Temporary camps will be positioned at the direction of DoT or DBCA and control measures on lighting colour and direction will be followed; therefore, the consequence of shoreline lighting is considered *Negligible*. These species are likely to be values of the protected area they occur in (e.g., Montebello Islands, Ningaloo), and the impact to the protected area from light is also considered *Negligible*. As a consequence of impacts to fauna, lighting has the potential to impact supported industries, such as tourism; however, as impacts to fauna are considered negligible, any indirect impacts on tourism will also be *Negligible*.

Overall worst-case consequence level	A – *Negligible*
Spill Response Operations – Acoustic Disturbance	
Threatened, migratory, or local fauna Physical environment or habitat Threatened ecological communities Protected areas Socio-economic receptors	The receptor considered most sensitive to vessel noise disturbance is the humpback whale during migration season, when these whales come close to the Montebello Islands and Barrow Island during their peak migration (July to October), as well as populations of marine turtles, whale sharks and pygmy blue whales. However, following the adoption of control measures to limit close interaction with protected fauna (i.e., Protected Marine Fauna Interaction and Sighting Procedure (EA-91-II-00003)), a temporary behavioural disturbance is expected only with a consequence of *Negligible*. With respect to noise from onshore operations (mobile equipment and vehicles), nesting, roosting or feeding birds are considered to be the most sensitive to noise, in particular shorebirds that may be aggregating at Montebello Islands, Barrow Island and the Ningaloo coast. The equipment used is not considered to have excessive sound levels and, following direction by DoT and DBCA on the location of temporary camp areas, the consequence to birds from noise is expected to be *Negligible*. Shorebirds may be official values of the protected area they occur in, and the impact to the protected area from noise is also considered *Negligible*.
Overall worst-case consequence level	A – *Negligible*
Spill Response Operations – Atmospheric Emissions	
Threatened, migratory, or local fauna Physical environment or habitat Threatened ecological communities Protected areas Socio-economic receptors	Atmospheric emissions from spill response equipment will be localised; and impacts to even the most sensitive fauna, such as birds, are expected to be *Negligible*. Because of the emissions will be localised and low level, impacts to protected area values, physical environment and socio-economic receptors are predicted to be *Negligible*.
Overall worst-case consequence level	A – *Negligible*
Spill Response Operations – Operational Discharges and Waste	
Threatened, migratory, or local fauna Physical environment or habitat Threatened ecological communities	Operational discharges from vessels may create a localised and temporary reduction in marine water quality, which has the potential to impact shallow coastal habitats in particular; however, following the adoption of regulatory requirements for vessel discharges, which prevent discharges close to shorelines, discharges will have a *Negligible* impact to habitats, fauna or protected area values. Furthermore, washing of vessels and equipment will take place only in defined offshore hot zones preventing impacts to shallow coastal habitats. As a consequence of impacts to fauna, operational discharges from vessels has the potential to impact supported industries, such as tourism and

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Protected areas Socio-economic receptors	commercial fishing; however, as impacts to fauna are considered *Negligible*, any indirect impacts on socio-economic receptors will also be *Negligible*. Onshore, the use of flushing water has the potential to damage sensitive shoreline and intertidal habitats, e.g., mangroves; however, low-pressure flushing only will be used, preventing further damage to habitats or erosion of sediments. For sensitive habitats, the deployment of booms will be considered to retain flushed hydrocarbons, if this presents a net benefit. Following these control measures, the use of flushing to clean shorelines and intertidal habitats is seen to have a *Negligible* additional impact to habitats, fauna or protected area values. The cleaning of contaminated vehicles and equipment onshore has the potential to spread oily waste and damage habitats if not contained. Decontamination units will be in used during the spill response, thus containing waste and preventing any secondary contamination. The consequence of cleaning discharges is therefore ranked as *Negligible* in terms of impacts to habitats, fauna or protected area values. Sewage, putrescible waste and municipal waste generated onshore will be stored and disposed of at approved locations. The storage, transport and disposal of hydrocarbon-contaminated waste arising from spill response operation actions, such as containment and recovery and shoreline clean up, will be managed by Santos WA's appointed waste management contractor; and dedicated waste containment areas will prevent the spreading or leaching of hydrocarbon contamination. The consequence of sewerage discharges is therefore ranked as *Negligible* in terms of impacts to habitats, fauna or protected area values.
Overall worst-case consequence level	A – *Negligible*
Spill Response Operations – Physical Presence and Disturbance	
Threatened, migratory, or local fauna Physical environment or habitat Threatened ecological communities Protected areas Socio-economic receptors	The use of vessels and nearshore booms has the potential to disturb benthic habitats, including sensitive habitats in coastal waters, such as corals, seagrass, macroalgae and mangroves. A review of shoreline and shallow water habitats and of bathymetry and the establishment of demarcated areas for access and anchoring (along with other control measures in **Section 6.5**) will reduce the level of impact to *Negligible*. The use and movement of vehicles, equipment and personnel during shoreline response activities has the potential to disturb coastal habitats, such as dune vegetation, samphire and mangroves, and important habitats of threatened and migratory fauna, including nests of turtles and birds and bird roosting areas. Furthermore, clean-up can involve physical removal of substrates that could impact habitats and fauna and alter coastal hydrodynamics. As with vessel use, an assessment of appropriate vehicles and equipment to reduce habitat damage, along with the establishment of access routes, demarcation zones, and operational restrictions on equipment and vehicle use, will limit sensitive habitat damage and damage to important fauna areas. The establishment of temporary camp areas will be done under direction of DoT and DBCA with suitable advice sought if access is needed to culturally significant areas. Following these and other control measures, the resultant consequence to the physical environment and habitat is assessed as *Minor*, indicating that there may be a detectable reduction in habitat area from response activities (as separate from spill impacts), but recovery will be relatively rapid once spill response activities cease. As with all spill response activities, this disturbance will only occur if there is a net benefit to accessing and cleaning shoreline areas.

	The main direct disturbance to fauna would be the hazing, capture, handling, transportation, cleaning and release of wildlife susceptible to oiling impacts, such as birds and marine turtles. This would only be done if this intervention were to deliver a net benefit to the species, but it may result in a *Minor* consequence following compliance with the WA Oiled Wildlife Response Plan and the Pilbara Region Oiled Wildlife Response Plan. These habitats or environments are likely to be values of the protected area they occur in, and the impact to the protected areas from physical disturbance is therefore also considered *Minor*. The disturbance to marine and coastal natural habitat, as well as the potential for disruption to culturally sensitive areas, which may occur in specially protected areas, may have flow-on impacts to socio-economic values and industry (e.g., tourism, fisheries). This impact is considered *Minor.*
Overall worst-case consequence level	B – *Minor*
Spill Response Operations – Disruption to Other Users of Marine and Coastal Areas and Townships	
Threatened, migratory, or local fauna	The use of vessels in the nearshore and offshore environment and spill response activities at shoreline locations and within townships may exclude general public and industry use. Note that this is distinct from the socio-economic impact of a spill itself, which would have a far greater detrimental impact to industry and recreation. Following the application of control measures, it is considered that the additional impact of spill response activities on affected industries would be *Minor*.
Physical environment or habitat	
Threatened ecological communities	
Protected areas	
Socio-economic receptors	
Overall worst-case consequence level	B – *Minor*

6.7.5 Demonstration of ALARP

A net environmental benefit analysis is the primary tool used during spill response to evaluate response strategies with the goal of selecting strategies that result in the least net impact to key environmental sensitivities. The net environmental benefit analysis process conducted as a spill occurs will identify and compare net environmental benefits of alternative spill response options. The analysis will effectively determine whether an environmental benefit will be achieved through implementing a response strategy compared to undertaking no response. The analysis will be undertaken by the relevant Control Agency for the activity. For those activities under the control of Santos WA, the Environment Team Leader will be responsible for reviewing the priority receptors and selected response strategies identified within this EP and coordinating the net environmental benefit analysis for each operational period. This will ensure that, at the strategy level, the response operations reduce additional environmental impacts to ALARP.

Spill response activities will be conducted in offshore and coastal waters, using vessels and aircraft. The greatest potential for additional impacts from implementing spill response is considered to be to wildlife in offshore waters from oiled wildlife response activities and to shoreline habitats and fauna receptors within shallow waters or on shorelines from shoreline clean-up activities.

Given the types of activities considered appropriate to responding to a worse-case spill and the scale of operations, the standard control measures adopted by Santos WA for spill response to reduce the level of additional impacts are considered to reduce these impacts to ALARP. This includes working with the relevant Control Agency for spill response and applying the processes and standards, e.g., for oiled wildlife response as included in the WA Oiled Wildlife Response Plan.

Santos WA has considered the actions prescribed in the Recovery Plan for Marine Turtles in Australia (DoEE, 2017) and approved conservation advice for other relevant threatened fauna relevant to spill responses for the activities to minimise noise and light impacts on marine cetaceans, fish, sharks and marine turtles, especially flatback turtles. The proposed activity will not result in significant impacts on these species, and implementation of identified control measures is in line with the relevant conservation advice and recovery plans. Pollution events (such as hydrocarbon spills) could impact on fauna, and the use of vessels and equipment during the spill response could result in potential impacts as described in this EP. Control measures in place for vessel and helicopter use as provided in **Section 6.2** will reduce potential impacts to marine fauna, and these are consistent with current conservation advice. The assessed residual consequence for this impact is *Minor* and cannot be reduced further without grossly disproportionate costs. It is considered therefore that the impact of the activities conducted is ALARP.

6.7.6 Acceptability Evaluation

Is the consequence ranked as A or B?	Yes – Maximum consequence is a B (Minor).
Is further information required in the consequence assessment?	No – Potential impacts and risks are well understood through the information available.
Are risks and impacts consistent with relevant legislation, international agreements and conventions, guidelines and codes of practice (including species recovery plans, threat abatement plans, conservation advice and Australian marine park zoning objectives)?	Yes – IUCN principles of nearby reserves (Montebello Australian Marine Park and the MPNMP) are met (**Section 3.2.3**). Control measures implemented will minimise the potential impacts from spill response activities to protected areas and their values and to species identified in recovery plans and conservation advice as having the potential to be impacted. Consistent with relevant species recovery plans, conservation management plans and management actions set out in **Table 3-6**.
Are risks and impacts consistent with Santos WA's Environmental Management Policy?	Yes – Aligns with Santos WA's Environmental Management Policy.
Are risks and impacts consistent with stakeholder expectations?	Yes – No concerns raised by stakeholders for this event. During any spill response, a close working relationship with relevant regulatory bodies (e.g., DoT, DBCA, AMSA, and Director of National Parks) will occur, and thus there will be ongoing consultation with relevant stakeholders on the acceptability of response operations. Wildlife response will be conducted in accordance with the WA Oiled Wildlife Response Plan.
Are performance standards such that the impact or risk is considered to be ALARP?	Yes – See ALARP above.

The implementation of response activities to reduce the potential impacts from a spill are required by legislation. The spill response options selected have been demonstrated to show a net environmental benefit, are standard industry practice, and are consistent with relevant standards and guidelines, including the National Plan for Maritime Environmental Emergencies (AMSA, 2019). No concerns from stakeholders have been raised regarding response activities, and the controls proposed reduce the consequences of the potential impacts to Minor (B) and ALARP. The controls used during spill response activities are therefore considered to reduce additional impacts and risks to an acceptable level.

7 Environmental Assessment for Unplanned Events

OPGGS(E)R 2009 Requirements
Regulation 13(5)
The environment plan must include: (a) details of the environmental impacts and risks for the activity; and (b) an evaluation of all the impacts and risks, appropriate to the nature and scale of each impact or risk; and (c) details of the control measures that will be used to reduce the impacts and risks of the activity to as low as reasonably practicable and an acceptable level.
Regulation 13(6)
To avoid doubt, the evaluation mentioned in paragraph (5)(b) must evaluate all the environmental impacts and risks arising directly or indirectly from: (a) all operations of the activity; and (b) potential emergency conditions, whether resulting from accident or any other reason.
Regulation (13)(7)
The environment plan must: (a) set environmental performance standards for the control measures identified under paragraph (5)(c); and (b) set out the environmental performance outcomes against which the performance of the titleholder in protecting the environment is to be measured; and (c) include measurement criteria that the titleholder will use to determine whether each environmental performance outcome and environmental performance standard is being met.

Santos WA's environmental assessment identified seven potential sources of environmental risks associated with unplanned events for this activity. The results of the environmental assessment are summarised in **Table 7-1**. A comprehensive risk and impact assessment for each of the unplanned events and subsequent control measures proposed by Santos WA to reduce the risk and impacts to ALARP are detailed in the following subsections. **Section 7.5** also describes the credible spill scenarios and relevant information on the hydrocarbon spill modelling conducted for the activity.

Table 7-1: Summary of the Risk Assessment Ranking for Unplanned Activities

EP Section	Event	Consequence	Likelihood	Residual risk ranking

7.1	Introduction of invasive marine species	D - Major	2 – Very Unlikely	Medium
7.2	Marine fauna interaction	C - Moderate	2 – Very Unlikely	Medium
7.3	Release of solid objects (dropped objects)	A – Negligible	3 – Unlikely	Low
7.3	Release of solid objects (accidental release)	A – Negligible	2 – Very Unlikely	Low
7.4	Hazardous liquid releases	A –Negligible	2 – Very unlikely	Low
7.6	Surface release of condensate from the Reindeer WHP	D - Major	1 - Rare	Medium
7.7	Subsea release of condensate from a subsea pipeline	D - Major	1 - Rare	Medium
7.8	Surface release of diesel	B - Minor	1 - Rare	Low

7.1 Introduction of Invasive Marine Species

7.1.1 Description of Event

Event	Introduction of invasive marine species may occur due to: + Biofouling on support vessels and external or internal (e.g., sea chests, seawater systems) niches; + Biofouling on equipment that is routinely submerged in water (e.g., mooring lines, ROVs); + Discharge of high-risk ballast water; and + Cross-contamination between vessels. Once established, invasive marine species have the potential to outcompete indigenous species and affect overall ecosystem function.
Extent	Localised (seabed within the operational area) to widespread (if successfully translocated to new areas via ocean currents or project equipment transit).
Duration	Temporary to long-term (in the event of successful translocation and establishment).

7.1.2 Nature and Scale of Impacts

Potential receptors: Marine ecosystem as a whole and commercial or recreational users of the marine environment

Invasive marine species are marine plants, animals and algae that have been introduced into a region that is beyond their natural range and have the ability to survive and possibly thrive (DAFF, 2011). The majority of climatically compatible invasive marine species of the North West Shelf are found in Southeast Asian countries.

Some invasive marine species pose a significant risk to environmental values, biodiversity, ecosystem health, human health, fisheries, aquaculture, shipping, ports and tourism (Wells *et al*., 2009; DAFF, 2011). When invasive marine species achieve pest status, they are commonly referred to as introduced marine pests and can cause a variety of adverse effects in a receiving environment, including:

- Over predation of native flora and fauna;
- Outcompeting of native flora and fauna for food;
- Human illness through released toxins;
- Depletion of viable fishing areas and aquaculture stock;
- Reduction of coastal aesthetics; and
- Damage to marine and industrial equipment and infrastructure.

Species of concern are those that are not native to the region, are likely to survive and establish in the region, and are able to spread by human-mediated or natural means. Species of concern vary from one region to another depending on various environmental factors, such as water temperature, salinity, nutrient levels and habitat type. These factors dictate their survival and invasive capabilities.

It is recognised that artificial, disturbed and polluted habitats in tropical regions are susceptible to introductions, which is why ports are often areas of higher invasive marine species risk (Neil *et al*., 2005). However, in Australia there are limited records of detrimental impact from invasive marine species compared to other tropical regions (such as the Caribbean).

Following their establishment, eradication of invasive marine species populations is difficult, limiting management options to ongoing control or impact minimisation. However, this depends on the environmental conditions and species. For this reason, increased management requirements have been implemented in recent years by Commonwealth and State regulatory agencies.

Potential sources for the introduction of marine species into the operational area include biofouling on the support vessels, including external niches (e.g., propulsion units, steering gear and thruster tunnels) and internal niches (e.g., sea chests, strainers, seawater pipe work, anchor cable lockers and bilge spaces).

Equipment that is submerged in water for periods of time (e.g., AUVs and ROVs) may acquire marine pest species, which can be spread if the equipment is not cleaned prior to use in pest-free areas.

Support vessels based in local ports, such as Dampier or Onslow, do not carry the same quarantine risks as international vessels (e.g., offtake tankers) or out of State vessels, as they supply the same waters as those the operational area resides in. Given the depths at the Reindeer facilities, establishment may not occur on the seabed; however, there is potential for invasive marine species to establish on WHP infrastructure.

7.1.3 Environmental Performance and Control Measures

Environmental performance outcomes (EPOs) relating to this event include:

- No introduction of marine pest species [EPO-RE-06].

The control measures considered for this activity are shown in **Table 7-2,** with EPSs and measurement criteria for the EPOs described in **Table 8-3**.

Table 7-2: Control Measures Evaluation for Introduction of Invasive Marine Species

Control Measure Ref. No.	Control Measure	Environmental Benefit	Potential Costs/Issues	Evaluation
Standard Controls				
RE-CM-25	Implementation of the management controls in the Santos WA	The risk of introducing invasive marine species is reduced	Personnel costs involved in risk assessing vessels in accordance with the Invasive Marine Species Management Plan. Costs	**Adopted** – Minimal personnel costs and potential delays or costs to

Control Measure Ref. No.	Control Measure	Environmental Benefit	Potential Costs/Issues	Evaluation
	Invasive Marine Species Management Plan.	due to assessment procedure.	associating with reducing the vessel risk to 'low' (e.g., dry docking, hull cleaning or additional costs due to inspections). Could lead to potential delays and therefore costs in vessel contracting process due to unavailability of vessels.	project are considered outweighed by the benefits of reducing the risk of invasive marine species.
RE-CM-26	Anti-foulant system.	The risk of introducing invasive marine species is reduced due to anti-foulant systems.	Could lead to potential delays and therefore costs in vessel contracting process due to unavailability of vessels with appropriate anti-foulant systems.	**Adopted** – Minimal potential delays or costs to project are considered outweighed by the benefits of reducing the risk of invasive marine species.
RE-CM-27	Ballast water management plan.	The risk of introducing invasive marine species is reduced through procedures managing ballast water exchange and identifying high-risk ballast water.	Personnel costs in producing and implementing ballast water management plan and in maintaining record books and logs.	**Adopted** – Minimal personnel costs are considered outweighed by the benefits of reducing the risk of invasive marine species.
Additional Control Measures				
N/A	Heat treatment of ballast water to eliminate invasive marine species.	Would reduce potential for invasive marine species to establish by eliminating individuals present in ballast water.	High cost compared to existing risk; introduction of water at much higher temperature than surrounding marine environment would likely result in death of native marine species.	**Rejected** – Based on increased risk to marine environment compared to base case risk.
NA	Restrict vessel operations to using vessels and equipment that have only operated in local, State or Commonwealth waters to reduce	Reduce potential for invasive marine species to be transported into area since vessels would not have originated elsewhere.	Vessels and equipment suitable for the activity that have only operated in local, State or Commonwealth waters may not be available; therefore, work could not be completed.	**Rejected** – Not feasible.

Control Measure Ref. No.	Control Measure	Environmental Benefit	Potential Costs/Issues	Evaluation
	potential for invasive marine species.			
NA	Mandatory dry docking of vessels prior to entering field to clean vessel and equipment and remove biofouling.	Ensure that no invasive marine species are present on vessel or associated equipment.	Significant cost (grossly disproportionate to the risk); would lead to scheduling delays.	**Rejected –** Costs disproportionately high compared to environmental benefit given that other controls in place already reduce the risk.
NA	Use an alternative ballast system to avoid uptake or discharge of water.	Eliminate need for ballast water exchange, therefore decreasing risk of introducing invasive marine species through ballast water.	Vessels suitable for the activity may not have options for alternative ballast system, therefore would require modification at significant cost.	**Rejected** – Costs disproportionately high compared to environment benefit.
N/A	Zero discharge of ballast water.	Would reduce the potential for invasive marine species by implementing a no ballast water exchange policy on support vessels.	Ballast water exchange required on the support vessels for stability.	**Rejected** – On the basis that ballast water exchange is a safety-critical activity for marine operations.

7.1.4 Environmental Impact Assessment

Description – Invasive Marine Species	
Receptors	Introduction of invasive marine species Disruptions to other marine users Impact to marine primary producers - reduced access to fishing grounds Socio-economic impact
Consequence	D - Major
Ballast water is responsible for 20 to 30% of all marine pest incursions into Australian waters; however, research indicates that biofouling (the accumulation of aquatic micro-organisms, algae, plants and animals on vessel hulls and submerged surfaces) has been responsible for more foreign marine introductions than ballast water (DAFF, 2011). Invasive marine species, if successfully established, can outcompete native species for food or space, prey on native species or change the nature of the environment and can subsequently impact on fisheries or aquaculture. If an invasive marine species is introduced, the species has been known to colonise areas outside of the areas it is introduced to. In the event that an invasive marine species is introduced into the operational area, given the lack of diversity and extensiveness of similar benthic habitat in the	

Description – Invasive Marine Species	
region, there would only be a minor reduction in the physical environment. No threatened ecological communities are present in the area that could be affected. The overall consequence level was assessed as *Major*.	
Likelihood	2 – Very Unlikely
The pathways for invasive marine species introduction are well known; consequently, standard preventive measures are proposed. The ability for invasive marine species to colonise a habitat depends on a number of environmental conditions. It has been found that highly disturbed environments (such as marinas) are more susceptible to colonisation than are open water environments where the number of dilutions and the degree of dispersal are high (Paulay *et al*., 2002). Invasive marine species are more likely to populate shallower areas with favourable substrates. Given that the depth of the operational area (approximately 38 to 59 m) creates an unfavourable habitat for colonisation (i.e., light limiting and low habitat biodiversity with sparse epibiota) and that it is distant from shallow coastal habitats, there is a very low likelihood that invasive marine species would be able to survive translocation and subsequently establish and colonise. With control measures in place to reduce the risk of introduction of invasive marine species, the likelihood of introducing an invasive marine species is considered *Very Unlikely*.	
Residual Risk	The residual risk associated with this event is *Medium*.

7.1.5 Demonstration of ALARP

Support vessels are required for the safe and efficient operation of the Reindeer facilities. Without vessels providing support for operational activities via replenishment of materials and subsea inspections, the risk of equipment failure leading to a safety or environmental incident is increased. Therefore, eliminating subsea equipment inspection activities or supply transfer to eliminate the risk of introducing invasive marine species is not considered practicable.

Ballast water will be managed through a Ballast Water Management Plan and completion of the DPIRD Vessel Check tool prior to movement or transit into the operational area.

The frequency of materials transfers has been scheduled to ensure the optimal safe and efficient operation of the platform. A reduction in the frequency of material supply is possible; however, this would require an increased holding capacity of such consumables as diesel and chemicals, increasing the risk of a larger hydrocarbon or chemical spill and the risk from use of larger vessels. Therefore, reducing this frequency is not practicable. In addition the frequency of subsea inspections has been scheduled for the safe operational duration to proactively prevent equipment failure based on the Company’s experience on the North West Shelf. Smaller vessels are more likely to be sourced locally, reducing the potential for invasive marine species presence. Therefore, the frequency of vessels required in the field is considered ALARP, based on the required safe operation and maintenance requirements of the platform and pipeline.

Ballast water exchange will be managed through a Ballast Water Management Plan, and a vessel biosecurity risk assessment in accordance with the Invasive Marine Species Management Plan (EA-00-RI-10172) will be undertaken to demonstrate that vessels are low risk so that IMS are not introduced.

Santos WA has adopted a risk-based approach to managing biofouling given it is not practicable or reasonable to inspect and/or clean every vessel before each voyage. Such an approach is consistent with other petroleum operators on the North West Shelf and is beyond that enforced on the majority of commercial and recreation vessels that regularly transit the same bioregion. International vessels are given the highest priority to prevent the introduction of IMS into Australian waters. However, domestic vessels (interstate and locally sourced) are also risk-assessed to reduce the likelihood of spreading marine pest species already established in Australian waters. The biofouling risk assessment approach adopted by Santos WA will ensure that the Aquatic Resources Management Act 2016[1] and associated regulations prohibiting the introduction of non-endemic fish species will be met.

No other controls were identified to reduce the risk of introducing invasive marine species. Therefore, with the above control measures in place, the risk of introducing invasive marine species has been reduced to ALARP.

7.1.6 Acceptability Evaluation

Is the risk ranked between Low to Medium?	Yes – Introduction of invasive marine species residual risk ranking is Medium.
Is further information required in the consequence assessment?	No – Potential impacts and risks well understood through the information available.
Are risks and impacts consistent with the principles of ecologically sustainable development?	Yes – Activity evaluated in accordance with Santos WA's Environmental Hazard Identification and Assessment Procedure, which considers principles of ecologically sustainable development.
Are risks and impacts consistent with relevant legislation, international agreements and conventions, guidelines and codes of practice (including species recovery plans, threat abatement plans, conservation advice and Australian marine park zoning objectives)?	Yes – management consistent with Biosecurity Act 2015 and National Biofouling Management Guidance for the Petroleum Production and Exploration Industry (Marine Pest Sectoral Committee, 2018). Also consistent with the Fish Resources Management Act 1994 (expected to be replaced by the Aquatic Resources Management Act 2016 in 2019).
Are risks and impacts consistent with Santos WA's Environmental Management Policy?	Yes – Aligns with Santos WA's Environmental Management Policy.
Are risks and impacts consistent with stakeholder expectations?	Yes – No concerns raised.
Are performance standards such that the impact or risk is considered to be ALARP?	Yes – see ALARP above.

The mobilisation of vessels and equipment to undertake offshore petroleum activities is industry standard practice, and the IMS risks are well understood and subject to regulation. The vessels and equipment that are internationally mobilised will meet Australian biosecurity requirements, and proposed management is consistent with National Biofouling Management Guidance for the petroleum Production and Exploration Industry (Marine Pest Sectoral Committee, 2018).

Application of the proposed control measures and adherence to legislation and regulations reduce the likelihood of introducing IMS into the operational area, and the dispersive offshore location in the operational area reduces the probability of successful establishment in the unlikely event of introduction.

No stakeholder concerns have been raised regarding this aspect, and the proposed controls will reduce the residual level of risk to medium and ALARP. Therefore, the residual risk associated with IMS is considered by Santos WA to be environmentally acceptable.

[1] The Aquatic Resources Management Act 2016 will replace the Fish Resources Management Act 1994 and the Pearling Act 1990. The new act was scheduled for commencement on 1 January 2019; however, commencement has been deferred while an amendment to the act is progressed.

7.2 Marine Fauna Interaction

7.2.1 Description of Event

Event	There is the potential for vessels or equipment (e.g., ROV) involved in operational activities to interact with marine fauna, including potential strike or collision potentially resulting in severe injury or mortality. Fauna strike may also occur from helicopter or unmanned aerial vehicles collision, during take-off and landing.
Extent	Within the operational area, in the immediate vicinity of support vessels, subsea equipment or helicopters, while moving.
Duration	For the operational life of the activity.

7.2.2 Nature and Scale of Impacts

Potential receptors: Fish and sharks, cetaceans, marine reptiles and seabirds

7.2.2.1 Physical Presence of Reindeer Facilities

Demersal fish (**Section 3**) that associate with reef and hard substrate areas are likely to be attracted to the artificial habitat created by the subsea infrastructure, although, on a population level, this attraction is unlikely to be significant in terms of redistributing the abundance of fishes. This artificial habitat may increase the local survival and recruitment of some demersal fishes, although again this is unlikely to be significant on a population or ecosystem level given the small area of infrastructure and the existence of natural hard substrate and reef habitats nearby (particularly adjacent to the Montebello, Barrow and Lowendal islands).

Pelagic fishes may also be attracted to the Reindeer facilities either through the physical presence (shelter), alteration of currents, artificial lighting (**Section 6.2**) or increased prey abundance.

The whale shark and humpback whale BIAs overlap the operational area; and species may be temporarily attracted to the platform, especially around the time when aggregations occur adjacent to the Ningaloo coastline between March and May or during the humpback migration along the east coast.

The presence of the WHP provides a structure for birds to rest, with subsequent short-term positive effects. Seabirds may be attracted to the Reindeer WHP due to increased feeding opportunities on pelagic fish. Although the presence of bird deterrents will result in the birds being deterred from landing on the infrastructure.

7.2.2.2 Vessels and Subsea Equipment

Movement of support vessels in the operational area introduces the potential for interaction with marine fauna present at the same location during the activity. Marine fauna in surface waters that would be most at risk from vessel collision include marine mammals, marine turtles and whale sharks. A summary of the marine fauna and their BIAs that intersect with the operational area is in **Table 3-5**.

The worst-case scenario is the occurrence of a vessel strike leading to mortality of a threatened or migratory species listed under the EPBC Act (**Table 3-5**).

Turtle/vessel interactions arising from increased vessel traffic is also recognised as one of a number of key impacts to marine turtles in the Recovery Plan for Marine Turtles in Australia (DoEE, 2017). In the recovery plan, vessel disturbance is identified as a risk to flatback turtles. Marine turtles are highly mobile and, given the low speeds of vessels used for operations, are likely to be able to move from an area where there is vessel activity. Marine turtles make extensive migrations through the region; and it is possible that individual turtles of any of the species known from the region may be encountered in the operational area, particularly given the proximity to the designated flatback turtle BIA associated with the Montebello Islands and Barrow Island nesting locations. However, given the distance to nesting beaches (nearly 60 km and 90 km to the Montebello Islands and Barrow Island respectively) and the absence of important foraging habitat for any species in the operational area, large numbers of turtle encounters are not expected.

Marine turtle mortality due to boat strike has been identified as an issue in Queensland waters in the Recovery Plan for Marine Turtles in Australia (DoEE, 2017). However, turtles appear to be more vulnerable to boat strike in areas of high urban population where incidents of pleasure crafts are higher. WA turtle populations have not been highlighted as those most affected by boat strike, possibly due to the relatively low human population density of the North West Shelf coastline.

The most commonly sighted whale in continental shelf waters of the region is the humpback whale. Vessel activity may occur during the humpback migration period, creating the potential for humpback whales to be encountered in the operational area. Approved Conservation Advice for *Megaptera novaeangliae* (humpback whale) (TSSC, 2015a) indicates that humpback whales are one of the most frequently reported whale species involved in vessel strikes worldwide (Laist *et al*., 2001; Jensen & Silber, 2003). This observation is supported by Australian studies referenced in the Draft National Strategy for Mitigating Vessel Strike of Marine Mega-fauna (DoEE, 2016). Similarly, boat strike is recognised by the Approved Conservation Advice for *Rhincodon typus* (whale shark) (TSSC, 2015b) as one of the threats to their recovery. Blue, sei, fin, Bryde's and killer whales are migratory species that may transect the operational area. Sei and fin whales may also encounter foraging or feeding habitat through the operational area, although it is unlikely that there will be significant numbers of these species encountered during the activity. Given the operational area overlaps with the whale shark foraging BIA (**Table 3-5**), individuals may be encountered during the activity. However, large numbers of whale shark encounters are not expected, given that the BIA is approximately 80 km wide at this location, extending predominantly through deeper waters and with the nearest whale shark aggregation site approximately 280 km from the operational area.

The reaction of whales to the approach of a vessel is quite variable. Some species remain motionless when in the vicinity of a ship, while others are known to be curious and often approach vessels that have stopped or are slow-moving, although they generally do not approach, and sometimes avoid, faster-moving vessels (Richardson *et al*., 1995).

The worst potential impact from vessel collision would be mortality or serious injury of an individual. Collisions between vessels and cetaceans are most frequent on continental shelf areas where high vessel traffic and cetacean habitat occur simultaneously (WDCS, 2006). There have been recorded instances of cetacean deaths (e.g., a Bryde's whale in Bass Strait in 1992) as a result of vessel collisions in Australian waters (WDCS, 2006), although the data indicate this is likely to be associated with container ships and fast ferries. The Whale and Dolphin Conservation Society (WDCS, 2006) also indicates that some cetacean species, such as humpback whales, can detect and change course to avoid a vessel.

Whale sharks, other pelagic fish and demersal fish are likely to exhibit a short-term avoidance to vessels, divers or ROVs. This is likely to be initiated through the vibrations and underwater noise emitted from these activities (**Section 6.1**) rather than the physical presence. Such avoidance is likely to be temporary.

The operation of vessels, ROVs, and divers is highly unlikely to impact on the migration routes of whales (in particular the humpback whale, which passes close to Barrow and Montebello islands between June and September (**Table 3-9**). The Approved Conservation Advice for *Megaptera novaeangliae* (Humpback Whale) (TSSC, 2015c) identifies vessels as a threat. Although some level of disturbance may occur, this is likely to be primarily caused by underwater noise from vessels and ROVs within the operational area (**Section 6.1**), rather than their physical presence.

Dugong are known to occur in and around seagrass growth areas and to exhibit some stereotypical inquisitive behaviours (Anderson, 1982). Though they are migratory, some species habitat is likely to occur within the region. The risk of dugong strike can be lowered significantly by minimising movements directly over seagrass beds in shallow waters. Vessels will be operating in depths of approximately 38 to 59 m. Seagrasses are unlikely to be present within the operational area, given the water depths and insufficient light availability.

Sea snakes are known to intermittently occur within the operational area. During use of ROVs for inspections in close proximity to subsea infrastructure, sea snakes are at risk of strike by the ROV thrusters or entanglement. Impacts could range from injury to the individual to mortality.

The likelihood of lethal collision depends on the number of animals in the vicinity of vessel operations, the probability of a fauna collision and the severity of damage caused by that collision. Given that the support vessels will move slowly (less than 5 knots) within the operational area and that the activity is of short duration, the risk of fauna collision is extremely low. Consequences will be limited to, at worst, injury or mortality of individuals of any species.

7.2.2.3 Helicopters and Unmanned Aerial Vehicles

A number of protected species of marine birds have potential habitats or migratory routes in and around the operational area (**Table 3-5**). Seabirds may be attracted to the WHP due to increased feeding opportunities on pelagic fish. However, these behavioural changes are unlikely to alter population dynamics or significantly change the habitat use of birds.

The number of helicopter flights required to the WHP is relatively low; and flights occur in the daylight, thereby reducing potential interactions with birds.

Helicopter noise is expected to elicit a behavioural response in birds to avoid collision; and given the relatively low speeds helicopters would be flying at during take-off or landing, the risk of helicopter strike is not high.

During landing and take-off, large slow birds are at risk of strike from helicopter rotors. Ornithological technological specialists have not identified any EPBC Act–listed protected species within the operational area as at very high or extreme risk of strike. The incident of bird strike is a significant safety concern for helicopters and is classified as a major accident event in the Reindeer WHP Safety Case RE-02-RF-00029). Santos WA is committed to ensuring the safety of aircraft and passengers visiting the normally unmanned Reindeer WHP. The Santos WA Bird Management Plan (EA-00-RI-10191) has been developed with technical advice from ornithological and technological specialists to ensure the safety of helicopter transfers and minimal impact to birds.

An additional hazard caused by birds is the build-up of guano on the platform, leading to:

+ Helideck markings and lights becoming obscured;
+ Safety-critical equipment on the platform becoming obscured and possibly deteriorating at a quicker rate;
+ Health and hygiene issues for personnel on the WHP; and
+ Surfaces becoming slippery, particularly after rainfall.

To minimise the risk of bird strike and serious safety events, bird deterrent devices are being trialled. This will ensure birds safely vacate the platform prior to helicopter landing and take-off. Guano is periodically cleaned from the platform using seawater.

7.2.3 Environmental Performance and Control Measures

Environmental performance outcomes (EPOs) relating to this event include:

+ No injury or mortality to EPBC Act–listed marine fauna during operational activities [EPO-RE-01].

The control measures considered for this activity are shown in **Table 7-3,** with EPSs and measurement criteria for the EPOs described in **Table 8-3**.

Table 7-3: Control Measures Evaluation for Marine Fauna Interaction

Control Measure Ref. No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
Standard Controls				
RE-CM-16	Constant bridge watch on support vessels.	Monitoring of surrounding marine environment to identify potential collision risks (and reducing harm) to cetaceans and other marine fauna.	No additional cost; industry practice and regulated by AMSA.	**Adopted** – Industry practice; benefits outweigh cost.
RE-CM-01	Procedure for interacting with marine fauna.	Reduces risk of physical and behavioural impacts to EPBC Act–listed marine fauna from interactions with support vessels and helicopters.	Potential delay in vessel movement, increasing activity duration and costs to Santos WA. Personnel costs involved in reporting sightings to authorities.	**Adopted** – Benefits of reducing risk of impacts to marine fauna outweigh the costs. Implementing relevant EPBC Act procedures for interacting with EPBC Act–listed marine fauna complies with the EPBC Regulations 2000.
Additional Control Measures				
N/A	Restrict the timing of activities to operate only outside of sensitive periods.	Reduce risk of collisions (causing harm) during environmentally sensitive periods for listed marine fauna.	Protected marine fauna species are present year-round, meaning there are no non-sensitive periods to operate in.	**Rejected** – Grossly disproportionate to the environmental benefit and would severely limit operations, which are required to occur 24 hours a day, 7 days a week.
N/A	Dedicated Marine Fauna Observer on support vessels.	Improves ability to spot and identify marine fauna at risk of collision (that may cause harm).	Additional cost of contracting several specialist Marine Fauna Observers.	**Rejected** – Grossly disproportionate to the environmental benefit and would severely limit operations, which are required to occur 24 hours a

Control Measure Ref. No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
				day, 7 days a week.
N/A	Activities will only occur during daylight hours.	Potential for a vessel-fauna collision occurring is decreased due to vessel being stationary when visibility is lower at night.	Lengthens time of the activity as operations only continue for approximately 10 hours/day or less in winter. Increased cost due to increased operation time (more than double the cost and therefore grossly disproportionate).	**Rejected** – Substantial additional cost due to doubling of activity duration. No overall environmental benefit as results in increased impacts and risks.

7.2.4 Environmental Impact Assessment

Description – Marine Fauna Interaction	
Receptors	Threatened, migratory, or local fauna
Consequence	C - Moderate
In the event of a collision with fauna, there is the potential for injury or death of an individual. The number of receptors present in the operational area during the intermittent transport or maintenance activities is expected to be limited to a small number of transient individuals. Boat strike and vessel disturbance are identified as potential threats to a number of marine fauna species in relevant recovery plans and conservation advice. The above information demonstrates that, with control measures in place, the activity will be conducted in a manner that reduces potential impacts to ALARP and an acceptable level. There is the potential for death or injury of EPBC Act–listed individual species; however, as they would represent an individual within the local population, it is not expected that it would result in a decreased population size.	
Likelihood	2 – Very Unlikely
The National Marine Safety Committee reports that, during 2009, there was one report of a vessel collision with a marine animal (species not defined) (NMSC, 2010). The operational area overlaps whale migration pathways; thus, migrating individuals may traverse the operational area. No known aggregation areas (breeding, resting or calving) occur within the operational area; therefore, concentrations of milling individuals are unlikely. Vessels will be moving very slowly while inside the operational area, posing a low risk of collision with marine fauna. In addition, the noise generated from vessel operations may locally deter marine fauna from coming in close proximity to vessels. Consequently, the likelihood of a collision with marine fauna is considered to be *Very Unlikely*.	
Residual Risk	The residual risk associated with this event is *Medium*

7.2.5 Demonstration of ALARP

The Reindeer WHP and DC supply pipeline are fixed structures that have been in place since 2011. The continued presence of this infrastructure is highly unlikely to impact on marine fauna or cetacean migration as the infrastructure is fixed in place and does not prevent or obstruct the movement of marine fauna in the area.

Any impact caused by the physical presence of the Reindeer WHP and pipeline is likely to be localised and temporary, with marine species expected to resume normal behavioural patterns in the open oceanic waters surrounding the operational area in a short time frame.

The use of support vessels in the field is necessary for the safe and efficient operation of the production facilities. Without vessels providing support for operational activities via replenishment of materials and subsea inspections, the risk of equipment failure leading to a safety or environmental incident is increased. Therefore, elimination of subsea equipment inspection activities or supply transfer to eliminate the risk of marine fauna collision is not considered practicable.

The frequency of materials transfers has been determined to ensure the optimal safe and efficient operation of the platform. A reduction in the frequency of material supply is possible; however, this would require an increased holding capacity of consumables, such as diesel and chemicals, and increase the risk of a larger hydrocarbon or chemical spill. Therefore, reducing this frequency is not practicable. In addition the frequency of subsea inspections has been determined for the safe operational duration to proactively prevent equipment failure based on Santos WA's experience on the North West Shelf. Therefore, the frequency of vessels required in the field is considered ALARP, based on the required safe operation and maintenance requirements of the platform and pipeline.

In the event that vessels come in close proximity to EPBC Act–listed marine fauna, such as whales and whale sharks, environmental performance standards (**Table 8-3**) have been implemented for limiting vessel operations, as well as for ensuring that the crew are aware through inductions of the risk posed by conducting the activity, in order to reduce the likelihood of a marine fauna collision to ALARP. Inductions for the crew of support vessels will include information on how to interact with cetaceans and whale sharks in accordance with the EPBC Regulations.

The inherent likelihood of encountering fauna in the operational area is limited by the short duration of the activities and the separation from areas of high surface-fauna density. With low vessel speeds and compliance with fauna interaction procedures, including Regulation 8 of the EPBC Regulations 2000, which aim to prevent adverse interactions of vessels with marine megafauna, a fauna collision is considered very unlikely. With the controls adopted, the assessed residual risk for this impact is ALARP.

7.2.6 Acceptability Evaluation

Is the risk ranked between Low to Medium?	Yes – Maximum marine fauna collision residual risk ranked Medium.
Is further information required in the consequence assessment?	No – Potential impacts and risks are well understood through the information available.
Are risks and impacts consistent with the principles of ecologically sustainable development?	Yes – Activity evaluated in accordance with Santos WA's Environmental Hazard Identification and Assessment Procedure, which considers principles of ecologically sustainable development.
Are risks and impacts consistent with relevant legislation, international agreements and conventions, guidelines and codes of practice (including species recovery plans, threat abatement plans, conservation advice and Australian marine park zoning objectives)?	Yes – Management consistent with Part 8 of the EPBC Regulations. Control measures implemented will minimise the potential risks and impacts from vessel strike from the activity to relevant species identified in recovery plans and conservation advice **(Table 3-3)**.

	Consistent with relevant species recovery plans, conservation management plans and management actions set out in **Table 3-6**. Relevant species Recovery Plans, Conservation Management Plans and management actions including but not limited to: + Recovery Plan for Marine Turtles in Australia (2017) + Recovery Plan for Threatened Albatrosses and Giant Petrels (DSEWPaC, 2011) + Approved Conservation Advice for Megaptera novaeangliae (humpback whale) + Approved Conservation Advice for Rhincodon typus (whale shark). + Conservation Management Plan for the Blue Whale, 2015-2025 + Approved Conservation Advice for Balaenoptera borealis (sei whale) (2015) + Conservation Management Plan for the Southern Right Whale 2011 – 2021 (2012) + Recovery Plan for the Grey Nurse Shark (Carcharias taurus) (2014) + Recovery Plan for the White Shark (Carcharodon carcharias) (2013) + Sawfish and River Sharks Multispecies Recovery Plan (2015) + Approved Conservation Advice for Calidris canutus (red knot) (2016) + Approved Conservation Advice for Calidris ferruginea (curlew sandpiper) (2015) + Approved Conservation Advice for Malurus leucopterus edouardi (White-winged Fairy-wren (Barrow Island))
Are risks and impacts consistent with Santos WA's Environmental Management Policy?	Yes – Aligns with Santos WA's Environmental Management Policy.
Are risks and impacts consistent with stakeholder expectations?	Yes – No concerns raised.
Are performance standards such that the impact or risk is considered to be ALARP?	Yes – See ALARP above.

Application of the proposed management controls and adherence to Commonwealth regulations reduces the likelihood of vessel interactions with marine fauna. While the potential exists for a collision to occur, it is considered a very unlikely (2) scenario. Vessels will be travelling at low speeds within the operational area, further reducing the likelihood of fauna strike. In the unlikely event that an impact did occur, it would be highly probable that only a single individual would be contacted (although it is noted that even if it is a single species, if it's a protected species the consequence will be more than minor in accordance with the Environmental Consequence Descriptors (**Appendix E**); therefore, the impact is considered to be ALARP and environmentally acceptable.

7.3 Release of Solid Objects

7.3.1 Description of Event

Event	Solid objects such as those listed below can be accidentally released to the marine environment: + Non-hazardous solid wastes, e.g., paper, plastics and packaging; + Hazardous solid wastes, e.g., batteries, fluorescent tubes, medical wastes, and aerosol cans; and + Equipment and materials, e.g., hard hats, tools or infrastructure parts.
Extent	The event will only occur within the operational area, and all non-buoyant waste material or dropped objects are expected to remain within the operational area. Buoyant objects could potentially move beyond the operational area.
Duration	An unplanned release of solids may occur during operational activities.

7.3.2 Potential Impacts

Potential Receptors: Benthic habitats, fish and sharks, marine mammals, marine reptiles and seabirds

Solids such as plastics have the potential to affect benthic environments and to harm marine fauna through entanglement or ingestion. Marine turtles and seabirds are particularly at risk from entanglement. Marine turtles may mistake plastics for food; once ingested, plastics can damage internal tissues and inhibit physiological processes, which can both potentially result in fauna fatality. Floating, non-biodegradable marine debris has been highlighted as a threat to marine turtles, whales, whale sharks, and albatrosses and giant petrels in the relevant recovery plans and approved conservation advice (refer to **Table 3-6**). The recovery plans and approved conservation advice, as well as the Threat Abatement Plan for the Impacts of Marine Debris on the Vertebrate Wildlife of Australia's Coasts and Oceans (DoEE, 2018), have specified a number of recovery actions to help combat this threat. Of relevance to this event is the legislation for the prevention of garbage disposal from vessels. As Reindeer WHP is an unmanned platform and vessel activity is infrequent, the risk from small plastics is diminished.

Release of hazardous solids (e.g., wastes such as batteries) may result in the pollution of the immediate receiving environment, leading to detrimental health impacts to marine flora and fauna. Physiological damage can occur through ingestion; or absorption may occur in individual fish and sharks, marine mammals, marine reptiles or seabirds.

The typical AUV that will be used for Reindeer operational activities is the Gavia Offshore Surveyor AUV, which is 3.2 m long, weighs approximately 90 kg, has a maximum water depth rating of 1,000 m and has a battery endurance of up to 24 hrs. These AUVs are one of the smallest units available for subsea inspection activities such as those required for Reindeer operations. The AUVs and ROVs (which are typically smaller units) therefore present one of the smallest seabed damage or snagging capability if dropped during operational activities.

In addition, the AUVs utilise acoustic doppler measurements to detect and prevent seafloor contact; and in the event of low power, they are designed to float to the surface and transmit their position for recovery.

The area of potential seabed disturbance due to release of a heavier non-hydrocarbon solid would be restricted to the operational area. Potential for the object to be recovered may take time but would be less than 1 year). The seabed within the operational area is primarily soft sediments with little epifauna. This habitat type is widely distributed and well represented in the North West Shelf region. The potential for benthic habitat damage would be greatest over sensitive seabed features, which, within the operational area, comprise filter-feeding communities, including sponges, gorgonians and other sessile (fixed in one place) invertebrates.

While soft sediment benthic habits will not be destroyed, disturbance of the communities on and within them (i.e., the epifauna and infauna) will occur in the event of a dropped object; and depressions may remain on the seabed for some time after removal of the dropped object as they gradually infill over time. Similarly, the temporary turbidity and sedimentation associated with the ROV activities is not considered likely to cause a significant environmental impact, given the sparseness of benthic cover and the highly localised impact zone. The seafloor of this bioregion is strongly affected by cyclonic storms, long-period swells and large internal tides, which can resuspend sediments within the water column and move sediment across the seafloor. In this context, any potential sediment movement caused by the event is likely to have minimal impacts.

7.3.3 Environmental Performance and Control Measures

Environmental performance outcomes (EPOs) relating to this event include:

- No unplanned objects, emissions or discharges to sea or air [EPO-RE-03].

The control measures considered for this activity are shown in **Table 7-4,** with EPSs and measurement criteria for the EPOs described in **Table 8-3**.

Table 7-4: Control Measures Evaluation for Release of Solid Objects

Control Measure Ref. No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
Standard Controls				
RE-CM-21	Garbage management.	Reduces probability of garbage (waste) being accidentally discharged to sea, reducing potential impacts to marine fauna. Complies with Marine Order 95, Marine Pollution Prevention – Garbage.	Personnel cost of vessel audits and inspections, and in reporting discharge levels.	**Adopted** – Benefits of ensuring vessel is compliant outweigh the minimal costs of personnel time, and it is a legislated requirement.
RE-CM-02	Facilities Planned Maintenance System.	Requires that lifting equipment is maintained and certified and that lifting procedures are followed, reducing probability of dropped objects occurring.	Additional personnel costs of ensuring equipment is maintained and certified as appropriate and that procedures are in place and followed.	**Adopted –** Benefits of ensuring procedures are followed and equipment is compliant outweigh the minimal costs of personnel time.
RE-CM-03	Vessels Planned Maintenance System.	Requires that lifting equipment is maintained and certified, and that	Additional personnel costs of ensuring equipment is maintained and	**Adopted –** Benefits of ensuring procedures are followed and equipment is

Control Measure Ref. No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
		lifting procedures are followed, reducing probability of dropped objects occurring.	certified as appropriate and that procedures are in place and followed.	compliant outweigh the minimal costs of personnel time.
RE-CM-09	Dropped Object Prevention Procedure (LEMS).	Impacts to environment are reduced by preventing dropped objects.	Personnel costs involved in implementing procedures and in incident reporting.	**Adopted** – Benefits of ensuring procedures are followed and measures implemented outweigh the costs of personnel time.
RE-CM-10	Dropped Object Recovery.	Requires dropped objects to be recovered (where safe and practicable to do so unless the environmental consequences are negligible).	Additional personnel and vessel costs to plan and undertake if safe and practicable to do so.	**Adopted –** Benefits of recovering dropped objects where safe and practicable to do so (unless the environmental consequences are negligible) outweigh the costs.
Additional Control Measures				
N/A	Eliminate lifting in field.	Reduces the risk of releasing non-hydrocarbon solid to the marine environment due to dropped object.	Eliminating lifting would require support vessels storing more equipment and supplies on board, and/or additional trips to shore. Support vessels will not have enough deck space to store all required equipment, materials, and supplies needed for the duration of the activity, without incurring safety risks	**Rejected –** Not feasible to eliminate lifting in the field.

7.3.4 Environmental Impact Assessment

Description – Release of Solid Objects	
Receptors	Physical environment or habitats (benthic)
Consequence	A – Negligible
Physical environment – Seabed disturbance	

Description – Release of Solid Objects	
In the event of a dropped object, there will be localised and short-term damage to the seabed. The extent of the impact is limited to the size of the dropped object; given the size of standard materials transferred, any impact is expected to be very small. Previous surveys indicate the seabed is likely to comprise soft sediments with little epifauna (**Section 3**). Consequently, any impacts are predicted to be short term in nature. Any impact to the seabed through dropped objects would result in a *Negligible* reduction in habitat area or function impacted.	
<u>Marine fauna – Cetaceans, marine turtles, seabirds, fish and sharks</u> In the event of loss of a solid object, the quantities would be limited by the Reindeer activities defined in **Section 2.5**. The release could cause localised impacts to water quality and the benthic environment. If the solid object can be ingested by marine fauna, impacts would be restricted to a small number of individuals, if any. Relevant recovery plans and conservation advice (**Table 3-6**) have identified marine debris as a potential threat. There is a Threat Abatement Plan for the Impacts of Marine Debris on the Vertebrate Wildlife of Australia's Coasts and Oceans (DoEE, 2018). The limited quantities associated with this event indicate that, even in a worst-case release of solid waste, impacts to fauna would be limited to individuals and are not expected to result in a decrease of the local population size. The consequence level is therefore *Negligible*.	
Likelihood	3 – Unlikely (for dropped objects) 2 – Very Unlikely (for accidental release during transfers or waste accidentally discharged to sea e.g. blown overboard)
Control measures proposed ensure that the risk of solid objects to the environment has been minimised. The likelihood of transient marine fauna occurring in the operational area coincident with a release is *Very Unlikely;* and given the control measures in place and the infrequency of personnel and vessels in the operational area, the likelihood of a loss of solid objects resulting in a consequence greater than *Negligible* is considered *Unlikely* (assumes potential for a single loss of solid waste event during the activity).	
Residual Risk	The residual risk associated with this event is *Low*.

Description – Release of Hazardous Objects	
Receptors	Threatened, migratory, or local fauna Physical environment or habitats (benthic)
Consequence	A - Negligible
Impacts – (This table covers only those impacts specific to hazardous objects.)	<u>Physical environment – Seabed disturbance</u> The release could cause localised impacts to water quality and the benthic environment if the solid object can degrade, leading to localised impacts on flora and fauna. <u>Marine fauna – Cetaceans, marine turtles, seabirds, fish and sharks</u> Ingestion of hazardous solid wastes by marine fauna could occur in small quantities. Only small volumes of non-hydrocarbon solids would be generated during the activity. Impacts from ingestion may occur to a small number of individuals, if any. No consequences for conservation status or reproductive success of cetaceans, marine turtles or fish species that may occur in the area are expected. Relevant recovery plans and conservation advice (**Table 3-6**) has identified marine debris as a potential threat, and the DoEE has established the Threat Abatement Plan for the Impacts of Marine Debris on the Vertebrate Wildlife of Australia's Coasts and Oceans (DoEE, 2018). The limited quantities associated with this event indicate that, even in a worst-case release of hazardous solid waste, impacts to fauna would be limited to individuals and is not expected to result in a decrease of the local population size. The consequence level is therefore *Negligible*.
Likelihood	2 – Very Unlikely
	Control measures proposed ensure that the risk of dropped objects, lost equipment or release of non-hydrocarbon solid waste to the environment has been minimised. The likelihood of transient marine fauna occurring in the operational area coincident with a release is limited; and given the control measures in place, the likelihood of releasing non-hydrocarbon solids to the environment resulting in a greater than *Negligible* consequence is considered Very Unlikely (assumes potential for a single loss of solid waste event during the activity).
Residual Risk	The residual risk associated with this event is *Low*.

7.3.5 Demonstration of ALARP

Solid objects will unavoidably be handled during the activity. The control measures proposed reduce the residual risk of their release to Low, and this cannot be reduced further with any reasonably practicable additional control measures. The potential unplanned impacts in this scenario are considered to be ALARP.

Transfer of objects to the WHP is required for the activity to accomplish maintenance, repair and general operations of the Reindeer facilities; these transfers are managed through transfer procedures and equipment management. Without ongoing maintenance, occasional repairs and upgrade of equipment, the risk of failure leading to a safety or environmental incident is increased. The Reindeer facilities need to be restocked with essential operating materials. Therefore, eliminating supply transfer to eliminate the risk of a dropped objects is not considered practicable.

The frequency of materials transfers has been scheduled to ensure the optimal safe and efficient operation of the platform. A reduction in the frequency of material supply would not reduce the number of lifts (thereby reducing the risk of dropping an object) as the same volume of supplies would still be required. In addition, the frequency of subsea inspections has been scheduled to achieve the safe operational duration to proactively prevent equipment failure based on Santos WA's experience on the North West Shelf. Decreasing the frequency of supply and maintenance activities will require larger supply transfers and increases in the duration and complexity of maintenance activities. This frequency of material supplies and subsea inspections is considered ALARP, based on the safe operation and maintenance requirements of the platform and pipeline.

If an object is dropped, the incident will be responded to in accordance with the implementation strategy for incident response (Section 8.9). With the above controls in place, Santos WA considers the residual risk arising from a dropped object is ALARP.

7.3.6 Acceptability Evaluation

Is the risk ranked between Low to Medium?	Yes – Maximum seabed disturbance residual risk ranked Low
Is further information required in the consequence assessment?	No – Potential impacts and risks are well understood through the information available.
Are risks and impacts consistent with the principles of ecologically sustainable development?	Yes – Activity evaluated in accordance with Santos WA's Environmental Hazard Identification and Assessment Procedure, which considers principles of ecologically sustainable development.
Are risks and impacts consistent with relevant legislation, international agreements and conventions, guidelines and codes of practice (including species recovery plans, threat abatement plans, conservation advice and Australian marine park zoning objectives)?	Yes – Management consistent with MARPOL Annex III. Control measures implemented will minimise the potential impacts from the activity to species identified in recovery plans and approved conservation advice as well as the Threat Abatement Plan for the Impacts of Marine Debris on the Vertebrate Wildlife of Australia's Coasts and Oceans (DoEE, 2018) as having the potential to be impacted by non-hydrocarbon surface releases of solid objects. Consistent with relevant species recovery plans, conservation management plans and management actions set out in **Table 3-6**.Relevant species Recovery Plans, Conservation Management Plans and management actions including but not limited to: + Recovery Plan for Marine Turtles in Australia (2017) + Recovery Plan for Threatened Albatrosses and Giant Petrels (DSEWPaC, 2011) + Approved Conservation Advice for *Megaptera novaeangliae* (humpback whale) + Approved Conservation Advice for *Rhincodon typus* (whale shark) + Conservation Management Plan for the Blue Whale, 2015-2025 + Approved Conservation Advice for

	Balaenoptera borealis (sei whale) (2015) + Conservation Management Plan for the Southern Right Whale 2011 – 2021 (2012) + Recovery Plan for the Grey Nurse Shark (*Carcharias taurus*) (2014) + Recovery Plan for the White Shark (*Carcharodon carcharias*) (2013) + Sawfish and River Sharks Multispecies Recovery Plan (2015) + Approved Conservation Advice for *Calidris canutus* (red knot) (2016) + Approved Conservation Advice for *Calidris ferruginea* (curlew sandpiper) (2015)
Are risks and impacts consistent with Santos WA's Environmental Management Policy?	Yes – Aligns with Santos WA's Environmental Management Policy.
Are risks and impacts consistent with stakeholder expectations?	Yes – No concerns raised.
Are performance standards such that the impact or risk is considered to be ALARP?	Yes – See ALARP above.

Potential environmental impacts from a dropped object would most likely be extremely minor and related to indents in the soft sediment habitat assumed to be within the operational area. Given the sediment habitat is expected to recover relatively rapidly (within 6 to 12 months), the potential impacts are considered environmentally acceptable. Through implementation of the proposed management controls, the risk of dropping an object is reduced to a level that is considered acceptable.

With the controls in place, which align with relevant actions prescribed in the Threat Abatement Plan for the Impacts of Marine Debris on Vertebrate Wildlife of Australia's Coasts and Oceans (DoEE, 2018) to prevent accidental release of solid objects, and the negligible (A) impact predicted from entanglement or ingestion with solid waste material by marine fauna, the low risk of a solid object release to the environment is considered to be ALARP environmentally acceptable..

7.4 Hazardous Liquid Releases

7.4.1 Description of Event

Event	Causes for accidental liquid releases (other than diesel and loss of well control) include: + Hydraulic fluids, lubricant oils and stored waste oils from: – ROV failure (including oil seal, hydraulic system hose and quick-disconnect system failures); – Loss of primary containment (drums, tanks, intermediate bulk containers, etc.) due to handling, storage and dropped objects (e.g., swinging load during lifting activities); – Vessel or WHP pipework failure or rupture, hydraulic hose failure and inadequate bunding; + Chemicals, including corrosion inhibitor, cleaning and cooling agents, recovered solvents, stored or spent chemicals, leftover paint materials and used greases, through:

	– Bunkering from storage tanks to bulk tanks or transferring to day tanks or due to component failure, such as flexible hoses; – Spills or leaking machinery accidentally discharged overboard in deck drainage water; – Overflow of the open and closed drainage systems; – Tank or pipework corrosion or rupture on the Reindeer WHP; and – Loss of primary containment (drums, tanks, intermediate bulk containers, etc.) due to handling, storage and dropped objects (e.g., swinging load during lifting activities). The WHP and supply vessel main engines and equipment, such as pumps, cranes, winches, power packs and generators, require diesel for fuel and a variety of hydraulic fluids and lubricating oils for efficient operation and maintenance of moving parts. These products are present within the equipment and also held in storage containers and tanks on the WHP (approximately 200 L) and supply vessels. Small hydrocarbon leaks could occur from loss of primary containment due to handling, storage and dropped objects (during lifting activities). Volumes are likely to be small and limited to the volume of individual containers (e.g., intermediate bulk containers, 44-gallon drums) stored on the deck of supply vessels or the WHP. The credible spill for this scenario is considered to be the loss of an intermediate bulk container (1 m^3) during transfer from a vessel to the WHP. ROV operations can result in unplanned discharges (of hydraulic fluids) directly to the marine environment due to equipment failure, ROV interactions with the vessel thrusters or accidental contact with subsea infrastructure. The largest credible hydrocarbon spill from ROV operations would be an accidental release of approximately 0.05 m^3 (50 L) of hydraulic fluid from the deployed ROV. Minor accidental loss of other hydrocarbon-based liquids (e.g., used lubricating oils, cooking oil, and hydraulic oil) to the marine environment could also occur via tank or pipework failure or rupture, hydraulic hose failure, inadequate bunding or storage, insufficient fastening or inadequate handling, which could result in impacts to water quality and hence sensitive environmental receptors. Oily water from the open drain system on the WHP is stored in an atmospheric sump, while hydrocarbons collected from the closed drainage system (liquid separated in the fuel gas system, drainage from the production header during maintenance and pig launcher drainage) is collected in a closed drain sump. The hydrocarbons collected in both the atmospheric and closed sump are pumped into the production stream by automatic sump pumps. In the event that the sump pump fails, the oily water could be discharged overboard. Oily water from vessels includes bilge water and deck drainage water. In the event that the oil discharge monitoring equipment fails, water containing hydrocarbons at more than 15 ppm could be accidentally discharged overboard. Release of chemicals to the sea could occur via tank or pipework corrosion or rupture on the Reindeer WHP. The chemical injection system located on the main deck is required to control corrosion in the DC supply pipeline. The chemical injection system includes three corrosion inhibitor injection tanks (two 1,600 L and one 3,800 L capacity tanks). The corrosion inhibitor is a continuously used chemical that is injected at the wellheads. Other chemicals (e.g., biocide) may be used as required for such operations as pigging or biocide runs. Release could also occur from transport of chemicals between support vessels and the Reindeer WHP (i.e., dropped objects or a leak or spill from a transfer hose).
Extent	The relative low volumes are expected to rapidly disperse into the marine environment. Concentrations below toxic or harmful thresholds are expected to occur at short distances from the release point. Should a spill occur, potential impacts beyond the operational area are not expected in the event of a worst-case spill.

Duration	Potentially toxic or harmful threshold concentrations limited to a very short period immediately following release.

7.4.2 Nature and Scale of Impacts

Potential receptors: Fish and sharks, marine mammals, marine reptiles and seabirds

Hydraulic fluids and lubricating fluids behave similarly to marine diesel when spilt in the marine environment. Hydraulic fluids are oils of light to moderate viscosity and have a relatively rapid spreading rate. Like diesel, they will dissipate quickly, particularly in high sea states, although lubricating oils are more viscous and so the spreading rate of a spill of these oils would be slightly slower.

Impacts associated with the unplanned discharge of hazardous liquids to the marine environment depend on the nature of the liquid released, the volume and its behaviour in the marine environment (i.e., whether it sinks, floats, disperses, etc.). In the event of a spill to the marine environment, these liquids would be subjected to rapid dispersion and dilution by the open ocean water conditions and prevailing currents.

Potential impacts include a temporary and highly localised decline in water quality. This would have limited potential for toxicity to marine fauna, due to the likely short duration of exposure and rapid dilution of the released hazardous liquids in the marine environment. Impacts are likely to be limited to the immediate vicinity of the spill and would not affect population viability of contacted species or ecosystem function. For small hydrocarbon-based releases, the environmental impacts are expected to be minimal but may include a visual sheen and a slight oiling of wildlife within the first few hours following the spill if conditions are calm.

7.4.3 Environmental Performance and Control Measures

Environmental performance outcomes (EPOs) relating to this event include:

- No unplanned objects, emissions or discharges to sea or air [EPO-RE-03].

The control measures considered for this activity are shown in **Table 7-5,** with EPSs and measurement criteria for the EPOs described in **Table 8-3**.

Table 7-5: Control Measures Evaluation for Hazardous Liquid Releases

Control Measure Ref. No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
Standard Controls				
RE-CM-28	Inspection of platform structures and hydrocarbon-containing equipment.	Reduces likelihood of leaks from equipment on offshore platforms reaching the marine environment.	Personnel and operational costs associated with visiting the offshore platform for an inspection and to check on equipment.	**Adopted** – Benefits of the inspection to determine operational integrity outweigh the cost to undertake the inspection.
RE-CM-20	Offshore platform deck drain system and bunding.	Reduces the likelihood of any oily or chemical content reaching the marine	Personnel and operational costs associated with construction and maintenance of	**Adopted** – Benefits of the system in reducing impacts to the

Control Measure Ref. No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
		environment from the offshore platform.	offshore platform bunding and maintenance of bunding procedure.	marine environment outweigh the personnel and operational costs.
RE-CM-29	Hazardous chemical management procedures.	Reduces the risk of spills and leaks (discharges) to sea by controlling the storage, handling and clean-up.	Personnel cost associated with implementation of procedures and permanent or temporary storage areas.	**Adopted** – Benefits of ensuring procedures are followed and measures implemented outweigh costs.
RE-CM-30	General chemical management procedures.	Potential impacts to the environment are reduced through following correct procedures for the safe handling and storage of chemicals.	Personnel costs associated with ensuring procedures are in place and implemented during handling and storage of chemicals.	**Adopted –** Benefits of ensuring procedures are followed and measures implemented outweigh the costs.
RE-CM-31	Refuelling and chemical transfer procedure.	Minimises risk of pollution to ALARP during chemical transfers from an offshore support vessel to an offshore facility.	Personnel costs associated with ensuring procedures are in place and implemented during refuelling and chemical transfers.	**Adopted** – Benefits of ensuring procedures are followed and measures implemented outweigh the costs.
RE-CM-32	Spill response equipment on producing offshore platforms.	Provides a means to prevent any deck spills of hazardous liquids reaching the sea.	Costs associated with stocking spill response equipment on vessels and offshore platforms, training personnel and maintaining equipment.	**Adopted** – Benefits of stocking, using and maintaining spill response equipment outweighs the costs of personnel time and costs of maintenance and training.
RE-CM-33	Vessel spill response plan (SOPEP/SMPEP).	Implements response plans on board vessels to deal with unplanned	Administrative costs of preparing documents. Plan generally undertaken	Adopted – Benefits considered to outweigh costs.

Control Measure Ref. No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
		hydrocarbon releases and spills quickly and efficiently in order to reduce impacts to the marine environment.	by vessel contractor so time for Santos WA personnel to confirm and check SOPEP/SMPEP is in place.	
RE-CM-34	Remotely operated vehicle inspection and maintenance procedures.	Maintenance and pre-deployment inspection on ROV completed as scheduled to reduce the risk of hydraulic fluid releases to the marine environment.	Additional personnel costs of ensuring procedures in place and followed.	**Adopted –** Benefits of ensuring procedures are followed outweigh costs.

7.4.4 Environmental Impact Assessment

Description – Hazardous Liquid Releases	
Receptors	Threatened, migratory, or local fauna Physical environment or habitats
Consequence	A –Negligible

In the event of a minor hydrocarbon or chemical spill, the quantities would be very small (worst case identified to be limited to approximately 1 m^3 for the loss of the contents of an intermediate bulk container or 50 L for ROV hydraulic fluid). The small volumes and dilution and dispersion from natural weathering processes such as ocean currents are such that spills will be limited in area and duration. The number of receptors present at the activity location are expected to be limited to a small number of transient individuals.

Habitat degradation, deteriorating water quality and marine pollution are identified as potential threats to a number of marine fauna species, including turtles and some bird and shark species, in relevant recovery plans and conservation advice.

However, the potential releases of hazardous liquids are not expected to significantly impact the receiving environment, given the control measures proposed to prevent releases; therefore, the activity will be conducted in a manner that is considered acceptable.

For marine species that may be exposed to the more toxic aromatic components of spilled hydrocarbons, toxic effects are considered unlikely since these species are mobile and therefore will not be constantly exposed for extended durations that would be required to cause any major toxic effects.

Although humpback and blue whales may be exposed, this event is not expected to interfere with their migration activity. Toxic impacts are not expected to the benthic community due to the water depths.

Near the sea surface, fish are able to detect and avoid contact with surface slicks; and as a result, fish mortalities rarely occur in open waters from surface spills (Kennish, 1997; Scholz *et al*., 1992). Pelagic fish species are therefore generally not highly susceptible to impacts from chemical spills. Pelagic fish in offshore waters are highly mobile and comprise species such as tunas, sharks and mackerel. Due to their mobility, it is unlikely that pelagic fish would be exposed to toxic components for long periods in this spill scenario. The more toxic components would also rapidly evaporate, and concentrations would significantly diminish with distance from the spill site, limiting the potential area of impact.

Deteriorating water quality is identified as a potential threat to turtles in the marine turtle recovery plan and to some bird and shark species (**Table 3-6** However, the potential minor hydrocarbon or chemical releases are not expected to significantly impact the receiving environment, given the control measures proposed to prevent releases. Therefore, the activity will be conducted in a manner that is considered acceptable. Given that a small hydrocarbon or chemical spill would not result in a decreased population size at a local or regional scale, it is expected that a spill of this nature would result in a *Negligible* consequence.

Likelihood	2 – Very unlikely
The likelihood of a small hydrocarbon release occurring is *Very Unlikely,* given the control measures in place for this event.	
Residual Risk	The residual risk associated with this event is *Low*.

7.4.5 Demonstration of ALARP

Storage and use of hydraulic and lubricating oils or fluids for equipment and machinery, including for ROV operations, are required to undertake the activity, so their removal from the activity is not viable.

The generation of hazardous liquid wastes is unavoidable during some WHP maintenance activities or well intervention or suspension activities. However, less toxic chemicals can be substituted for some hazardous liquids. This is done by having all chemicals go through the Santos WA Chemical Selection process, in order that low toxicity chemicals are preferentially used over more hazardous types, where practicable.

In addition, administrative controls, such as all vessels being required to have a Garbage Management Plan that describes the on-board controls for preventing unplanned discharges, will minimise the risk of the hazardous liquid being accidentally discharged through mishandling or poor storage.

Other management controls that have been implemented include designated storage and handling areas, use of material safety data sheets, spill clean-up equipment and procedural controls (e.g., employee inductions and lifting and handling training), not only to minimise the risk of an accidental release, but also to reduce the impact in the event that a release does occur.

A thorough set of control measures has been proposed to ensure the risks of minor hazardous liquid spills and leaks occurring and subsequent impacts are minimised. The resulting impacts to marine fauna that could potentially result from a spill of this size would be minor, with impacts restricted to a small number of individuals within a localised area.

The control measures proposed are in line with applicable actions described in relevant recovery plans and conservation advice to reduce the risk of habitat degradation and deteriorating water quality (e.g., from pollution) to a level considered to be ALARP by Santos WA. The assessed residual risk for this impact is low and cannot be reduced further. It is considered therefore that the impact of the activities conducted is ALARP.

7.4.6 Acceptability Evaluation

Is the risk ranked between Low to Medium?	Yes – Maximum minor hydrocarbon spill residual risk is ranked Low.
Is further information required in the consequence assessment?	No – Potential impacts and risks are well understood through the information available.
Are risks and impacts consistent with the principles of ecologically sustainable development?	Yes – Activity evaluated in accordance with Santos WA's Environmental Hazard Identification and Assessment Procedure, which

	considers principles of ecologically sustainable development.
Are risks and impacts consistent with relevant legislation, international agreements and conventions, guidelines and codes of practice (including species recovery plans, threat abatement plans, conservation advice and Australian marine park zoning objectives)?	Yes – Management consistent with International Convention of the Safety of Life at Sea (SOLAS) 1974 and Navigation Act 2012, MARPOL Annex I – Oil. Consistent with relevant species recovery plans, conservation management plans and management actions set out in **Table 3-6**. Relevant species Recovery Plans, Conservation Management Plans and management actions including but not limited to: + Recovery Plan for Marine Turtles in Australia (2017) + Recovery Plan for Threatened Albatrosses and Giant Petrels (DSEWPaC, 2011) + Conservation Management Plan for the Blue Whale, 2015-2025 + Approved Conservation Advice for Balaenoptera borealis (sei whale) (2015) + Conservation Management Plan for the Southern Right Whale 2011 – 2021 (2012) + Commonwealth Conservation Advice on *Aipysurus apraefrontalis* (short-nosed seasnake) (2011) + Sawfish and River Sharks Multispecies Recovery Plan (2015) + Approved Conservation Advice for *Calidris canutus* (red knot) (2016) + Approved Conservation Advice for *Calidris ferruginea* (curlew sandpiper) (2015) + Approved Conservation Advice for *Numenius madagascariensis* (eastern curlew) (2015) + Approved Conservation Advice *for Limosa lapponica baueri* (bar-tailed godwit western Alaskan) (2016) + Approved Conservation Advice for *Limosa lapponica menzbieri* (bar-tailed godwit northern Siberian) (2016) + Approved Conservation Advice for *Malurus leucopterus edouardi* (White-winged Fairy-wren (Barrow Island))
Are risks and impacts consistent with Santos WA's Environmental Management Policy?	Yes – Aligns with Santos WA's Environmental Management Policy.
Are risks and impacts consistent with stakeholder expectations?	Yes – No concerns raised.
Are performance standards such that the impact or risk is considered to be ALARP?	Yes – See ALARP above.

With the control measures in place to prevent an accidental release of hazardous liquids and the negligible impacts predicted from unplanned spills, the risk to the marine environment is considered low. Potential risks are unlikely to be greater than those caused by other commercial marine vessels or offshore petroleum activities in deep water.

Hazardous liquids will be managed in accordance with relevant legislation and industry standards and Santos WA procedures. The small volume negates the need for any further contingencies to be in place that are included for some of the larger spill scenarios associated with the activity.

With the control measures in place to prevent accidental spills and the negligible impacts predicted from a spill of this size, the environmental risk of using and handling the required chemicals is considered acceptable.

7.5 Accidental Release of Hydrocarbons

7.5.1 Credible Spill Scenarios

A number of accidental release of hydrocarbon events have been considered for the purposes of this EP specific to the Reindeer facilities (from the Commonwealth–State waters boundary to the WHP). An accidental release of hydrocarbon event may result in the potential release of condensate or diesel to the marine environment. Santos WA has critically assessed the Reindeer infrastructure and activity to understand the potential scenarios that may result in hydrocarbons being released to the environment. Of the credible spill scenarios, Santos WA has identified three maximum credible spill scenarios. The identified Reindeer maximum credible spill scenarios are further discussed, assessed for risk, and have controls and response strategies applied below in **Sections 7.6, 7.7,** and **7.8**. The assessed credible spill scenarios are summarised in **Table 7-6**.

7.5.2 Spill Scenario Selection

The maximum credible spill scenario at the WHP is a loss of well containment resulting in a surface release of condensate. Given there is no subsea wellhead, the platform substructure and surface conductor protect the primary and secondary barrier envelopes from direct contact. Preventive barriers also include barrier monitoring and testing as per the well operations management plans (WOMPs) (DR-91-ZG-10045, Rev 1, and DR-91-ZG-10038, Rev 1). Therefore, a subsea loss of well control is not considered credible in the event of a loss of platform integrity.

The subsea loss of well control for the Reindeer-1 well was also deemed not a credible spill scenario. The Reindeer-1 well is an open-water, temporarily abandoned exploration well approximately 1.3 km from the WHP. Reindeer-1 is temporarily abandoned, with a cap (approximately 3 m high) installed, and is not connected to the WHP. No intervention activities are planned on this open-water well and therefore have not been assessed in this EP. If well intervention activities are required on this well at a later date, it will be the subject of a separate approval. The well has been assessed as having barrier envelopes to the reservoir (as described in the NOPSEMA-accepted WOMP (DR-91-ZG-10045, Revision 0, accepted 12 December 2016)); and therefore, a loss of well control is not considered credible. Well integrity monitoring is completed as per the NOPSEMA-accepted WOMP.

In the event of a vessel collision with the platform resulting in significant damage to the platform, the fail-safe closed actuated wing valves on the production trees will shut in, and the subsurface safety valves on each well will fail-safe closed upon loss of control line pressure. Accordingly, a loss of well control at the surface is not considered credible in the event of a vessel collision. The maximum credible spill scenario of a loss of well control at the surface at the WHP from well intervention activities is discussed in **Section 7.6** below.

It is considered credible that an unplanned release of condensate and gas could occur from the subsea DC supply pipeline. Loss of containment caused by a dropped object, anchor drag or loss of pipeline integrity is deemed a credible scenario under the assumption of multiple and simultaneous failures of the controls in place. A loss of containment would escalate to a loss that would be detected and result in an almost instantaneous emergency shutdown (ESD). The maximum credible scenario was determined as being a complete loss of the volume of condensate in the pipeline (largest hydrocarbon storage capacity of 275 m^3), due to an automatic detection of the leak and the safety valves at the WHP end and the DCGP end of the pipeline being automatically closed. A subsea release of condensate from the pipeline in Commonwealth waters is considered in **Section 7.7** below.

It is considered credible that a release of diesel to the marine environment could occur from a support vessel collision with the Reindeer WHP or with another vessel in the operational area. Such a collision could have sufficient impact to result in rupture of a vessel's diesel tank. This is considered credible given that the diesel tanks may not be protected or double-hulled and that fuel tank ruptures leading to hydrocarbon release have occurred before. Support vessels also regularly load and unload supplies to the WHP; it is possible that a dropped object during this process could damage the hull of a support vessel, leading to a release of diesel from a tank. The maximum credible spill volume from a vessel incident is 329 m^3 based on the largest single fuel tank capacity. This scenario would result in a spill of diesel at the sea surface.

Another credible spill scenario identified is a release during vessel bunkering (fuel hose failure or rupture, coupling failure, or tank overfilling) where fuel bunkering would need to be stopped manually. Fuel released prior to the cessation of pumping, as well as fuel remaining in the transfer line, may escape to the environment. Technical Guidelines for Preparing Contingency Plans for Marine and Coastal Facilities (AMSA, 2015) provides guidance for calculating a maximum credible spill volume for a refuelling spill. The maximum credible spill volume during refuelling is calculated as transfer rate (60 m^3/hr) x 15 minutes of flow, resulting in a potential 15 m^3 spill volume at the sea surface. The detection time of 15 minutes is seen as conservative but applicable following failure of multiple barriers followed by manual detection and isolation of the fuel supply.

A vessel collision scenario is the maximum credible diesel spill scenario from a vessel fuel tank and has been modelled at the WHP and at the Commonwealth–State waters boundary. A surface release of vessel tank diesel at the Commonwealth–State waters boundary represents the worst-case spill of the two scenarios and is discussed in **Section 7.8** below.

Table 7-6: Summary of Maximum Credible Spill Scenarios

Maximum Credible Spill Scenario	Hydrocarbon Type	Maximum Credible Volume	Comment	EP Section
Scenario 1 Surface release: Hydrocarbon spill from a loss of well containment.	Gas/Condensate	14,935m^3 over 77 days	Maximum credible volume modelled (see Note 1 below) – with highest flow potential derived by combining the most optimistic reservoir flow parameters for the wells.	**7.6**
Scenario 2 Subsea release: Hydrocarbon spill from a loss of pipeline containment.	Condensate	275 m^3		**7.7**
Scenario 3 Surface release: Hydrocarbon spill from vessel collision, dropped objects or bunkering.	Marine diesel oil	329 m^3	Maximum credible volume based on predicted largest fuel tank on support vessel.	**7.8**

Note 1: The maximum credible spill scenarios presented above were based on Santos WA's Reindeer Blowout Modelling Technical File Note Rev 0 (reissued March 2019) (Santos WA, 2019). Stochastic hydrocarbon dispersion and fate modelling undertaken to inform the environmental impact and risk assessment and to assist with emergency planning was based on preliminary maximum release volumes provided in the technical file note.

7.5.3 Hydrocarbon Characteristics

Table 7-7 provides a summary of characteristics of hydrocarbons relevant to the credible spill scenarios identified for the Reindeer facilities.

Table 7-7: Characteristics of Oil

Oil Type	Initial Density (g/cm³)	Viscosity (cP)	Component	Volatiles (%)	Semi-volatiles (%)	Low Volatility (%)	Residual (%)	Aromatics (%)
			Boiling Points (°C)	Less Than 180 C4 to C10	180 to 265 C11 to C15	265 to 380 C16 to C20	More than 380 More than C20	Of Whole Oil Less Than 380
				NON-PERSISTENT			PERSISTENT	
Diesel	0.8368 @ 15°C	4 @ 15°C	% of total	6	34.6	54.4	Less than 5	3.0
Reindeer Condensate	0.792 @ 15°C	0.803 @ 20°C		65.4	17.4	14.8	2.4	34.9

Sources: APASA (2014); RPS (2019).

7.5.4 Hydrocarbon Contact Thresholds

The hydrocarbon fate and transport modelling method used in this EP is able to track hydrocarbon concentrations of floating oil, entrained oil and dissolved aromatic hydrocarbons below biologically significant impact levels. Consequently, threshold concentrations are specified for the models to control what contact is recorded for surface (floating oil) and subsurface (entrained oil and dissolved aromatic hydrocarbons) locations to ensure that recorded contacts are for biologically meaningful concentrations.

The determination of biologically meaningful impact levels is complex since the degree of impact will depend on the sensitivity of the biota contacted, the duration of the contact (exposure) and the toxicity of the hydrocarbon mixture making the contact. The toxicity of a hydrocarbon will change over time, due to weathering processes altering the composition of the hydrocarbon. To ensure conservatism in the environmental impact assessment process, the threshold concentrations applied to the model are selected to adopt the most sensitive receptors that may be exposed, the longest likely exposure times and the more toxic hydrocarbons.

For marine diesel and condensate releases, a conservative approach has been taken whereby contact by different components (i.e., floating on the surface, entrained and dissolved) has been used. These are summarised in **Table 7-8** and discussed below.

Table 7-8: Summary of Contact Thresholds Applied During Spill Modelling

Hydrocarbon Component	Surface Oil Concentration (g/m^2)	Hydrocarbons Ashore (g/m^2)	Dissolved Aromatic Hydrocarbon Concentration (ppb)	Entrained Oil Concentration (ppb)
EMBA threshold	>1	>100	>6	>100
Impact assessment minimum threshold	>10	>100	>6	>100

7.5.4.1 Surface Hydrocarbons

There is a paucity of data on floating oil concentrations with respect to impacts to marine organisms. The impact of floating oil on birds is better understood than other receptors. A conservative threshold of 10 g/m2 has been applied to biological impacts from surface hydrocarbons (floating oil) in this EP. Although based on birds, this hydrocarbon threshold is also considered appropriate for turtles, sea snakes and marine mammals (NRDAMCME, 1997) and has also been applied herein to determine impacts of surface oils to emergent habitats (habitats that may be partially or temporarily submerged during tidal changes but otherwise are above water). It is recognised that a lower floating oil concentration of 1 g/m^2 (equivalent to a thickness of 0.001 mm or 1 ml of oil per m^2) is visible as a rainbow sheen on the sea surface and at the lower limit of visible oil. Although this is lower than the threshold for ecological impacts, it may be relevant to socio-economic receptors and has been used as the threshold to define the spatial extent of the environment that may be affected (EMBA) from floating oil.

7.5.4.2 Shoreline Accumulation of Hydrocarbons

The EMBA and impact threshold concentration for exposure to hydrocarbons stranded on shorelines is derived from levels likely to cause adverse impacts to marine or coastal fauna and habitats. These habitats and marine fauna known to use shorelines are most at risk of exposure to shoreline accumulations of oil, due to smothering of intertidal habitats (such as mangroves and emergent coral reefs) and coating of marine fauna. Environmental risk assessment studies (French-McCay, 2009) report that an oil thickness of 0.1 mm (100 g/m^2) on shorelines is assumed as the lethal threshold for invertebrates on hard substrates (rocky, artificial or man-made) and sediments (mud, silt, sand or gravel) in intertidal habitats. Therefore, a conservative threshold of 100 g/m^2 has been applied to impacts from shoreline accumulation of oil in this EP.

7.5.4.3 Dissolved Aromatic Hydrocarbons

Dissolved Aromatic Hydrocarbons include the mono-aromatic hydrocarbons (MAHs) (compounds with a single benzene ring such as BTEX [benzene, toluene, ethyl benzene, and xylenes]) and polycyclic aromatic hydrocarbons (PAHs) (compounds with multiple benzene rings such as naphthalenes and phenanthrenes). These compounds have a greater bioavailability that other components of oil and are considered to be main contributors to oil toxicity. The toxicity of DAHs is a function of the concentration and the duration of exposure by sensitive receptors with greater concentration and exposure time causing more sever impacts. Typically tests of toxicity done under laboratory conditions measure toxicity as proportion of test organisms affected (e.g. 50% mortality or LC50) at the end of a set time period, often 48 or 96 hours.

French-McCay (2002) in a review of literature, reported LC50 for dissolved PAHs with 96 h exposure, range between 30 ppb for sensitive species (2.5th-percentile species) and 2,260 ppb for insensitive species (97.5th-percentile species), with an average of about 250 ppb. The range of LC50s for PAHs obtained under turbulent conditions (this includes fine oil droplets) was 6 ppb to 410 ppb with an average of 50 ppb (French-McCay, 2002).

The DAH modelling results used to inform the EMBA and risk assessment outlined within this EP considers instantaneous exposure and therefore applying the literature concentration data for PAH exposure over 96 hours is considered highly conservative. Nevertheless a lower threshold of 6 ppb has been used to inform the EMBA based on it being a concentration that could have some potential negative effect on marine organisms. This is considered to be sub lethal for all but the most sensitive species and life stages. For most marine organisms, a concentration of between 50 and 250 ppb is considered to be more appropriate for risk assessment.

7.5.4.4 Entrained Hydrocarbons

Entrained hydrocarbons, as opposed to DAHs, are oil droplets suspended in the water column and insoluble. Entrained hydrocarbons are not as bioavailable to marine organisms compared to DAHs and on that basis are considered to be a less toxic, especially over shorter exposure time frames. Entrained hydrocarbons still have potential effects on marine organisms through direct contact with exposed tissues and ingestion (NRC, 2005) however the level of exposure causing effects is considered to be considerably higher than for DAHs.

Much of the published scientific literature does not provide sufficient information to determine if toxicity is caused by entrained hydrocarbons, but rather the toxicity of total oils which includes both dissolved and entrained components. Variations in the methodology of the water accommodated fraction may (WAF) account for much of the observed wide variation in reported threshold values, which also depend on the test organism types, duration of exposure, oil type and the initial oil concentration. Total oil toxicity acute effects of total oil as LC50 for molluscs range from 500 to 2,000 ppb (Clark et al., 2001; Long and Holdway, 2002). A wider range of LC50 values have been reported for species of crustacea and fish from 100 to 258,000,000 ppb (Gulec et al., 1997; Gulec and Holdway, 2000; Clark et al., 2001) and 45 to 465,000,000 ppb (Gulec and Holdway, 2000; Barron et al., 2004), respectively. Given these results and on the basis that entrained oil is expected to have considerably lower acute toxicity that DAHs, a conservative lower instantaneous threshold of 100 ppb has been used to define the entrained oil EMBA which represents negative effects to sensitive species and life stages. Higher concentrations of over 500 ppb are considered more appropriate to define impacts to most species.

7.6 Surface Release of Condensate from the WHP

7.6.1 Description of Event

Event	There are currently three production wells at the platform. During well intervention activities (e.g., wire-line activities), the pressure envelope of the well is entered via fit-for-purpose pressure-control equipment at the surface. A loss of well control at surface through the completion string, although very unlikely, is considered credible and represents the worse-case discharge scenario for the wells during the production lifecycle phase.

Extent	Modelling results show that hydrocarbon concentrations above the impact threshold of 10 g/m^2 are not predicted to occur. Therefore, there is no contact with sensitive receptors above 10 g/m^2. However, there was a potential for thinner sheens (less than or equal to 1 g/m^2) to reach shorelines; and accumulations were predicted for a number of shoreline sections. In terms of the volumes of oil that could accumulate on shorelines, the worst-case estimate is predicted for shorelines of Montebello Islands 8m^3. Entrained oil in the water column above the impact threshold of 100 ppb is predicted to occur up to 252 km from the release site. Dissolved aromatic hydrocarbons in the water column above the impact threshold of 6 ppb are predicted to occur up 788 km from the release site.
Duration	The above scenario would result in a surface release of an estimated 14,935 m^3 of Reindeer condensate, released at a rate of 6.51 m^3/hr for 77 days from a 15.2 cm (6-inch) hole. Rather than using the AMSA assumption of mobilisation time + 20 days to cap a well, the release period (77 days) is based on a conservative rig mobilisation and relief well drilling schedule. Further information on the spill modelling is provided in **Section 7.6.1.1**.

7.6.1.1 Spill Modelling Information

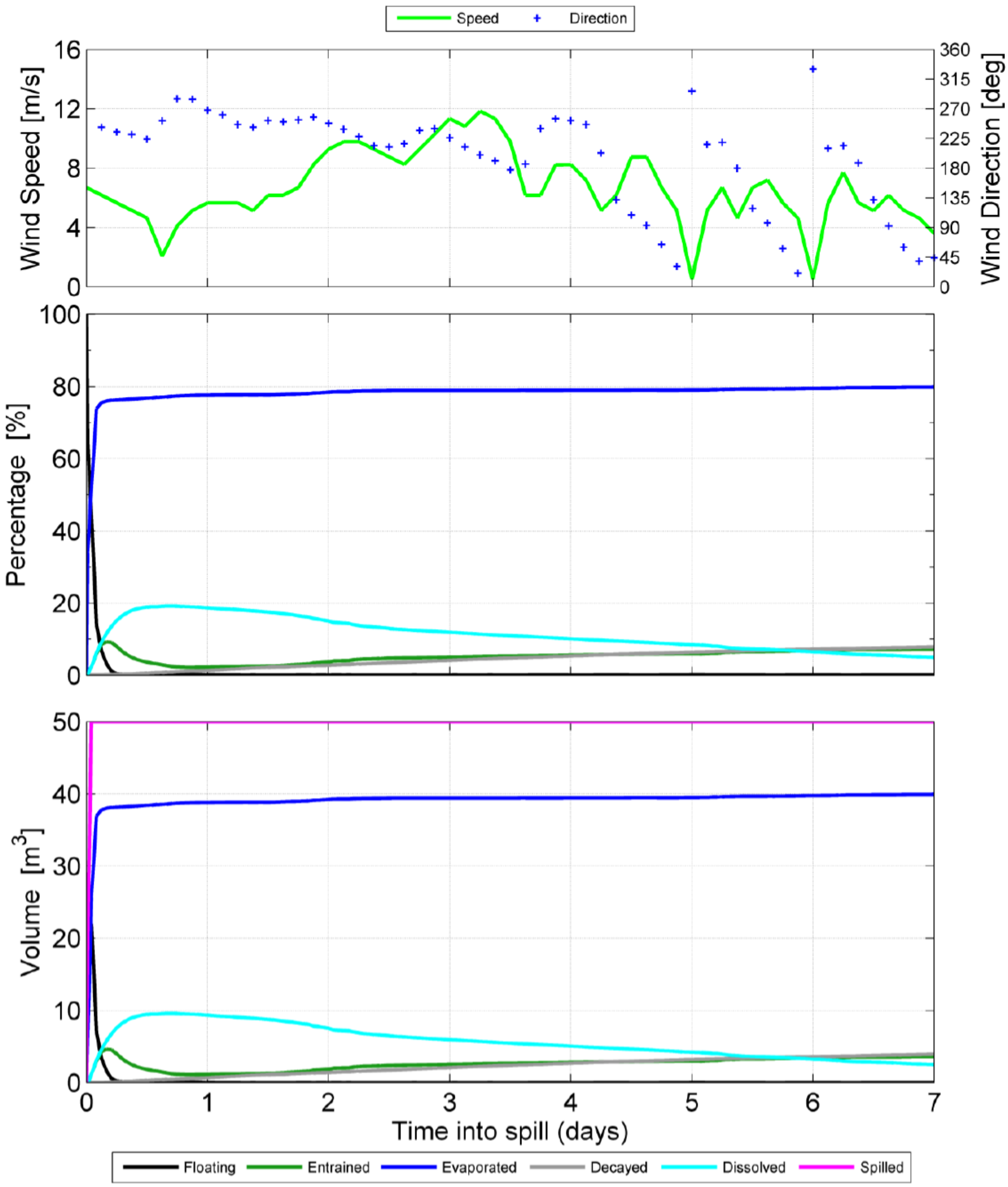
7.6.1.1.1 Volume and type of Release

To determine the spatial extent of impacts from a potential surface release of condensate from a Reindeer WHP loss of well control and the dispersion characteristics over time, modelling was completed by RPS (RPS, 2019). A volume of 14,935 m^3 released over 77 days at the sea surface was modelled at the WHP location.

Spill modelling was performed using a number of simulated environmental conditions from all seasons, thus providing a range of realistic spill trajectories from which to determine the spatial extent of potential impacts and receptors that might be impacted by a spill.

7.6.1.1.2 Hydrocarbon Weathering Behaviour

Weathering characteristics of Reindeer condensate when released from the sea surface under variable wind conditions are shown in **Figure 7-1.**



Source: RPS (2019).

Figure 7-1: Mass Balance Plot Representing the Weathering of Reindeer Condensate Spilled into the Water Column as a One-off Release (50 m^3 over 1 hour) and Subject to Variable Wind at 27°C Water Temperature and 25°C Air Temperature

These results show little oil mass predicted to persist on the sea surface after 7 days (less than 1%) as a result of wind conditions. Higher wind speeds generate significant entrainment events and therefore result in a proportion of the oil dissolving (19% of oil dissolving in water after 24 hours). The evaporation rate also depends on wind conditions, such that around 80% of the spilled volume is expected to evaporate after 7 days. Biological and photochemical degradation is predicted to contribute to the decay of the floating slick, with an approximate rate of less than 1% per day and an accumulated total of about 1 to 8% after 7 days.

7.6.1.2 Spill Modelling Results

7.6.1.2.1 Surface Hydrocarbons above 10 g/m^2

Surface oil concentrations at or above 10 g/m^2 are not predicted to occur.

7.6.1.2.2 Entrained Hydrocarbons above 100 ppb

Entrained hydrocarbons above the 100 ppb threshold are predicted to be limited to within 252 km from the WHP. Modelling indicated that entrained hydrocarbons at more than 100 ppb would reach shorelines at probabilities more than 1%. These shorelines include the Montebello Islands, including the marine park and surrounds (within 114 hours); Barrow Island (within 143 hours); and Southern Island Coast (within 787 hours).

7.6.1.2.3 Dissolved Aromatic Hydrocarbons above 6 ppb

Dissolved aromatic hydrocarbons above the 6 ppb threshold are predicted to extend up to 788 km from the WHP. Dissolved aromatic hydrocarbon contact at more than pub occurs at multiple locations across the model domain, including Barrow Island, Montebello Islands (including the marine park), offshore Ningaloo, Glomar Shoals and Rankin Bank. The worst-case concentration of dissolved aromatic hydrocarbons is predicted in the Montebello Australian Marine Park at 510 ppb, with a 98% probability of contact above 6 ppb.

7.6.1.2.4 Hydrocarbons Ashore Above 100 g/m^2

Hydrocarbon volumes ashore above 100 g/m^2 concentration were found at Montebello Islands (8 m^3) and Lowendal Islands (5 m^3). Minimum predicted arrival times of condensate at these shorelines were, 19 days, 17 days.

7.6.2 Nature and Scale of Impacts

Hydrocarbon spills will cause a decline in water quality and may cause physical (e.g., coating of emergent habitats, oiling of wildlife at sea surface) and chemical (e.g., toxic) impacts to marine species (Table 7-9). The severity of the impact of a hydrocarbon spill depends on the magnitude of the spill (i.e., extent, duration) and the sensitivity of the receptor. . Given the Diesel and the Condensate are considered light hydrocarbons (Group 1 and 2 hydrocarbons, AMSA, 2005), the physical and chemical pathways to impact are comparable. Therefore, both are presented in Table 7-9.

Potential receptors: Intertidal and subtidal habitats, marine and coastal fauna, commercial and recreational fishing, socio-economic receptors, Commonwealth and State marine protected areas

Reindeer Condensate is considered a light hydrocarbon (Group I hydrocarbon under the AMSA classification). In the event of a surface spill, condensate undergoes rapid spreading and evaporative loss in warm waters. As the condensate is more buoyant than water, during a subsea release scenario, any hydrocarbon that rises to float on the sea surface will also undergo the same evaporation and spreading loss. A temporary slick on the sea surface and entrained hydrocarbon in the sea surface layer could have the physical effect of coating fauna interacting within and under the surface slick, including plankton, pelagic invertebrates and fishes, marine reptiles, marine mammals and seabirds, and may also cause slight secondary effects through ingestion after preening for seabirds or through ingestion of oiled fish. In the event that the slick and entrained hydrocarbon reach coastlines and shallow waters, shoreline, intertidal and subtidal habitats may also be oiled.

A surface spill could also cause toxic effects to marine fauna within the sea surface layer due to bioavailable aromatic hydrocarbons that dissolve into water from entrained droplets and floating hydrocarbon. A subsea release under pressure, such as a pipeline rupture scenario described in **Section 7.5.1**, is expected to have a greater percentage of dissolved aromatic hydrocarbons distributed throughout the water column. These aromatic hydrocarbons, including monocyclic aromatic hydrocarbons and low molecular weight polycyclic aromatic hydrocarbons can cause narcotic effects in fauna if concentrations and exposure are sufficiently high and long respectively. Narcotic effects of dissolved aromatic hydrocarbons are considered unlikely to occur from a spill of condensate of the size possible under operations. The dissolved aromatic hydrocarbons that tend to be toxic (e.g., monocyclic aromatic hydrocarbons such as BTEX chemicals) are also rapidly lost to the atmosphere through evaporation as they evaporate faster than they can dissolve in the water column due to their high volatility (French-McCay, 2002).

The intertidal and shoreline habitats at receptors within the EMBA and the sensitivities of these receptors to hydrocarbons are provided in **Table 7-10**. Further detailed information on the receptors can also be found in **Appendix C**.

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Table 7-9: Physical and Chemical Pathways and Oil Impacts to Marine Organisms

Receptor	Physical Pathway	Potential Impacts via Physical Pathway	Chemical Pathway	Potential Impacts via Chemical Pathway
Rocky shore	Shoreline loading and attachment may result in thin and sporadic coating of condensate/diesel residue. Degree of oil coating depends on the energy of the shoreline area, the type of the rock formation and continual biodegradation of the condensate/diesel.	Impacts to flora (mangroves) and fauna further described below.	Adsorption via cellular membranes and soft tissue, ingestion, irritation or burning on contact, and inhalation.	Impacts to flora (mangroves) and fauna further described below.
Sandy shore	Shoreline loading and water movement may allow condensate/diesel residue to filter down into sediments, continue to biodegrade on the surface or remobilise into the surf zone. Degree of loading depends on the energy and tidal reach of the shoreline, the type of the sandy shore and continual weathering of the condensate/diesel.	Indirect impacts to nesting and foraging habitats for birds and turtles. Direct impacts to infauna.	Adsorption via cellular membranes and soft tissue, ingestion, irritation or burning on contact, and inhalation.	Indirect impacts to nesting and foraging habitats for birds and turtles. Direct impacts (mortality) to infauna through toxic effects and smothering.
Intertidal flats	Shoreline loading and water movement may allow condensate/diesel residue to filter down into sediments, continue to biodegrade on the surface or remobilise into the surf zone. Degree of loading depends on the energy and tidal reach of the shoreline, the type of the substrate and continual weathering of the condensate/diesel.	Indirect impacts to foraging habitats for birds and turtles. Direct impacts to infauna.	Adsorption via cellular membranes and soft tissue, ingestion, irritation or burning on contact, and inhalation.	Indirect impacts to foraging habitats for birds. Direct impacts (mortality) to infauna through toxic effects and smothering.

Receptor	Physical Pathway	Potential Impacts via Physical Pathway	Chemical Pathway	Potential Impacts via Chemical Pathway
Mangroves	Coating of root system reducing air and salt exchange. Degree of coating depends on the energy and tidal reach of the shoreline, the type of the substrate and continual weathering of the condensate/diesel.	Yellowing of leaves. Defoliation. Increased sensitivity to stressors. Tree death. Reduced growth. Reduced reproductive output. Reduced seed viability.	External contact by oil and adsorption across cellular membranes.	Yellowing of leaves. Defoliation. Increased sensitivity to stressors. Tree death. Reduced growth. Reduced reproductive output. Reduced seed viability. Growth abnormalities.
Algae and seagrass	Coating of leaves and thalli reducing light availability and gas exchange. Degree of coating depends on the energy and tidal reach of the shoreline, the type of the receptor and continual weathering of the condensate/diesel.	Bleaching or blackening of leaves. Defoliation. Reduced growth.	External contact by oil and adsorption across cellular membranes.	Mortality. Bleaching or blackening of leaves. Defoliation. Disease. Reduced growth. Reduced reproductive output. Reduced seed or propagule viability.
Hard corals	Coating of polyps, shading resulting in reduction of light availability. Degree of coating depends on the metocean conditions, dilution, whether corals are emergent at all and continual weathering of the condensate/diesel.	Bleaching. Increased mucous production. Reduced growth.	External contact by oil and adsorption across cellular membranes.	Mortality. Cell damage. Reduced metabolic capacity. Reduced immune response. Disease. Reduced growth. Reduced reproductive output.

Receptor	Physical Pathway	Potential Impacts via Physical Pathway	Chemical Pathway	Potential Impacts via Chemical Pathway
				Reduced egg or larval success. Growth abnormalities.
Invertebrates	Coating of adults, eggs and larvae. Degree of coating depends on the energy and tidal reach of the shoreline, the type of the receptor and continual weathering of the condensate/diesel.	It is commonly thought that condensate does not cause problems to wildlife due to the lack of visible oiling, however may be toxic (WAOWRP, 2014).	Ingestion and inhalation. External contact and adsorption across exposed skin and cellular membranes. Uptake of dissolved aromatic hydrocarbons across cellular membranes.	Mortality. Cell damage. Reduced metabolic capacity. Reduced immune response. Disease. Reduced growth. Reduced reproductive output. Reduced egg or larval success. Growth abnormalities. Behavioural disruption.
Fish	Coating of adults but primarily eggs and larvae. Reduced mobility and capacity for oxygen exchange.	Mortality. Oxygen debt. Starvation. Dehydration. Increased predation. Behavioural disruption.	Ingestion. External contact and adsorption across exposed skin and cellular membranes. Uptake of dissolved aromatic hydrocarbons across cellular membranes (e.g., gills).	Mortality. Cell damage. Flesh taint. Reduced metabolic capacity. Reduced immune response. Disease. Reduced growth. Reduced reproductive output. Reduced egg or larval success. Growth abnormalities. Behavioural disruption.

Receptor	Physical Pathway	Potential Impacts via Physical Pathway	Chemical Pathway	Potential Impacts via Chemical Pathway
Birds	Light coating. Degree of coating depends on the energy and tidal reach of the shoreline, the type of the receptor and continual weathering of the condensate/diesel.	Feather and skin irritation and damage. It is commonly thought that condensate does not cause problems to wildlife due to the lack of visible oiling, however may be toxic (WAOWRP, 2014).	Ingestion (during feeding or preening). External contact and adsorption across exposed skin and membranes.	Mortality. Cell damage, lesions. Secondary infections. Reduced metabolic capacity. Reduced immune response. Disease. Reduced growth. Reduced reproductive output. Growth abnormalities. Behavioural disruption.
Marine reptiles	Light coating. Degree of coating depends on the energy and tidal reach of the shoreline, the type of the receptor and continual weathering of the condensate/diesel.	Behavioural disruption. It is commonly thought that condensate does not cause problems to wildlife due to the lack of visible oiling, however may be toxic (WAOWRP, 2014).	Inhalation. Ingestion. External contact and adsorption across exposed skin and membranes.	Mortality. Cell damage, lesions. Secondary infections. Reduced metabolic capacity. Reduced immune response. Disease. Reduced growth. Reduced hatchling success. Reduced reproductive output. Growth abnormalities. Behavioural disruption.
Marine mammals	Light coating. Coating of feeding apparatus in some species (i.e., baleen whales).	Fur damage and matting, reduced mobility and buoyancy (for applicable species).	Inhalation. Ingestion.	Mortality. Cell damage, lesions. Secondary infections. Reduced metabolic capacity.

Receptor	Physical Pathway	Potential Impacts via Physical Pathway	Chemical Pathway	Potential Impacts via Chemical Pathway
		It is commonly thought that condensate does not cause problems to wildlife due to the lack of visible oiling, however may be toxic (WAOWRP, 2014).	External contact and adsorption across exposed skin and membranes.	Reduced immune response. Disease. Reduced growth. Reduced reproductive output. Growth abnormalities. Behavioural disruption.

Table 7-10 summarises the potential impacts of hydrocarbon spills on sensitive receptors and values within the EMBA.

Table 7-10: Impacts of Condensate on Sensitive Receptors and Values Found Within the EMBA

<table>
<tr><th rowspan="2">Receptor</th><th colspan="2">Impacts of Condensate from the Well Loss of Containment</th></tr>
<tr><th>Entrained and Dissolved Hydrocarbon in the Water Column</th><th>Surface Hydrocarbons</th></tr>
<tr><td colspan="3">Marine Fauna</td></tr>
<tr><td rowspan="2">Plankton (including zooplankton; fish and coral larvae)</td><td>There is potential for localised mortality of plankton due to reduced water quality and toxicity. Effects will be greatest in the upper 10 m of the water column and areas close to the spill source where hydrocarbon concentrations are likely to be highest.</td><td>Surface condensate will have a negligible impact on plankton.</td></tr>
<tr><td colspan="2">A particularly high abundance of phytoplankton is not expected to occur within the EMBA area as there are no topographical features that may result in upwelling or a disruption to the current flow. The EMBA has the potential to overlap with spawning of some fish species given the year-round spawning of some species. In the unlikely event of a spill occurring, fish larvae may be impacted by hydrocarbons entrained in the water column with effects greatest in the upper 10 m of the water column and closest to the spill source. However, following release, the condensate will rapidly evaporate, disperse and degrade in the offshore environment, reducing the concentration and toxicity of the spill. Given the duration of fish spawning periods, the lack of suitable habitat for aggregating fish populations near the surface, the quick evaporation and dispersion of condensate, impacts to overall fish populations are not expected to be significant.</td></tr>
<tr><td rowspan="2">Marine mammals</td><td>Lethal or sublethal physical and toxic effects such as irritation of eyes or mouth and potential illness.

It is commonly thought that condensate does not cause problems for wildlife due to the lack of visible oiling, however may be toxic (WAOWRP, 2014).</td><td>At risk of direct contact with condensate due to chance of surfacing within slick. Effects include irritation of eyes or mouth and potential illness. Surface respiration could lead to accidental ingestion of hydrocarbons or result in the coating of sensitive epidermal surfaces.</td></tr>
<tr><td colspan="2">Twelve migratory marine mammals were identified by the EPBC Protected Matters Search (Section 3.2). Of these, four are listed as threatened, and one additional species is listed as endangered but not migratory:

<u>Humpback whale</u>: The EMBA overlaps the humpback whale migration BIA. In the unlikely event of condensate spill, migrating humpback whales or female whales and calves resting at Montebello Islands and transiting in the offshore Ningaloo area may encounter condensate on the surface or in the water column. However, given the rapid evaporation of condensate, significant numbers are not expected to be impacted.

<u>Blue whales</u>: The EMBA overlaps with the blue whale migratory BIA. Since blue whales show preference for water depths greater than 500 m, a small number of individuals may encounter condensate at the sea surface and within the water column. However, the absence of any known feeding, resting or breeding areas in the operational area or EMBA means significant numbers are unlikely to be impacted.</td></tr>
</table>

<table>
<tr><td></td><td colspan="2"><u>Fin whale</u>: Fin whales have a worldwide distribution generally in deeper waters, and their distribution in Australia is not clear due to the sparse sightings. Given the absence of any known feeding, resting or breeding areas, significant numbers are unlikely to be impacted. No BIAs occur within the EMBA.

<u>Sei whale</u>: Sei whales move between Australian waters and Antarctic feeding areas; however, they are only infrequently recorded in Australian waters (Bannister et al., 1996) and their movements and distribution in Australian waters is not well known (DoE, 2014). Given the absence of any known feeding, resting or breeding areas, significant numbers are unlikely to be impacted.

<u>Southern right whale</u>: The southern right whale is seasonally present along the Australian coast between late April and early November. It has been recorded in the coastal waters of all Australian states except the Northern Territory. It is principally found along the southern coastline. Given the absence of any known feeding, resting or breeding areas in the EMBA, significant numbers are unlikely to be impacted.

Other migratory cetaceans, as well as migratory dugongs, are predicted to occur in the EMBA and may encounter either condensate at the sea surface or in the water column; however, the absence of any known feeding, resting or breeding areas means significant numbers are unlikely to be impacted.</td></tr>
<tr><td rowspan="2">Marine reptiles</td><td>Lethal or sublethal physical and toxic effects such as irritation of eyes or mouth and potential illness.

It is commonly thought that condensate does not cause problems for wildlife due to the lack of visible oiling, however may be toxic (WAOWRP, 2014).</td><td>At risk of direct contact with condensate due to chance of surfacing within slick. Effects include irritation of eyes or mouth and potential illness. Surface respiration could lead to accidental ingestion of hydrocarbons or result in the coating of sensitive epidermal surfaces.</td></tr>
<tr><td colspan="2">Threatened and migratory marine reptile species that may occur within the EMBA and that have been identified by the EPBC Protected Matters Search are listed in Section 3.2. Short-nosed seasnake and flatback, hawksbill, leatherback, green and loggerhead turtles are widely dispersed at low densities across the North West Shelf; and in the unlikely event of a condensate spill occurring, individuals traversing open water may come into contact with water column or surface condensate. The operational area and EMBA overlap with the flatback turtle's internesting BIA, an internesting buffer critical to the survival of the species (60 km of Barrow Island and the Dampier Archipelago). The EMBA also intercepts BIAs for green, hawksbill and loggerhead turtles (Section 3). The results of the spill modelling indicated that concentrations of hydrocarbons are below the 10 g/m^2 impact threshold near shorelines.</td></tr>
<tr><td>Seabirds and shorebirds</td><td>Lethal or sublethal physical and toxic effects such as irritation of eyes or mouth and potential illness.

It is commonly thought that condensate does not cause problems for wildlife due to the lack of visible oiling, however may be toxic (WAOWRP, 2014).

Seabirds may encounter entrained condensate while diving and foraging.</td><td>Particularly vulnerable to surface condensate. As most fish survive beneath floating slicks, they will continue to attract foraging seabirds, which typically do not exhibit avoidance behaviour. Smothering can lead to reduced waterproofing of feathers and ingestion while preening. In addition, condensate can erode feathers via chemical damage to the feather structure that subsequently affects the bird's ability to thermoregulate and maintain buoyancy on water.</td></tr>
</table>

	Shorebirds may encounter condensate accumulating on shorelines at feeding, roosting and breeding sites.	
	Threatened and migratory seabirds and shorebirds that may occur within the EMBA and that have been identified by the EPBC Protected Matters Search are listed in **Section 3.2** and may have foraging, feeding, breeding or nesting habitat in the vicinity of the EMBA. The loss of well control EMBA intercepts with breeding BIAs for several migratory species (Australian fairy tern, roseate tern and wedge-tailed shearwater) and one listed marine bird species (lesser crested tern) (**Section 3**). The Australian fairy tern has foraging and breeding habitat in the area and so may be impacted by surface and water column hydrocarbons while foraging (dive and skim feeding). Higher numbers would be expected during the breeding period of July to September. Due to the fast evaporation and dispersion of condensate, significant impacts are not anticipated. While a number of seabird species may occur in the area, no BIAs are designated for breeding for these species within the EMBA.	
Fish and sharks	Hydrocarbon droplets can physically affect fish and sharks exposed for an extended duration (weeks to months). Smothering through coating of gills can lead to the lethal and sublethal effects of reduced oxygen exchange, and coating of body surfaces may lead to increased incidence of irritation and infection. Fish may also ingest hydrocarbon droplets or contaminated food leading to reduced growth. The operational area and EMBA overlap with the whale shark foraging BIA. The EPBC Act–listed whale shark occurs in the region particularly around the time of aggregation events off the Ningaloo coast between April and June. This species is oceanic but also comes into shore and feeds in surface waters, which often coincide with specific productivity events that are a focus of feeding for the animals. It is therefore possible that surface, entrained and dissolved aromatic hydrocarbon could come in contact with or be ingested by the species if whale sharks are migrating in the area at the time. However, given the distance to the whale shark aggregation location, significant impacts to whale shark are not expected should a spill occur. There is potential for localised mortality of fish eggs and larva due to reduced water quality and toxicity. Effects will be greatest in the upper 10 m of the water column and areas close to the spill source where hydrocarbon concentrations are likely to be highest;	While fish and sharks do not generally break the sea surface, individuals may feed at the surface. However, since the condensate is expected to quickly disperse and evaporate (modelling results indicate a significant proportion of the oil mass from the water surface evaporates within 24 hours at moderate wind speeds), the probability of prolonged exposure to a surface slick by fish and shark species is low.

	therefore, demersal fish communities are not expected to be impacted.	
	The North West Shelf supports a diverse assemblage of fish and shark species, including 456 species of finfish, particularly in shallower water near the mainland and islands. Threatened species identified by the EPBC Protected Matters Search include the great white shark, whale shark, grey nurse shark and green and dwarf sawfish, which may be present in the affected area (**Section 3.2**). However, given the absence of critical habitat for most of these species, significant numbers are not expected to be impacted. The only BIA in this category overlapping the operational area and EMBA is for the whale shark. While this is for foraging, it is not for high-density prey where congregations are expected, so impacts would be limited to transient migrating individuals. Other migratory species that may transit the EMBA and so could be present include sawfish species, mako, mackerel shark, reef and giant manta ray, blind gudgeon and blind cave eel.	
Socio-economic		
Fisheries	Condensate in the water column can have toxic effects on fish (as outlined above), reducing catch rates and rendering fish unsafe for consumption.	In addition to the effects of entrained and dissolved hydrocarbons, exclusion zones surrounding a spill can directly impact fisheries by restricting access for fishermen.
	Both water column and surface condensate have the potential to lead to temporary financial losses due to impacts to fish (see above).	
Tourism	There are many sources of marine-based tourism within the EMBA. Aquatic recreational activities, such as boating, diving and fishing, occur around the Montebello Islands but are concentrated in the vicinity of the population centres, such as Exmouth and Ningaloo. Exclusion zones surrounding a spill will reduce access for vessels for the duration of the response undertaken for spill clean-up (if applicable).	
Protected areas	Several Commonwealth and State marine protected areas are within the region (**Section 3.2.3**). Combined, these areas support all the habitats and faunal groups described above. Impacts to the habitat or fauna receptors described have an impact on the values of these reserves, which could have flow-on effects to tourism revenue of coastal communities that provide access to these marine reserves. The protected areas described in this EP may support nursery, feeding, or aggregation areas for fisheries species and therefore assist in maintaining healthy fish stocks and commercial and recreational fisheries.	
Shipping	Hydrocarbons in the water column will have no effect on shipping.	Exclusion zones surrounding a spill will reduce access for shipping vessels for the duration of the response undertaken for spill clean-up (if applicable); vessels may have to take large detours, leading to potential delays and increased costs.
Defence	The level of defence activities carried out in the vicinity of the operational area is low, if any; therefore, impacts on defence activities due to a condensate spill are likely to be minimal.	
Shipwrecks	Shipwrecks are not predicted to be impacted as they will not be contacted by in-water or surface oil threshold concentrations	

Indigenous	The level of activities undertaken by indigenous users is expected to be low; therefore, impacts due to a condensate spill are likely to be minimal. However, in event there is a requirement for land-based response activities or disturbance, relevant representatives will be contacted as outlined in Section 5 of the OPEP.
Existing oil and gas activity	Exclusion zones surrounding spills will reduce access, potentially leading to delays to work schedules with subsequent financial implications. Chevron undertake a number of activities on Barrow Island and therefore may be impacted in the event of an unplanned spill event through exclusion from undertaking those activities.
KEFs	The EMBA overlaps several KEFs (Figure 3-6), including the Ancient Coastline at 125-m Depth Contour, Glomar Shoals, the Continental Slope Demersal Fish Communities and the Exmouth Plateau. Key features associated with these KEFS are described within **Appendix C** and include benthic sea floor features and habitats. Some KEFs may contain corals. In the worst instance, direct contact to corals by surface or entrained hydrocarbon could lead to smothering and reduced capacity for photosynthesis or to chemical toxicity across cellular structures, leading to coral bleaching or colony death. Direct contact by dissolved aromatic hydrocarbons can cause lethal and sublethal effects in corals, depending on the time and duration of exposure of the concentrations, with sublethal effects, including decreased growth rates and reduced reproductive success. As with corals, intertidal and subtidal macroalgae and seagrass could be impacted by surface or entrained hydrocarbons. Impacts could include reduced capability for photosynthesis if the seagrass or macroalgae were smothered or toxic effects could occur from contact with the hydrocarbon. Impacts due to reduced water quality and toxicity will be greatest in the upper 10 m of the water column and areas close to the spill source where hydrocarbon concentrations are likely to be highest; therefore, demersal fish and other benthic communities are not expected to be impacted.

7.6.3 Environmental Performance and Control Measures

Environmental performance outcomes (EPOs) relating to this event include:

- No loss of containment of hydrocarbon to the marine environment [EPO-RE-07].
- Implementation of source control methods to stop the release of hydrocarbons into the marine/onshore environment. [EPO-RE-OPEP-01]
- Implement monitor and evaluate tactics in order to provide situational awareness to inform IMT decision making. [EPO-RE- OPEP-02]
- Implement mechanical dispersion to reduce the concentration of surface hydrocarbons to reduce contact with protection priorities. [EPO-RE- OPEP-03]
- Implement shoreline protection and deflection tactics to reduce hydrocarbon contact with coastal protection priorities. [EPO-RE- OPEP-04]
- Implement shoreline clean-up tactics to remove stranded hydrocarbons from shorelines in order to reduce impact on coastal protection priorities and facilitate habitat recovery. [EPO-RE- OPEP-05
- Assist DFES in the control of hazardous material. Remediate the site as directed by the Jurisdictional Authority. [EPO-RE- OPEP-06]
- Implement tactics in accordance with the Western Australian Oiled Wildlife Response Plan (WAOWRP) to prevent or reduce impacts, and to humanely treat, house, and release or euthanase wildlife. [EPO-RE- OPEP-07]
- Comply with waste treatment, transport and disposal regulations and prevent secondary contamination while reducing, reusing and recycling waste where possible. [EPO-RE-OPEP-08
- Implement monitoring programs to assess and report on the impact, extent, severity, persistence and recovery of sensitive receptors contacted by a spill. [EPO-RE- OPEP-09]

Control measures applied to prevent an oil spill and preparedness measures applied to maintain a state of readiness to respond to an oil spill are shown in **Table 7-11,** with EPSs and measurement criteria for the EPOs described in **Table 8-3** (preventative controls) and **Table 8-4** (spill response preparedness controls).

Operational controls that would be implemented to guide and effective response after a spill has occurred are provided within relevant sections of the OPEP, together with corresponding EPSs and Measurement Criteria.

Table 7-11: Control Measures Evaluation for Surface Release of Condensate from Wellheads at the Reindeer WHP

Control Measure Ref. No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
Standard Controls				
RE-CM-35	NOPSEMA-accepted WOMP.	Includes control measures for well integrity and well control.	Costs associated with personnel time in writing, reviewing and implementing the WOMP.	**Adopted** – Benefits considered to outweigh costs. Regulatory requirement must be adopted.

Control Measure Ref. No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
RE-CM-36	Well services procedures and criteria.	Includes control measures for well integrity, well operations and well control.	Costs associated with personnel time in writing, reviewing and implementing the procedures.	**Adopted** – Benefits considered to outweigh costs.
RE-CM-28	Inspection of platform structures and hydrocarbon-containing equipment.	Regular inspections reduce the risk of leaks from platform structures and hydrocarbon-containing equipment by confirming appropriate integrity.	Costs associated with personnel time in performing the inspection, and reporting of inspections and follow-up actions.	**Adopted** – Benefits considered to outweigh costs.
RE-CM-42	Inspection and corrosion monitoring.	Regular inspections reduce the risk of leaks from subsea pipelines and risers by confirming appropriate integrity.	Costs associated with personnel time in performing the inspections, monitoring and reporting of inspections and follow-up actions.	**Adopted** – Benefits considered to outweigh costs.
RE-CM-37	Testing and maintenance of emergency shutdown systems and shutdown/safety valves.	Maintenance and testing of emergency systems and shutdown valves enables potential spill volumes to be minimised.	Costs associated with personnel time in performing the testing and maintenance.	**Adopted** – Benefits considered to outweigh costs.
RE-CM-12	WHP petroleum safety zone.	Petroleum safety zone applies around the Reindeer WHP and the WHP and pipeline is marked on Australian Nautical Charts. Reduces the potential for collisions with the platform	No additional costs to Santos WA. Other marine users may be temporarily excluded from areas, disrupting their activities.	**Adopted** – Regulatory requirement must be adopted. Risk of excluding other marine users within a 500-m radius of the Reindeer WHP is unlikely to significantly impact upon the marine user. The benefits to safety of the activity (thus reducing risk of

Control Measure Ref. No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
		resulting in a loss of well control.		environmental impacts due to vessel collisions) outweighs potential costs.
RE-CM-13	Navigational charting of infrastructure.	Provides a means for other marine users to be aware of the presence of the platform and vessels.	Costs associated with personnel time in issuing notifications.	**Adopted** – Benefits considered to outweigh costs.
RE-CM-14	Navigation lighting and aids.	Reduces risk of environmental impact from vessel collisions due to ensuring safety requirements are fulfilled and other marine users are aware of the presence of the WHP and vessels.	Costs of operating and maintaining navigational equipment.	**Adopted** – Benefits considered to outweigh Costs.
RE-CM-39	Accepted Oil pollution emergency plan (OPEP).	Implements response plan to deal with an unplanned hydrocarbon spills quickly and efficiently in order to reduce impacts to the marine environment.	Personnel and administrative costs associated with preparing documents, ongoing management (spill response exercises) and implementation of OPEP.	**Adopted** – Benefits of ensuring procedures are followed and control measures implemented outweigh costs to Santos WA.
RE-CM-09	Dropped object prevention procedure (LEMs).	Impacts to the environment are reduced by preventing dropped objects. Requires lifting equipment is certified and inspected.	Costs associated with personnel time in implementing procedures and in incident reporting.	**Adopted** – Benefits considered to outweigh costs.
RE-CM-40	Support vessel positioning.	Allows the vessel to maintain accurate	Costs associated with vessels requiring appropriate positioning systems; however,	**Adopted** - The benefits to safety and the environment (thus reducing risk of

Control Measure Ref. No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
		positioning and reduce potential to impact the platform.	these are standard on certain classes of vessel.	environmental impacts due to vessel collisions) outweigh potential costs.
RE-CM-38	Emergency power system is provided on Reindeer WHP to secure secondary power source for safety integrity system.	Provides backup power for the offshore safety integrity system for control of emergency shutdowns in abnormal operational situations.	Costs associated with the personnel time in performing the testing and maintenance.	**Adopted** – Benefits of ensuring procedures are followed and control measures implemented outweigh costs to Santos WA.
RE-OPEP-CM-02	Incident management facilities.	Ensures adequate facilities are maintained and documented should an incident occur.	Costs associated with the documenting equipment and personnel levels.	**Adopted – As essential to spill response strategy.**
RE-OPEP-CM-03	Source Control Plan	Ensures relief well drilling will be implemented in a timely manner should incident occur.	Costs associated with the personnel time in writing a source control plan.	**Adopted – As essential to spill response strategy.**
RE-OPEP-CM-04	MSA with aircraft supplier.	Ensures aircraft will be mobilised in a timely manner should an incident occur.	Costs of having a contract in place.	**Adopted – As essential to spill response strategy.**
RE-OPEP-CM-05	AMOSC contract to facilitate mutual aid arrangements for access to Trained Aerial Observers	Ensures trained aerial observers are available should an incident occur.	Costs associated with the AMOSC contract.	**Adopted – As essential to spill response strategy.**
RE-OPEP-CM-06	Maintenance of MSAs with multiple vessel providers for emergency response	Ensures vessels are available should an incident occur	Costs of having a contract in place.	**Adopted – As essential to spill response strategy.**

Control Measure Ref. No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
RE-OPEP-CM-07	AMOSC contract to facilitate mutual aid arrangements for access to Oil Spill crew	Ensures personnel are available should an incident occur	Costs of having a contract in place.	**Adopted – As essential to spill response strategy.**
RE-OPEP-CM-08	Maintenance of contract for emergency response modelling	Ensures emergency response modelling is available should an incident occur	Costs of having a contract in place.	**Adopted – As essential to spill response strategy.**
RE-OPEP-CM-09	Maintenance of oil spill response capability (including satellite imagery provision) through Oil Spill Response Limited (OSRL)	Ensures hydrocarbon response capability is available should an incident occur	Costs of having a contract in place.	**Adopted – As essential to spill response strategy.**
RE-OPEP-CM-10	Maintenance of Monitoring Service Provider contract for scientific monitoring services	Ensures preparedness to conduct the response should an incident occur.	Costs of having a contract in place.	**Adopted – As essential to spill response strategy.**
RE-OPEP-CM-11	Capability reports from Monitoring Service Provider	Ensures preparedness to conduct the response should an incident occur.	Costs of having a contract in place.	**Adopted – As essential to spill response strategy.**
RE-OPEP-CM-12	Conduct periodical review of existing baseline data sources across the Santos WA combined EMBA	Ensures preparedness to conduct the response should an incident occur.	Costs of having a contract in place.	**Adopted – As essential to spill response strategy.**
RE-OPEP-CM-13	Tracking buoys available.	Ensures preparedness to conduct the response should an incident occur.	Costs of having a contract in place.	**Adopted – As essential to spill response strategy.**

Control Measure Ref. No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
RE-OPEP-CM-14	Arrangements to enable access to fluorometry services	Ensures preparedness to conduct the response should an incident occur.	Costs of having a contract in place.	**Adopted – As essential to spill response strategy.**
RE-OPEP-CM-15	Access to protection and deflection equipment and personnel through AMOSC, AMSA National Plan and OSRL	Ensures preparedness to conduct the response should an incident occur.	Costs of maintaining arrangements with AMOSC, AMSA and OSRL.	**Adopted – As essential to spill response strategy.**
RE-OPEP-CM-16	Access to waste tanks and waste transfer equipment	Ensures preparedness to conduct the response should an incident occur.	Costs of maintaining contracts with waste management providers.	**Adopted – As essential to spill response strategy.**
RE-OPEP-CM-17	Access to shoreline clean-up equipment and personnel through AMOSC, AMSA National Plan and OSRL	Ensures preparedness to conduct the response should an incident occur.	Costs of maintaining arrangements with AMOSC, AMSA and OSRL.	**Adopted – As essential to spill response strategy.**
RE-OPEP-CM-18	Maintain access to waste management equipment, personnel, transport and disposal facilities.	Ensures preparedness to conduct the response should an incident occur.	Costs of maintaining contracts with waste management providers.	**Adopted – As essential to spill response strategy.**
RE-OPEP-CM-19	Maintenance of access to oiled wildlife response equipment and personnel.	Ensures preparedness to conduct the response should an incident occur.	Costs of maintaining arrangements with AMOSC, AMSA and OSRL.	**Adopted – As essential to spill response strategy.**
Additional Control Measures				
N/A	Dedicated resources (e.g., dedicated spill response facilities on location) in the event of loss of	May allow for quicker response to a spill as resources will be within close proximity. Limits	Large costs associated with dedicated resources.	**Rejected –** Grossly disproportionate to environmental benefit.

Control Measure Ref. No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
	hydrocarbons to allow rapid response.	extent of potential spills.		
N/A	Standby vessel in situ 24 hrs/day at unmanned WHP.	Monitor the WHP 500-m-radius petroleum safety zone and be equipped with an automatic identification system to aid in its detection at sea, and radar to aid in the detection of approaching third-party vessels. Reduces risk of vessel collision and subsequent unplanned release of hydrocarbons causing potential harm to the marine environment.	High cost associated with contracting standby vessel. Costs of operating navigational equipment.	**Rejected** – The costs associated with having a vessel on location 24/7 are considered disproportionate to the environmental benefit gained, particularly given the WHP and infrastructure are marked on charts and navigational aids are present.
N/A	Source control plans in place for all wells.	May allow for quicker response to a loss of well control scenario, therefore limiting potential spill extent and volume.	Costs associated with personnel time in writing and reviewing source control plans.	**Rejected** - Santos WA only has source control plans in place for wells undergoing intervention activities, and it is part of the intervention planning process. Given the low risk presented by wells and the standards used to manage well integrity it is not considered an effective control.

7.6.4 Environmental Impact Assessment

Description – Surface Release of Condensate from the WHP	
Receptors	Threatened, migratory, or local fauna Protected areas

	Physical environment or habitats Socio-economic receptors
Consequence	D - Major

Marine fauna

A surface release of Reindeer condensate to the marine environment would result in a localised reduction in water quality in the upper surface waters of the water column. No shoreline contact of hydrocarbons greater than 10 g/m^2 is expected. However, a worst-case shoreline accumulation was predicted at the Montebello Islands (8 m^3). The potential pathways and impacts to shoreline receptors through hydrocarbon exposure and potential toxicity effects are summarised in Table 7-9). Marine fauna present in the area may be impacted by a spill through exposure to floating oil, entrained oil, or dissolved aromatic hydrocarbons.

Upon release to the marine environment, the condensate will rapidly lose toxicity with time and will spread thinner at the surface as evaporation continues or will become entrained within the water column. The potential sensitive receptors in the surrounding areas of the spill will include fish, marine mammals, marine reptiles and seabirds at the sea surface, as discussed **Section 3.1**.

Habitat modification, degradation, disruption or loss; deteriorating water quality; and marine pollution are identified as potential threats to a number of marine fauna species in relevant recovery plans and conservation advice (Table 3-6**Table 3-6**). In line with the relevant actions prescribed in Recovery Plan for Marine Turtles, conservation advice for humpback, fin, sei and whale shark, and conservation management plan for the blue whale, the activity will be conducted in a manner that reduces potential impacts to ALARP and acceptable levels.

In addition, the Management Plan for the Montebello/Barrow Islands Marine Conservation Reserves states that Department of Parks and Wildlife (DPaW) should 'Ensure that important seabird and shorebird breeding and feeding areas are not significantly affected by human activities'. The potential impacts of a hydrocarbon release on seabird breeding and feeding areas are discussed in **Table 7-10**. Impacts in relation to human activities from responding to a spill are described in **Section 6.7**.

Physical environment or habitats

In the event of condensate release, hydrocarbons that reach nearshore environments have the potential to impact benthic coral reefs and mangrove areas, which may result in a long-term decrease in ecological values given the toxicity impacts associated with hydrocarbon exposure.

Protected areas

The EMBA intersects several protected areas and Australian marine parks and marine management areas (**Section 3.2.3**). Combined, these areas support all the habitats and faunal groups described above. Impacts to the habitat or fauna receptors described above therefore have an impact on the values of these reserves, which could have flow-on effects to tourism revenue of coastal communities that provide access to these marine reserves. Many of these receptors are values of protected areas, and there could be a major effect on them.

Socio-economic receptors

There is the potential for entrained oil to temporarily disrupt fishing activities if the surface or entrained oil moves through fishing areas.

Entrained oil greater than 100 ppb could reach pearl farming activities at the Montebello Islands. Pearl oysters are filter feeders; therefore, entrained oil droplets could create negative impacts through ingestion and accumulation of hydrocarbon compounds in oyster tissues or interference with respiratory structures. Ecotox (2009) reported that no observable effect concentration levels from weathered condensates for a comparable oyster species ranged from approximately 9,000 to 28,000 ppm (9,000,000 to 28,000,000 ppb).

Significant impacts on aquaculture would therefore be unlikely, as predictive modelling reported that the maximum entrained hydrocarbon concentration for the worst replicate at the Montebello Islands was 229 ppb, well below the reported impact levels stated above. Additionally, pearling leases identified in the region are currently inactive, and no stakeholder concerns have been raised.

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A number of oil and gas operators operate within the EMBA with existing projects and infrastructure in place as well as continuing drilling and exploration programs. A condensate release has the potential to disrupt these activities, with associated economic impact, albeit on a temporary basis. Tourism could be affected by spilled condensate, either from reduced water quality or shoreline oiling preventing recreational activities or reducing aesthetic appeal or from impacts to habitats and marine fauna. Marine habitats may also be impacted with relatively small volumes (worst case 31 m^3) of condensate potentially accumulating on shorelines. Indigenous users may be impacted in the event that a land-based response is required. However, consultation will help manage activities such that potential impacts are reduced to acceptable levels. On the basis of the above assessments, a condensate surface release from the platform from a loss of well control has the potential to impact an array of receptors. Given the extent, the worst-case consequence is considered to be *Major* (D).	
Likelihood	Rare
Given the management controls in place, a loss of well control as a result of an accident during planned well intervention activities is considered to be *Rare*. This assessment of likelihood (for a loss of well control event occurring during the well intervention) is further supported when considering industry statistics, Santos WA statistics and the preventive control measures in place. Management controls in place to control the flow of hydrocarbons include construction design, safety shutdown systems, regular inspection and maintenance, and competent personnel. Additional industry standard and activity-specific control measures to reduce the chance of a loss of containment event have also been implemented, including (but not limited to) procedures such as the WOMP, crew training and awareness, and a spill response plan (OPEP). In conjunction with controls to prevent vessel collisions the control measures are considered to reduce the risk of a loss of containment (and minimise impacts) occurring to a level that is acceptable. The likelihood of a worst-case surface release at the Reindeer WHP resulting in a Major (D) consequence is considered to be *Rare*.	
Residual Risk	The residual risk associated with this event is *Medium*

7.6.5 Spill Response Strategies

Numerous oil spill response strategies are available to be implemented in the event of a spill. This section is an overview of the evaluation of spill response strategies applicable to all condensate spill scenarios shown in **Section 7.5.1**. The loss of containment from the WHP scenario represents the worst case in terms of volume of hydrocarbon released and therefore extent of impact and thus has been used to describe the most conservative spill response strategies.

The assessment presented in **Table 7-12** is based on the largest condensate spill at the Reindeer WHP and is the outcome of the first-level screening, undertaken based on the suitability of the broad response strategies available. Below are the key considerations taken into account for the evaluation:

+ The properties and weathering profile of the spilled oil;
+ The nature and scale of the credible spill scenarios; and
+ The potential safety and environmental aspects, as well as the impacts involved with the selected responses.

Table 7-12: Spill Response Strategies Considered for Condensate Release Scenarios

OSR Strategy	Activities	Applicability and Designated Primary (1) or Secondary (2) Response Strategy	Considerations
Source Control	Spill kits	✔ 1	Relevant for containing spills that may arise on board WHP.
	Secondary containment	✔ 1	Relevant for spills that may arise due to stored hydrocarbons, and from spills arising from machinery and equipment on board a vessel or WHP. Bunded areas will contain hydrocarbons reducing the potential for a spill escaping to marine waters. Where applicable open deck drainage will be closed to prevent hydrocarbon d
	Pipeline isolation (Emergency Shutdown (ESD))	✔ 1	Triggered automatically or manually as per Devil Creek Incident Response Plan
	Well Emergency Shutdown (ESD)	✔ 1	
	Surface well kill	✔ 1	Considered during relief well planning but may not be possible depending upon technical and safety constraints
	Capping Stack	X	Not applicable for production platform wells (not compatible with Capping Stack).
	Relief well drilling	✔ 1	Relevant to for loss of well control. Relief well drilling is the primary method for killing the well. To be conducted as per the Source Control Emergency Response Plan (SCERP - DR-00-ZF-10001).
In-Situ Burning	Controlled burning of oil spill	X	Not applicable to gas wells due to safety hazards. The condensate is predicted to be very volatile with naturally high rates of volatilisation and evaporation.

OSR Strategy	Activities	Applicability and Designated Primary (1) or Secondary (2) Response Strategy	Considerations
Monitor and Evaluate Plan (Operational Monitoring)	Vessel surveillance	✔ 1	Provides real-time information on spill trajectory and behaviour (e.g. weathering). Informs implementation of other response strategies. Vessel personnel may not be trained observers. Vessel observers on leaking vessel may not have capacity to observe oil during emergency response procedure implementation. Constrained to daylight. Limited to visual range from the vessel. Limited capacity to evaluate possible interactions with sensitive receptors.
	Aerial surveillance		Provides real-time information on spill trajectory and behaviour (e.g. weathering). May identify environmental sensitivities impacted or at risk of impact (e.g. seabird aggregations, other users such as fishers). Informs implementation of other response strategies.
	Tracking buoys		Can be implemented rapidly. Can provide indication of near-surface entrained / dissolved hydrocarbons (most other monitor and evaluate techniques rely on the hydrocarbon being on the surface or shoreline).
	Trajectory Modelling		Can be implemented rapidly. Predictive - provides estimate of where the oil may go, which can be used to prepare and implement other responses. No additional field personnel required.

OSR Strategy	Activities	Applicability and Designated Primary (1) or Secondary (2) Response Strategy	Considerations
			Not constrained by weather conditions. Can predict floating, entrained, dissolved and stranded hydrocarbon fractions.
	Satellite Imagery		Can work under large range of weather conditions (e.g. night time, cloud cover etc.) Mobilisation likely to be >24 hours Requires processing May return false-positives
	Operational Water Quality Monitoring		Fluorometry surveys are used to determine the location and distribution of the entrained oil and dissolved aromatic hydrocarbon components of the spill and validate the spill fate modelling predictions.
	Shoreline and Coastal Habitat Assessment		Provides information on shoreline oiling (state of the oil, extent of pollution etc.). Can provide information on amenability of shoreline response options (e.g. clean-up, protect and deflect). Provides information on status of impacts to sensitive receptors. Considerable health & safety considerations. Requires trained observers. Constrained to daylight. Delayed response time.

OSR Strategy	Activities	Applicability and Designated Primary (1) or Secondary (2) Response Strategy	Considerations
Chemical dispersion	Vessel Application	X	Reindeer condensate is not considered a persistent hydrocarbon, and has a very high natural evaporation and dispersion rates in the marine environment reducing the volume of hydrocarbon remaining at the sea surface. Spill modelling indicates that these natural weathering processes will prevent floating condensate from impacting shorelines at all but extremely low volumes. Given the gas release and relative shallow depth of the Reindeer platform, applying subsea dispersant through an SFRT is not considered feasible due to access and safety constraints. On the basis of the above, chemical dispersant application is not recommended as an applicable strategy the credible spill scenarios covered under this OPEP.
	Aerial Application	X	
	Subsea Application	X	
Offshore Containment and Recovery	Use of offshore booms/ skimmers or other collection techniques deployed from vessel/s to contain and collect oil.	X	Given the fast spreading nature of Reindeer condensate causing the slick to break up and disperse, this response is not considered to be effective in reducing the impacts of a spill. The ability to contain and recover spreading Reindeer condensate on the ocean water surface is extremely limited due the very low viscosity of the product.
Mechanical Dispersion	Vessel prop-washing	✔ 2	Reindeer condensate are very light oils that can be easily dispersed in the water column by running vessels through the plume and using the turbulence developed by the propellers to break up the slick. Once dispersed in the water column the smaller droplet sizes enhance the biodegradation process. Given the condensate is predicted to have a high rate of natural volatility and a spill would originate in offshore waters, dispersing fresh condensate underwater would not be recommended. Dispersing weathered condensate away from the spill site (that has lost lighter products) may be beneficial if there was a potential for this hydrocarbon to impact on receptors at the sea surface or along shorelines.

OSR Strategy	Activities	Applicability and Designated Primary (1) or Secondary (2) Response Strategy	Considerations
			Mechanical dispersion will be considered for non-ship sourced spills at the discretion of the On-Scene Commander/IMT or by the relevant Controlling Agency.
Protection and Deflection	Booming in nearshore waters and at shorelines	✔ 2	Considered if operational monitoring shows or predicts contact sensitive shorelines.
Shoreline clean-up	Activities include physical removal, surf washing, flushing, bioremediation, natural dispersion	✔ 2	Intrusive activities such as physical removal of waste using manual labour or mechanical aids requires careful site-specific planning to reduce secondary impacts of habitat disturbance, erosion and spreading oil beyond shorelines. Flushing may be considered if the oil enters high priority/slow recovery habitats such as mangroves. Natural dispersion will occur as the hydrocarbon is remobilised from rock shelves and hard substrates, while residual will biodegrade. This response has potential to cause more harm than benefit especially if oiling is light. Shoreline assessments as part of operational monitoring provide site-specific guidance on the applicability and likely benefits of different clean-up techniques.
Oiled wildlife Response	Activities include hazing, pre-emptive capture, oiled wildlife capture, cleaning and rehabilitation.	✔ 2	Can be used to deter and protect wildlife from contact with oil. Mainly applicable for marine and coastal fauna (e.g. birds) where oil is present at the sea surface or accumulated at coastlines. Potential for onshore releases to impact nesting areas. Surveillance can be carried out as a part of the fauna specific operational monitoring Wildlife may become desensitised to hazing method.

OSR Strategy	Activities	Applicability and Designated Primary (1) or Secondary (2) Response Strategy	Considerations
			Hazing may impact upon animals (e.g. stress, disturb important behaviours such as nesting or foraging) Permitting requirements for hazing and pre-emptive capture.
Scientific Monitoring	The monitoring of environmental receptors to determine the level of impact and recovery form the oil spill and associated response activities.	✔ 1	Monitoring activities include: + Water and sediment quality + Biota of shorelines (sandy beaches, rocky shores and intertidal mudflats) + Mangrove monitoring + Benthic habitat monitoring (seagrass, algae, corals) + Seabirds and shorebirds + Marine megafauna (incl. whale sharks and mammals) + Marine reptiles (incl. turtles) + Seafood quality + Fish, fisheries and aquaculture The type and extent of scientific monitoring will depend upon the nature and scale of oil contact to sensitive receptor locations as determined through operational monitoring. Pre-defined initiation criteria exist for scientific monitoring plans associated with marine and coastal sensitivities.

7.6.6 Spill risk assessment

The spill risk assessment approach adopted is based on Santos WA's Oil Spill Risk Assessment and Response Planning Procedure (QE-91-II-20003). The procedure describes the spill risk assessment process as follows:

1. Identify the spatial extent of the environment that may be affected (the EMBA);
2. Identify areas of high environmental value (HEV) within the EMBA; and
3. Risk assess areas of HEV with a high probability and level of oil contact (Hot Spots).

7.6.6.1 Spill EMBA

Defining the EMBA by an oil spill is the first step in oil spill risk assessment. For activities where there is the potential for multiple spill scenarios, the spill scenario, or combination of spill scenarios, resulting in the greatest spatial extent of impacts is used to define the overall EMBA for the activity. The EMBA is further described in **Section 3.1**.

7.6.6.2 Areas of High Environmental Value

Santos WA has predetermined areas of HEV (**Figure 3-2**) along the Western Australian coastline by ranking these areas based on:

+ Protected area status – This is used as an indicator of the biodiversity values contained within that area, where a World Heritage Area, Ramsar Wetland and Marine Protected Area will score higher than areas with no protection assigned; and
+ BIAs of listed threatened species – These are spatially defined areas where aggregations of individuals of a species are known to display biologically important behaviour, such as breeding, feeding, resting or migration. Each one of these within the predefined areas contributes to the score.

Further input to determine areas of HEV included:

+ Sensitivity of habitats to impact from hydrocarbons in accordance with the guidance document Sensitivity Mapping for Oil Spill Response produced by IPIECA, the International Maritime Organisation and International Association of Oil and Gas Producers;
+ Sensitivities of receptors with respect to hydrocarbon-impact pathways;
+ Status of zones within protected areas (i.e., IUCN (1a) and sanctuary zones compared to IUCN (VI) and multiple use zones);
+ Listed species status and predominant habitat (surface versus subsurface); and
+ Social values, i.e., socio-economic and heritage features (e.g., commercial fishing, recreational fishing, amenities, aquaculture).

Tallied scores for each predefined area along the Western Australian coastline were then ranked from 1 to 5, with an assignment of 1 representing areas of the highest environmental value and those with 5 representing the areas of the lowest environmental value. The predefined areas assigned the ranks of 1, 2 or 3 are considered by Santos WA to be HEV areas and are included in **Table 7-13**.

7.6.6.3 Hot Spots

While the entire EMBA will be considered during risk assessment and spill response planning, it is best practice to concentrate greatest effort and level of detail on those parts of the EMBA that have:

+ The greatest intrinsic environmental value – i.e., HEV areas;
+ The greatest likelihood of contact by oil (either floating, entrained or dissolved aromatic); and
+ The greatest potential volume or concentration of oil arriving at the area.

These areas are termed 'Hot Spots'. Defining Hot Spots is typically the first step in undertaking detailed spill risk assessment and spill response planning. Hot Spots are a subset of HEV areas that:

+ Have the highest probability of contact (at least higher than 5%) above the impact assessment thresholds for surface hydrocarbons and shoreline accumulation based on modelling results; and

+ Receive the greatest concentration or volume of oil, either floating or stranded oil, entrained oil or dissolved aromatic hydrocarbons.

7.6.6.4 Priorities for Protection

For the purposes of a spill response preparedness strategy, it is not necessary for all Hot Spots to have detailed planning. For example, wholly submerged Hot Spots may only be contacted by entrained oil, and the response would be largely to implement scientific monitoring to determine impact and recovery. Hot Spots with features that are not wholly submerged (i.e., emergent features) should have specific spill response planning conducted. This final determination of Hot Spots, designated as 'Priority for Protection' sites for the oil spill response strategy, is based on the worst-case estimate of floating oil concentration, shoreline loading and minimum contact time at threshold concentrations. An assessment of each protection priority will be undertaken to determine the most appropriate spill response strategies based on the type of oil and the values of the protection priority area. This can be done through a strategic NEBA approach.

Based on the stochastic spill modelling results, four areas are considered to be the most sensitive environmental areas within the EMBA and those at highest risk (vulnerability) to oiling impacts (shoreline loading, probability of shoreline loading and floating oil) (refer to **Table 7-13**). They are:

+ Montebello Islands;[2]
+ Lowendal Islands;

Montebello Islands receptors include the geographic receptor region and Montebello Marine Park. Barrow Island and Montebello Islands receptors include the Barrow-Montebello surrounds designated by the waters surrounding these islands (illustrated in **Figure 3-2**). All other HEV receptors shown in **Figure 3-2**, did not meet the hydrocarbon designated thresholds to be carried forward to further assessment in **Table 7-13.** While the offshore Ningaloo was predicted to receive hydrocarbon contact above the designated thresholds, Santos WA has ranked this receptor as a 4 in terms of sensitivity; therefore, it does not qualify as a HEV and is not assessed further in **Table 7-13**. Modelling did not predict contact above the designated thresholds to other Ningaloo HEVs defined in **Figure 3-2**.

Table 7-13 provides a simplified summary of the consequence assessment results for each of the HEVs, which provides the basis for the identification of the protection priority areas. The consequence assessment was mainly based on predicted floating oil and/or shortest time to contact by floating oil. In addition, shoreline loading, length of shoreline contacted and probability of shoreline loading to these locations from stochastic oil spill modelling were also taken into account.

Potential impacts (consequence rankings) were determined after considering the receptor values (protected area status, threatened species, BIAs, KEFs, social values including heritage values, and concerns raised during stakeholder consultation) and the potential impacts to these (**Table 7-14** and **Table 7-15**) from the predicted concentrations or levels of condensate for each location.

[2] Montebello Islands receptors include the geographic receptor region and state marine park, both of which had the same dissolved and entrained concentrations and contact probabilities predicted.

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Table 7-13: Consequence Summary for Protection Areas for Focused Spill Response

<table>
<tr><th>Receptor Name</th><th>Santos WA Sensitivity Ranking Score
[High Environ-mental Value Rank]</th><th>Values</th><th colspan="2">Oil Spill Modelling Parameter</th><th>Surface Blowout (NC = No Contact)</th><th>Consequence Category</th><th>Consequence Ranking</th><th>Total</th></tr>
<tr><td rowspan="6">Montebello Islands</td><td rowspan="6">12-15
[3]</td><td rowspan="6"><u>Habitats</u>
Reefs
Algae (40%)
Fish habitat
Intertidal sand flat communities
Mangroves (considered globally unique as they are offshore)
<u>Turtles</u>
Loggerhead and green (significant rookery), hawksbill, flatback turtles
Northwest and Eastern Trimouille Islands (hawksbill)
Western Reef and Southern Bay at Northwest Island (green)
<u>Seabirds</u>
Migratory and threatened seabirds – 14 species
Significant nesting, foraging and resting areas
<u>Whales</u></td><td>Probability of contact by floating oil at 10 g/m²</td><td>(%)</td><td>NC</td><td rowspan="6">+ Threatened or migratory fauna;
+ physical habitat;
+ protected areas;
+ socio-economic receptors</td><td rowspan="6">B

C
C

C</td><td rowspan="6">C</td></tr>
<tr><td>Maximum oil loading on shorelines <u>(worst-case deterministic)</u></td><td>m³</td><td>8 m³</td></tr>
<tr><td>Maximum accumulated concentration (>100 g/m²)</td><td>g/m²</td><td>211 g/m²</td></tr>
<tr><td>Maximum length of shoreline oiled <u>(>100 g/m²)</u></td><td>(km)</td><td>34 km</td></tr>
<tr><td>Minimum time to contact by floating oil 10 g/m²</td><td>Time (d)</td><td>NC</td></tr>
<tr><td>Maximum total entrained oil</td><td>(ppb)</td><td>241 ppb</td></tr>
</table>

Receptor Name	Santos WA Sensitivity Ranking Score [High Environ-mental Value Rank]	Values	Oil Spill Modelling Parameter		Surface Blowout (NC = No Contact)	Consequence Category	Consequence Ranking	Total
		Humpback/ pygmy blue whale migration <u>Socio-economic</u> Pearling (inactive/pearling zones) Very significant for recreational fishing and charter boat tourism Social amenities and other tourism Nominated place (national heritage)	*when >100 ppb*					
			Maximum concentration of dissolved aromatic hydrocarbons >6ppb	*(ppb)*	240.3			
Lowendal Islands	12-15 [3]	<u>Habitats</u> Important shallow lagoons with seagrass for dugongs Deep water benthic (soft sediment) habitats Dugong and batman reef (eastern side), Mangroves considered globally unique as they are offshore Macroalgal reefs (40%) <u>Turtles</u> Important hawksbill (Beacon, Parakeelya, Kaia and Pipeline), loggerhead and green turtle	*Probability of contact by floating oil at 10 g/m^2*	*(%)*	NC	+ Threatened or migratory fauna; + physical habitat; + protected areas; + socio-economic receptors	B C C B	C
			Maximum oil loading on shorelines (worst-case deterministic)	*m^3*	4 m^3			
			Maximum accumulated concentration (>100 g/m^2)	*g/m^2*	163 g/m^2			
			Maximum length of	*(km)*	31 km			

Receptor Name	Santos WA Sensitivity Ranking Score [High Environ-mental Value Rank]	Values	Oil Spill Modelling Parameter		Surface Blowout (NC = No Contact)	Consequence Category	Consequence Ranking	Total
		nesting (minor) Varanus pipeline, Harriet and Andersons)	*shoreline oiled (>100 g/m²)*					
		Nesting is reported to occur throughout the year in WA, peaking between October and January Significant flatback rookery, nesting season for flatback turtles peaks in December and January with subsequent peak hatchling emergence in February and March	*Minimum time to contact by floating oil 10 g/m²*	*Time (d)*	NC			
			Maximum Total entrained oil when >100 ppb	*(ppb)*	NC			
		<u>Seabirds</u> Approximately 89 species of avifauna, 12 to 14 species of migratory seabirds	*Maximum concentration of dissolved aromatic hydrocarbons >100 ppb*	*(ppb)*	NC			
		<u>Marine mammals</u> Seagrass beds around the Lowendal islands thought to provide valuable food source for dugongs <u>Protected areas</u> The Barrow Island Marine Management Area, most of the waters around Barrow Island, the Lowendal Islands and the Barrow Island Marine Park	*Maximum concentration of DAH >6 ppb*	*(ppb)*	49 ppb			

Receptor Name	Santos WA Sensitivity Ranking Score [High Environ-mental Value Rank]	Values	Oil Spill Modelling Parameter		Surface Blowout (NC = No Contact)	Consequence Category	Consequence Ranking	Total
		<u>Socio-economic and heritage values</u> Very significant for recreational fishing and charter boat tourism Social amenities and other tourism						

Note: < means less than; > means greater than.

7.6.7 Net Environmental Benefit Analysis

A net environmental benefit analysis is a structured approach used by the response community and stakeholders to select spill response strategies that will effectively remove oil, are feasible to use safely in particular conditions, and will reduce the impact of an oil spill on the environment. The process provides an estimate of potential environmental effects that is sufficient to allow the comparison and selection of a preferred combination of response strategies to reduce environmental impacts to ALARP.

A strategic net environmental benefit analysis has been developed for all response strategies identified as applicable to credible spills, with the benefit or potential impact to each sensitivity identified within protection priority areas. This will assist in informing the selection of response strategies tailored to the key environmental values within the areas of highest priority. Building on the information presented in this section, **Table 7-14** presents a summary of spill response strategies available for each of the priorities for protection and the potential impact that a response strategy has on the area's environmental values, noting that response strategies are not used in isolation.

This information is to be considered in the net environmental benefit analysis process during a spill response (i.e., an operational net environmental benefit analysis). An operational net environmental benefit analysis will also consider real time monitoring of the effectiveness and potential impacts of a response and will also consider accessibility, feasibility and safety of responders (refer to the OPEP).

Table 7-14: Impact of Spill Response Strategies on the Environmental Values of the Protection Priorities

Priority for Protection Area	No Controls	Source Control	Monitor and Evaluate	Mechanical Dispersion	Shoreline Protection & Deflection	Shoreline Clean-Up	Oiled Wildlife Response	Scientific Monitoring
Note: These strategies are implemented with consideration to the control measures in **Table 7-15.**								
Montebello Islands								
Turtle nesting – North West and Eastern Trimouille islands (hawksbill); Western Reef, Southern Bay and North West Island (green)								
Mangroves – particularly Stephenson Channel							N/A	
Coral and other subsea benthic primary producers					N/A	N/A	N/A	
Seabird nesting								
Migratory shorebirds								
Humpback/pygmy blue whale migration					N/A	N/A		
Fishing/charter boat tourism								
Lowendal Islands								
Turtle nesting – particularly flatback and green turtles								
Mangroves and mudflats (shorebird foraging)							N/A	
Coral and other subsea benthic primary producers					N/A	N/A	N/A	
Seabird nesting								

Priority for Protection Area	No Controls	Source Control	Monitor and Evaluate	Mechanical Dispersion	Shoreline Protection & Deflection	Shoreline Clean-Up	Oiled Wildlife Response	Scientific Monitoring
Migratory shorebirds								
Aboriginal listed sites incl. pearling camps							N/A	N/A

Legend	
	Beneficial impact.
	Possible beneficial impact depending on the situation (e.g., time frames and metocean conditions to dilute entrained oil).
	Negative impact.
N/A	Not applicable for the environmental value.

7.6.8 Demonstration of ALARP

Well intervention is required for the ongoing safe and efficient operation of the Reindeer production wells and is a standard industry activity. Removing well intervention and other well maintenance activities is therefore not considered a practicable option.

The Reindeer Well Operations Management Plan (WOMP) (DR-91-ZG-10038) identifies direct intervention, top-kill and relief well drilling as contingency strategies to respond to a loss of well control at Reindeer Platform wells. The primary means of controlling a well that cannot be brought under control using onsite resources is the drilling of a relief well to intercept the well bore and kill the flow of hydrocarbons.

Spill response and impact assessment for this activity has been based on the relief well taking 77 days (11 weeks) to execute.

Supporting controls to allow the relief well schedule to be met include:

+ Rig capability register to identify suitable rigs. Identification of suitable rigs is also included in the terms of reference for “Assurance Review 4: Readiness to Spud” under the WLMS Well Delivery Workflow;
+ Source Control Emergency Response Plan (SCERP) (DR-00-ZF-10001) (details relief well planning matters, including but not limited to relief well design and procurement matters);
+ Preliminary relief well planning prior to well interventions is embedded into the well delivery workflow;
+ APPEA Memorandum of Understanding (MoU) provides for access to other Operator rigs; and
+ Contracts and MoUs for personnel are in place.

No additional controls can be considered that reduce the likelihood of a well blowout further in terms of equipment and practices, given that industry standards are adhered to in terms of well design (i.e., provision of subsea safety valves), well equipment certification, well integrity testing and the trained and competent personnel. These practices are stipulated within the Reindeer WHP WOMP, which has regulatory approval. It is therefore considered that the risk of a loss of containment occurring has been reduced to ALARP.

Santos WA considers that through the resourcing arrangements outlined within the OPEP (including spill response equipment and personnel from internal and external sources including Santos WA, AMOSC, AMSA, other operators, OSRL, and other national and international suppliers) the spill response strategies and control measures reduce potential risk and impacts from to ALARP.

In terms of further reducing the risk of a vessel collision to the WHP, there are no practicable alternatives that would not provide a disproportionate environmental benefit given the low likelihood of a collision for a vessel of sufficient size to lead to a catastrophic platform collision. The Reindeer WHP Safety Case considers that the only vessels capable of catastrophic platform damage are large support vessels (e.g., a diving support vessel under power but not a typical support vessel, which are smaller vessels, i.e., typically less than 75 tonne displacement). The use of large diving support style vessels cannot be eliminated as they are necessary for the maintenance of subsea infrastructure that reduces environmental risk from hydrocarbon releases. The risk of an errant powered vessel (e.g., a ship) colliding with the platform cannot be completely eliminated but is a low risk given there are no nearby shipping channels.

The controls in place for preventing vessel impact are consistent with those provided in the Reindeer WHP Safety Case and are considered to reduce risk to ALARP. The Reindeer WHP is an unmanned platform, and while the manning of the platform or a permanently stationed support vessel as a means of communicating with collision threats could be considered, the cost and effort of these measures are grossly disproportionate to their possible benefit and carry other environmental and safety risks. Unmanned navigation hazards (but which are marked on nautical charts) are commonplace on the North West Shelf, and the likelihood of collision with the Reindeer WHP is no more likely than with these other hazards.

The combination of the standard prevention control measures (**Section 7.6.3**) (which reduce the likelihood of the event happening) and the spill response strategies (which may reduce the consequence) together reduce the overall hydrocarbon spill risk.

A strategic net environmental benefit analysis (**Section 7.6.7**) has been undertaken on the spill response strategies. An ALARP assessment of further control measures to reduce potential risks and impacts from a loss of well control or vessel collision are presented in **Table 7-15**.

Table 7-15: ALARP Assessment of the Resourcing for Spill Response Strategies

Strategy	Resourcing	Justification	Environmental Benefit of Additional Resources	Cost of Additional Resources	ALARP Assessment
Relief Well Drilling	Rig capability register to identify suitable rigs. Identification of suitable rigs is also included in the terms of reference for “Assurance Review 4: Readiness to Spud” under the WLMS Well Delivery Workflow; Source Control Emergency Response Plan (SCERP)(DR-00-ZF-10001) (details relief well planning matters, including but not limited to relief well design and procurement matters); Preliminary source control plan prior to well intervention campaign is embedded into the well delivery workflow;	A second MODU positioned on standby in the vicinity of the activity during the drilling campaign was considered as an additional control that could reduce the length of time taken to drill a relief well. This would involve hiring an additional rig for the duration of the activity. If adopted, this may reduce the timeframe for stopping a blowout by up to two weeks, although planning/approval/set-up requirements mean the reduction would likely be less.	If adopted, this may reduce the timeframe for stopping a blowout by up to two weeks reducing the hydrocarbons released to the environment.	The cost of having a MODU and personnel/equipment on standby (at a rate of ca. $600k/day) would double the cost of the activity	this is considered grossly disproportionate to the environmental benefit (reduction of 2 weeks of release), considering the rare likelihood of a LOWC, the existing preventative control measures in place to prevent a well blowout and the additional safety and environmental risks of having another MODU and support equipment/personnel on standby. Having a dedicated second MODU on standby for the purpose of relief well drilling was therefore rejected as a control measure

Strategy	Resourcing	Justification	Environmental Benefit of Additional Resources	Cost of Additional Resources	ALARP Assessment
	APPEA Memorandum of Understanding (MoU) provides for access to other Operator rigs; and Contracts and MoUs for personnel are in place				
Direct surface intervention	Through arrangements with Wild Well Control, as outlined within the *Source Control Emergency Response Plan* (SCERP) (DR-00-ZF-10001	Direct surface intervention (i.e. deployment onto the jack-up rig) using specialised well control personnel is a strategy that could be adopted.	This strategy is contingent on technical aspects of the LOWC event and safety considerations which could only be assessed at the time of a spill event. Therefore the environmental benefit provided would be contingent on the conditions at the time. Potential to reduce well kill time.	The cost would be comparable to relief well drilling	Given the uncertainty for the response strategy feasibility, in combination with the potential safety hazards surrounding the well, the current preparedness measures for well intervention is considered ALARP
Aerial Surveillance	Helicopter services available through Santos WA primary contracted supplier based out of Karratha.	Given location of spill site, mobilisation of helicopters from Karratha (via Varanus Island if required) is considered adequate for surveillance. Endurance not considered a limiting factor at this location. The helicopter provider runs to	Resource not considered limiting. Primary supplier on contract with additional providers available to provide desired overpass frequency. Santos WA– trained	No additional costs as helicopters are currently contracted for day-to-day operations to and from Santos WA facilities. In the event that additional passes are	There is no value in increasing dedicated overpasses; therefore, the arrangements are considered to be ALARP. However, opportunistic aerial surveillance can be

Strategy	Resourcing	Justification	Environmental Benefit of Additional Resources	Cost of Additional Resources	ALARP Assessment
	Ad-hoc contracts through other providers. Initial aerial observation using helicopter pilots will occur within 3 hours of notification of the spill. Trained Aerial Observers (7) available from Day 2 of incident following activation (based Perth and Santos WA facilities).	Varanus Island regularly for crew transfers. Mobilisation and refuelling from Exmouth is possible, depending upon trajectory of spill. Current arrangements can provide for two passes (a.m. and p.m.) of the spill area per day; this has been exercised as part of major spill exercises. Trained Aerial Observers can mobilise to Karratha or Exmouth for Day 2 operations. Day 1 surveillance and recording using helicopter pilots considered adequate for initial situational awareness.	observers can be provided on rotation from Day 2.	required due to data gaps, the cost of the additional flights will be added to the cost of the response.	provided through the shared use of aircraft deployed for other purposes.
Vessel Surveillance	On-hire vessels supporting Santos WA's Varanus Island and Ningaloo Vision facilities. Vessels of opportunity from other operators. Additional vessels contracted through Santos WA vessel	On-contract vessels performing duties at Varanus Island and Ningaloo Vision will be available, as well as vessels of opportunity from other petroleum operators. The activity area is central on the North West Shelf and offshore from the major marine base of Dampier;	Based on the close proximity of the activity to Varanus Island and the central location of the activity relative to the main marine base at Dampier, dedicated additional vessels for the purpose of oil spill surveillance are not	The current vessel arrangements are considered to provide the required function. Dedicated vessels on standby for vessel surveillance would cost tens of thousands per day and are not considered required.	There is no benefit in having additional dedicated surveillance vessels, given surveillance can be performed from any vessel and these duties will be shared among spill response vessels.

Strategy	Resourcing	Justification	Environmental Benefit of Additional Resources	Cost of Additional Resources	ALARP Assessment
	providers out of Dampier. Santos WA has access to automatic identification system live vessel tracking portal to establish vessel availability. Vessel surveillance will be activated within 90 minutes for available on-site (at VI) vessels.	additional available vessels out of Dampier can be put on hire through Santos WA's contracted vessel providers; mobilisation times to site can provide additional contracted vessels relatively quickly. Additional mobilisation from Exmouth can be made through Santos WA's contracted vessel providers. This strategy is not designed to perform 'whole of spill' coverage, which is provided by aerial surveillance (i.e., it is a secondary strategy).	considered required given the need is met through vessel sharing. Surveillance will also be conducted through a number of complementary strategies (aerial surveillance, oil spill trajectory modelling, and tracker buoys).		
Oil Spill Fate Modelling	24/7 stand-by spill modelling service provider. Provider will be contacted immediately (within 2 hours) upon notification of a Level 2 or 3 spill. Spill modelling to be initiated within 24 hours.	RPS APASA is to provide at least daily updates to the IMT of trajectory model outputs to inform response planning. More frequent updates can be provided if weather conditions are highly variable or change suddenly. Operational surveillance data (aerial, vessel, tracker buoys) are to be provided to RPS APASA to verify and adjust	Predictive oil spill modelling will be used to forecast (using real-time data) the trajectory and fate of the spill. Resource is not considered limiting with no environmental benefit from dedicating additional modelling capability.	Santos WA pays for the provision of the service by RPS APASA. This is considered to provide the required function.	There is no benefit in having additional modelling capability given that RPS APASA have staff based across Australia and can provide 24/7 coverage.

Strategy	Resourcing	Justification	Environmental Benefit of Additional Resources	Cost of Additional Resources	ALARP Assessment
	Upon activation, trajectory models provided within: + 2 hours for OILMAP model for offshore and open ocean + 4 hours for OILMAP operation for nearshore	fate predictions of the spill and improve predictive accuracy.			
Tracker Buoys	Up to 12 Santos WA tracker buoys (at different Santos WA facilities); 4 are immediately available on Varanus Island, and deployment can be at a staggered rate determined by the need to track oil heading towards sensitive receptors. Subscription to tracker buoy tracking website. Santos WA on-hire vessels and vessels of opportunity for buoy deployment. Subject to weather and vessel availability, the	Tracker buoys are an additional strategy to aerial surveillance to provide real-time verification data (particularly beneficial at night and in conditions limiting aerial surveillance). 12 x buoys is sufficient to enable timely retrieval and redeployment. Four are available on Varanus Island. Vessels for buoy deployment will be Santos WA on-hire vessels and other operators' vessels of opportunity. Vessels can be shared across this and other tasks (e.g., surveillance and tracker buoy deployment).	Additional buoys are available through secondary suppliers (e.g., AMOSC, OSRL and AMSA – more than 20 buoys available) if required. These can be registered on the Santos WA/Joubeh satellite tracking system within hours. Dedicated vessels are not required, given need is met through vessel sharing.	Santos WA has 12 buoys linked to a satellite tracking website designed for first strike deployment across its operational facilities. No additional buoys are required to be purchased by Santos WA given secondary availability through AMSA, AMOSC, and OSRL within days. There is no additional upfront cost for accessing these secondary buoys.	The number of buoys immediately available and the availability of secondary buoys within days is sufficient to cover tracking of oil fronts, especially given the spread of oil will be limited within the initial days of the spill. Therefore, no additional requirements, and the response is considered to be ALARP.

Strategy	Resourcing	Justification	Environmental Benefit of Additional Resources	Cost of Additional Resources	ALARP Assessment
	tracker buoys can be mobilised within 2 hours upon request from IMT or on-scene commander.				
Water Quality Monitoring (Operational and Scientific)	Fluorometers (for hydrocarbon detection) within subsea gliders or towed fluorometers. CTD (conductivity, temperature and depth) meters, including fluorometry and dissolved oxygen sensors. Water sampling equipment (e.g., Niskin bottles, jars). Water quality monitoring personnel. Glider Field Engineer for deployment/ recovery. Dedicated vessels for towed fluorometers, CTD profiler deployment, water sampling. Vessels of opportunity (vessel sharing) for	Santos WA has field tested deployment of subsea gliders and data transfer using local provider with access to gliders within Australia and USA. Towed fluorometers and glider service are available through contract with OSRL located in Singapore. CTD profilers with fluorometers and water sampling equipment are available locally and are to be arranged through Santos WA's contracted scientific monitoring provider. Contractual standby arrangements are in place for rapid activation, planning and deployment of operational water quality monitoring personnel. Subsea gliders and towed fluorometers can cover approximately 1 km/hr.	There are locally available subsea gliders and access to towed fluorometers. Water sampling equipment and CTD profilers are also available locally. Water sampling equipment is not considered a bottleneck to deployment. Given multiple access avenues to equipment, dedicated equipment (i.e., purchased or standby on-hire equipment) is not considered required. Deployment personnel will initially be provided through Santos WA's contracted monitoring provider and subsea	Santos WA can access subsea gliders with fluorometers and towed fluorometers through OSRL. Santos WA's contracted scientific monitoring provider is on an existing standby footing in Perth with mobilisation time of personnel to site within 72 hours following approved monitoring action plan based on incident specifics. An enhanced standby with vessels, equipment and personnel, all prepositioned for immediate deployment, would be	The existing arrangements are considered sufficient to provide targeted 'first strike' operational water quality monitoring to priority sites as identified through oil spill modelling and surveillance.

Strategy	Resourcing	Justification	Environmental Benefit of Additional Resources	Cost of Additional Resources	ALARP Assessment
	subsea glider deployment. Oil sample collected using a vessel of opportunity and analysed on Varanus Island or in Perth.	One fluorometer could cover 24 km/day. CTD profilers provide discrete 'single point' readings over a depth profile. Water quality sampling at discrete locations. For subsea gliders and towed fluorometers, the deployment philosophy is not to 'blindly' patrol the entire spill area. Deployments will be targeted to ground truth spill modelling predictions. That is, the predicted front or fronts of entrained oil will be traversed by gliders to verify entrained oil presence. This will be prioritised where fronts are predicted to reach sensitive receptor areas. Similarly, discrete water sampling will target sites positioned to validate modelling predictions.	glider deployment personnel.	in order of tens of thousands per day. Similarly, subsea gliders set-up and prepositioned on standby for immediate deployment would be in tens of thousands of dollars.	
Mechanical Dispersion	On-hire vessels supporting Santos WA's Varanus Island	Mechanical dispersion may be beneficial depending on the state of the hydrocarbon, weather	Given there will be on-hire vessels supporting the activities and the	The current vessels arrangements are considered to provide the required function	The strategy depends on conditions at the time of the spill and can

Strategy	Resourcing	Justification	Environmental Benefit of Additional Resources	Cost of Additional Resources	ALARP Assessment
	and Ningaloo Vision facilities. Vessels of opportunity from other operators.	conditions and proximity of oil to sensitive receptors. It is a strategy that therefore depends on situational awareness gathered at the time of the incident. This strategy targets discrete patches of oil in an opportunistic manner and can be undertaken by vessels performing other duties. Dedicated vessels are therefore not considered to be required.	central location of activity relative to the main marine base of Dampier, dedicated additional vessels specifically for the purpose of mechanical dispersion are not considered required, particularly given this strategy can be tasked through vessel sharing.	given this strategy is applied opportunistically. Vessels and crew on standby would cost tens of thousands per day and are not considered required based on the limited value they would provide.	be delivered by vessels co-tasked with other operations. Therefore, the ongoing vessel access arrangements and vessels contracted are considered adequate.
Shoreline Protection and Deflection	Shoreline and nearshore boom + ancillary equipment (Santos WA Varanus Island; AMOSC (Exmouth, Fremantle and Geelong); AMSA (Fremantle and Dampier). Boom tow-vessels. Spill response teams (Santos WA and AMOSC core group, State Response Team). Tactical response plans in place for the deployment of booms	Shoreline and nearshore boom provided by Santos WA or through AMOSC or AMSA is available from Exmouth, Varanus Island and Dampier within close proximity to shorelines potentially contacted as predicted by modelling. Combined, multiple km of boom are available from these locations. Mutual aid arrangements through AMOSC also provide access to additional booms from other operators (e.g., Chevron equipment based at Barrow Island).	Boom equipment is not considered limiting. Relatively low volumes of condensate are predicted to arrive at shorelines under worst-case conditions as predicted by modelling. Deployment times can be achieved within worst-case arrival times and within the time frames for analysis of real-time oil spill modelling and	The cost of boom, vessels and personnel on an enhanced standby footing or prepositioned boom is in the order of tens of thousands per day and considered to be of limited value given the tested arrangements for rapid deployment and the minimum contact times predicted through spill modelling.	Given there is limited environmental benefit of additional resources or prepositioned resources, the current arrangements are considered ALARP.

Strategy	Resourcing	Justification	Environmental Benefit of Additional Resources	Cost of Additional Resources	ALARP Assessment
	at offshore island locations (e.g., Varanus Island/Montebello Islands).	Response exercises deploying boom from Varanus Island and Dampier are conducted annually by Santos WA. Protection priorities along shorelines potentially contacted have been assessed as part of spill response planning. Minimum contact times for shoreline accumulation is 401 hrs (16.7 days at the Montebello Islands) based on worst-case modelling.	aerial or vessel surveillance data and completion of an operational net environmental benefit analysis to confirm the most effective boom deployment locations. Prepositioning or having personnel and equipment on an enhanced standby footing would reduce deployment time but is not considered to provide appreciable benefit given rapid deployments are tested annually. Pre-deploying booms at sensitive locations creates potential for impacts that, weighed against the risk of an oil spill reaching the location, are deemed unacceptable.		
Shoreline Clean-up	Manual clean-up and flushing equipment (Santos WA, AMOSC, AMSA, hardware supplies)	Given the light and volatile nature of the condensate and the relatively low concentration or volumes predicted to arrive at	Given the light nature of the condensate and high proportion of volatile components, intrusive clean-up and	During a spill event, the cost of additional resources is not considered the limiting factor; the	Given the relatively low concentration of oil predicted to arrive at shorelines and the current

Strategy	Resourcing	Justification	Environmental Benefit of Additional Resources	Cost of Additional Resources	ALARP Assessment
	Staging infrastructure Clean-up team leaders (Santos WA, AMOSC core group, AMSA) Clean-up labour personnel (labour hire as required) Vessels for transport (Santos WA contracted vessel providers). Equipment is prepositioned on Varanus Island so readily available.	shorelines under worst-case conditions, intrusive and labour-intensive methods are unlikely to be favoured or required. Shoreline loading of hydrocarbon is predicted to have minimum timeframes of approx. 16.7 days under worst-case conditions with 18.2 m^3 accumulating at the Montebello Islands. Existing Santos WA equipment and that available through AMOSC and AMSA arrangements are considered to be sufficient given stockpile locations at Dampier, Exmouth and Varanus Island. Further equipment can be provide through additional Australian stockpile locations.	removal of oiled debris may not be required. Acquiring additional resources (e.g., flushing equipment, shovels, decontamination equipment) is not considered required given the worst-case scale of loading predicted. Further prepositioning of equipment is not considered to provide additional value. While oil is arriving (i.e., the source is not controlled), there is limited benefit from additional resources that might remove oil more quickly. One of the limitations of undertaking a shoreline clean-up response is based on access by plant and personnel to remote offshore island locations.	limiting factor is considered to be numbers of personnel available to undertake shoreline clean-up. Mobilising additional personnel to undertake shoreline clean-up via vessel to remote offshore locations presents increased associated health and safety risks. Personnel mobilised via helicopter is limited to 10 passengers per trip. Once at the locations, there is a need to provide adequate facilities, which may be difficult given the limited numbers of beds available on Varanus Island and in other offshore locations.	arrangements to access clean-up equipment and personnel, the resourcing is considered ALARP for this strategy.

Strategy	Resourcing	Justification	Environmental Benefit of Additional Resources	Cost of Additional Resources	ALARP Assessment
Waste Management	Assorted waste receptacles and trucks Waste personnel: project manager, local responsible personnel and operations personnel Vessels for waste transport from offshore islands. Dedicated spill equipment container available on Varanus Island with equipment to establish waste storage areas during shoreline clean-up (e.g., collapsible bunds, absorbent rolls, drain covers and temporary fencing)	Santos WA's waste service provider is contracted to provide first-strike and ongoing waste storage, transport and disposal requirements commensurate to a worst-case spill across Santos WA's operations. These resources are over and above those required for the worst case for the activities covered in this EP.	Service provider has access to sufficient resources for the worst-case waste requirements associated with the activity; there is no benefit to acquiring additional resources specifically for the activity. Additional equipment to manage shoreline clean-up waste on offshore islands can be accessed and replenished from the mainland during an ongoing response.	Contracted resources are considered greater than required to respond to a worst-case scenario.	Resources are considered to be adequate based on worst case modelled waste requirements.
Oiled Wildlife Response	Oiled wildlife response kits and containers (AMOSC, AMSA, DBCA, DoT) – Darwin, Broome, Exmouth, Karratha, Fremantle, Kensington.	The nature of the hydrocarbon released (condensate) and the spatial extent of floating oil above an impact threshold of 10 g/m^2 indicates that widespread physical oiling of wildlife is not expected.	Pre-hire or positioning of staging areas and responders is not considered to be required for this spill scenario given worst-case oil contact time frame at any shoreline is approx. 6.5 days or greater and that oil	The cost of personnel (Level 1 responders) on standby is $1,500 per person per day as per existing arrangements through recruiting agencies. This is a guaranteed cost regardless of whether	Given the timeframe for oil contact and the nature and thickness of condensate released, resourcing required for oiled wildlife response is considered to be within the capacity of

Strategy	Resourcing	Justification	Environmental Benefit of Additional Resources	Cost of Additional Resources	ALARP Assessment
	Oiled wildlife response personnel Level 2 to 4 as per the WA Oiled Wildlife Response Plan (AMOSC, AMOSC-activated oiled wildlife response contractors, Industry Mutual Aid, DBCA, OSRL-activated oiled wildlife response contractors, "Sea Alarm"). Level of escalation of the oiled wildlife response is under authority of the DoT Incident Controller with technical input from the DBCA Oiled Wildlife Advisor.	The equipment and personnel arrangements are consistent with the equipment and personnel requirements specified in the WA Oiled Wildlife Response Plan. The resources defined are consistent with the activities covered in this plan. All oiled wildlife response efforts would be undertaken in consultation with DBCA, and Santos WA would undertake the response following the outcome of an operational net environmental benefit analysis that would direct efforts for maximum effectiveness.	above a threshold for physical oiling is predicted to be limited to areas well offshore where any condensate slick is predicted to break up relatively quickly.	a spill occurs or not. Given that personnel on this level can be arranged within relatively short time frames, there is not considered sufficient environmental value in putting responders on standby.	Santos WA and contracted service providers and the response arrangements are considered ALARP.

7.6.9 Acceptability Evaluation

Is the risk ranked between Low to Medium?	Yes – Maximum credible spill scenario from the Reindeer WHP is ranked as *Medium*.
Is further information required in the consequence assessment?	No – Potential impacts and risks are well understood through the information available.
Are risks and impacts consistent with the principles of ecologically sustainable development?	Yes – Activity evaluated in accordance with Santos WA's Environmental Hazard Identification and Assessment Procedure, which considers principles of ecologically sustainable development.
Are risks and impacts consistent with relevant legislation, international agreements and conventions, guidelines and codes of practice (including species recovery plans, threat abatement plans, conservation advice and Australian marine park zoning objectives)?	Yes – management consistent with OPGGS Regulations, including safety case and WOMP. Santos WA has considered the values and sensitivities of the receiving environment including, but not limited to: + Conservation values of the identified protection priorities (Section 7.6.6) including the Montebello Australian Marine Park, and Dampier Archipelago. Consistent with relevant species recovery plans, conservation management plans and management actions set out in **Table 3-6**.Relevant species Recovery Plans, Conservation Management Plans and management actions including but not limited to: + Approved Conservation Advice for Balaenoptera borealis (sei whale) (2015) + Commonwealth Conservation Advice on Aipysurus apraefrontalis (short-nosed seasnake) (2011) + Recovery Plan for Marine Turtles in Australia (2017) + Approved Conservation Advice for Calidris canutus (red knot) (2016) + Recovery Plan for Threatened Albatrosses and Giant Petrels (DSEWPaC, 2011) + Australian Fairy Tern (DSEWPaC, 2011) + Approved Conservation Advice for Calidris ferruginea (curlew sandpiper) (2015) + Approved Conservation Advice for Numenius madagascariensis (eastern curlew) (2015) + Approved Conservation Advice for Limosa lapponica baueri (bar-tailed godwit western Alaskan) (2016) + Approved Conservation Advice for Limosa lapponica menzbieri (bar-tailed godwit northern Siberian) (2016) + Approved Conservation Advice for Malurus

	leucopterus edouardi (White-winged Fairy-wren (Barrow Island))
Are risks and impacts consistent with Santos WA's Environmental Management Policy?	Yes – Aligns with Santos WA's Environmental Management Policy.
Are risks and impacts consistent with stakeholder expectations?	Yes – No concerns raised. DoT has been consulted during the development of the OPEP and strategic net environmental benefit analysis and raised no concerns.
Are performance standards such that the impact or risk is considered to be ALARP?	Yes – See ALARP above.

The likelihood of a loss of well control event is extremely low (*Rare*) when considering industry statistics, Santos WA statistics and the preventive controls in place. Additional industry standards and activity-specific control measures to reduce the chance of a loss of well control event (and minimise impacts) have also been implemented, including (but not limited to) procedures such as the WOMP, safety case, personnel training and awareness, and a spill response plan (the OPEP). In accordance with Santos WA's risk assessment process, the residual risk is considered to be *Medium* and ALARP. The proposed control measures will reduce the risk of impacts from a loss of well control event to a level that is considered acceptable.

7.7 Subsea Release of Condensate from a Subsea Pipeline

7.7.1 Description of Event

Event	It is considered credible that an unplanned release of condensate could occur from the subsea pipeline. This maximum credible spill would result in a subsea pipeline leak of 275 m^3 of Reindeer condensate over 14.6 hours.
Extent	The spill scenario is credible anywhere along the pipeline in Commonwealth waters. Predictive oil spill modelling for a subsea release of 275 m^3 of Reindeer condensate at the State waters boundary has been modelled. Concentrations at the sea surface above the impact threshold of 10 g/m^2 are predicted to extend for 4 km from the release site, with no contact to sensitive receptors above this threshold. Entrained oil in the water column above the impact threshold of 100 ppb is predicted to occur within a region up to 8 km, with no predicted contact above this threshold. Dissolved aromatic hydrocarbons in the water column above an impact threshold of 6 ppb are predicted to occur up to 389 km from the release site, with contact predicted at multiple locations (Barrow Island, Montebello Islands (including the marine park), and Ningaloo Coast North.
Duration	Release over 14 hours.

7.7.1.1 Spill Modelling Information

Modelling showed that the results of the OILMAP simulation predicted that the discharge will generate a cone of rising gas that will entrain the hydrocarbon droplets and ambient sea water up to the water surface (APASA, 2019). The mixed plume is initially forecast to jet to the water surface with a vertical velocity of around 1.5 m/s. The diameter of the central cone of rising water and oil at the point of surfacing is predicted to range between 2.6 and 7.2 m depending on the location of the subsurface pipeline leak.

The low discharge velocity and turbulence generated by the expanding gas plume are predicted to generate large-sized oil droplets (greater than 9,000 µm). These droplets will be subject to mixing due to turbulence generated by the lateral displacement of the rising plume, as well as vertical mixing induced by wind and breaking waves. These large droplets have the potential to reach the surface within minutes of the release, with floating slicks likely to be formed under typical wind conditions. The mass balance and weathering for the pipeline condensate is further described in **Section 7.6.1.1**.

7.7.1.2 Spill Modelling Results

7.7.1.2.1 Surface Hydrocarbons above 10 g/m^2

Concentrations at the sea surface above the impact threshold of 10 g/m^2 are predicted to extend for 4 km from the release site with no contact to sensitive receptors above this threshold.

7.7.1.2.2 Entrained Hydrocarbons above 100 ppb

Entrained oil in the water column above the impact threshold of 100 ppb is predicted to occur within a region up to 8 km, with contact predicted at Dampier Archipelago (44 hours) and Montebello Australian Marine Park.

7.7.1.2.3 Dissolved Aromatic Hydrocarbons above 6 ppb

Dissolved aromatic hydrocarbons in the water column above an impact threshold of 6 ppb are predicted to occur up 389 km from the release site, with contact predicted at multiple locations (Barrow Island, Montebello Islands (including the marine park), and Ningaloo Coast North).

7.7.1.2.4 Hydrocarbons Ashore Above 100 g/m^2

Results of stochastic modelling by RPS (2019) predicted no accumulation above the 100 g/m^2 threshold.

7.7.2 Nature and Scale of Impacts

Hydrocarbon spills will cause a decline in water quality and may cause chemical (e.g., toxic) and physical (e.g., coating of emergent habitats, oiling of wildlife at sea surface) impacts to marine species. The severity of the impact of a hydrocarbon spill depends on the magnitude of the spill (i.e., extent, duration) and sensitivity of the receptor.

<u>Potential receptors: Shallow benthic, intertidal and shoreline habitats; plankton; invertebrates; fish; marine mammals; marine reptiles; birds (seabirds and shorebirds); fisheries' oil and gas industry; tourism; KEFs; and marine reserves.</u>

A subsea release of condensate from the Reindeer pipeline to the marine environment would result in a localised reduction in water quality in the upper surface waters of the water column near the location of the spill and may result in condensate contacting shorelines. Potential impact pathways (physical and chemical) of hydrocarbon exposure for receptors are summarised in Table 7-9 and potential impacts to receptors found within the EMBA are further described in **Section 7.6.4**.

7.7.3 Environmental Performance and Control Measures

Environmental performance outcomes (EPOs) relating to this event include:

- No loss of containment of hydrocarbon to the marine environment [EPO-RE-07].
- Implementation of source control methods to stop the release of hydrocarbons into the marine/onshore environment. [EPO-RE-OPEP-01]
- Implement monitor and evaluate tactics in order to provide situational awareness to inform IMT decision making. [EPO-RE- OPEP-02]
- Implement mechanical dispersion to reduce the concentration of surface hydrocarbons to reduce contact with protection priorities. [EPO-RE- OPEP-03]
- Implement shoreline protection and deflection tactics to reduce hydrocarbon contact with coastal protection priorities. [EPO-RE- OPEP-04]
- Implement shoreline clean-up tactics to remove stranded hydrocarbons from shorelines in order to reduce impact on coastal protection priorities and facilitate habitat recovery. [EPO-RE- OPEP-05
- Assist DFES in the control of hazardous material. Remediate the site as directed by the Jurisdictional Authority. [EPO-RE- OPEP-06]
- Implement tactics in accordance with the Western Australian Oiled Wildlife Response Plan (WAOWRP) to prevent or reduce impacts, and to humanely treat, house, and release or euthanase wildlife. [EPO-RE- OPEP-07]
- Comply with waste treatment, transport and disposal regulations and prevent secondary contamination while reducing, reusing and recycling waste where possible. [EPO-RE-OPEP-08
- Implement monitoring programs to assess and report on the impact, extent, severity, persistence and recovery of sensitive receptors contacted by a spill. [EPO-RE- OPEP-09]

Control measures applied to prevent an oil spill, and preparedness measures applied to maintain a state of readiness to respond to an oil spill are shown in **Table 7-16,** with EPSs and measurement criteria for the EPOs described in **Table 8-3** (preventative controls) and **Table 8-4** (spill response preparedness controls).

Operational controls that would be implemented to guide an effective response after a spill has occurred are provided within relevant sections of the OPEP, together with corresponding EPSs and Measurement Criteria.

Table 7-16: Control Measures Evaluation for Subsea Release of Condensate from Subsea Pipeline

Control Measure Ref. No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
Standard Controls				
RE-CM-41	NOPSEMA-accepted safety case.	Includes control measures for pipeline integrity and management controls.	Costs associated with personnel time in writing, reviewing and implementing the safety case.	**Adopted** – Benefits considered to outweigh costs. Regulatory requirement must be adopted.

Control Measure Ref. No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
RE-CM-42	Inspection and corrosion monitoring.	Regular inspections reduce the risk of leaks from subsea pipelines by confirming appropriate integrity.	Costs associated with personnel time in performing the inspections, monitoring and reporting of inspections and follow-up actions.	**Adopted** – Benefits considered to outweigh costs.
RE-CM-37	Testing and maintenance of emergency shutdown systems and shutdown/safety valves.	Maintenance and testing of emergency systems and shutdown valves enable potential spill volumes to be minimised.	Costs associated with personnel time in performing the testing and maintenance.	**Adopted** – Benefits considered to outweigh costs.
RE-CM-13	Navigational charting of infrastructure.	Provides a means for marine users to be aware of the presence of the platform and subsea infrastructure.	Costs associated with personnel time in issuing notifications.	**Adopted** – Benefits considered to outweigh costs.
RE-CM-09	Dropped object prevention procedures (LEMS).	Impacts to environment are reduced by preventing dropped objects. Minimises drop risk during lifting operations. Requires lifting equipment to be certified and inspected.	Costs associated with personnel time in implementing procedures and in incident reporting.	**Adopted** – Benefits considered to outweigh costs.
RE-CM-38	Emergency power equipment is provided on Reindeer WHP to provide secondary power source for safety integrity system.	Provides backup power for the offshore safety integrity system for control of emergency shutdowns in abnormal operational situations.	Costs associated with the personnel time in performing the testing and maintenance.	**Adopted** – Benefits of ensuring procedures are followed and control measures implemented outweigh costs.
RE-CM-39	Accepted Oil pollution emergency plan (OPEP).	Implements response plan to deal with an unplanned hydrocarbon release quickly and efficiently in order to reduce impacts to	Administrative costs associated with preparing documents, ongoing management (spill response exercises) and implementation of OPEP.	**Adopted -** Benefits of ensuring procedures are followed and measures implemented and that the

Control Measure Ref. No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
		the marine environment.		vessels are compliant outweighs the costs. Regulatory requirement must be adopted.
RE-OPEP-CM-02	Incident management facilities.	Ensures adequate facilities are maintained and documented should an incident occur.	Costs associated with the documenting equipment and personnel levels.	**Adopted – As essential to spill response strategy.**
RE-OPEP-CM-04	MSA with aircraft supplier.	Ensures aircraft will be mobilised in a timely manner should an incident occur.	Costs of having a contract in place.	**Adopted – As essential to spill response strategy.**
RE-OPEP-CM-05	AMOSC contract to facilitate mutual aid arrangements for access to Trained Aerial Observers	Ensures trained aerial observers are available should an incident occur.	Costs associated with the AMOSC contract.	**Adopted – As essential to spill response strategy.**
RE-OPEP-CM-06	Maintenance of MSAs with multiple vessel providers	Ensures vessels are available should an incident occur	Costs of having a contract in place.	**Adopted – As essential to spill response strategy.**
RE-OPEP-CM-07	AMOSC contract to facilitate mutual aid arrangements for access to Oil Spill crew	Ensures personnel are available should an incident occur	Costs of having a contract in place.	**Adopted – As essential to spill response strategy.**
RE-OPEP-CM-08	Maintenance of contract for emergency response modelling	Ensures emergency response modelling is available should an incident occur	Costs of having a contract in place.	**Adopted – As essential to spill response strategy.**
RE-OPEP-CM-09	Maintenance of oil spill response capability (including satellite imagery provision) through Oil Spill	Ensures hydrocarbon response capability is available should an incident occur	Costs of having a contract in place.	**Adopted – As essential to spill response strategy.**

Control Measure Ref. No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
	Response Limited (OSRL)			
RE-OPEP-CM-10	Maintenance of Monitoring Service Provider contract for scientific monitoring services	Ensures preparedness to conduct the response should an incident occur.	Costs of having a contract in place.	**Adopted – As essential to spill response strategy.**
RE-OPEP-CM-11	Capability reports from Monitoring Service Provider	Ensures preparedness to conduct the response should an incident occur.	Costs of having a contract in place.	**Adopted – As essential to spill response strategy.**
RE-OPEP-CM-12	Conduct periodical review of existing baseline data sources across the Santos WA combined EMBA	Ensures preparedness to conduct the response should an incident occur.	Costs of having a contract in place.	**Adopted – As essential to spill response strategy.**
RE-OPEP-CM-13	Tracking buoys available.	Ensures preparedness to conduct the response should an incident occur.	Costs of having a contract in place.	**Adopted – As essential to spill response strategy.**
RE-OPEP-CM-14	Arrangements to enable access to fluorometry services	Ensures preparedness to conduct the response should an incident occur.	Costs of having a contract in place.	**Adopted – As essential to spill response strategy.**
RE-OPEP-CM-15	Access to protection and deflection equipment and personnel through AMOSC, AMSA National Plan and OSRL	Ensures preparedness to conduct the response should an incident occur.	Costs of maintaining arrangements with AMOSC, AMSA and OSRL.	**Adopted – As essential to spill response strategy.**
RE-OPEP-CM-16	Access to waste tanks and waste transfer equipment	Ensures preparedness to conduct the response should an incident occur.	Costs of maintaining contracts with waste management providers.	**Adopted – As essential to spill response strategy.**
RE-OPEP-CM-17	Access to shoreline clean-up equipment	Ensures preparedness to conduct the	Costs of maintaining arrangements with	**Adopted – As essential to**

Control Measure Ref. No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
	and personnel through AMOSC, AMSA National Plan and OSRL	response should an incident occur.	AMOSC, AMSA and OSRL.	**spill response strategy.**
RE-OPEP-CM-18	Maintain access to waste management equipment, personnel, transport and disposal facilities.	Ensures preparedness to conduct the response should an incident occur.	Costs of maintaining contracts with waste management providers.	**Adopted – As essential to spill response strategy.**
RE-OPEP-CM-19	Maintenance of access to oiled wildlife response equipment and personnel.	Ensures preparedness to conduct the response should an incident occur.	Costs of maintaining arrangements with AMOSC, AMSA and OSRL.	**Adopted – As essential to spill response strategy.**
Additional Control Measures				
RE-CM-11	Anchoring and equipment deployment management.	Anchoring and placement of equipment is controlled through ensuring that any anchoring occurs at pre-approved locations, thereby reducing potential environmental impacts.	Costs associated with implementing procedures.	**Adopted** – Benefits considered to outweigh costs.
N/A	Flyover inspection of pipelines during helicopter transfers.	Identification of bubbles at the sea surface may indicate a potential leak from a subsea pipeline that would be further investigated and therefore limit the potential volume of a spill event.	Costs associated with helicopter and training of crew to observe.	**Rejected** – A safe distance above sea level needs to be maintained by the helicopter. To observe any bubbles at the sea surface, weather conditions and sea state would need to be flat calm. Based on these limitations, this is not considered an effective stand-alone control.

7.7.4 Environmental Impact Assessment

Description – Subsea Release of Condensate from a Subsea Pipeline	
Receptors	Threatened, migratory, or local fauna Protected areas Physical environment or habitats Socio-economic receptors
Consequence	D - Major

Marine fauna

In the event of a pipeline release, the volume of hydrocarbons released would be the entire condensate volume within the pipeline between isolation points, that is 275 m^3 condensate based on the pipeline inventory. Given the nature of condensate (light oil) and dilution and dispersion from natural weathering processes (such as ocean currents), the extent of exposure will be limited in area and duration.

The susceptibility of marine fauna to hydrocarbons depends on hydrocarbon type and exposure duration; however, given that exposures would be limited in extent and duration, exposure to marine fauna from this hazard is not expected to result in a fatality. Potential impacts to marine fauna from a larger condensate release are described in detail in **Section 7.6.4**.

Habitat modification, degradation, disruption or loss, deteriorating water quality, and marine pollution are identified as potential threats to a number of marine fauna species in relevant recovery plans and conservation advice (**Table 3-6**). With controls in place that are in accord with relevant actions described in various recovery plans, the activity will be conducted in a manner that reduces potential impacts to ALARP and of acceptable level.

In the unlikely event that a pipeline rupture did occur and resulted in a condensate release from the pipeline, the potential impacts to the environment would be greatest within several kilometres from the release location, when the toxic aromatic components of the fuel would be at their highest concentration. Condensate will rapidly lose toxicity with time and will spread thinner as evaporation continues. The potential sensitive receptors in the areas surrounding the spill will include those in the water column, such as fish, marine mammals, marine reptiles and submerged habitats. Receptors at the sea surface and on shorelines may also be impacted from a pipeline rupture. Hydrocarbons that reach nearshore environments have the potential to impact benthic coral reefs and mangrove areas, which may result in a long-term decrease in ecological values given toxicity impacts associated with hydrocarbon exposure. Potential impacts to these receptors from a larger condensate release are described in detail in **Section 7.6.4**.

Protected areas

Impacts to the habitat and fauna receptors described above have an impact on the values of Australian marine parks and marine management areas, which could have flow-on effects to tourism revenue of coastal communities that provide access to these marine reserves. Many of these receptors are values of protected areas, and there could be a major effect on them. Potential impacts to these receptors from a larger condensate release are described in detail in **Section 7.6**.

Physical environment or habitats

In the event of condensate release, hydrocarbons that reach nearshore environments have the potential to impact benthic coral reefs and mangrove areas, which may result in a long-term decrease in ecological values given the toxicity impacts associated with hydrocarbon exposure.

Socio-economic receptors

There is the potential for entrained oil to temporarily disrupt fishing activities if the surface or entrained oil moves through fishing areas.

Entrained oil greater than 100 ppb could reach pearl farming activities at the Montebello Islands. Potential impacts to these receptors from a larger condensate release are described in detail in **Section 7.6**. Tourism could be affected by spilled condensate, either from reduced water quality or shoreline oiling preventing recreational activities or reducing aesthetic appeal or from impacts to habitats and marine fauna. Potential impacts to these receptors from a larger condensate release are described in detail in **Section 7.6**. On the basis of the above assessments, a condensate release from a pipeline rupture has the potential to impact receptors in the water column. Given the extent, the worst-case consequence is considered to be *Major*.	
Likelihood	1 - Rare
A hydrocarbon release resulting from a pipeline rupture caused by an integrity or corrosion issue, dropped object or anchor drag is unlikely to have widespread ecological effects, given the nature of the condensate, controls in place, the safety design of the production system, the limited volumes that could be released, the water depth and the transient nature of marine fauna in this area. Deteriorating water quality is identified as a potential threat to turtles in the marine turtle recovery plan and to some bird and shark species (**Table 3-6**). Habitat modification, degradation, disruption, and loss are also identified as threats to sharks, birds, cetaceans and turtles in conservation management and recovery plans. However, the potential hydrocarbon releases as a result of pipeline rupture are not expected to significantly impact the receiving environment, given the management controls proposed. Additionally, long-term impacts resulting in complete habitat loss or degradation are not considered likely, given the controls proposed to prevent releases; therefore, the activity will be conducted in a manner that is considered acceptable. The likelihood of a hydrocarbon release occurring due to pipeline rupture is limited by the set of mitigation and management controls in place. Consequently, the likelihood of a pipeline rupture releasing hydrocarbons to the environment which results in a minor consequence is considered to be *Rare* (1).	
Residual Risk	The residual risk associated with this event is Medium**.**

7.7.5 Demonstration of ALARP

It is considered that there are no additional practicable risk reduction measures further to those described in **Section 7.7.4**, that would provide benefit to the environment as detailed below.

Since the transfer of condensate and gas to DCGP processing facilities is an integral part of operational activities, the risk of a condensate spill from a pipeline cannot be completely eliminated along the length of the pipeline.

The identified causes of pipeline rupture from external factors are through a loss of integrity, corrosion, dropped objects and anchor drag. A number of procedural controls are in place that reduce the likelihood of these events. Eliminating the potential from dropped objects and anchoring is not feasible since vessel activity is also inherent in the operational activities (e.g., inspection and maintenance activities using ROVs and divers), and equipment and materials are required to be loaded onto Reindeer WHP.

The subsea pipelines are designed to reduce the potential for rupture and release of condensate and associated gas to the marine environment. The integrity of the subsea production system is maintained through planned inspection, monitoring and testing of its components, ensuring that the system operates within its design requirements and that there is no unacceptable degradation of the system (e.g., materials, or ESD valve shutdown time or leakage).

The primary mechanism to immediately respond to a rupture in the subsea production system is through the ESD system. This system responds to both manual and automatic activation with automatic activation triggered by abnormal process conditions, such as pressure drop across the subsea production system. The ESD system is designed to result in near-instantaneous shut-in following loss of pressure and is considered to reduce the spill volume to ALARP for a major leak or rupture scenario. The ESD system is maintained through regular testing of the shutdown systems and the subsea valves.

In terms of spill response activities, Santos WA will implement oil spill response as specified in the OPEP. This includes the use of resources (equipment and personnel) owned by Santos WA or available through third-party providers through contracts, agreements or memoranda of understanding. The proposed spill response strategies (**Section 6.7**, Spill Response Operations) consider relevant values and receptors present in the area, including Australian marine parks. These strategies will limit impacts to the identified Australian marine parks, thereby protecting and conserving the ecosystems, habitats and native species, consistent with the park values.

For oil spill readiness, the spill risk associated with a pipeline condensate release is considered within that for a condensate release from the Reindeer WHP, and thus the ALARP assessment presented in **Section 7.6.8** is considered to apply.

7.7.6 Acceptability Evaluation

Is the risk ranked between Low to Medium?	Yes –Maximum credible spill volume from a subsea pipeline (max. 235 m^3) residual risk is ranked as Low.
Is further information required in the consequence assessment?	No – Potential impacts and risks are well understood through the information available.
Are risks and impacts consistent with the principles of ecologically sustainable development?	Yes – Activity evaluated in accordance with Santos WA's Environmental Hazard Identification and Assessment Procedure, which considers principles of ecologically sustainable development.
Are risks and impacts consistent with relevant legislation, international agreements and conventions, guidelines and codes of practice (including species recovery plans, threat abatement plans, conservation advice and Australian marine park zoning objectives)?	Yes – Management consistent with OPGGS Regulations including Safety Case and OPMP. Santos WA has considered the values and sensitivities of the receiving environment including, but not limited to: + Conservation values of the identified protection priorities (Section 7.6.6) including the Montebello Australian Marine Park, the Barrow Island Marine Park Management Area, Montebello Marine Park, Muiron Island Marine Management Area, Ningaloo Australian Marine Park. Consistent with relevant species recovery plans, conservation management plans and management actions set out in **Table 3-6**.
Are risks and impacts consistent with Santos WA Environmental Management Policy?	Yes – Aligns with Santos WA's Environmental Management Policy
Are risks and impacts consistent with the principles of ecologically sustainable development?	Yes – Activity evaluated in accordance with Santos WA's Environmental Hazard Identification and Assessment Procedure, which considers principles of ecologically sustainable development.
Are risks and impacts consistent with stakeholder expectations?	Yes – No concerns raised
Are performance standards such that the impact or risk is considered to be ALARP?	Yes – See ALARP above.

The likelihood of a subsea condensate release from a pipeline is extremely low (*Rare*) when considering industry statistics, Santos WA statistics and the preventive controls in place. Additional industry standard and activity-specific control measures to reduce the chance of the event occurring (and minimise impacts) have also been implemented, including (but not limited to) procedures such as the safety case, OPMP, personnel training and awareness, and a spill response plan (the OPEP). In accordance with Santos WA's risk assessment process, the residual risk is considered to be *Low* and ALARP. The proposed control measures will reduce the risk of impacts from a subsea pipeline condensate release to a level that is considered acceptable.

7.8 Surface Release of Diesel

7.8.1 Description of Event

Event	It is considered credible that a release of diesel to the marine environment could occur from a support vessel collision with the Reindeer WHP or another vessel within the operational area.
Extent	A surface release (329 m^3) of diesel at the Commonwealth–State boundary represents a worst-case spill from a vessel collision from the two modelled locations. The surface slick is predicted to spread out rapidly to form a thin film on the sea surface, and a large proportion of it (50%) is predicted to evaporate within several days of release. Over time, the diesel will become increasingly subject to entrainment into the water column as the density increases after losing the lighter components through evaporation. The rate of entrainment will be influenced by sea conditions (wind and wave action) at the time of the spill. Spill modelling predicted floating hydrocarbon to extend up to 45 km from the release location at 10 g/m^2. Floating oil at concentrations equal to or greater than 10 g/m^2 is unlikely (probability less than 1%) to reach the buffer zones around any receptor. Entrained oil concentrations greater than 100 ppb extend up to 235 km from the release location. Entrained hydrocarbon contact greater than 100 ppb is predicted at multiple locations, including Montebello Islands (49 hours), Lowendal Islands (44 hours), Barrow Island (55 hours), Port Hedland (82 hours), Dampier Archipelago (38 hours), Southern Island Coast (164 hours), and Thevenard Island (183 hours). The probability of exposure to dissolved hydrocarbons above the 6 ppb impact threshold was low for all locations (less than or equal to 0.5%), with the exception of the Montebello Australian Marine Park (6.5%) with a maximum predicted concentration of 57 ppb and offshore Ningaloo (3.5%) with a maximum predicted concentration of 39 ppb. Shoreline accumulation greater than 100 g/m^2 is not predicted.
Duration	24 hours: A decreasing rate of 131.6 m^3/hr in the first hour, 79.0 m^3/hr in the second hour, 47.4 m^3/hr in the third hour, 28.4 m^3/hr in the fourth hour and 2.13 m^3/hr for the remaining 20 hours, yielding a total release volume of 329 m^3.

7.8.1.1 Spill Modelling Information

The Reindeer WHP has the greatest risk of a diesel spill since this is the most frequented part of the operational area in terms of vessel activity. Support vessels undertake routine personnel and equipment transfer trips to the platform on a monthly basis on average. The Reindeer WHP is also a fixed collision hazard and a source of dropped objects. A surface spill of 329 m^3 over 24 hours was modelled by APASA (2014). The release was modelled at two locations: at the Reindeer WHP and at the location where the Reindeer pipeline intersects the Commonwealth–State waters boundary; the latter represents the worst-case location where a vessel spill could occur as a result of the activities covered in this EP (i.e., closest to shallow or shoreline habitats) and is therefore discussed in greater detail.

ITOPF (2011) and the Australian Marine Oil Spill Centre (AMOSC, 2011) categorise diesel as a light 'group II' hydrocarbon. In the marine environment, a 5% residual of the total quantity of diesel spilt will remain after the volatilisation and solubilisation processes associated with weathering.

In the marine environment, diesel is expected to behave as follows:

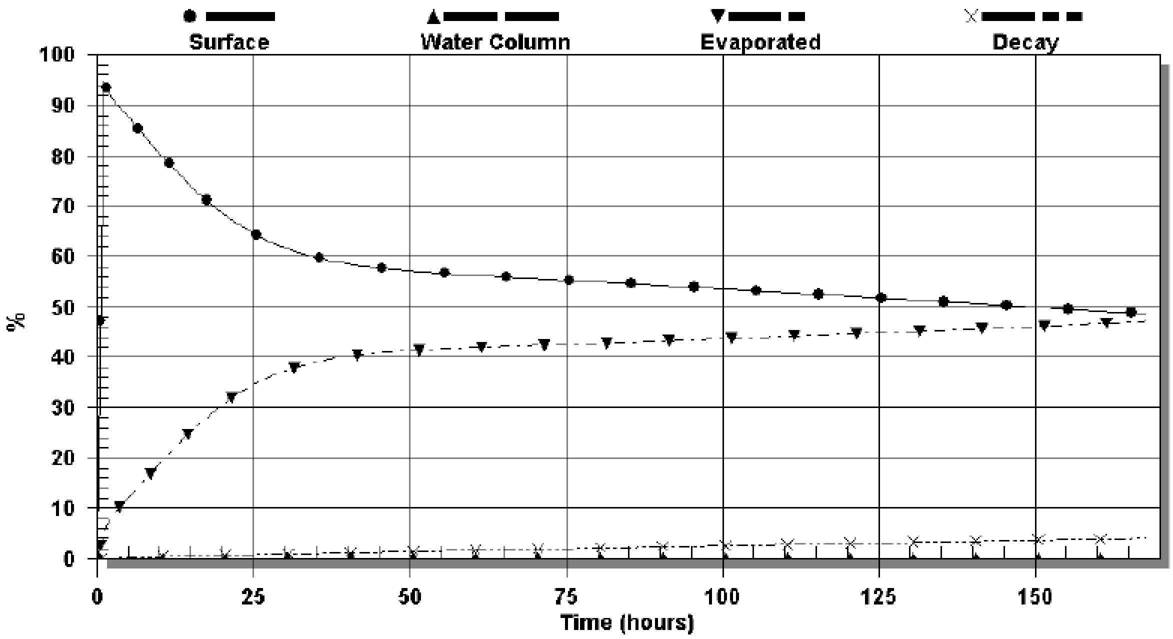
+ Diesel will spread rapidly in the direction of the prevailing wind and waves;

+ Evaporation will be the dominant process contributing to the fate of spilled diesel from the sea surface and will account for 60 to 80% reduction of the net hydrocarbon balance;
+ The evaporation rate of diesel will increase in warmer air and sea temperatures; and
+ Diesel residues usually consist of heavy compounds that may persist longer and will tend to disperse as oil droplets into the upper layers of the water column.

Modelling of surface diesel spills by APASA (2014) indicates that at least 40% by volume would evaporate within 40 hours of release under calm conditions (**Figure 7-2**). The remaining diesel would mostly remain on the surface, where it would be subject to continuing weathering including evaporation and photo-oxidation, although at a slowed rate (APASA, 2014). Almost no diesel in this scenario is predicted to become entrained, and almost no aromatic hydrocarbons are predicted to become dissolved.

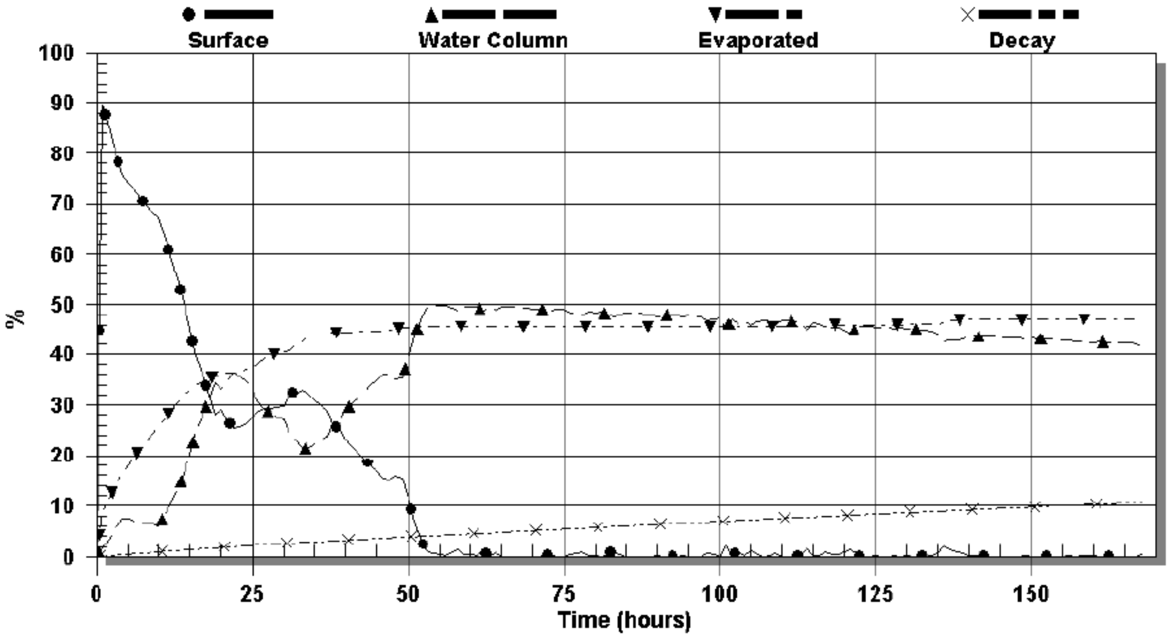
In variable weather simulation, wind-generated wave action and physical forces cause up to 45% of the diesel to become entrained into the water column after 40 hours (APASA, 2014). At the end of 48 hours (2 days), approximately 45% is predicted to have evaporated (**Figure 7-3**). Under conditions that generate wind waves (i.e., winds approximately 12 knots), an increased portion of the residual component of diesel is predicted to become entrained beneath the surface (APASA, 2014) with very little on the surface.

The intertidal and shoreline habitats at receptors within the EMBA and the sensitivities of these receptors to hydrocarbons are provided in the condensate risk assessment section in **Table 7-10**. Further detailed information on the receptors can also be found in **Appendix C**.



Source: APASA (2014).

Figure 7-2: Proportional Mass Balance Plot Representing the Weathering of Marine Diesel Spilled onto the Surface as a Once Off Release (50 m^3 over 1 hr) and Subject to a Constant 5-knot Wind at 27°C Water Temperature and 25°C Air Temperature



Source: APASA (2014).

Figure 7-3: Proportional Mass Balance Plot Representing the Weathering of Marine Diesel Spilled onto the Surface as a Once Off Release (50 m³ over 1 hr) and Subject to Variable Wind at 27°C Water Temperature and 25°C Air Temperature

7.8.1.2 Spill Modelling Results

7.8.1.2.1 Surface Hydrocarbons above 10 g/m²

Spill modelling predicted floating hydrocarbon to extend up to 45 km from the release location at 10 g/m². Floating oil at concentrations less than or equal to 10 g/m² is unlikely (probability less than 1%) to reach the buffer zones around any receptor.

7.8.1.2.2 Entrained Hydrocarbons above 100 ppb

Entrained oil concentrations above 100 ppb extend up to 235 km from the release location. Entrained hydrocarbon contact greater than 100 ppb is predicted at multiple locations, including: Montebello Islands (49 hours) Lowendal Islands (44 hours), Barrow Island (55 hours), Port Hedland (82 hours) and Dampier Archipelago (39 hours), Southern Island Coast (164 hours), and Thevenard Island (183 hours).

7.8.1.2.3 Dissolved Aromatic Hydrocarbons above 6 ppb

The probability of exposure to dissolved aromatic hydrocarbons above the 6 ppb impact threshold was low for all locations (less than or equal to 0.5%) with the exception of the Montebello Australian Marine Park (6.5%) with a maximum predicted concentration of 57 ppb and offshore Ningaloo (3.5%) with a maximum predicted concentration of 39 ppb.

7.8.1.2.4 Hydrocarbons Ashore Above 100 g/m²

Results of stochastic modelling by RPS (2019) predicted no accumulation above the 100 g/m² threshold.

7.8.2 Nature and Scale of Impacts

Hydrocarbon spills will cause a decline in water quality and may cause chemical (e.g., toxic) and physical (e.g., coating of emergent habitats, oiling of wildlife at sea surface) impacts to marine species. The severity of the impact of a hydrocarbon spill depends on the magnitude of the spill (i.e., extent, duration) and sensitivity of the receptor.

Potential receptors: Plankton (including zooplankton and fish and coral larvae), Marine mammals,

Marine reptiles, Seabirds and shorebirds, Shallow benthic, intertidal and shoreline habitats, Fish and sharks, Fisheries, Tourism, Protected areas, Shipping, Defence, Shipwrecks, Indigenous, Existing oil and gas activity and KEFs

A surface release of diesel to the marine environment would result in a localised reduction in water quality in the upper surface waters of the water column near the location of the spill. Based on modelling results, shoreline no shoreline accumulation greater than 100 g/m^2 was predicted. To account for a diesel release that may occur anywhere within Commonwealth waters and closer to sensitive receptors, potential impact pathways (physical and chemical) of hydrocarbon exposure for receptors are summarised in and potential impacts to receptors found within the EMBA are further described in Table 7-9.

Table 7-17 summarises the potential impacts of hydrocarbon spills to sensitive receptors and values within the EMBA. Modelling of surface diesel spills by APASA (2014) indicates that at least 40% by volume would evaporate within 40 hours of release under calm conditions (**Figure 7-2**). Almost no diesel in this scenario is predicted to become entrained, and almost no aromatic hydrocarbons are predicted to become dissolved. Therefore, no impact is expected from entrained or dissolved hydrocarbons.

Table 7-17: Impacts of Diesel on Sensitive Receptors and Values Found Within the EMBA

Receptor	Impacts of Marine Diesel Surface Hydrocarbons
Marine Fauna	
Plankton (including zooplankton and fish and coral larvae)	Surface diesel will have a negligible impact on plankton existing within the water column.
Marine mammals	At risk of direct contact with diesel due to chance of surfacing within slick. Effects include irritation of eyes or mouth and potential illness. Surface respiration could lead to accidental ingestion of hydrocarbons or result in the coating of sensitive epidermal surfaces.
	Twelve migratory marine mammals were identified by the EPBC Protected Matters Search. Of these, four are listed as threatened, and one additional is listed as endangered but not migratory: Humpback whale: The EMBA overlaps the humpback whale migration BIA. In the unlikely event of a diesel spill, migrating humpback whales or female whales and calves resting at Montebello Islands and transiting in the offshore Ningaloo area may encounter diesel on the surface or in the water column. However, given the rapid evaporation of diesel, significant numbers are not expected to be impacted. Blue whales: The EMBA overlaps with the blue whale migratory BIA. Since blue whales show preference for water depths deeper than 500 m, a small number of individuals may encounter diesel at the sea surface and within the water column. However, the absence of any known feeding, resting or breeding areas in the operational area or EMBA means significant numbers are unlikely to be impacted. Fin whale: Fin whales have a worldwide distribution generally in deeper waters, and their distribution in Australia is not clear due to the sparse sightings. Given the absence of any known feeding, resting or breeding areas, significant numbers are unlikely to be impacted. No BIAs occur within the EMBA. Sei whale: Sei whales move between Australian waters and Antarctic feeding areas; however, they are only infrequently recorded in Australian waters (Bannister *et al*., 1996), and their movements and distribution in Australian waters is not well known (DoE, 2014). Given the absence of any known feeding, resting or breeding areas, significant numbers are unlikely to be impacted. Southern right whale: The southern right whale is seasonally present along the Australian coast between late April and early November. It has been recorded in the coastal waters of all Australian states except the Northern Territory. It is principally found along the southern coastline. Given the absence of any known feeding, resting or breeding areas in the EMBA, significant numbers are unlikely to be impacted. Other migratory cetaceans, as well as migratory dugongs, are predicted to occur in the EMBA and may encounter either diesel at the sea surface or in the water column; however, the absence of any known feeding, resting or breeding areas means significant numbers are unlikely to be impacted.

Marine reptiles	At risk of direct contact with diesel due to chance of surfacing within slick. Effects include irritation of eyes or mouth and potential illness. Surface respiration could lead to accidental ingestion of hydrocarbons or result in the coating of sensitive epidermal surfaces.
	Threatened and migratory marine reptile species that may occur within the spill EMBA identified by the EPBC Protected Matters Search are listed in **Section 3**. Short-nosed seasnake and flatback, hawksbill, leatherback, green and loggerhead turtles are widely dispersed at low densities across the North West Shelf; and in the unlikely event of a diesel spill occurring, individuals traversing open water may come into contact with water column or surface diesel. The operational area and EMBA overlap with the flatback turtle's internesting BIA and internesting buffer critical to the survival of the species (60 km of Barrow Island and the Dampier Archipelago). The spill EMBA also intercepts BIAs for green, hawksbill and loggerhead turtles (**Section 3**). The results of the spill modelling indicated that concentrations of hydrocarbons are below the 10 g/m^2 impact threshold near shorelines.
Seabirds and shorebirds	Particularly vulnerable to surface diesel. As most fish survive beneath floating slicks, they will continue to attract foraging seabirds, which typically do not exhibit avoidance behaviour. Smothering can lead to reduced waterproofing of feathers and ingestion while preening. In addition, diesel can erode feathers via chemical damage to the feather structure that subsequently affects the bird's ability to thermoregulate and maintain buoyancy on water.
	Threatened and migratory seabirds and shorebirds that may occur within the spill EMBA identified by the EPBC Protected Matters Search are listed in **Section 3** and may have foraging, feeding, breeding and or nesting habitat in the vicinity of the EMBA. The loss of well control spill EMBA intercepts with breeding BIAs for several migratory species (Australian fairy tern, roseate tern and wedge-tailed shearwater) and one listed marine bird species (lesser crested tern) (**Section 3**). The Australian fairy tern has foraging and breeding habitat in the area and so may be impacted by surface and water column diesel while foraging (dive and skim feeding). Higher numbers would be expected during the breeding period of July to September. Due to the fast evaporation and dispersion of diesel, significant impacts are not anticipated. While a number of other species may occur in the area, no BIAs are designated for breeding for these species within the EMBA.
Benthic Habitats	
Shallow benthic, intertidal and shoreline habitats	The subtidal benthic habitats in the wider Northwest Shelf Province Bioregion include coral reefs, macroalgae, seagrasses, hard substrates and supported assemblages, and soft sediments and associated benthic fauna.
Fish and sharks	While fish and sharks do not generally break the sea surface, individuals may feed at the surface. However, since the diesel is expected to quickly disperse and evaporate (modelling results indicate a significant proportion of the oil mass from the water surface evaporates within 24 hours at moderate wind speeds), the probability of prolonged exposure to a surface slick by fish and shark species is low.
	The North West Shelf supports a diverse assemblage of fish and shark species, including 456 species of finfish, particularly in shallower water near the mainland and islands. Threatened species identified by the EPBC Protected Matters Search include the great white shark, whale shark, grey nurse shark, and green and dwarf sawfish, which may be present in the affected area (**Section 3**). However, given the absence of critical habitat for most of these species, significant numbers are not expected to be impacted. The only BIA

	overlapping the operational area and EMBA is for the whale shark. While this is for foraging, it is not for high-density prey where congregations are expected, so impacts would be limited to transient migrating individuals. Other migratory species that may transit the EMBA and so could be present include narrow sawfish, mako sharks and manta rays; however, the absence of any known feeding, resting or breeding areas means significant numbers are unlikely to be impacted if an unplanned release were to occur.
Socio-economic	
Fisheries	In addition to the effects of entrained and dissolved hydrocarbons, exclusion zones surrounding a spill can directly impact fisheries by restricting access for fishers.
	Both water column and surface diesel have the potential to lead to temporary financial losses due to impacts to fish (see above).
Tourism	There are many sources of marine-based tourism within the EMBA. Aquatic recreational activities such as boating, diving and fishing occur around the Montebello Islands but are concentrated in the vicinity of the population centres such as Exmouth and Ningaloo. Exclusion zones surrounding a spill will reduce access for vessels for the duration of the response undertaken for spill clean-up (if applicable).
Protected areas	Several Commonwealth and State marine protected areas are within the region (see **Section 3.2.3**). Combined, these areas support all the habitats and faunal groups described above. Impacts to the habitat and fauna receptors described have an impact on the values of these reserves, which could have flow-on effects to tourism revenue of coastal communities that provide access to these marine reserves. The protected areas described in this EP may support nursery, feeding, or aggregation areas for fisheries species and therefore assist in maintaining healthy fish stocks and commercial and recreational fisheries.
Shipping	Exclusion zones surrounding a spill will reduce access for shipping vessels for the duration of the response undertaken for spill clean-up (if applicable); vessel may have to take large detours, leading to potential delays and increased costs.
Defence	The level of defence activities carried out in the vicinity of the operational area is low, if any; therefore, impacts on defence activities due to a diesel spill is likely to be minimal.
Shipwrecks	Shipwrecks are not predicted to be impacted as they will not be contacted by in-water or surface oil threshold concentrations
Indigenous	The level of activities undertaken by indigenous users is expected to be low, therefore impacts on due to a diesel spill are likely to be minimal, however in event there is a requirement for land based response activities/ disturbance relevant representatives will be contacted as outlined in Section 5 of the OPEP.
Existing oil and gas activity	Exclusion zones surrounding spills will reduce access, potentially leading to delays to work schedules with subsequent financial implications. Chevron undertake a number of activities on Barrow Island and therefore may be impacted in the event of an unplanned spill event through exclusion from undertaking activities.

KEFs	The EMBA overlaps several KEFs (**Figure 3-6**), including the Ancient Coastline at 125-m Depth Contour, Glomar Shoals, the Continental Slope Demersal Fish Communities, Exmouth Plateau, Commonwealth waters adjacent to Ningaloo Reef, and Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula. No impact is expected from the diesel release due to impacts being limited to the surface.

7.8.3 Environmental Performance and Control Measures

Environmental performance outcomes (EPOs) relating to this event include:

- No loss of containment of hydrocarbon to the marine environment [EPO-RE-07].
- Implementation of source control methods to stop the release of hydrocarbons into the marine/onshore environment. [EPO-RE-OPEP-01]
- Implement monitor and evaluate tactics in order to provide situational awareness to inform IMT decision making. [EPO-RE- OPEP-02]
- Implement mechanical dispersion to reduce the concentration of surface hydrocarbons to reduce contact with protection priorities. [EPO-RE- OPEP-03]
- Implement shoreline protection and deflection tactics to reduce hydrocarbon contact with coastal protection priorities. [EPO-RE- OPEP-04]
- Implement shoreline clean-up tactics to remove stranded hydrocarbons from shorelines in order to reduce impact on coastal protection priorities and facilitate habitat recovery. [EPO-RE- OPEP-05
- Assist DFES in the control of hazardous material. Remediate the site as directed by the Jurisdictional Authority. [EPO-RE- OPEP-06]
- Implement tactics in accordance with the Western Australian Oiled Wildlife Response Plan (WAOWRP) to prevent or reduce impacts, and to humanely treat, house, and release or euthanase wildlife. [EPO-RE- OPEP-07]
- Comply with waste treatment, transport and disposal regulations and prevent secondary contamination while reducing, reusing and recycling waste where possible. [EPO-RE-OPEP-08
- Implement monitoring programs to assess and report on the impact, extent, severity, persistence and recovery of sensitive receptors contacted by a spill. [EPO-RE- OPEP-09]

Control measures applied to prevent an oil spill, and preparedness measures applied to maintain a state of readiness to respond to an oil spill are shown in **Table 7-18**, with EPSs and measurement criteria for the EPOs described in **Table 8-3** (preventative controls) and **Table 8-4** (spill response preparedness controls).

Operational controls that would be implemented to guide an effective response after a spill has occurred are provided within relevant sections of the OPEP, together with corresponding EPSs and Measurement Criteria.

Table 7-18: Control Measures Evaluation for Surface Release of Diesel

Control Measure Ref. No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
Standard Controls				
RE-CM-15	Seafarer Certification.	Requires appropriately trained and competent personnel, in accordance with Marine Order 70, to navigate vessels	Costs associated with personnel time in obtaining qualifications.	**Adopted –** Benefits considered to outweigh costs, and it is a legislated requirement.

Control Measure Ref. No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
		to reduce interaction with other marine users.		
RE-CM-14	Navigation lighting and aids.	Reduces risk of environmental impact from vessel collisions due to ensuring safety requirements are fulfilled and other marine users are aware of the presence of the WHP and vessels.	Costs of operating and maintaining navigational equipment.	**Adopted** – Benefits considered to outweigh Costs.
RE-CM-40	Support vessel positioning.	Allows the vessel to maintain accurate positioning and reduces potential to impact the platform.	Costs associated with requiring vessels to have appropriate positioning systems; however, these are standard on certain classes of vessel.	**Adopted** – The benefits to safety and the environment, (thus reducing risk of environmental impacts due to vessel collisions) outweigh potential costs.
RE-CM-13	Navigational charting of infrastructure.	Provides a means for other marine users to be aware of the presence of the platform and vessels.	Costs associated with personnel time in issuing notifications.	**Adopted** – Benefits considered to outweigh costs.
RE-CM-12	WHP petroleum safety zone.	Petroleum safety zone applies around the Reindeer WHP and on Australian Nautical Charts. Reduces the potential for collisions with the platform resulting in a loss of hydrocarbon containment.	No additional costs to Santos WA. Other marine users may be temporarily excluded from areas, disrupting their activities.	**Adopted** – Regulatory requirement must be adopted. Excluding other marine users within a 500-m-radius of the Reindeer WHP is unlikely to significantly impact upon the marine user. The benefits to safety of the activity (thus

Control Measure Ref. No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
				reducing risk of environmental impacts due to vessel collisions) outweigh potential costs.
RE-CM-33	Vessel spill response plan (SOPEP/SMPEP).	Implements response plans on board vessels to deal with unplanned hydrocarbon releases and spills quickly and efficiently in order to reduce impacts to the marine environment.	Administrative costs of preparing documents. Generally undertaken by vessel contractor, so time for Santos WA personnel to confirm and check SOPEP/SMPEP is in place.	**Adopted** – Benefits considered to outweigh costs.
RE-CM-39	Accepted oil pollution emergency plan (OPEP).	Implements response plan to deal with an unplanned hydrocarbon spills quickly and efficiently in order to reduce impacts to the marine environment.	Personnel and administrative costs associated with preparing documents, ongoing management (spill response exercises) and implementation of OPEP.	**Adopted** – Benefits of ensuring procedures are followed and control measures implemented outweigh costs to Santos WA.
RE-CM-31	Refuelling and chemical transfer procedure.	Minimises risk of pollution to ALARP during chemical transfers from an offshore support vessel to an offshore facility.	Personnel costs associated with ensuring procedures are in place and implemented during inspections.	**Adopted** – Benefits of ensuring procedures are followed and measures implemented outweigh the costs of personnel time.
RE-CM-38	Emergency power system is provided on Reindeer WHP to secure secondary power source for safety integrity system.	Provides backup power for the offshore safety integrity system for control of emergency shutdowns in abnormal	Costs associated with the personnel time in performing the testing and maintenance.	**Adopted** – Benefits of ensuring procedures are followed and control measures implemented

Control Measure Ref. No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
		operational situations.		outweigh costs to Santos WA.
RE-OPEP-CM-04	MSA with aircraft supplier.	Ensures aircraft will be mobilised in a timely manner should an incident occur.	Costs of having a contract in place.	**Adopted – As essential to spill response strategy.**
RE-OPEP-CM-05	AMOSC contract to facilitate mutual aid arrangements for access to Trained Aerial Observers	Ensures trained aerial observers are available should an incident occur.	Costs associated with the AMOSC contract.	**Adopted – As essential to spill response strategy.**
RE-OPEP-CM-06	Maintenance of MSAs with multiple vessel providers for emergency response	Ensures vessels are available should an incident occur	Costs of having a contract in place.	**Adopted – As essential to spill response strategy.**
RE-OPEP-CM-07	AMOSC contract to facilitate mutual aid arrangements for access to Oil Spill crew	Ensures personnel are available should an incident occur	Costs of having a contract in place.	**Adopted – As essential to spill response strategy.**
RE-OPEP-CM-08	Maintenance of contract for emergency response modelling	Ensures emergency response modelling is available should an incident occur	Costs of having a contract in place.	**Adopted – As essential to spill response strategy.**
RE-OPEP-CM-09	Maintenance of oil spill response capability (including satellite imagery provision) through Oil Spill Response Limited (OSRL)	Ensures hydrocarbon response capability is available should an incident occur	Costs of having a contract in place.	**Adopted – As essential to spill response strategy.**
RE-OPEP-CM-10	Maintenance of Monitoring Service Provider contract for scientific monitoring services	Ensures preparedness to conduct the response should an incident occur.	Costs of having a contract in place.	**Adopted – As essential to spill response strategy.**
RE-OPEP-CM-11	Capability reports from Monitoring Service Provider	Ensures preparedness to conduct the response should an incident occur.	Costs of having a contract in place.	**Adopted – As essential to spill response strategy.**
RE-OPEP-CM-12	Conduct periodical review of existing baseline data sources	Ensures preparedness to conduct the	Costs of having a contract in place.	**Adopted – As essential to**

Control Measure Ref. No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
	across the Santos WA combined EMBA	response should an incident occur.		**spill response strategy.**
RE-OPEP-CM-13	Tracking buoys available.	Ensures preparedness to conduct the response should an incident occur.	Costs of having a contract in place.	**Adopted – As essential to spill response strategy.**
RE-OPEP-CM-14	Arrangements to enable access to fluorometry services	Ensures preparedness to conduct the response should an incident occur.	Costs of having a contract in place.	**Adopted – As essential to spill response strategy.**
RE-OPEP-CM-15	Access to protection and deflection equipment and personnel through AMOSC, AMSA National Plan and OSRL	Ensures preparedness to conduct the response should an incident occur.	Costs of maintaining arrangements with AMOSC, AMSA and OSRL.	**Adopted – As essential to spill response strategy.**
RE-OPEP-CM-16	Access to waste tanks and waste transfer equipment	Ensures preparedness to conduct the response should an incident occur.	Costs of maintaining contracts with waste management providers.	**Adopted – As essential to spill response strategy.**
RE-OPEP-CM-17	Access to shoreline clean-up equipment and personnel through AMOSC, AMSA National Plan and OSRL	Ensures preparedness to conduct the response should an incident occur.	Costs of maintaining arrangements with AMOSC, AMSA and OSRL.	**Adopted – As essential to spill response strategy.**
RE-OPEP-CM-18	Maintain access to waste management equipment, personnel, transport and disposal facilities.	Ensures preparedness to conduct the response should an incident occur.	Costs of maintaining contracts with waste management providers.	**Adopted – As essential to spill response strategy.**
RE-OPEP-CM-19	Maintenance of access to oiled wildlife response equipment and personnel.	Ensures preparedness to conduct the response should an incident occur.	Costs of maintaining arrangements with AMOSC, AMSA and OSRL.	**Adopted – As essential to spill response strategy.**
Additional Control Measures				
N/A	Require all support vessels involved in the	Reduces the likelihood of a loss of hydrocarbon inventory in the	Vessels are subject to availability and are required to meet Santos WA's	**Rejected** – Large costs associated with vessel selection

Control Measure Ref. No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
	activity to be double hulled.	highly unlikely event of a vessel collision, minimising potential environmental impact.	standards during activities; requirement of a double hull on vessels would limit the number available to Santos WA; requiring vessels to be refitted to ensure double hulls would also be of high cost.	and by having an activity schedule determined by vessel availability considered grossly disproportionate compared to low risk of a vessel collision and low risk of a large diesel spill.

7.8.4 Environmental Impact Assessment

Description – Surface Release of Diesel	
Receptors	Threatened, migratory, or local fauna Protected areas Physical environment or habitats Socio-economic receptors
Consequence	B - Minor

Given the properties of marine diesel and the distance from shorelines, dilution and dispersion from natural weathering processes, such as evaporation and ocean currents, indicate that the extent of exposure will be limited in area and duration. Minor accumulations on shorelines are expected (8 m^3, maximum loading) but no contact from floating hydrocarbons above 10 g/m^2.

The susceptibility of marine fauna to hydrocarbons depends on hydrocarbon type and exposure duration. Given that exposures would be limited in extent and duration, exposure to marine fauna from this event is not expected to result in a fatality. Potential impacts to marine fauna within the EMBA from a hydrocarbon exposure are further described in **Section 7.8.2.**

Habitat modification, degradation, disruption or loss, deteriorating water quality, and marine pollution are identified as potential threats to a number of marine fauna species in relevant recovery plans and conservation advice (**Table 3-6**).

In the unlikely event of a vessel collision, dropped object or bunkering spill of marine diesel, the potential impacts to the environment would be greatest within a few kilometres from the spill when the toxic aromatic components of the fuel will be at their highest concentration. Diesel will rapidly lose toxicity with time and will spread thinner as evaporation continues.

Tourism could be affected by spilled diesel, either from reduced water quality or shoreline oiling preventing recreational activities or reducing aesthetic appeal or from impacts to habitats and marine fauna.

Marine habitats may also be impacted by relatively small volumes of diesel with no accumulation predicted below 100 g/m. Indigenous users may be impacted in the event that a land-based response is required. However, consultation will help manage activities such that potential impacts are reduced to acceptable levels.

On the basis of the above assessments, a surface diesel release at the Reindeer WHP or the Commonwealth–State waters boundary has the potential to impact receptors in the water column. Given the limited extent, the worst-case consequence is considered to be *Minor* (B).	
Likelihood	1 - Rare
A worst-case diesel release resulting from a vessel collision is unlikely to have widespread ecological effects, given the nature of the hydrocarbons on board, the finite volumes that could be released, the water depth and the transient nature of marine fauna in this area. Long-term impacts resulting in complete habitat loss or degradation are not considered likely, given the control measures proposed to prevent releases; therefore, the activity will be conducted in a manner that is considered acceptable. The likelihood of a diesel release occurring due to a dropped object or bunkering is limited, given the set of mitigation and management controls in place. Consequently, the likelihood of a vessel collision releasing hydrocarbons to the environment that results in a minor consequence is considered to be *Rare* (1).	
Residual Risk	The residual risk associated with this event is *Low.*

7.8.5 Spill Response Strategies

Numerous oil spill response strategies are available to be implemented in the event of a spill. The following section is an overview of the evaluation of spill response strategies applicable to the diesel spill scenario described in **Section 7.5.1.** This scenario represents the worst case, in terms of shoreline impact for diesel scenarios and thus has been used to describe the most conservative spill response strategies.

The assessment presented below is based on the largest diesel scenario of a vessel collision resulting in tank rupture and is the outcome of the first-level screening undertaken based on the suitability of the broad response strategies available. Below are the key considerations taken into account for the evaluation:

+ The properties and weathering profile of the spilled oil;
+ The nature and scale of the credible spill scenario; and
+ The potential safety and environmental aspects, as well as the impacts involved with the selected responses.

Table 7-19: Spill Response Strategies Considered for Condensate Release Scenarios

OSR Strategy	Activities	Applicability and Designated Primary (1) or Secondary (2) Response Strategy Diesel	Considerations
Source Control	Spill kits	✔ 1	Relevant for containing spills that may arise on board a vessel or platform
	Secondary containment	✔ 1	Relevant for spills that may arise due to stored hydrocarbons, and from spills arising from machinery and equipment on board a vessel. Bunded areas will contain hydrocarbons reducing the potential for a spill escaping to marine waters. Where applicable open deck drainage will be closed to prevent hydrocarbon d
	Shipboard Oil Pollution Emergency Plan (SOPEP)	✔ 1	MARPOL requirement for applicable vessels. In the event a vessel hydrocarbon storage tank is ruptured, applicable strategies for reducing the volume of hydrocarbon releases will be contained within the vessel SOPEP. This may include securing cargo via transfer to another storage area on-board the vessel, transfer to another vessel, or through pumping in water to affected tank to create a water cushion (tank water bottom). Trimming the vessel may also be used to avoid further damage to intact tanks. These actions will aim to minimise the volume of fuel spilt.
In-Situ Burning	Controlled burning of oil spill	X	Not applicable to diesel spills due to inability to contain marine diesel making it very difficult to maintain necessary slick thickness for ignition and sustained burning.
Monitor and Evaluate Plan (Operational Monitoring)	Vessel surveillance	✔ 1	Provides real-time information on spill trajectory and behaviour (e.g. weathering). Informs implementation of other response strategies. Vessel personnel may not be trained observers. Vessel observers on leaking vessel may not have capacity to observe oil during emergency response procedure implementation.

OSR Strategy	Activities	Applicability and Designated Primary (1) or Secondary (2) Response Strategy Diesel	Considerations
			Constrained to daylight. Limited to visual range from the vessel. Limited capacity to evaluate possible interactions with sensitive receptors.
	Aerial surveillance		Provides real-time information on spill trajectory and behaviour (e.g. weathering). May identify environmental sensitivities impacted or at risk of impact (e.g. seabird aggregations, other users such as fishers). Informs implementation of other response strategies.
	Tracking buoys		Can be implemented rapidly. Can provide indication of near-surface entrained / dissolved hydrocarbons (most other monitor and evaluate techniques rely on the hydrocarbon being on the surface or shoreline).
	Trajectory Modelling		Can be implemented rapidly. Predictive - provides estimate of where the oil may go, which can be used to prepare and implement other responses. No additional field personnel required. Not constrained by weather conditions. Can predict floating, entrained, dissolved and stranded hydrocarbon fractions.
	Satellite Imagery		Can work under large range of weather conditions (e.g. night time, cloud cover etc.)

OSR Strategy	Activities	Applicability and Designated Primary (1) or Secondary (2) Response Strategy Diesel	Considerations
			Mobilisation likely to be >24 hours Requires processing May return false-positives
	Operational Water Quality Monitoring		Fluorometry surveys are used to determine the location and distribution of the entrained oil and dissolved aromatic hydrocarbon components of the spill and validate the spill fate modelling predictions.
	Shoreline and Coastal Habitat Assessment		Provides information on shoreline oiling (state of the oil, extent of pollution etc.). Can provide information on amenability of shoreline response options (e.g. clean-up, protect and deflect). Provides information on status of impacts to sensitive receptors. Considerable health & safety considerations. Requires trained observers. Constrained to daylight. Delayed response time.
Chemical dispersion	Vessel Application	X	Marine spills of a size where chemical dispersion could potentially be applied are a vessel diesel tank rupture and a loss of well control at Reindeer platform. Marine diesel is not considered a persistent hydrocarbon, and has high natural dispersion rates in the marine environment. Chemical dispersant application is not recommended as a beneficial option for diesel as it has a low additional
	Aerial Application	X	

OSR Strategy	Activities	Applicability and Designated Primary (1) or Secondary (2) Response Strategy Diesel	Considerations
	Subsea Application	X	benefit of increasing the dispersal rate of the spill while introducing the potential for increased impacts.
Offshore Containment and Recovery	Use of offshore booms/ skimmers or other collection techniques deployed from vessel/s to contain and collect oil.	X	Given the fast spreading nature of diesel causing the slick to break up and disperse, this response is not considered to be effective in reducing the impacts of a diesel spill. The ability to contain and recover spreading diesel on the ocean water surface is extremely limited due the very low viscosity of the fuel.
Mechanical Dispersion	Vessel prop-washing	✔ 2	Marine diesel is easily dispersed in the water column by running vessels through the plume and using the turbulence developed by the propellers to break up the slick. Once dispersed in the water column the smaller droplet sizes enhance the biodegradation process.
Protection and Deflection	Booming in nearshore waters and at shorelines	✔ 2	Considered if operational monitoring shows or predicts contact sensitive shorelines.
Shoreline clean-up	Activities include physical removal, surf washing, flushing, bioremediation, natural dispersion	✔ 2	Intrusive activities such as physical removal of waste using manual labour or mechanical aids requires careful site-specific planning to reduce secondary impacts of habitat disturbance, erosion and spreading oil beyond shorelines. Flushing may be considered if the oil enters high priority/slow recovery habitats such as mangroves. Natural dispersion will occur as the hydrocarbon is remobilised from rock shelves and hard substrates, while residual will biodegrade.

OSR Strategy	Activities	Applicability and Designated Primary (1) or Secondary (2) Response Strategy Diesel	Considerations
			This response has potential to cause more harm than benefit especially if oiling is light. Shoreline assessments as part of operational monitoring provide site-specific guidance on the applicability and likely benefits of different clean-up techniques.
Oiled wildlife Response	Activities include hazing, pre-emptive capture, oiled wildlife capture, cleaning and rehabilitation.	✔ 2	Can be used to deter and protect wildlife from contact with oil. Mainly applicable for marine and coastal fauna (e.g. birds) where oil is present at the sea surface or accumulated at coastlines. Potential for onshore releases to impact nesting areas. Surveillance can be carried out as a part of the fauna specific operational monitoring Wildlife may become desensitised to hazing method. Hazing may impact upon animals (e.g. stress, disturb important behaviours such as nesting or foraging) Permitting requirements for hazing and pre-emptive capture.
Scientific Monitoring	The monitoring of environmental receptors to determine the level of impact and recovery form the oil spill and associated response activities.	✔ 1	Monitoring activities include: + Water and sediment quality + Biota of shorelines (sandy beaches, rocky shores and intertidal mudflats) + Mangrove monitoring + Benthic habitat monitoring (seagrass, algae, corals) + Seabirds and shorebirds

OSR Strategy	Activities	Applicability and Designated Primary (1) or Secondary (2) Response Strategy	Considerations
		Diesel	
			+ Marine megafauna (incl. whale sharks and mammals) + Marine reptiles (incl. turtles) + Seafood quality + Fish, fisheries and aquaculture The type and extent of scientific monitoring will depend upon the nature and scale of oil contact to sensitive receptor locations as determined through operational monitoring. Pre-defined initiation criteria exist for scientific monitoring plans associated with marine and coastal sensitivities.

7.8.6 Protection Priorities

As described in **Section 3.1,** the EMBA and identification of high environmental values are based on the stochastic spill modelling results. Within the EMBA, high environmental values with a potential (probability) to be contacted in the event of a spill are defined as Hot Spots; this is the first step in determining the nature and scale of the oil spill response strategy. The Hot Spots specific to the particular spill event have been identified as priorities for protection based on worst-case shoreline accumulation volumes (>100 g/m^2), shortest time to contact (hours) and the highest probability of contact (at least >5%). The process for identifying priorities for protection promotes a clear link between the scale, characteristics and probability of the spill scenario and the identified environmentally sensitive receptors such that selected response strategies are appropriate and demonstrated to be effective and adequate.

Given the nature of marine diesel and dilution and dispersion from natural weathering processes (such as ocean currents), the extent of exposure will be limited in area and duration. Based on the spill modelling results for a worst-case credible hydrocarbon release, accumulations from a worst replicate spill did not exceeded the threshold of 100 g/m^2: Therefore, no protection priorities have been identified for the diesel release.

7.8.7 Demonstration of ALARP

The use of support vessels is integral to the functioning of the facility; therefore, vessels and the associated risk of a diesel release cannot be completely eliminated. Vessel presence is required during operational activities in order to transfer supplies and equipment to the facility, offload equipment and waste, and perform inspection, maintenance, monitoring and repair activities. Helicopter transfers are used to transfer crew to and from the facility but cannot accommodate the volumes of supplies and waste material that are transferred by vessel; thus, there is no substitute for vessel-to-vessel loading.

Offshore refuelling is standard industry practice; and oil pollution legislation, including Protection of the Sea (Prevention of Pollution from Ships) Act 1983 and Marine Order 91, have been developed to safeguard against the risk of an unplanned hydrocarbon spill occurring during refuelling (bunkering). The risk of a diesel spill during refuelling has been further reduced through the platform using solar power as the primary energy source, which reduces the frequency of diesel transfers to the Reindeer WHP.

Given the controls in place detailed above, the assessed residual risk for this impact is low and cannot be reduced further. It is considered therefore that the impact of the activities conducted are reduced to ALARP.

In terms of spill response activities, Santos WA will implement oil spill response as specified within the vessel SOPEP/SMPEP and/or OPEP. For oil spill readiness, the spill risk associated with a diesel release is considered within that for a larger hydrocarbon spill (condensate release from the Reindeer WHP), and thus the ALARP assessment presented in **Section 7.6.8** is considered to apply.

7.8.8 Acceptability Evaluation

Is the risk ranked between Low to Medium?	Yes –Maximum credible spill volume from vessel collision (329 m^3) residual risk is ranked as low.
Is further information required in the consequence assessment?	No – Potential impacts and risks are well understood through the information available.
Are risks and impacts consistent with the principles of ecologically sustainable development?	Yes – Activity evaluated in accordance with Santos WA's Environmental Hazard Identification and Assessment Procedure which

	considers principles of ecologically sustainable development.
Are risks and impacts consistent with relevant legislation, international agreements and conventions, guidelines and codes of practice (including species recovery plans, threat abatement plans, conservation advice and Australian marine park zoning objectives)?	Yes – Management consistent with OPGGS Regulations including Safety Case and WOMP. Santos WA has considered the values and sensitivities of the receiving environment including, but not limited to: + Conservation values of the identified protection priorities (Section 7.6.6) including the Montebello Australian Marine Park, the Barrow Island Marine Park Management Area, Montebello Marine Park, Muiron Island Marine Management Area, Ningaloo Australian Marine Park. Consistent with relevant species recovery plans, conservation management plans and management actions set out in **Table 3-6**. Relevant species Recovery Plans, Conservation Management Plans and management actions including but not limited to: + Approved Conservation Advice for Balaenoptera borealis (sei whale) (2015) + Commonwealth Conservation Advice on Aipysurus apraefrontalis (short-nosed seasnake) (2011) + Recovery Plan for Marine Turtles in Australia (2017) + Approved Conservation Advice for Calidris canutus (red knot) (2016) + Recovery Plan for Threatened Albatrosses and Giant Petrels (DSEWPaC, 2011) + Australian Fairy Tern (DSEWPaC, 2011) + Approved Conservation Advice for Calidris ferruginea (curlew sandpiper) (2015) + Approved Conservation Advice for Numenius madagascariensis (eastern curlew) (2015) + Approved Conservation Advice for Limosa lapponica baueri (bar-tailed godwit western Alaskan) (2016) + Approved Conservation Advice for Limosa lapponica menzbieri (bar-tailed godwit northern Siberian) (2016) + Approved Conservation Advice for Malurus leucopterus edouardi (White-winged Fairy-wren (Barrow Island))
Are risks and impacts consistent with Santos WA's Environmental Management Policy?	Yes – Aligns with Santos WA's Environmental Management Policy.
Are risks and impacts consistent with stakeholder expectations?	Yes – No concerns raised.

Are performance standards such that the impact or risk is considered to be ALARP?	Yes – See ALARP above.

The potential impacts and risks from diesel spills are well understood, and the event will be managed in accordance with relevant legislation and standards. With the implementation of industry standards and activity-specific control measures to reduce the likelihood of a diesel spill event (and minimise impacts), the residual risk is assessed to be *Low* and ALARP. No stakeholder concerns have been raised regarding this hazard. Therefore, it is considered that the proposed control measures will reduce the risk of impact from a diesel spill to a level that is acceptable.

8 Implementation Strategy

OPGGS(E)R 2009 Requirements
Regulation 14(1)
The environment plan must contain an implementation strategy for the activity in accordance with this regulation.

The specific measures and arrangements that will be implemented in the event of an oil pollution emergency are detailed within the Oil Pollution Emergency Plan (OPEP).

Stakeholder engagement is assessed separately for the requirements of the Reindeer activities. Ongoing stakeholder management strategies are discussed in **Section 4**.

8.1 Environmental Management System

OPGGS(E)R 2009 Requirements
Regulation 14(3)
The implementation strategy must contain a description of the environmental management system for the activity, including specific measures to be used to ensure that, for the duration of the activity: (a) the environmental impacts and risks of the activity continue to be identified and reduced to a level that is as low as reasonably practicable; and (b) control measures detailed in the environment plan are effective in reducing the environmental impacts and risks of the activity to as low as reasonably practicable and an acceptable level; and (c) environmental performance outcomes and standards set out in the environment plan are being met.

The Santos WA Management System exists to support its ethical, professional and legal obligations to undertake work in a manner that does not cause harm to people or the environment. The Santos WA Management System is a framework of policies, standards, processes, procedures, tools and control measures that, when used together by a properly resourced and competent organisation, result in these outcomes:

+ A common health, safety and environment (HSE) approach is followed across the organisation;
+ HSE is proactively managed and maintained;
+ The mandatory requirements of HSE management are implemented and are auditable;
+ HSE management performance is measured and corrective actions are taken;
+ Opportunities for improvement are recognised and implemented; and
+ Workforce commitments are understood and demonstrated.

This implementation strategy is designed to meet the requirements of the EP to ensure that:

+ Environmental impacts and risks continue to be identified for the duration of the activity and reduced to ALARP;
+ Control measures are effective in reducing environmental impacts and risks to ALARP and acceptable levels;

- Environmental performance outcomes and standards set out in this EP are met; and
- Stakeholder consultation is maintained throughout the activity as appropriate.

8.2 Environmental Management Policy

Santos WA's Environmental Management Policy (Appendix A) clearly sets out Santos WA's strategic environmental objectives and the commitment of the management team to continuous environmental performance improvement. This EP has been prepared in accordance with the fundamentals of this policy. By accepting employment with Santos WA, each employee and contractor is made aware during the recruitment process that he or she is responsible for the application of this policy.

8.3 Hazard Identification, Risk and Impact Assessment and Controls

Hazards and associated environmental risks and impacts for the proposed activities have been systematically identified and assessed in this EP (**Sections 6 and 7**). The control measures and environmental performance standards that will be implemented to manage the identified risks and impacts and the environmental performance outcomes that will be achieved are detailed in **Section 8.4**.

To ensure that environmental risks and impacts remain acceptable and ALARP during the activity and for the duration of this EP, hazards will continue to be identified, assessed and controlled as described in Document Management (**Section 8.11**) and audits and inspections (**Section 8.12**).

Any new, or proposed amendment to a, control measure or environmental performance standard or outcome will be managed in accordance with the management of change procedure (**Section 8.11.2**).

Oil spill response control measures and environmental performance standards and outcomes are listed in the OPEP.

8.3.1 Performance Standard Assurance Plans

Where relevant, performance standard assurance plans are referred to throughout this EP to provide evidence that critical systems are maintained in accordance with their design criteria. Performance standard assurance plans detail the performance criteria and associated maintenance routines, including frequency and schedule of inspections, and ensure compliance with relevant regulations (e.g., SOLAS) where appropriate.

8.4 Environmental Performance

To ensure environmental risks and impacts will be of an acceptable level, environmental performance outcomes (EPOs) have been defined and are listed in **Table 8-1** for planned activities and **Table 8-2** for contingency spill response activities.

Table 8-1: Environmental Performance Outcomes (Environment Plan)

Reference	Environmental Performance Outcomes
EPO-RE-01	No injury or mortality to EPBC Act–listed marine fauna during operational activities.
EPO-RE-02	Emissions or discharges to sea or air meet legislative requirements and are ALARP and acceptable.
EPO-RE-03	No unplanned objects, emissions or discharges to sea or air.
EPO-RE-04	Seabed disturbance is limited to the operational area.
EPO-RE-05	Information is available to regulatory authorities and marine users directly affected by planned activities.
EPO-RE-06	No introduction of marine pest species.
EPO-RE-07	No loss of containment of hydrocarbon to the marine environment.

Table 8-2: Environmental Performance Outcomes (Oil Spill Response)

Reference	Environmental Performance Outcomes
EPO-RE-OPEP-01	Implementation of source control methods to stop the release of hydrocarbons into the marine/onshore environment.
EPO-RE- OPEP-02	Implement monitor and evaluate tactics in order to provide situational awareness to inform IMT decision making.
EPO-RE- OPEP-03	Implement mechanical dispersion to reduce the concentration of surface hydrocarbons to reduce contact with protection priorities.
EPO-RE- OPEP-04	Implement shoreline protection and deflection tactics to reduce hydrocarbon contact with coastal protection priorities.
EPO-RE- OPEP-05	Implement shoreline clean-up tactics to remove stranded hydrocarbons from shorelines in order to reduce impact on coastal protection priorities and facilitate habitat recovery.
EPO-RE- OPEP-06	Assist DFES in the control of hazardous material Remediate the site as directed by the Jurisdictional Authority.
EPO-RE- OPEP-07	Implement tactics in accordance with the Western Australian Oiled Wildlife Response Plan (WAOWRP) to prevent or reduce impacts, and to humanely treat, house, and release or euthanase wildlife.
EPO-RE- OPEP-08	Comply with waste treatment, transport and disposal regulations and prevent secondary contamination while reducing, reusing and recycling waste where possible.
EPO-RE- OPEP-09	Implement monitoring programs to assess and report on the impact, extent, severity, persistence and recovery of sensitive receptors contacted by a spill

8.4.1 Control Measures and Performance Standards

The control measures that will be used to manage identified environmental impacts and risks and the associated statements of performance required of the control measure (i.e., environmental performance standards) are listed in **Table 8-3**. Measurement criteria outlining how compliance with the control measure and the expected environmental performance could be evidenced are also listed.

Performance Standards and associated measurement criteria relating to contingency oil response operations are contained within the Devil Creek Pipeline and Reindeer WHP OPEP. There are, however, a number of control measures and performance standards relating to maintaining a state of oil spill response readiness which ensure spill response operation scan be implemented in a timely and effective manner. These preparedness control measures, performance standards and measurement criteria are outline in **Table 8-4**.

Table 8-3: Control Measures, Environmental Performance Standards and Measurement Criteria for the Proposed Activity (Environment Plan)

Control Measure	Control Measure Ref. No.	Environmental Performance Standard	EPS Reference No.	Measurement Criteria	EPO Reference (Table 8-1)	Relevant Section of this EP
Procedure for Interacting with Marine Fauna	RE-CM-01	Vessels comply with Santos WA's Protected Marine Fauna Interaction and Sighting Procedure (EA-91-11-00003), which ensures compliance with Part 8 of the EPBC Regulations 2000, which includes controls for minimising the risk of collision with marine fauna.	RE-CM-01-EPS-01	Completed vessel statement of conformance.	EPO-RE-01	6.1
		Helicopter contractor procedures comply with Santos WA's Protected Marine Fauna Interaction and Sighting Procedure (EA-91-11-00003), which ensures compliance with Part 8 of the Environment Protection and Biodiversity Conservation Regulations 2000, which includes controls for minimising interaction with marine fauna.	RE-CM-01-EPS-02	Helicopter contractor procedures align with Santos WA's Protected Marine Fauna Interaction and Sighting Procedure (EA-91-11-00003)	EPO-RE-01	6.1
		UAV's comply with Santos WA's Protected Marine Fauna Interaction and Sighting Procedure (EA-91-11-00003) which includes controls for	RE-CM-01-EPS-01	Contractor procedures align with Santos WA's Protected Marine Fauna Interaction	EPO-RE-01	6.1

Control Measure	Control Measure Ref. No.	Environmental Performance Standard	EPS Reference No.	Measurement Criteria	EPO Reference (Table 8-1)	Relevant Section of this EP
		minimising the risk of interaction with marine fauna.		and Sighting Procedure		
Facilities Planned Maintenance System	RE-CM-02	Documented maintenance program is in place for equipment on facilities that provides a status on the maintenance of equipment.	RE-CM-02-EPS-01	CMMS records.	EPO-RE-02 EPO-RE-03	6.3, 7.3
Vessels Planned Maintenance System	RE-CM-03	Documented maintenance program is in place for equipment on vessels that provides a status on the maintenance of equipment.	RE-CM-03-EPS-01	Planned maintenance system records.	EPO-RE-02 EPO-RE-03	6.3, 7.3
Fuel Oil Quality	RE-CM-04	MARPOL-compliant (Marine Order 97) fuel oil (diesel) will be used during the activity.	RE-CM-04-EPS-01	Fuel bunkering records.	EPO-RE-02	6.3
International Air Pollution Prevention Certificate	RE-CM-05	Pursuant to Marine Order 97, vessels will maintain a current International Air Pollution Prevention Certificate that certifies that measures to prevent ozone-depleting substance emissions and to reduce NOx, SOx and incineration emissions during the activity are in place.	RE-CM-05-EPS-01	Current International Air Pollution Prevention Certificate.	EPO-RE-02	6.3, 6.7
Ozone-depleting Substance Handling Procedures	RE-CM-06	Ozone-depleting substances managed in accordance with Marine Order 97 to reduce the risk of an accidental release of ozone-depleting substances to air.	RE-CM-06-EPS-01	Completed ozone-depleting substance record book or recording system.	EPO-RE-02 EPO-RE-03	6.3
Waste Incineration Management	RE-CM-07	Waste incineration managed in accordance with Marine Order 97.	RE-CM-07-EPS-01	Completed waste record book or recording system.	EPO-RE-02 EPO-RE-03	6.3

Control Measure	Control Measure Ref. No.	Environmental Performance Standard	EPS Reference No.	Measurement Criteria	EPO Reference (Table 8-1)	Relevant Section of this EP
Planned Subsea and Offshore Maintenance	RE-CM-08	Detailed inspection work packs, risk assessments, and all supporting HSE procedures and documentation are prepared for subsea maintenance or inspection, repair and intervention activities, as outlined in the Santos WA Subsea Inspection Procedure (QE-35-IS-00001).	RE-CM-08-EPS-01	CMMS records.	EPO-RE-04	6.4
Dropped Object Prevention Procedures (LEMS)	RE-CM-09	Implementation of the Santos WA Lifting Equipment Management System (QE-91-IF-00011) and Lifting Equipment Management System (LEMS) Safe Lifting Operations (QE-91-IF-00017), which includes the following controls: + Lifting equipment certification and inspection; + Lifting crew competencies; + Heavy-lift procedures; and + Preventive maintenance on cranes.	RE-CM-09-EPS-01	CMMS records. Lifting equipment register. Permit to work records. Training records.	EPO-RE-04	6.4, 7.3, 7.6, 7.7
Dropped Object Recovery	RE-CM-10	Objects dropped overboard are recovered to mitigate the environmental consequences from	RE-CM-10-EPS-01	Fate of dropped objects detailed in incident documents.	EPO-RE-04	6.4, 7.3

Control Measure	Control Measure Ref. No.	Environmental Performance Standard	EPS Reference No.	Measurement Criteria	EPO Reference (Table 8-1)	Relevant Section of this EP
		objects remaining in the marine environment, unless the environmental consequences are negligible or safety risks are disproportionate to the environmental consequences.				
Anchoring and Equipment Deployment Management	RE-CM-11	If anchoring or placement of equipment is required, vessels will anchor or place equipment on seabed only at Santos pre-approved locations.	RE-CM-11-EPS-01	Incident database records show no anchoring or placement of equipment occurred at non-approved locations.	EPO-RE-04	6.4, 7.7
		Support vessels anchoring near subsea infrastructure must keep an anchor watch and an hourly log of anchor wire lengths and tensions to ensure that the vessel does not drag an anchor in accordance with the Santos WA Mooring Operations Procedure (QE-91-IT-10001).	RE-CM-11-EPS-02	Records of anchor watch.	EPO-RE-04	6.4
WHP Petroleum Safety Zone.	RE-CM-12	A 500-m-radius petroleum safety zone is defined around the offshore platforms and marked on Australian Hydrographic Service nautical charts.	RE-CM-12-EPS-01	Incident records show that no breaches have occurred of unauthorised access within the petroleum safety zone.	EPO-RE-05 EPO-RE-07	6.5, 7.6, 7.8
Navigational Charting of Infrastructure	RE-CM-13	The offshore facilities and subsea infrastructure are charted on	RE-CM-13-EPS-01	Australian Hydrographic Service nautical	EPO-RE-05 EPO-RE-07	6.5, 7.6, 7.7, 7.8

Control Measure	Control Measure Ref. No.	Environmental Performance Standard	EPS Reference No.	Measurement Criteria	EPO Reference (Table 8-1)	Relevant Section of this EP
		Australian Hydrographic Service nautical charts.		charts show Santos WA's offshore facilities are charted.		
Navigation Lighting and Aids	RE-CM-14	Navigational lighting and communication aids on offshore platforms are provided and inspected at frequencies outlined in PS-04 Navigational Aids (RE-00-RG-045), which manages the methods to alert marine vessels and aircraft of the position of the facility to minimise the potential for collision.	RE-CM-14-EPS-01	CMMS records.	EPO-RE-05 EPO-RE-07	6.5
		Support vessel navigation equipment is compliant with SOLAS/AMSA Marine Order Part 30, Prevention of Collisions, and with Marine Order Part 21, Safety and Emergency Arrangements.	RE-CM-14-EPS-02	Vessel inspection records.		6.5, 7.6, 7.8
Seafarer Certification	RE-CM-15	Vessel crew are trained and competent, in accordance with Marine Order 70, to navigate vessels and reduce interaction with other marine users.	RE-CM-15-EPS-01	Training records.	EPO-RE-05 EPO-RE-07	6.5, 7.8
Constant bridge Watch on Support Vessels	RE-CM-16	Monitoring of surrounding marine environment undertaken from vessel bridge.	RE-CM-16-EPS-01	Records of bridge watch.	EPO-RE-01 EPO-RE-05 EPO-RE-07	6.5, 7.2
Stakeholder Consultation	RE-CM-17	Santos WA provided a quarterly consultation update to relevant stakeholders, and all stakeholder	RE-CM-17-EPS-01	Records of transmittal.	EPO-RE-05	6.5, 6.7

Control Measure	Control Measure Ref. No.	Environmental Performance Standard	EPS Reference No.	Measurement Criteria	EPO Reference (Table 8-1)	Relevant Section of this EP
		correspondence has been recorded in stakeholder database.		Stakeholder communications database.		
Sewage System	RE-CM-18	Pursuant to Marine Order 96, support vessels have a current International Sewage Pollution Prevention Certificate, which certifies that required measures to reduce impacts from sewage disposal are in place.	RE-CM-18-EPS-01	Current International Sewage Pollution Prevention certificate.	EPO-RE-02	6.6
		Preventive maintenance on sewage treatment equipment is completed as scheduled.	RE-CM-18-EPS-02	Maintenance records.		
		Sewage from vessels is discharged or retained, in accordance with Marine Order 96.	RE-CM-18-EPS-03	Records demonstrates that sewage was appropriately discharged or retained.		
Oily Mixture System	RE-CM-19	Oily mixtures (bilge water) only discharged to sea in accordance with Marine Order 91.	RE-CM-19-EPS-01	Oil record book.	EPO-RE-02	6.6
		Preventive maintenance on oil filtering equipment completed as scheduled.	RE-CM-19-EPS-02	Maintenance records.		
		Pursuant to Marine Order 91, support vessels larger than 400 t) will have an International Oil Pollution Prevention Certificate, which certifies that required	RE-CM-19-EPS-03	Current International Oil Pollution Prevention Certificate.		

Control Measure	Control Measure Ref. No.	Environmental Performance Standard	EPS Reference No.	Measurement Criteria	EPO Reference (Table 8-1)	Relevant Section of this EP
		measures to reduce impacts of planned oil discharges are in place.				
Offshore platform deck drain system and bunding	RE-CM-20	Preventive maintenance on deck drainage sump and associated equipment completed in accordance with Reindeer WHP Performance Standard Assurance Plan: PS-14 Bunding and Open Drains (RE-00-RG-00054).	RE-CM-20-EPS-01	CMMS records.	EPO-RE-02	6.6, 7.4
Garbage management	RE-CM-21	Garbage management plan implemented to reduce the risk of waste released to sea, in accordance with Marine Order 95. The plan includes detail for: + Bin types; + Lids and covers; + Waste segregation; + Bin storage; and + Food waste.	RE-CM-21-EPS-01	Garbage record book. Audit records. Inspection records.	EPO-RE-02	6.6, 7.3
		Pursuant to Marine Order 95, placards displayed to notify personnel of waste disposal restrictions.	RE-CM-21-EPS-02	Audit records. Inspection records.	EPO-RE-02	

Control Measure	Control Measure Ref. No.	Environmental Performance Standard	EPS Reference No.	Measurement Criteria	EPO Reference (Table 8-1)	Relevant Section of this EP
		Garbage generated on offshore facilities will not be discharged to the marine environment.		Incident records.		
Deck cleaning product selection	RE-CM-22	Deck cleaning products planned to be released to sea meet the criteria for not being harmful to the marine environment according to MARPOL Annex V.	RE-CM-22-EPS-01	Safety data sheet and product supplier supplementary data as required.	EPO-RE-02	6.6
Chemical Selection Procedure	RE-CM-23	Production or process chemicals potentially discharged to sea are Gold-, Silver-, D-, or E-rated through the Offshore Chemical Notification Scheme, or are PLONOR (pose little or no risk) substances listed by the OSPAR Commission, or have a complete risk assessment as per Santos WA's Operations Chemical Selection, Evaluation and Approval Procedure (EA-91-II-10001) so that only environmentally acceptable products are used.	RE-CM-23-EPS-01	Completed Santos WA risk assessments.	EPO-RE-02	6.6
Pipeline flushing prior to opening of the subsea system	RE-CM-24	Subsea system flushed to reduce hydrocarbon content prior to opening of the subsea system.	RE-CM-24-EPS-01	Completed operational records.	EPO-RE-02	6.6

Control Measure	Control Measure Ref. No.	Environmental Performance Standard	EPS Reference No.	Measurement Criteria	EPO Reference (Table 8-1)	Relevant Section of this EP
Implementation of the management controls within the Santos WA Invasive Marine Species Management Plan	RE-CM-25	Vessels are managed to low risk in accordance with the Santos WA Invasive Marine Species Management Plan (EA-00-RI-10172) prior to movement or transit into or within the invasive marine species management zone, which requires: + Assessment of applicable vessels using the DPIRD Vessel Check Tool; and + The management of immersible equipment to low risk.	RE-CM-25-EPS-01	Completed risk assessment demonstrating vessel is low risk.	EPO-RE-06	7.1
Anti-foulant System	RE-CM-26	Anti-foulant systems are maintained in compliance with International Convention on the Control of Harmful Anti-Fouling Systems on Ships.	RE-CM-26-EPS-01	Current International Anti-Fouling System Certificate.	EPO-RE-06	7.1
Ballast Water Management Plan	RE-CM-27	Pursuant to the Biosecurity Act 2015 and Australian Ballast Water Management Requirements 2017, support vessels carrying ballast water and engaged in international voyages shall manage ballast water in accordance with a Ballast Water Management Plan so that marine pest species are not introduced.	RE-CM-27-EPS-01	Ballast Water Management Plan. Completed ballast water record book or log.	EPO-RE-06	6.7, 7.1

Control Measure	Control Measure Ref. No.	Environmental Performance Standard	EPS Reference No.	Measurement Criteria	EPO Reference (Table 8-1)	Relevant Section of this EP
Inspection of Platform Structures and Hydrocarbon-containing Equipment	RE-CM-28	Platform hydrocarbon-containing equipment meets inspection criteria and frequency as specified in PS-02 Hydrocarbon Containment: Hydrocarbon Containing Equipment (RE-00-RG-00043), which provides hydrocarbon pressure containment and to prevent the uncontrolled release of hydrocarbons. All subsea inspections are carried out in accordance with the Underwater Inspection Manual (Santos WA Underwater Inspection Manual, QE-00-MG-00005).	RE-CM-28-EPS-01	CMMS records.	EPO-RE-03 EPO-RE-07	7.4, 7.6
		Structural integrity of offshore platforms meet inspection criteria and frequency as specified in PS-01 Structural Integrity (RE-00-RG-00042) to provide structural support for facilities.	RE-CM-28-EPS-02	CMMS Records.	EPO-RE-03 EPO-RE-07	
		Inspection of topsides structural and miscellaneous equipment meets inspection criteria and frequency as specified in the Topside Inspection Procedure (QE-91-IS-00002), which defines the philosophy, procedure and reporting requirements for topsides structural and miscellaneous equipment inspection of offshore fixed steel platforms and floating structures.	RE-CM-28-EPS-03	CMMS Records.	EPO-RE-03 EPO-RE-07	

Control Measure	Control Measure Ref. No.	Environmental Performance Standard	EPS Reference No.	Measurement Criteria	EPO Reference (Table 8-1)	Relevant Section of this EP
		Inspection of rigid hydrocarbon riser sections and wellhead conductors above sea level will meet the inspection criteria and frequency specified in the Topside Riser & Wellhead Conductor Inspection Procedure (QE-91-IS-00001), which defines the inspection philosophy, procedure and reporting requirements for rigid hydrocarbon risers and wellhead conductors above LAT.	RE-CM-28-EPS-04	CMMS Records.	EPO-RE-03 EPO-RE-07	
		Subsea assets will meet the inspection criteria and frequency specified in the Subsea Inspection Procedure (QE-35-IS-00001), the purpose of which is to describe the inspection philosophy, procedure and reporting requirements for Santos WA subsea assets.	RE-CM-28-EPS-05	CMMS Records.	EPO-RE-03 EPO-RE-07	
Hazardous chemical management procedures	RE-CM-29	For hazardous chemicals, including hydrocarbons, the following standards apply to reduce the risk of an accidental release to sea: + Storage containers closed when the product is not being used; + Storage containers managed in a manner that provides for	RE-CM-29-EPS-01	Audit records. Inspection records.	EPO-RE-03	7.4

Control Measure	Control Measure Ref. No.	Environmental Performance Standard	EPS Reference No.	Measurement Criteria	EPO Reference (Table 8-1)	Relevant Section of this EP
		secondary containment in the event of a spill or leak; + Storage containers labelled with the technical product name as per the safety data sheet; + Spills and leaks to deck, excluding storage bunds and drip trays, immediately cleaned up; + Storage bunds and drip trays do not contain free-flowing volumes of liquid; and + Spill response equipment readily available.				
General chemical management procedures	RE-CM-30	Safety data sheet available for all chemicals to aid in the process of hazard identification and chemical management.	RE-CM-30-EPS-01	Safety data sheet.	EPO-RE-03	7.4
		Chemicals managed in accordance with the safety data sheet in relation to safe handling and storage, spill-response and emergency procedures, and disposal considerations.	RE-CM-30-EPS-02	Audit records. Inspection records.	EPO-RE-03	

Control Measure	Control Measure Ref. No.	Environmental Performance Standard	EPS Reference No.	Measurement Criteria	EPO Reference (Table 8-1)	Relevant Section of this EP
		Dangerous goods managed in accordance with the International Maritime Dangerous Goods Code to reduce the risk of an environmental incident, such as an accidental release to sea or unintended chemical reaction.	RE-CM-30-EPS-03	Site records.	EPO-RE-03	
Refuelling and chemical transfer procedure	RE-CM-31	Fuel transfers are undertaken in accordance with the Santos WA Refuelling and Chemical Transfer Management Standard (QE-91-IQ-00098), which details requirements for the refuelling and chemical transfer from an offshore supply vessel to an offshore or onshore facility, as well as refuelling of fixed or portable equipment and machinery.	RE-CM-31-EPS-01	Completed work permits. Job safety analysis forms. Audit records. Inspection records.	EPO-RE-03 EPO-RE-07	7.4, 7.8
Spill Response Equipment on producing platforms	RE-CM-32	Spill response equipment is present on producing offshore platforms to contain and recover spills, thereby reducing potential for spills to reach the marine environment.	RE-CM-32-EPS-01	Audit records. Inspection records.	EPO-RE-03	7.4
Vessel spill response plan (SOPEP/SMPEP)	RE-CM-33	Support vessels have a shipboard oil pollution emergency plan (SOPEP) or shipboard marine pollution emergency plan (SMPEP), which outlines steps taken to combat spills.	RE-CM-33-EPS-01	Audit records. Inspection records.	EPO-RE-03	7.4, 7.8
Remotely operated vehicle	RE-CM-34	Preventive maintenance on ROV completed as scheduled to reduce	RE-CM-34-EPS-01	Maintenance records.	EPO-RE-03	7.4

Control Measure	Control Measure Ref. No.	Environmental Performance Standard	EPS Reference No.	Measurement Criteria	EPO Reference (Table 8-1)	Relevant Section of this EP
inspection and maintenance procedures		the risk of hydraulic fluid releases to sea.			EPO-RE-07	
		ROV pre-deployment inspection completed to reduce the risk of hydraulic fluid releases to sea.	RE-CM-34-EPS-02	Completed pre-deployment inspection of hose integrity.	EPO-RE-03 EPO-RE-07	
NOPSEMA-accepted WOMP	RE-CM-35	An accepted WOMP for Reindeer wells is in place to specifically manage the risks associated with operation of these wells (including well intervention and maintenance activities). WOMP includes control measures for well integrity that reduce the risk of an unplanned release of hydrocarbons, including: + Minimum of two barrier envelopes; + Certified pressure control equipment; + Certified pumping package (including hoses and pipework); and + Minimum requirements for pressure testing operations.	RE-CM-35-EPS-01	Regulatory-accepted WOMP includes control measures for well integrity. Incident records confirm no breach of containment.	EPO-RE-07	7.6
	RE-CM-36	Santos WA Asset Integrity Management Programme (QE-91-IP-00302) complied with, which	RE-CM-36-EPS-01	Certification and test records confirm compliance with	EPO-RE-07	7.6

Control Measure	Control Measure Ref. No.	Environmental Performance Standard	EPS Reference No.	Measurement Criteria	EPO Reference (Table 8-1)	Relevant Section of this EP
Well services procedures and criteria		includes the framework of policies, procedures, and performance standards for production operation assets.		project-specific procedures and Asset Integrity Management Programme (QE-91-IP-00302).		
		Well acceptance criteria for critical well operations and integrity aspects are achieved. Well acceptance criteria will be selected based on the well objectives and Santos WA Offshore Drilling and Completions technical standards.	RE-CM-36-EPS-02	Completed well acceptance criteria in well program. Incident records confirm no breach of containment.	EPO-RE-07	
Testing and maintenance of emergency shutdown systems and shutdown/safety valves	RE-CM-37	Emergency shutdown systems and shutdown/safety valves are routinely tested and maintained to ensure integrity and function is maintained. Their testing criteria and test frequency are specified in: + PS-06 ESD and Blowdown: Emergency Shutdown Valves (RE-00-RG-00047), which prevents the escalation of events by isolating the process plant and/or utility equipment; + PS-07 ESD and Blowdown: Reservoir Isolation (including Surface-controlled	RE-CM-37-EPS-01	CMMS records.	EPO-RE-07	7.6, 7.7

Control Measure	Control Measure Ref. No.	Environmental Performance Standard	EPS Reference No.	Measurement Criteria	EPO Reference (Table 8-1)	Relevant Section of this EP
		Subsurface Safety Valves and Christmas Tree Valves) (RE-00-RG-00048), which applies to surface-controlled subsurface safety valves, Christmas tree valves and wellhead control panel to isolate the well inventories; + PS-08 ESD and Blowdown: Safety Instrumented Systems (RE-00-RG-00049), which applies to the logic solver modules holding the safety logic. + PS-10 ESD and Blowdown: Pressure Safety Valves (RE-00-RG-00050), which applies to all pressure safety valves on pressure-containing equipment and pipework to prevent a loss of containment from equipment and piping by controlled disposal via the flare systems or an alternative safe				

Control Measure	Control Measure Ref. No.	Environmental Performance Standard	EPS Reference No.	Measurement Criteria	EPO Reference (Table 8-1)	Relevant Section of this EP
		location.				
Emergency power system is provided on Reindeer WHP to secure secondary power source for safety integrity system	RE-CM-38	Uninterruptible power supply meets test and inspection criteria and test and inspection frequency as specified in PS-18 Emergency Power (RE-00-RG-00055).	RE-CM-38-EPS-01	CMMS records.		7.6, 7.7, 7.8
Accepted Oil pollution emergency plan (OPEP)	RE-CM-39	In the event of an oil spill to sea, the Santos WA OPEP requirements implemented to mitigate environmental impacts.	RE-CM-39-EPS-01	Completed incident documentation.	EPO-RE-07	7.6, 7.7, 7.8
Support Vessel Positioning	RE-CM-40	As per NOPSEMA-accepted safety case requirements, support vessels will maintain a ‘drift-off’ position relative to offshore platforms to reduce potential for impact.	RE-CM-40-EPS-01	Completed vessel positioning logs.	EPO-RE-07	7.6, 7.8
		If support vessels are using dynamic positioning, the dynamic positioning system is specified as per the relevant safety case’s requirements.	RE-CM-40-EPS-02	NOPSEMA-accepted safety case.		
NOPSEMA-accepted safety case	RE-CM-41	A NOPSEMA-accepted safety case for all licensed pipelines is in place to specifically manage the risks associated with operation and integrity, including maintenance activities.	RE-CM-41-EPS-01	NOPSEMA-accepted safety case.	EPO-RE-07	7.7

Control Measure	Control Measure Ref. No.	Environmental Performance Standard	EPS Reference No.	Measurement Criteria	EPO Reference (Table 8-1)	Relevant Section of this EP
Inspection and corrosion monitoring	RE-CM-42	Offshore pipelines and risers meet inspection and monitoring criteria and frequency as outlined in PS-03 Hydrocarbon Containment; Risers and Pipelines (RE-00-RG-00044), which manages the inherent safety of risers and pipelines, including all mounted fittings, fixtures and supports.	RE-CM-42-EPS-01	CMMS records.	EPO-RE-07	7.6, 7.7

Table 8-4: Control Measures, Environmental Performance Standards and Measurement Criteria for maintaining a state of spill response preparedness

Control Measure	Control Measure Ref. No.	Environmental Performance Standard	EPS Reference No.	Measurement Criteria	EPO Reference (Table 8-2)	Relevant Section of this EP
Competent Incident Management Team (IMT) and oil spill responder personnel.	RE-OPEP-CM-01	Spill response personnel trained as per **Section 8.8.1**.	RE-OPEP-CM-01 EPS-01	Training and exercise records	EPO-RE-OPEP-01 EPO-RE-OPEP-02 EPO-RE-OPEP-03 EPO-RE-OPEP-04 EPO-RE-OPEP-05 EPO-RE-OPEP-06	Section 6.7, 7.6, 7.7and 7.8

					EPO-RE-OPEP-07 EPO-RE-OPEP-08 EPO-RE-OPEP-09	
Incident management facilities	RE-OPEP-CM-02	Maintain IMT/CST facilities as per the Incident Command and Management Manual (QE-00-ZF-00025).	RE-OPEP-CM-02 EPS-01	Bi-monthly inspection report	EPO-RE-OPEP-01 EPO-RE-OPEP-02 EPO-RE-OPEP-03 EPO-RE-OPEP-04 EPO-RE-OPEP-05 EPO-RE-OPEP-06 EPO-RE-OPEP-07 EPO-RE-OPEP-08 EPO-RE-OPEP-09	Section 6.7, 7.6, 7.7and 7.8
Source Control Plan	RE-OPEP-CM-03	Prior to well interventions there will be a source control plan in place.	RE-OPEP-CM-03 EPS-01	Source control plan	EPO-RE-OPEP-01	Section 6.7, 7.6, 7.7and 7.8
MSA with aircraft supplier.	RE-OPEP-CM-04	Master Services Agreement (MSA) in place with helicopter provider throughout activity.	RE-OPEP-CM-04 EPS-01	MSA with aircraft suppliers	EPO-RE-OPEP-02	Section 6.7, 7.6, 7.7and 7.8

AMOSC contract to facilitate mutual aid arrangements for access to Trained Aerial Observers	RE-OPEP-CM-05	Maintenance of AMOSC contract to facilitate mutual aid arrangements for access to Trained Aerial Observers.	RE-OPEP-CM-05 EPS-01	AMOSC Participating Member Contract	EPO-RE-OPEP-02	Section 6.7, 7.6, 7.7and 7.8
Maintenance of MSAs with multiple vessel providers for emergency response	RE-OPEP-CM-06	Santos WA maintains MSAs with multiple vessel providers	RE-OPEP-CM-06 EPS-01	MSAs with multiple vessel providers	EPO-RE-OPEP-02	Section 6.7, 7.6, 7.7and 7.8
AMOSC contract to facilitate mutual aid arrangements for access to Oil Spill crew	RE-OPEP-CM-07	Maintenance of AMOSC contract to facilitate mutual aid arrangements for access to Oil Spill Crew.	RE-OPEP-CM-07 EPS-01	AMOSC Participating Member Contract	EPO-RE-OPEP-02	Section 6.7, 7.6, 7.7and 7.8
Maintenance of contract for emergency response modelling	RE-OPEP-CM-08	Maintenance of contract for emergency response modelling services throughout activity.	RE-OPEP-CM-08 EPS-01	Modelling services contract	EPO-RE-OPEP-02	Section 6.7, 7.6, 7.7and 7.8
Maintenance of oil spill response capability (including satellite imagery provision) through Oil Spill Response Limited (OSRL)	RE-OPEP-CM-09	Maintenance of oil spill response capability (including satellite imagery provision) through Oil Spill Response Limited (OSRL) provider throughout activity.	RE-OPEP-CM-09 EPS-01	OSRL Associate Member Contract.	EPO-RE-OPEP-02	Section 6.7, 7.6, 7.7and 7.8
Maintenance of Monitoring Service Provider contract for scientific monitoring services	RE-OPEP-CM-10	Contract for scientific monitoring services in place throughout activity.	RE-OPEP-CM-10 EPS-01	Contract with monitoring service provider	EPO-RE-OPEP-09	Section 6.7, 7.6, 7.7and 7.8
Capability reports from Monitoring Service Provider	RE-OPEP-CM-11	Capability reports are provided monthly	RE-OPEP-CM-11 EPS-01	Capability reports	EPO-RE-OPEP-09	Section 6.7, 7.6, 7.7and 7.8
Conduct periodical review of existing baseline data sources across the Santos WA combined EMBA	RE-OPEP-CM-12	Regular review of baseline data	RE-OPEP-CM-12 EPS-01	Documented baseline data review	EPO-RE-OPEP-09	Section 6.7, 7.6, 7.7and 7.8

Tracking buoys available.	RE-OPEP-CM-13	Maintenance of 12 operable tracker buoys throughout the activity.	RE-OPEP-CM-13 EPS-01	Computer tracking software listing tracker buoys, last activation dates and location coordinates	EPO-RE-OPEP-09	Section 6.7, 7.6, 7.7and 7.8
		Maintenance of contract to provide buoy tracking services throughout the activity.	RE-OPEP-CM-13 EPS-02		EPO-RE-OPEP-09	Section 6.7, 7.6, 7.7and 7.8
Arrangements to enable access to fluorometry services	RE-OPEP-CM-14	Maintenance of arrangements to enable access to fluorometry services throughout activity.	RE-OPEP-CM-14 EPS-01	Arrangement with provider of flurometry equipment	EPO-RE-OPEP-09	Section 6.7, 7.6, 7.7and 7.8
Access to protection and deflection equipment and personnel through AMOSC, AMSA National Plan and OSRL	RE-OPEP-CM-15	Maintenance of access to protection and deflection equipment and personnel through AMOSC, AMSA National Plan and OSRL throughout activity.	RE-OPEP-CM-15 EPS-01	MoU for access to National Plan resources through AMSA	EPO-RE-OPEP-04	Section 6.7, 7.6, 7.7and 7.8
				AMOSC Participating Member Contract		
				OSRL Associate Member Contract		
Access to waste tanks and waste transfer equipment	RE-OPEP-CM-16	Maintain access to waste tanks and waste transfer equipment throughout activity.	RE-OPEP-CM-16 EPS-01	Contract with Waste Service Provider for emergency response services.	EPO-RE-OPEP-08	Section 6.7, 7.6, 7.7and 7.8
Access to shoreline clean-up equipment and personnel through AMOSC, AMSA National Plan and OSRL	RE-OPEP-CM-17	Maintenance of access to shoreline clean-up equipment and personnel through AMOSC, AMSA National Plan and OSRL throughout activity.	RE-OPEP-CM-17 EPS-01	MoU for access to National Plan resources through AMSA	EPO-RE-OPEP-05	Section 6.7, 7.6, 7.7and 7.8
				AMOSC Participating Member Contract.		
				OSRL Associate Member Contract.		
Maintain access to waste management equipment,	RE-OPEP-CM-18	Maintain access to waste management equipment,	RE-OPEP-CM-18 EPS-01	Contract with Waste Service Provider for	EPO-RE-OPEP-08	Section 6.7, 7.6, 7.7and 7.8

personnel, transport and disposal facilities.		personnel, transport and disposal facilities throughout activity.		emergency response services		
Maintenance of access to oiled wildlife response equipment and personnel.	RE-OPEP-CM-19	Maintenance of access to oiled wildlife response equipment and personnel through AMOSC, AMSA National Plan and Oil spill Response Limited (OSRL) throughout activity.	RE-OPEP-CM-19 EPS-01	MoU for access to National Plan resources through AMSA	EPO-RE-OPEP-07	Section 6.7, 7.6, 7.7and 7.8
				AMOSC Participating Member Contract.		
				OSRL Associate Member Contract.		

8.5 Leadership, Accountability and Responsibility

OPGGS(E)R 2009 Requirements
Regulation 14(4)
The implementation strategy must establish a clear chain of command, setting out the roles and responsibilities of personnel in relation to the implementation, management and review of the environment plan, including during emergencies or potential emergencies.

While Santos WA's Chief Executive Officer has the overall accountability for the implementation of the Santos WA Management System and Environmental Management Policy, the Santos WA Manager – Gas Assets is accountable for ensuring implementation, management and review of this EP.

The effective implementation of this EP requires collaboration and cooperation among Santos WA and its contractors. The accountabilities of personnel in relation to the implementation, management and review of the EP are outlined in **Figure 8-1** and detailed in **Table 8-5**. They are also outlined in the OPEP for oil spill response.

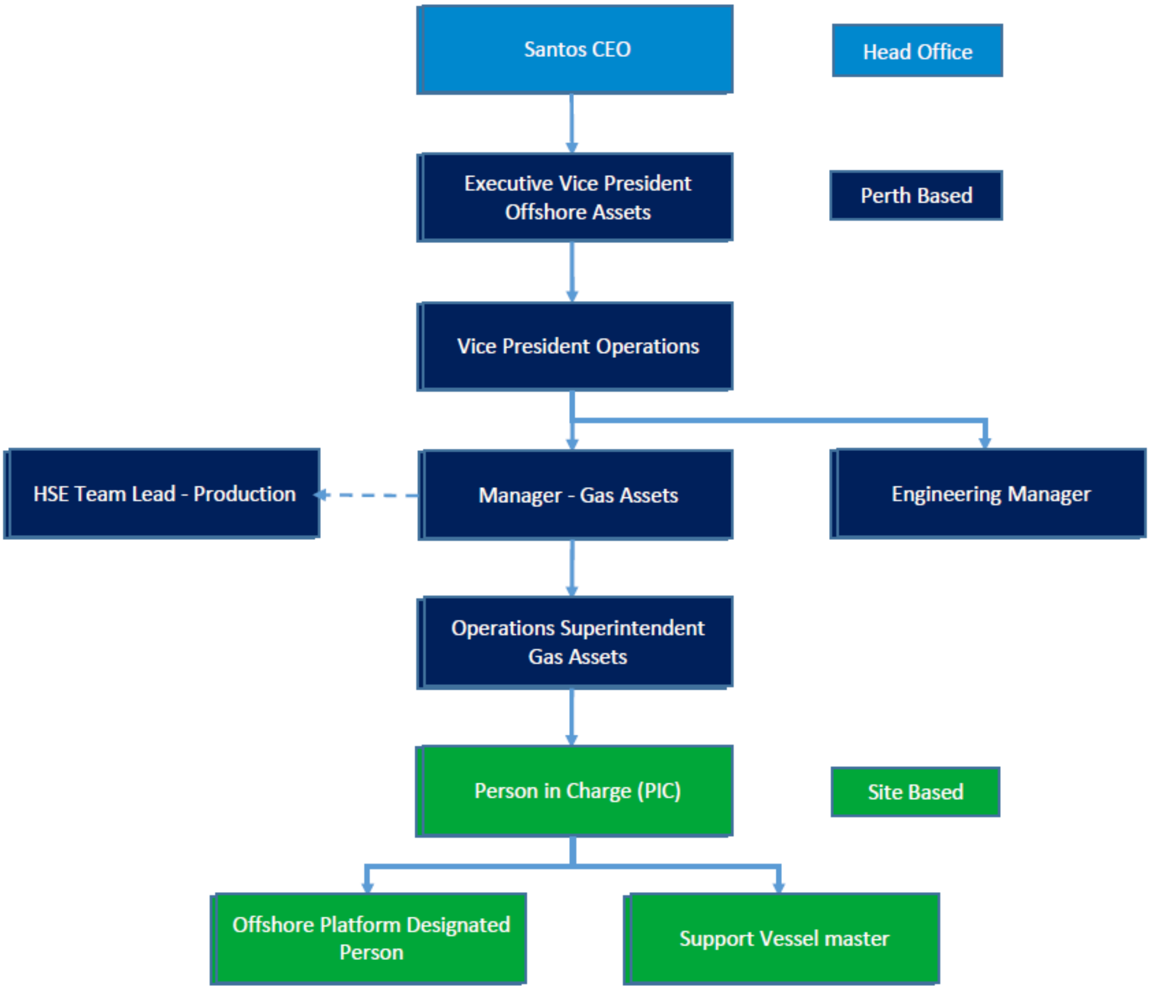


Figure 8-1: Chain of Command Organisation Chart

Table 8-5: Chain of Command, Key Leadership Roles and Responsibilities

Role	Responsibilities
Perth Office-based Roles	
VP – Offshore Production	Has overall responsibility for: + Complying with the EP and Santos WA policies and procedures; + Approving budgets to meet EP commitments; + Ensuring accurate reporting of environmental incidents; and + Ensuring company has contractual provisions in place to enable rapid response to oil spill incidents.
Manager – Gas Assets	Has overall responsibility for: + Implementing the EP and Santos WA policies and procedures; + Ensuring the appropriate level of budget and planning is in place to meet EP commitments; + Ensuring appropriate checks completed prior to mobilising support vessels; + Approving Environmental Management of Change (MoC) documents; + Ensuring environmental incidents are appropriately investigated; and + Applying appropriate enforcement mechanisms to prevent breaches of this EP.
Operations Superintendent	Has responsibility for: + Ensuring that all relevant plans, commitments and procedures are available to personnel; + Implementing the CMMS; + Ensuring appropriate level of risk assessment has been completed; + Approving procedures and work instructions; + Developing resourcing plans; and + Interfacing between onshore and offshore teams.
Overall Site-based Person in Charge	Has responsibility for: + Implementing EP commitments; + Ensuring personnel competency; + Ensuring compliance with procedures and work instructions; + Providing the site focal point for onshore/offshore communications; + Approving vessels entering the field; + Reporting all incidents and potential hazards; + Leading site-based incident response; and + Implementing corrective actions arising from environmental incidents and audits.

Offshore Designated Person (on WHP)	Has responsibility for: + Reporting all incidents and potential hazards to the Person in Charge; + Controlling and implementing risk reduction measures during site-based activities; + Providing site response to incidents to minimise environmental impact (if safe to do so); + Ensuring all personnel working on facility are knowledgeable about the specific risks of the tasks being undertaken; and + Ensuring a high standard of housekeeping is maintained at work locations.
Manager - Engineering WA	Has overall responsibility for: + Implementing subsea maintenance and integrity programme; + Providing engineering support to the operational activities; and + Providing technical assurance.
HSE Team Lead - Production	Has overall responsibility for: + Complying with Santos WA's Environmental Management Policy and this EP; + Providing operational HSE oversight and advice; + Ensuring adequate resources are provided for HSE support; + Facilitating the development and implementation of environmental management of change documents; + Ensuring EP-required reporting is accurate and timely; + Ensuring environmental incidents are appropriately investigated; + Ensuring that appropriate enforcement mechanisms to prevent breaches of this EP are implemented; and + Providing advice to ensure environmental incident reporting meets regulatory requirements (as outlined in the EP) and Santos WA's internal incident reporting and investigation procedure.
Support Vessel Masters	Have overall responsibility for: + Implementing and ensuring compliance with relevant environmental legislative requirements, EP commitments and operational procedures on the support vessel; + Maintaining clear communication with the crew and passengers; + Communicating hazards and risks to the workforce; + Monitoring daily activities on the vessel to ensure that the relevant environmental legislative requirements, EP commitments and operational procedures are being followed; + Maintaining their vessels to all regulatory and class requirements; + Maintaining their vessel in a state of preparedness for emergency response; and + Reporting environmental incidents to the Person in Charge and ensuring follow-up actions are carried out.

8.6 Workforce Training and Competency

OPGGS(E)R 2009 Requirements
Regulation 14(5)
The implementation strategy must include measures to ensure that each employee or contractor working on, or in connection with, the activity is aware of his or her responsibilities in relation to the environment plan, including during emergencies or potential emergencies, and has the appropriate competencies and training.

8.6.1 Inductions

All personnel that arrive on the facilities and crew on support vessels will complete an induction that will include a component addressing their EP responsibilities. Induction attendance records for all personnel will be maintained. Inductions will include information on:

+ Environmental Management Policy;
+ Regulatory regime (NOPSEMA regulations);
+ Operating environment (e.g., nearby protected marine areas, sensitive environmental periods);
+ Activities with highest risk (e.g., invasive marine species and hydrocarbon releases);
+ EP commitments (e.g., **Table 8-2**);
+ Incident reporting and notifications;
+ Regulatory compliance reporting;
+ Management of change process for changes to EP activities; and
+ Oil pollution emergency response (e.g., OPEP requirements).

8.6.2 Training and Competency

All members of the workforce on the WHP or support vessels will complete relevant training and/or hold relevant qualifications and certificates for their role. Santos WA and its contractors (e.g., support vessels, technical service providers) are individually responsible for ensuring that their personnel are qualified and trained. The systems, procedures and responsible persons will vary and will be managed through the use of online databases, staff on-boarding process, training departments, etc.

Personnel qualification and training records will be sampled at various times such as during the procurement process, inductions, crew change, and operational inspections and audits.

8.6.3 Workforce Involvement, Ongoing Training and Communication

Daily operational meetings will be held offshore at which HSE will be a standing agenda item. It is a requirement that supervisors attend daily operational meetings and that all personnel attend daily toolbox or pre-shift meetings.

Toolbox or pre-shift meetings will be regularly held offshore to plan jobs and discuss work tasks, including HSE risks and controls.

HSE performance will be monitored and reported during the activity, and performance metrics (such as the number of environmental incidents) will be regularly communicated to the workforce. Workforce involvement and environmental awareness will also be promoted by encouraging offshore personnel to report marine fauna sightings and marine pollution (e.g., oil on water, dropped objects).

8.7 Maintenance Management System

Santos WA uses a Computerised Maintenance Management System (CMMS) for offshore and onshore plant inspection. The planned maintenance management procedures are also supported by the Maintenance Management System. The objective of the Maintenance Management System is to ensure that the plant and associated equipment are fit for purpose, are safe to operate and are environmentally compliant for the life of the asset.

In addition to the scheduling of routine maintenance activities and inventory control, the Santos WA's Computer Maintenance Management System (CMMS) provides the information required to determine risk- or criticality-based maintenance requirements. This analysis matches the maintenance and inspection type and frequency to the criticality of the equipment and also allows efforts to be prioritised in the areas most critical for safety, environment, compliance and production. This results in effective and efficient practices to maximise reliability and availability of the plant. For each individual plant and facility, a preventive maintenance plan is incorporated into the CMMS. The preventive maintenance plan includes:

+ All routine inspections;
+ All statutory inspections; and
+ All maintenance carried out on a usage basis such as machine running hours

8.8 Emergency Preparedness and Response

OPGGS(E)R 2009 Requirements
Regulation 14(8)
The implementation strategy must contain an oil pollution emergency plan and provide for the updating of the plan.

Santos WA will implement the Reindeer and Devil Creek Oil Pollution Emergency Plan (EA-14-RI-10001.02) in the event of a Tier 2 or 3 hydrocarbon spill (refer to Table 2-1 of the OPEP). To maintain a state of oil spill preparedness, personnel with OPEP responsibilities are made aware of their obligations, oil spill response equipment is maintained, contracts with critical equipment and personnel suppliers are managed, and agreements are in place with regulatory agencies and service providers for support in oil spill response. Santos WA will also implement its oil spill response exercise and training schedule. Further information on oil spill response is provided in the OPEP.

In addition, vessels are required to have and implement incident response plans, such as an emergency response plan and a shipboard marine pollution emergency plan (SMPEP) or shipboard oil pollution emergency plan (SOPEP). Regular incident response drills and exercises (e.g., as defined in an emergency response plan, SMPEP or SOPEP) are carried out to refresh the crew in using equipment and implementing incident response procedures.

8.8.1 Training and Exercises

8.8.1.1 CST/IMT Training and Exercising

Santos WA provides training to its personnel to fill all required positions within the IMT and Crisis Support Team (CST).

Competency is maintained through participation in regular response exercises and workshops. Exercise and training requirements for Santos's CST/IMT members are summarised in **Table 8-6**.

Table 8-6: Training and Exercise Requirements for CST/IMT positions

CST Role	Exercise	Training
CST Leader	1 x IR exercise annually and 1 x IR workshop annually.	+ PMAOMIR650 + AMOSC – Oil Spill Response Familiarisation Training
CST Members: Finance Team Leader GPA Team Leader JV Coordinator/ Legal Team Leader Data Manager	1 x IR exercise annually and 1 x IR workshop annually.	+ PMAOMIR320 + AMOSC – Oil Spill Response Familiarisation Training
IMT Role	**Exercise**	**Training**
Incident Commander Operations/ Drilling Team Leader	1 x IR exercise annually and 1 x IR workshop annually.	+ PMAOMIR320; + PMAOMIR418; and + AMOSC – IMO3 Oil Spill Command & Control;
Planning Team Leader Logistics Team Leader Environmental Team Leader	1 x IR exercise annually and 1 x IR workshop annually.	+ PMAOMIR320; and + AMOSC – IMO2 Oil Spill Management Course
Safety Team Leader Supply Team Leader GIS Team Leader Data Manager HR/ Welfare Team Leader	1 x IR exercise annually and 1 x IR workshop annually.	+ PMAOMIR320; and + AMOSC – Oil Spill Response Familiarisation Training

8.8.1.2 Oil Spill Responder Training

Santos has an internal capability of trained oil spill responders that can be deployed into the field in a spill response and has access to external trained spill responder resources (**Table 8-7**).

Table 8-7: Oil Spill Responder Training and Resources

Responder	Role	Training	Available Number
Santos AMOSC Core Group Responders	Santos personnel trained and competency assessed by AMOSC as the AMOSC Core Group. Deployed by IMT for spill response operations	AMOSC Core Group Workshop (refresher training undertaken every 2 years). AMOSC – IMO1 Oil Spill Operators Course	12
Santos WA Facility Incident Response Teams	Present at Devil Creek, Varanus Island and Ningaloo Vision Facilities for first strike response to incidents	Internal Santos training and exercises as defined in each facility's Incident Response Plan On-scene commander to have AMOSC – Oil Spill Response Familiarisation Training.	One IR team per operational facility per shift.
Santos WA Aerial Observers	Undertake aerial surveillance of spill. Deployed by IMT in the aerial surveillance aircrafts.	AMOSC – Aerial Surveillance Course (refresher training undertaken tri-annually).	7
AMOSC Core Group Oil Spill Responders	Industry personnel as the AMOSC Core Group, available to Santos under the AMOSPlan. For providing incident management (IMT) and operations (field response) assistance.	AMOSC Core Group Workshop (refresher training undertaken every 2 years). AMOSC – IMO1 Oil Spill Operators Course and/or IMO2 Oil Spill Management Course	As defined in Core Group Member Reports Min.84 Max. 140 (incl. Santos).
OSRL Oil Spill Response Personnel	Oil Spill Response Ltd professionals, providing technical, incident management and operational advice and assistance available under Santos-OSRL contract.	As per OSRL training and competency matrix.	18
AMOSC Oil Spill Response Specialists	Professionals, providing technical, incident management and operational advice and assistance available under	As per AMOSC training and competency matrix.	8

Responder	Role	Training	Available Number
	Santos-AMOSC contract.		
Oiled Wildlife Response Roles (Level 2 to 4)	Refer OPEP Section 14 and Appendix L.		
Monitoring Service Provider :Monitoring Coordination Team (MCT) and SMP Teams	Monitoring Coordination Team (MCT) SMP Teams: Technical Advisers Field Team Leader Field Team Member	As defined in the Oil Spill Scientific Monitoring Standby and Response Manual (EA-00-RI-10162)	Capability defined in Monthly Capability Reports. MCT – 5 personnel SMP Teams 12+ per team
Level 1 Oiled Wildlife Responders (Workforce Hire)	Provide oiled wildlife support activities under supervision.	No previous training required; on the job training provided.	Nominally over 1,000.
Shoreline clean-up personnel (Workforce Hire)	Manual clean-up activities under supervision.		

In addition, the following resources are available to Santos WA:

+ National Plan: National Response Team (NRT) – Trained oil spill response specialists including aerial observers, containment and recovery crews and shoreline clean-up personnel deployed under the direction of AMSA and the IMT in a response. The NRT is trained and managed in accordance with the National Response Team Policy, approved by the National Plan Strategic Coordination Committee (AMSA, 2014); and
+ WestPlan–MOP: State Response Team (SRT) and NW Regional Response Team (RRT) – Oil pollution response teams available to assist under the jurisdiction of the DoT. SRT and RRT members remain trained and accredited in line with WestPlan–MOP requirements.

In the event of a spill, the trained spill responders would be required to undertake various roles in key spill response operations, including operational monitoring, shoreline protection, shoreline clean-up, oiled wildlife response and scientific monitoring.

In the event of a spill, Team Leader roles for protection and deflection and for shoreline clean-up would be filled through Santos WA AMOSC Core Group Responders and industry Core Group Responders, which combined represent approximately 100 personnel.

8.8.2 Response Testing

Testing of onsite Devil Creek emergency arrangements, including major hydrocarbon spill incidents, are as per the requirements of the Devil Creek Incident Response Plan (DC-40-IF-00096) and are recorded in the Santos WA Learning Management System with actions tracked in the Santos WA Action Tracking System.

Regulatory and service provider notifications/ activations of the plan are tested by the Emergency and Oil Spill Coordinator through a communications test to all external agencies and companies with roles defined within the plan. The communications tests are repeated annually for activities that extend longer than 1 year.

CST and IMT members undertake workshops and exercises to clarify and familiarise themselves with their respective roles and responsibilities within OPEPs and other emergency plans. Learning aids are also introduced through these workshops to assist improvement of capability for the personnel to perform the functions of their role.

Santos WA conducts a large IMT/CST exercise twice per year using an emergency scenario at either one of Santos's main operating facilities on the North West Shelf or at a drilling activity. The facility from which the exercise scenario is based is selected on a rotational basis, and the scenario is either a safety incident or an oil spill incident. An oil spill incident scenario is used for the exercise once per year. Both safety and oil spill incidents test the chain of command of the Santos WA response system, communications and notification with external parties, communication processes between office and facility, and field response tactics.

Testing of key response provider arrangements are done as part of larger exercises or as standalone tests where the capability and availability of resources through the response provider is assessed.

Santos WA regularly provides IMT and responder personnel to participate in exercises and workshops as the opportunity arises, run by response agencies and related organisations including DoT, AMSA, CSIRO, AMOSC and OSRL.

Field deployment tests are undertaken by Santos WA as a sole responder and through Santos WA's involvement in multi-operator response deployment exercises.

8.8.3 Testing Schedule

Oil spill– specific training, exercises, workshops and tests are detailed in the 5-year Incident and Crisis Management Exercise and Training Plan (QE-92-HG-10001). Once completed, records of exercises and workshops are entered into the Santos WA Training and Induction Database (Learning Management System). Key actions arising from exercises are recorded and tracked through the Santos WA Action Tracking System. Progress of training, exercise and workshop completion against the schedule is tracked and reported against on a monthly basis.

The 5-year Incident and Crisis Management Exercise and Training Plan (QE-92-HG-10001) is reviewed and revised annually.

8.8.4 Oil Spill Response Audits

Oil spill response audits will follow the Santos WA Assurance Procedure (QE-91-IQ-10022) and are scheduled as per the Santos WA Assurance Schedule. Audits will assist in identifying and addressing any deficiencies in systems and procedures. At the conclusion of the audit, any opportunities for improvement and corrective actions required (non-conformances) will be formally noted and discussed, with corrective actions developed and accepted. In some instances, audits may conclude with potential amendments to the OPEP.

The deployment readiness and capability of AMOSC's oil spill response equipment and resources in Geelong and Fremantle are audited every two years under the direction of AMOSC's participating members. The intent of this audit is to provide assurances to Santos WA and associated members about AMOSC's ability to respond to an oil spill incident as per the methods and responsibilities defined in oil pollution emergency plans.

The deployment readiness and capability of OSRL's oil spill response equipment and personnel in Singapore are audited every 2 years by the Emergency & Oil Spill Coordinator. The intent of this audit is to provide assurances to Santos WA of OSRL's ability to respond to an oil spill incident as per its service level agreement (SLA).

The objectives and frequency of oil spill response testing and auditing relevant to Devil Creek oil spill response are summarised in **Table 8-8**.

Table 8-8: Oil Spill Response Testing Arrangements

Exercise	Objective	Frequency	Recording and review
Communication Test	To test all communication and notification processes to service providers and regulatory agencies defined within the OPEP.	Required for every approved OPEP. When response arrangements have changed. At least annually.	Any results of the test are recorded in a Test Report. Corrections are updated within the Incident Response Telephone Directory (QE-00-ZF-00025.20)
IMT/CST Workshops	To refresh IMT & CST roles and responsibilities and provide familiarisation with OPEP processes and arrangements.	As per 5-year Incident and Crisis Management Exercise and Training Plan (QE-92-HG-10001) Typically 3-4 per Quarter are run	All workshops undertaken are recorded in Santos WA's Learning Management System.
OPEP Desktop and Activation Exercise	<u>Desktop Exercise</u> To familiarise IMT with functions and process in response to a simulated oil spill scenario <u>Activation Exercise</u> To activate full IMT/CST in response to oil spill scenario and test arrangements contained within OPEP	As per 5-year Incident and Crisis Management Exercise and Training Plan (QE-92-HG-10001) Minimum of one Desktop and one Activation oil spill exercise per year.	All exercises undertaken are recorded in Santos WA's Learning Management System. Key recommendations are recorded are tracked in Santos WA's Action Tracking System.
Response arrangement tests	Tests of response arrangements outlined within the OPEP either as part of desktop/ activation exercises or as standalone desktop tests	As per 5-year Incident and Crisis Management Exercise and Training Plan (QE-92-HG-10001)	Test reports are recorded
Equipment deployment exercises/ tests	To focus on Santos WA's deployment capability. To inspect and maintain the condition of the Santos oil spill response equipment. To maintain training of field response personnel.	When new response equipment is added. As per 5-year Incident and Crisis Management Exercise and Training Plan (QE-92-HG-10001) The following Santos-owned equipment is inspected and/or tested + Tracker buoys + Offshore boom/ nearshore boom + Power packs	Reports are generated for exercises and recorded in Santos WA's Learning Management System. Key recommendations are recorded are tracked in Santos WA's Action Tracking System. Tracker Buoy tests are recorded.

Exercise	Objective	Frequency	Recording and review
		+ Vessel dispersant spray systems +	
AMOSC audit	To test deployment readiness and capability of AMOSC.	Every 2 years.	Undertaken by two of AMOSC's participating members and the audit report made available to members.
OSRL Audit	To test deployment readiness and capability of OSRL in Singapore.	Every 2 years.	Undertaken by the Santos Emergency & Oil Spill Coordinator. Recommendations provided to OSRL for action and close-out.

8.9 Incident Reporting, Investigation and Follow-up

All personnel will be informed through inductions and daily operational meetings of their duty to report HSE incidents and hazards. Reported HSE incidents and hazards will be shared during daily operational meetings, and HSE incidents and hazards will be documented in the incident management systems as appropriate.

HSE incidents will be investigated in accordance with the Santos WA Incident Reporting and Investigation Procedure (QE-91-IF-00002).

Environmental recordable and reportable incidents will be reported to NOPSEMA, and other regulators as required, in accordance with **Table 8-6**. The incident reporting requirements will be provided to all crew on board the facilities and support vessels with special attention to the reporting time frames to provide for accurate and timely reporting.

For the purposes of this activity, in accordance with OPGGS(E)R 2009:

+ A recordable incident, for an activity, means a breach of an environmental performance outcome or environmental performance standard, in the environment plan that applies to the activity, that is not a reportable incident; and
+ A reportable incident, for an activity, means an incident relating to the activity that has caused, or has the potential to cause, moderate to significant environmental damage.

For the purposes of this EP, a reportable incident is an incident that is assessed to have an environmental consequence of moderate or higher in accordance with Santos WA's environmental impact and risk assessment process outlined in Section 5.

8.10 Reporting and Notifications

OPGGS(E)R 2009 Requirements
Regulation 14(2)
The implementation strategy must: (a) state when the titleholder will report to the Regulator in relation to the titleholder's environmental performance for the activity; and (b) provide that the interval between reports will not be more than 1 year.
Regulation 14(7)
The implementation strategy must provide for sufficient monitoring of, and maintaining a quantitative record of, emissions and discharges (whether occurring during normal operations or otherwise), such that the record can be used to assess whether the environmental performance outcomes and standards in the environment plan are being met.

8.10.1 Regulatory and Other Notifications

Regulatory and other notification requirements are summarised in **Table 8-9**.

8.10.2 Compliance Reporting

Compliance reporting requirements are summarised in **Table 8-9**.

8.10.3 Monitoring and Recording Emissions and Discharges

Vessel based discharges to the marine environment associated with this activity will be recorded and controlled in accordance with requirements under relevant marine orders.

Santos WA and support vessel contractors will maintain records so that emissions and discharges can be determined or estimated. Such records will be maintained for a period of five years. Contractors are required to make these records available upon request.

Santos

Table 8-9: Activity Notification and Reporting Requirements

Regulation	Requirement	Required Information	Timing	Type	Recipient
During the Activity					
Regulation 26B – Recordable Incidents	NOPSEMA must be notified of a breach of an environmental performance outcome or standard, in the environment plan that applies to the activity that is not a reportable incident.	Complete NOPSEMA's Recordable Environmental Incident Monthly Report form.	The report must be submitted as soon as practicable after the end of the calendar month, and in any case, not later than 15 days after the end of the calendar month.	Written	NOPSEMA
Regulation 16(c), 26 & 26A – Reportable Incident	NOPSEMA must be notified of any reportable incidents. For the purposes of Regulation 16(c), a reportable incident is defined as: An incident relating to the activity that has caused, or has the potential to cause, moderate to significant environmental damage.	The oral notification must contain: + All material facts and circumstances concerning the reportable incident known or by reasonable search or enquiry could be found out; and + Any action taken to avoid or mitigate any adverse environmental impacts of the reportable incident; and + The corrective action that has been taken, or is proposed to be taken, to stop, control or remedy the reportable incident.	As soon as practicable, and in any case not later than 2 hours after the first occurrence of a reportable incident, or if the incident was not detected at the time of the first occurrence, at the time of becoming aware of the reportable incident.	Oral	NOPSEMA
		A written record of the oral notification must be submitted. The written record is not required to include anything that was not included in the oral notification.	As soon as practicable after the oral notification.	Written	NOPSEMA NOPTA DMIRS
		A written report must contain: + All material facts and circumstances concerning the reportable incident known or by reasonable search or	Must be submitted as soon as practicable, and in any case not later than 3 days after the first occurrence	Written	NOPSEMA NOPTA DMIRS

Regulation	Requirement	Required Information	Timing	Type	Recipient
		enquiry could be found out; and + Any action taken to avoid or mitigate any adverse environmental impacts of the reportable incident; and + The corrective action that has been taken, or is proposed to be taken, to stop, control or remedy the reportable incident; and + The action that has been taken, or is proposed to be taken, to prevent a similar incident occurring in the future. Consider reporting using NOPSEMA's Report of an Accident, Dangerous Occurrence or Environmental Incident form.	of the reportable incident unless NOPSEMA specifies otherwise. Same report to be submitted to NOPTA and DMIRS within 7 days after giving the written report to NOPSEMA.		
Regulation 26C – Environmental Performance	NOPSEMA must be notified of the environmental performance at the intervals provided for in the EP.	Report must contain sufficient information to determine whether or not environmental performance outcomes and standards in the EP have been met.	Annual performance report to be submitted to NOPSEMA annually from the date of acceptance of this EP.	Written	NOPSEMA
AMSA Reporting	In consultation AMSA requests notification of reportable vessel incidents under Marine Safety (Domestic Commercial Vessel) National Law Act 2012, Schedule 1 including: + The loss of a vessel; + A collision	A written report must contain: + Incident details (date and time); + Location; + Type of incident; + Incident description; + Vessels involved (DCV); + Persons involved; and + Details of assistance rendered or received at the incident.	Within 72 hours of the incident.	Written	AMSA

Regulation	Requirement	Required Information	Timing	Type	Recipient
	with another vessel or an object; + The grounding, sinking, flooding or capsizing of a vessel; + A fire; + A loss of stability that affects the safety of the vessel; + A close quarters situation; + The death or injury, or possible death or injury, of a person on-board; and + The loss, or possible	Consider reporting using AMSA's Incident Report http://www.amsa.gov.au/domestic/vessels-operations-surveys/domestic-incident-reporting/.			

Regulation	Requirement	Required Information	Timing	Type	Recipient
	loss, of a person from a vessel.				
Director of National Parks Reporting	Notification of the event of oil pollution within a marine park or where an oil spill response action must be taken within a marine park.	Not specified, however should include details of event and response actions being undertaken with the marine park.	So far as reasonably practicable prior to response action being written.	Not defined.	Director of National Parks
DPIRD Reporting	If marine pests or disease are suspected this must be reported to DPIRD.	Notification of any suspected marine pests or diseases including any organism listed in the Western Australian Prevention List for Introduced Marine Pests and any other non-endemic organism that demonstrates invasive characteristics.	Within 24 hours.	Oral	DPIRD FishWatch
DoEE Reporting	Any harm or mortality to EPBC Act- listed threatened marine fauna.	Notification of any harm or mortality to an EPBC listed species of marine fauna whether attributable to the activity or not.	Within 7 days to EPBC.permits@environment.gov.au.	Written	DoEE
	Marine Fauna Sighting Data.	Marine fauna sighting data recorded in the marine fauna sighting database.	Not later than 3 months of the end of the activity.	Written	DoEE
	Any ship strike incident with cetaceans will also be reported to the National Ship Strike database.	Ship strike report provided to the Australian Marine Mammal Centre: https://data.marinemammals.gov.au/report/shipstrike.	As soon as practicable	Written	DoEE
DBCA Reporting	Impacts to marine mammals or turtles in reserves.	Notification of any incidence of entanglement, boat collisions and stranding of marine mammals in the reserves and any incident of turtle mortality and incidents of entanglement in the reserves as detailed	Within 48 hours.	Written	DBCA

Regulation	Requirement	Required Information	Timing	Type	Recipient
		in the Management Plan for the Montebello/Barrow Islands Marine Conservation Reserves.			

8.11 Document Management

8.11.1 Information Management and Document Control

This EP and the associated OPEP, as well as any approved MoC documents (**Section 8.11.2**), are controlled documents; and current versions will be available on the Santos WA intranet. Contractor vessels are also required to maintain current versions of Santos WA's HSE documents on their vessels.

Environmental performance outcomes and standards will be measured based on the measurement criteria listed in **Table 8-3**. Such records will be maintained for a period of five years. Contractors are required to make these records available upon request.

8.11.2 Management of Change

Proposed changes to this EP and OPEP will be managed in accordance with the Santos WA Environment Management of Change Procedure (EA-91-IQ-10001). The MoC process provides a systematic approach to initiate, assess, document, approve, communicate and implement changes to EPs and OPEPs.

The MoC process considers Regulations 7, 8 and 17 of the OPGGS(E)R 2009 and determines whether and in what manner a proposed change can proceed. The MoC procedure will determine whether a revision of the EP is required and whether that revision is to be submitted to NOPSEMA. For a change to proceed, the associated environmental impacts and risks must be demonstrated to be ALARP and acceptable. Additional stakeholder consultation may be required depending on the nature and scale of the change. Additional information on the MoC process is provided in **Figure 8-2.**

The MoC procedure also allows the assessment of new information that may become available after EP acceptance. For example, new management plans for marine reserves, recovery plans or conservation advice for species, and changes to the EPBC Act Protected Matters Search results. If review identifies new information, this is treated as 'Change that has an impact on Environment Plan' in **Figure 8-2,** and the MoC procedure is followed accordingly.

Accepted MoCs become part of the in-force EP or OPEP, are tracked on a register and are made available on Santos WA's intranet. Where appropriate, the EP compliance register will be updated so that control measure or environmental performance standard changes are communicated to the workforce and implemented. Any MoC will be distributed to the management people identified in **Table 8-5** (excluding the VP – Offshore production); and the most relevant management position will ensure the MoC is communicated and implemented, which may include crew meetings, briefings, or communications as appropriate for the change.

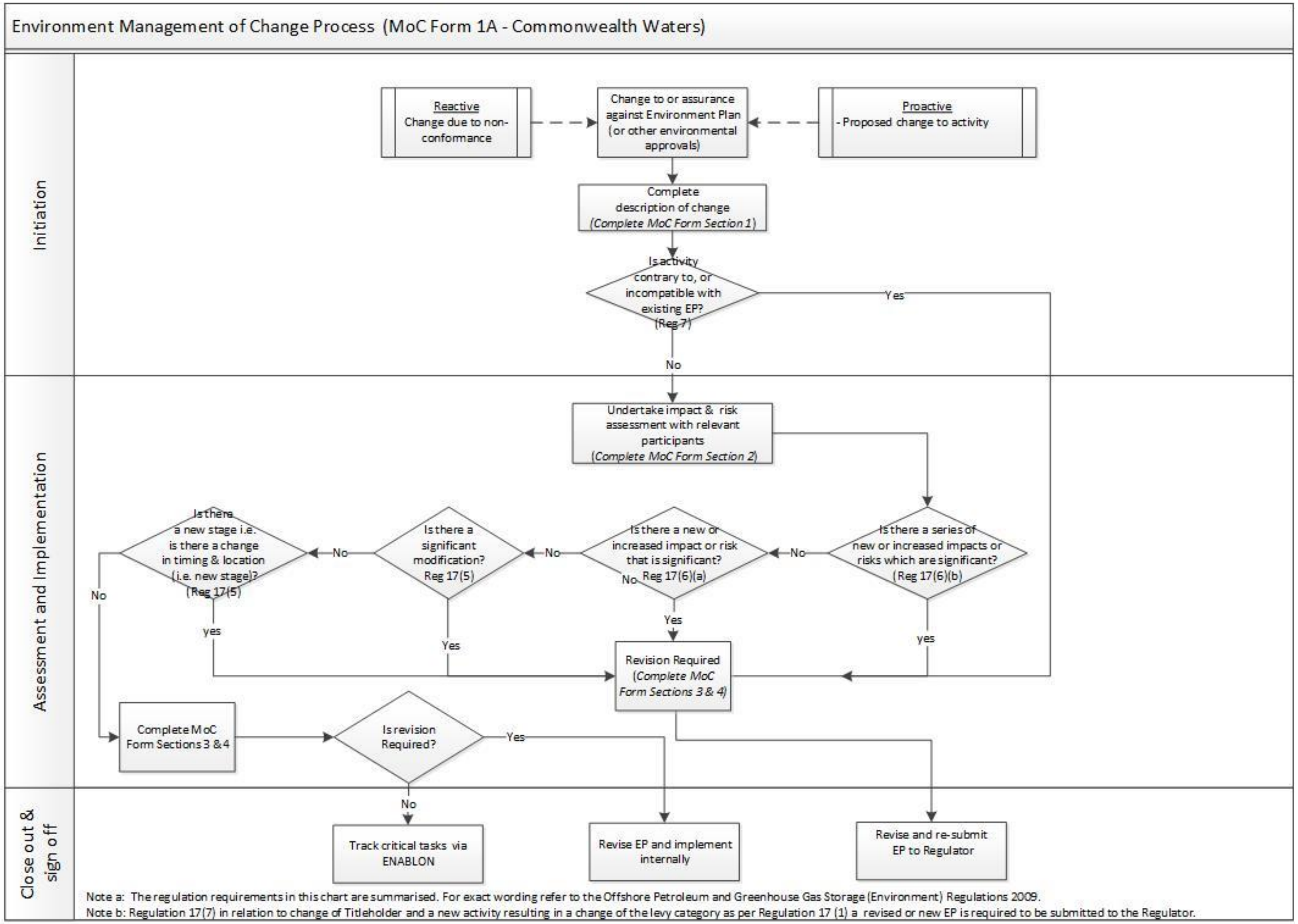


Figure 8-2: Environment Management of Change Process

8.11.3 Reviews

This EP includes an assessment of impacts and risks across the operational area during any time of the year for planned and unplanned events given the nature of the 24/7 operations.

It is recognised that the following may change over the term of the EP:

+ Legislation;
+ Businesses conditions, activities, systems, processes and people;
+ Industry practices;
+ Science and technology; and
+ Societal and stakeholder expectations.

To ensure that Santos WA maintains up to date knowledge of the industry, legislation and conservation advice, the following tasks are undertaken:

+ Maintaining membership of APPEA, which provides a mechanism for communicating potential changes in legislation, industry practice and other issues that may affect EP implementation to relevant personnel in Santos WA;
+ Undertaking annual spill response exercises to check spill response arrangements and capability are adequate;
+ Identifying stakeholders prior to any activity commencing under this EP via the mechanisms outlined in **Section 4.2**;
+ A review of the values and sensitivities within the EMBA which includes completing a new EPBC Protected Matters Search, reviewing **Appendix B** against relevant legislation to capture and review any relevant updates and incorporate as required, and reviewing any recently known published relevant scientific papers;
+ Subscription to NOPSEMA's "The Regulator" issued quarterly;
+ Subscriptions to various regulator updates; and
+ Regular liaison meetings with regulators.

Through maintenance of up to date knowledge (**Section 8.11**), these changes are identified. If the changes have an impact on the activity or risks described and assessed in this EP, the EP will be reviewed and any changes required documented in accordance with Santos WA's MoC procedure (**Section 8.11.2**).

8.12 Audits and Inspections

OPGGS(E)R 2009 Requirements
Regulation 14(6)
The implementation strategy must provide for sufficient monitoring, recording, audit, management of nonconformance and review of the titleholder's environmental performance and the implementation strategy to ensure that the environmental performance outcomes and standards in the environment plan are being met.

8.12.1 Audits

Santos WA audit plans and schedules are reviewed and updated at the beginning of each calendar year and cover all Santos WA facilities and activities. Santos WA's audit schedule may be amended to accommodate operational priorities, activity risk, personnel availability or high audit demand during certain periods (e.g., regulatory audits, contractor audits).

Audits will be undertaken in a manner consistent with Santos WA's Assurance Standard (QE-91-ZF-100073).

Audit scope typically includes a selection of control measures and environmental performance standards and outcomes. However, audits may also include other parts of the EP.

Audits findings may include opportunities for improvement and non-conformances. Audit non-conformances are managed as described in **Section 8.12.3**.

8.12.2 Inspections

During an activity, HSE inspections will be conducted to identify hazards, incidents and EP non-conformances to check compliance against all of the environmental performance outcomes and standards of this EP (**Table 8-3**). Any in-field opportunities for improvement or corrective actions will be discussed during the inspection with the work area supervisor and/or crew. Inspection reports will be distributed for review to Santos WA relevant personnel (e.g., Operations Superintendent, Santos WA on-board representatives), and HSE Department representatives.

8.12.3 Non-Conformance Management

EP non-conformances will be addressed and resolved by a systematic corrective action process as outlined in Santos WA's Assurance Standard (QE-91-ZF-10007). Non-conformances arising from audits and inspections will be entered into Santos WA's incident and action tracking management system (i.e., 'Enablon'). Once entered, corrective actions, time frames and responsible persons will be assigned. Corrective action 'close out' will be monitored using a management escalation process.

8.12.4 Continuous Improvement

For this EP, continuous improvement will be driven the list below and may result in a review of the EP with changes applied in accordance with **Section 8.11.2**:

+ Improvements identified from the review of business-level HSE key performance indicators;
+ Actions arising from Santos WA and departmental HSE improvement plans;
+ Corrective actions and feedback from HSE audits and inspections, incident investigations and after-action reviews;
+ Opportunities for improvement and changes identified during pre-activity reviews and MoC documents;
+ Actions taken to address concerns and issues raised during the ongoing stakeholder consultation process (**Section 4**); and
+ Identified continuous improvement opportunities assessed in accordance with the MoC process (**Section 8.11.2**) to ensure any potential changes to this EP or OPEP are managed in accordance with the OPGGS(E) Regulations 2009 and in a controlled manner.

9 References

AEL (2011a). Devil Creek Gas Plant Operations Environment Plan, Document No. DC-40-RI-021, prepared by AEL., September 2011.

AEL (2011b). Reindeer Wellhead Platform Safety Case: Part 2 – Facility Description, Document No. RE-02-RF-029.02 Rev 4, prepared by AEL, September 2011.

AES (2006). Turtle nest survey at 40 Mile Beach Field Visit Report. Report prepared by Astron Environmental Services for Apache Energy Limited.

AFMA (2011). Australian Fisheries Management Authority Annual Report 2010/2011. Australian Government, Canberra, Australia.

AHC (2008). Register of the National Estate. Australian Heritage Council.

AMOSC (2011). Oil pollution emergency plan: guidelines for the Australian marine petroleum exploration and production industry. Prepared by the Australian Marine Oil Spill Centre, November 2011.

Amoser, S. and Ladich, F. (2005). Are hearing sensitivities of freshwater fish adapted to the ambient noise in their habitats? Journal of Experimental Biology, vol. 208, pp. 3533-3542.

AMSA (2012). Commercial shipping advice provided through consultation.

AMSA (2013). Technical Guideline for the Preparation of Marine Pollution Contingency Plans for Marine and Coastal Facilities. A WWW publication accessed at http://www.amsa.gov.au/forms-and-publications/Publications/AMSA413_Contingency_Planning_Guidelines.pdf in August 2013. Australian Maritime Safety Authority, Canberra, ACT.

AMSA (2019). National Plan for Maritime Environmental Emergencies. Australian Maritime Safety Authority, Braddon, ACT.

APASA (2011). Reindeer Development – Blowout Spill Risk Assessment. Report prepared by Asia-Pacific Applied Science Associates (APASA) for AEL. J0104. Rev 1, May 2011.

APASA (2013). Quantitative Hydrocarbon Spill Modelling Report for Reindeer/Devil Creek Development. Report prepared for AEL, December 2013

APASA (2014). Reindeer – Devil Creek Quantitative Oil Spill Risk Assessment. Report prepared by Asia-Pacific Applied Science Associates (APASA) for AEL. J0280. January 2014.

APPEA (2004). Seismic and the Marine Environment. Australian Petroleum Production and Exploration Association Ltd. Canberra.

APPEA (2008). Code of Environmental Practice. Australian Petroleum Production and Exploration Association. Canberra.

Aurand, D. and Coelho, G. (Eds.) (2005). Cooperative Aquatic Toxicity Testing of Dispersed Oil and the "Chemical Response to Oil Spills: Ecological Effects Research Forum (CROSERF)." Ecosystem Management & Associates, Inc.,Technical Report 07e03. Ecosystem Management & Associates, Inc., Lusby, Maryland.

Australian Government (2009). National Biofouling Management Guidance for the Petroleum Production and Exploration Industry. The National System for the Prevention and Management of Marine Pest Incursions. Canberra, ACT.

Bancroft, K.P. (2003). A standardised classification scheme for the mapping of shallow-water marine habitats in Western Australia. Marine Conservation Branch, Department of Conservation and Land Management, Report MCB-05/2003. Fremantle, Western Australia.

Bancroft, K.P. and Davidson, J.A. (2001). Field survey of the macroalgal distributions in Ningaloo Marine Park (17–23 February 2001). Department of Conservation and Land Management, Marine Conservation Branch, Fremantle. Department of Conservation and Land Management, Western Australia, Marine Conservation Branch, Field Programme Report.

Bannister, J.L., Kemper, C.M. and Warneke, R.M. (1996). The Action Plan for Australian Cetaceans. [Online]. Canberra: Australian Nature Conservation Agency. Available from: http://www.environment.gov.au/coasts/publications/cetaceans-action-plan/pubs/whaleplan.pdf.

Bannister, J.L. and Hedley, S.L. (2001). Southern Hemisphere Group IV humpback whales: their status from recent aerial surveys. Memoirs of the Queensland Museum, vol. 47, Issue 2, pp. 587–598.

Barrett, G., Silcocks, A., Poulter, R., Barry, S. and Cunningham, R. (2003). Australian bird atlas 1998-2001: Main report to Environment Australia. Birds Australia, Melbourne.

Barron, M.G., Carls, M.G., Heintz, R., and Rice, S.D. (2004). Evaluation of fish early life-stage toxicity models of chronic embryonic exposures to complex polycyclic aromatic hydrocarbon mixtures. Toxicological Sciences, 78(1), 60-67.

Bartol, M.S. and Musick, J.A. (2003). Sensory biology of sea turtles. In: Lutz, P.L., Musick, J.A., Wyneken, J. (eds) Biology of sea turtles, Vol II. CRC Press, Boca Raton, FL, p. 79-102.

BBG (1994). Dampier Port Authority, Environmental Management Plan. Report prepared by Bowman Bishaw Gorham Perth, for the Dampier Port Authority, Dampier.

BHPB (2005). Pyrenees Development: Draft Environmental Impact Statement. BHP Billiton, Perth, Western Australia.

Blaber, S.J.M., Young, J.W. and Dunning, M.C. (1985). Community structure and zoogeographic affinities of the coastal fishes of the Dampier region of north-western Australia. Australian Journal of Marine and Freshwater Research 36(2): 247–266.

Blakers, M., Davies, S.J.J.F. and Reilly, P.N. (1984). The atlas of Australian birds, Melbourne University Press, Melbourne.

BoM (2013). Climatology of Tropical Cyclones in Western Australia. Bureau of Meteorology, Canberra, ACT. Available at http://www.bom.gov.au/cyclone/climatology/wa.shtml [Accessed 31 July 2013].

Borrell, A., Aguilar, A., Gazo, M., Kumarran, R.P., and Cardona, L. (2011). Stable isotope profiles in whale shark (Rhincodon typus) suggest segregation and dissimilarities in the diet depending on sex and size. Environmental biology of fishes, 92(4), 559-567.

Bradshaw, C.J.A., Meekan, M.G., Press, M., McLean, C., Richards, A., Quasnichka, S. and Taylor, J.G. (2006). Population size and structure of whale sharks Rhincodon typus at Ningaloo Reef, Western Australia, Marine Ecology Progress Series, vol. 319, pp. 275–285.

Branch, T.A., Stafford, K.M., Palacios, D.M., Allison, C., Bannister, J.L., Burton, C.L.K., Cabrera, E., Carlson, C.A., Galletti Vernazzani, B., Gill, P.C., Hucke-Gaete, R., Jenner, K.C.S., Jenner, M.N.M., Matsuoka, K., Mikhalev, Y.A., Miyashita, T., Morrice, M.G., Nishiwaki, S., Sturrock, V.J., Tormosov, D., Anderson, R.C., Baker, A.N., Best, P.B., Borsa, P., Brownell Jr, R.L., Childerhouse, S., Findlay K.P., Gerrodette, T., Ilangakoon, A.D., Joergensen, M., Kahn, B., Ljungblad, D.K., Maughan, B., McCauley, R.D., McKay, S., Norris, T.F. and Rankin, S. (2007). Past and present distribution, densities and movements of blue whales Balaenoptera musculus in the Southern Hemisphere and northern Indian Ocean. Mammal Review 37:116–175.

Burnell, S.R. (2001). Aspects of the reproductive biology, movements and site fidelity of right whales off Australia. Journal of Cetacean Research and Management (Special Issue 2). Page(s) 89-102.

Cailliet, G.M. and Mollet, H.E. (1996). Using allometry to predict body mass from linear measurements of the white shark. p. 81-90. In A.P. Klimley and D.G. Ainley (eds.) Great white sharks. The biology of Carcharodon carcharias. Academic Press, Inc., San Diego.

CALM (2004). Indicative Management Plan for the Proposed Montebello/Barrow Islands Marine Conservation Reserves, 2004. Marine Conservation Branch, Department of Conservation and Land Management.

CALM (2005). Indicative Management Plan for the Proposed Dampier Archipelago Marine Park and Cape Preston Marine Management Area. Department of Conservation and Land Management, Perth, Western Australia.

CALM and MPRA (2005). Management Plan for the Ningaloo Marine Park and Muiron Islands Marine Management Area 2005-2015. Management Plan No. 52. Department of Conservation and Land Management and Marine Parks and Reserves Authority.

Chen, C.T., Liu, K.M. and Joung, S.L. (1997). Preliminary Report on Taiwan's Whale Shark fishery. TRAFFIC Bulletin, 17(1). Pp 53-57.

Chevron Australia (2005). Environmental Impact Statement/Environmental Review and Management Programme for the proposed Gorgon Development. Chevron Australia Pty Ltd, Perth, Western Australia.

Chevron Australia (2008). Gorgon Gas Development Revised and Expanded Proposal Public Environmental Review Operated by Chevron Australia in joint venture with Gorgon Project. EPBC Referral 2008/4178 Assessment No. 1727. Chevron Australia Pty Ltd, Perth, Western Australia, September 2008.

Chevron Australia (2010). Wheatstone Draft Environmental Impact Statement (EIS) and Environmental Review Management Programme (ERMP). Prepared by Chevron Australia Pty Ltd, Perth.

Chidlow, J., Gaughan, D. and McAuley, R.B. (2006). Identification of Western Australian Grey Nurse Shark final report to the Australian Government Department of the Environment and Heritage, Fisheries research report no. 155, Department of Fisheries, Western Australia.

Chittleborough, R.G. (1965). Dynamics of two populations of the humpback whale, Megaptera Novaengliae (Borowski), Australian Journal of Marine and Freshwater Research, vol.16, pp. 33-128.

CITES (2004). Thirteenth meeting of the Conference of the Parties.

Clark, J.R., Bragin, G.E., Febbo, R.J. and Letinski, D.J. (2001). Toxicity of physically and chemically dispersed oils under continuous and environmentally realistic exposure conditions: Applicability to dispersant use decisions in spill response planning. Pp. 1249– 1255 in Proceedings of the 2001 International Oil Spill Conference, Tampa, Florida. American Petroleum Institute, Washington, D.C.

Clark, E. and Nelson, D.R. (1997). Young whale sharks, Rhincodon typus, feeding on a copepod bloom near La Paz, Mexico. Environmental Biology of Fishes 50:63-73.

Compagno, L.J.V. (2001). Sharks of the world: an annotated and illustrated catalogue of shark species known to date (Vol. 2, No. 1). FAO.

Condie, S., Andrewartha, J., Mansbridge, J. and Waring, J. (2006). Modelling circulation and connectivity on Australia's North West Shelf. North West Shelf Joint Environmental Management Study: Technical Report No. 6. CSIRO Marine and Atmospheric Research, Hobart, Tasmania.

Connell, D.W. and Miller, G.J. (1981). Petroleum hydrocarbons in aquatic ecosystems - behaviour and effects of sublethal concentrations, Part 1, Critical Reviews in Environmental Control, vol. 11, pp. 37-104.

DEC (2006). Management Plan for the Montebello/Barrow Islands Marine Conservation Reserves, 2007–2017. Management Plan No. 55. Department of Environment, Perth, Western Australia.

DEC (2007). Management Plan for the Montebello/Barrow Islands Marine Conservation Reserves 2007–2017: Management Plan No. 55. Department of Environment and Conservation, Perth, Western Australia.

DEC (2012). World Heritage Areas in Western Australia. Online database for Department of Environment and Conservation. Available at http://www.dec.wa.gov.au/parks-and-recreation/key-attractions/world-heritage-areas.html [Accessed 12 June 2013].

DEH (2005). Blue, Fin and Sei Whale Recovery Plan 2005–2010. [Online]. Department of the Environment and Heritage. Canberra, Commonwealth of Australia.

DECC (2011). Review and Assessment of Underwater Sound Produced from Oil and Gas Sound Activities and Potential Reporting Requirements under the Marine Strategy Framework Directive. Genesis Oil and Gas Consultants for the Department of Energy and Climate Change, United Kingdom. July 2011.

Department of Agriculture (2011). Australian Ballast Water Management Requirements, Version 5. Canberra. A WWW publication accessed at http://www.daff.gov.au/__data/assets/pdf_file/0004/713884/ballast-water-mgmt-requirements-v5.pdf.

Department of the Environment (2013). Matters of National Environmental Significance – Significant Impact Guidelines 1.1, Environment Protection and Biodiversity Conservation Act 1999. Canberra

Department of the Environment (2014). Sonar and seismic impacts. Website accessed 14 February 2014. http://www.environment.gov.au/node/18410

DEH (2006).A guide to the Integrated Marine and Coastal Regionalisation of Australia – version 4.0 June 2006. Department of the Environment and Heritage, Commonwealth of Australia, Canberra, ACT.

DEWHA (2008). The North-west Marine Bioregional Plan: Bioregional profile: A Description of the Ecosystems, Conservation Values and Uses of the North-West Marine Region. Department of the Environment Water, Heritage and the Arts, Canberra, ACT.

DEWHA (2010). Ningaloo Coast: World Heritage Nomination. Report prepared by the Department of Environment, Water, Heritage and the Arts. Commonwealth of Australia, Canberra, January 2010.

DEWR (2007). The Humpback Whales of Eastern Australia Factsheet. Department of Environment and Water Resources, Canberra, ACT. Available at http://www.environment.gov.au/coasts/publications/pubs/eastern-humpback-whales.pdf.

DNV (2011). Final Report Assessment of the Risk of Pollution from Marine Oil Spills in Australian Ports and Waters. Report for Australian Maritime Safety Authority, Report No PP002916Rev 4, 21 October 2011.

DoE (2005). Australian National Guidelines for Whales and Dolphin Watching Department of Environment. http://www.environment.gov.au/resource/australian-national-guidelines-whale-and-dolphin-watching-2005

DoE (2015). Conservation Advice: Megaptera novaeangliae (Humpback Whale). A WWW publication accessed at http://www.environment.gov.au/biodiversity/threatened/species/pubs/38-conservation-advice-10102015.pdf on 16 June 2019. Department of Environment, Threatened Species Scientific Committee, Canberra, ACT.

DoEE (2016). Draft National Strategy for Mitigating Vessel Strike of Marine Mega-fauna. Department of Environment and Energy, Canberra, ACT.

DoF (2011). State of the Fisheries and Aquatic Resources Report 2010/11. Fletcher, W.J. and Santoro, K. (eds). Department of Fisheries. Perth. 359pp.

DoF (2012). State of the Fisheries and Aquatic Resources Report 2011/12. Fletcher, W.J. and Santoro, K. (eds). Department of Fisheries. Perth.

DoF (2013). Department of Fisheries Aquaculture website, accessed 9 August 2013 at http://www.fish.wa.gov.au/Fishing-and-Aquaculture/Aquaculture/Pages/default.aspx.

DoT (2018). Offshore Petroleum Industry Guidance Note, Marine Oil Pollution: Response and Consultation Arrangements. Department of Transport, Perth, WA.

Dunlop, J.N., Surman, C.A. and Wooller, R.D. (1995). Distribution and abundance of seabirds in the Eastern Indian Ocean: an analysis of the potential interactions with offshore petroleum industry. A report for the Australian Petroleum Production and Exploration Association and the Australian Nature Conservation Agency.

Double, M.C., Gales, N., Jenner, K.C.S. and Jenner, M.N. (2010). Satellite tracking of south-bound female humpback whales in the Kimberley region of Western Australia. Australian Marine Mammal Centre, Tasmania. September, 2010.

Environmental Protection Authority (EPA) (2006). Gorgon Gas Development, Barrow Island Nature Reserve – Chevron Australia, Report and recommendations of the Environmental Protection Authority, Bulletin 1221 June, Western Australia.

Environmental Protection Authority (EPA) (2010). Environmental Impact Assessment Guidelines – No. 5: Environmental Assessment Guideline for Protecting Marine Turtles from Light Impacts. November 2010. Environmental Protection Authority, Western Australia.

Erbe, C. (2011). Studying the effects of man-made noise on marine animals. Proceedings of the 161st Acoustical Society of America Meeting. http://www.acoustics.org/press/161st/Erbe.html

Falkner, I., Whiteway, T., Przeslawski, R. and Heap, A.D. (2009). Review of Ten Key Ecological Features (KEFs) in the North-west Marine Region. Geoscience Australia, Record 2009/13. Geoscience Australia, Canberra. 117pp.

Feng, M., Meyers, G., Pearce, A. and Wijffels, S. (2003). Annual and interannual variations of the Leeuwin Current at 32°C. Journal of Geophysical Research, Vol. 108, No. C11, doi:10.1029/2002JC001763.

Feng, M., Weller, E. and Hill, K. (2009). The Leeuwin Current. In A Marine Climate Change Impacts and Adaptation Report Card for Australia 2009 (Eds. E.S. Poloczanska, A.J. Hobday and A.J. Richardson), NCCARF Publication 05/09, ISBN 978-1-921609-03-9.

Foote, A.D., Osborne, R.W. and Hoelzel, R.A. (2004). Whale-call response to masking boat noise, Nature (London) 428, 910. http://dx.doi.org/10.1038/428910a

French, D.P. (2000). Estimation of oil toxicity using an additive toxicity model. Proceedings of the 23rd Arctic and Marine Oil Spill Program Technical Seminar, June 2000, Vancouver, British Columbia, Canada (561-600).

French-McCay, D.P. (2002). Development and Application of an Oil Spill Toxicity and Exposure Model, OilToxEx. Environmental Toxicology and Chemistry 21(10): 2080-2094.

French-McCay, D. (2009) State-of-the-Art and Research Needs for Oil Spill Impact Assessment Modelling. Proceedings of the 32nd AMOP Technical Seminar on Environmental Contamination and Response, Emergencies Science Division, Environment Canada, Ottawa, Ontario, Canada, pp. 601–653.

Fristrup, K.M., Hatch, L.T. and Clark, C.W. (2003). Variation in humpback whale (Megaptera novaeangliae) song length in relation to low-frequency sound broadcasts. Journal of the Acoustical Society of America, Vol. 113, Issue 6, June 2003.

Fugro (2011). Gavia Offshore Surveyor AUC Product Introduction. Presentation by Fugro Survey Pty Ltd to Apache Energy Ltd, 2011.

Gallaway, B.J., Martin, L.R., Howard, R.L., Boland, G.S. and Dennis, G.D. (1981). Effects on artificial reef and demersal fish and macrocrustacean communities, In: Middleditch BS (ed) Environmental Effects of Offshore Oil Production: The Buccaneer Gas and Oil Field Study. Plenum Press, Houston, Texas, USA, pp. 237–299.

Godfrey, J.S. and Ridgway, K.R. (1985). The Large-Scale Environment of the Poleward-Flowing Leeuwin Current, Western Australia: Longshore Steric Height Gradients, Wind Stresses and Geostrophic Flow. Journal of Physical Oceanography, Vol. 15, pg 481-495.

Gordon, J., Gillespie, D., Potter, J., Frantzis, A., Simmonds, M. P., Swift, R., and Tompson, D. 2004. A review of the effects of seismic surveys on marine mammals. Mar. Technol. Soc. J. 37(4): 16–34.

Guinea, M.L. and Whiting, S.D. (2005). Insights into the distribution and abundance of sea snakes at Ashmore Reef. The Beagle (Supplement 1). Pp. 199-206.

Gulec, I. and Holdway, D.A. 2000. Toxicity of crude oil and dispersed crude oil to ghost shrimp *Palaemon serenus* and larvae of Australian bass *Macquaria novemaculeata*. Environmental Toxicology, 15(2): 91-98.

Gulec, I., Leonard, B. and Holdway, D.A. 1997. Oil and Dispersed Oil Toxicity to Amphipods and Snails. Spill Science & Technology Bulletin, 4(1): 1-6.

Hart, J.L., Hagan, J. and Baker, J. (1842). Report on whaling in South Australia. Proceedings of the Royal Geographical Society of Australasia 22, 22-34.

HCWA (2008). State Register of Heritage Places. Heritage Council of Western Australia.

Hedley, S.L., Dunlop, R.A. and Bannister, J.L. (2011). Evaluation of WA humpback surveys 1999, 2005, 2008: where to from here? Project 2009/23, report to the Australian Marine Mammal Centre, Kingston.

Heyman, W., Graham, R., Kjerfve, B. and Johannes, R.E. (2001). Whale sharks Rhincodon typus aggregate to feed on fish spawn in Belize. Marine Ecology Progress Series 251:275-282.

Holloway, P.E. and Nye, H.C. (1985). Leeuwin current and wind distributions on the southern part of the Australian North West Shelf between January 1982 and July 1983. Australian Journal of Marine and Freshwater Research 36(2): 123–137.

IALA-AISM (2013). Recommendation O-139: The Marking of Man-made Offshore Structures. International Association of Marine Aids to Navigation and Lighthouse Authorities–Association Internationale de Signalisation Maritime, Saint Germain en Laye, France.

IMCA (2011). Common Marine Inspection Document. International Marine Contractors Association website, last updated 2011. http://www.imca-int.com/marine-division/cmid.aspx [Accessed: 14 March 2014].

IRCE (2002). Victoria, Little Sandy and Pedrika wells environmental monitoring programme. Prepared for AEL by IRC Environment, Perth, Western Australia.

IRCE (2003). Environmental monitoring of drilling discharges in shallow water habitats. Prepared for AEL by IRC Environment, Perth, Western Australia.

IRCE (2004). Biannual Coral Monitoring Survey 2004. Prepared for AEL by IRC Environment, Perth, Western Australia.

IRCE (2006). Biannual Macroalgae Monitoring Survey 2005. Prepared for AEL by IRC Environment, Perth, Western Australia.

IRCE (2007). Annual Marine Monitoring 2007: Lowendal and Montebello Islands Macroalgal Survey. Prepared for AEL by IRC Environment, Perth, Western Australia.

ISO (2018). AS/NZS ISO 31000:2018, Risk Management – Guidelines. International Organization for Standards, Geneva, Switzerland.

ITOPF (2011). ITOPF Members Handbook 2011/12. Prepared by the International Tanker Owners Pollution Federation Ltd. http://www.itopf.com/news-and-events/documents/itopfhandbook2011.pdf [Accessed: 2 December 2011].

IWC (2009). Country report on ship strikes: Australia. Report to the International Whaling Commission Conservation Committee. IWC/61/CC3, 1pp.

IWC (2010). Country report on ship strikes: Australia. Report to the International Whaling Commission Conservation Committee. IWC/62/CC4, 1pp.

IWC (2011). Country report on ship strikes: Australia. Report to the International Whaling Commission Conservation Committee. IWC/63/CC12, 1pp.

Jarman, S.N. and Wilson, S.G. (2004). DNA-based species identification of krill consumed by whale sharks. Journal of Fish Biology 65: 586-591.

JASCO (2013). Underwater Sound Modelling of Low Energy Geophysical Equipment Operations. JASCO Document 00600, Version 2.0. Technical report by JASCO Applied Sciences for CSA Ocean Sciences Inc.

Jenner, K.C.S., Wilson, S., Hunt, Y. and Jenner, M.N. (2002). Evidence of blue whale feeding in the Perth Canyon, Western Australia. Unpublished note.

Koops, W., Jak, R.G., van der Veen, D.P.C. (2004). Use of dispersants in oil spill response to minimize environmental damage to birds and aquatic organisms. Interspill 2004, June 2004, Trondheim, Norway (Presentation 429).

Last, P.R. and Stevens, J.D. (2009). Sharks and Rays of Australia (Second Edition). Collingwood, Victoria: CSIRO Publishing.

LDM (1994). Harriet Oil and Gas Fields Development Marine Management and Monitoring Programme. Prepared for AEL by LeProvost Dames and Moore, Perth, Western Australia.

LDM (1996). Appraisal drilling program for the Wonnich Field South-west of the Montebello Islands. Consultative Environmental Review. Prepared for AEL by LeProvost Dames and Moore, Report R583, Perth, Western Australia.

Leatherwood, S., Awbrey, F.T. and Thomas, A. (1982). Minke whale response to a transiting survey vessel. Report of the International Whaling Commission 32: 795–802.

LeProvost, I., Semeniuk, V. and Chalmer (1986). Harriet Oilfield Marine Biological Monitoring Programme. Environmental Description, Establishment of Baseline and Collection of First Data Set. Unpublished report to Bond Corporation Pty Ltd.

Limpus, CJ (1971). Sea turtle ocean finding behaviour. Search, vol. 2, pp. 385–387.

Limpus, C.J. and MacLachlin, N. (1994). The conservation status of the Leatherback Turtle, Dermochelys coriacea, in Australia. Proceedings of the Australian Marine Turtle Conservation Workshop, Gold Coast 14-17 November 1990. Page(s) 63-67. Edited by James, R. Queensland Department of Environment and Heritage. Canberra: ANCA.

Limpus, C.J. (2006). Marine Turtle Conservation and Gorgon Gas Development, Barrow Island, Western Australia, Report to Environmental Protection Authority and Department of Conservation and Land Management, Western Australia. 20 pp.

Limpus, C.J. (2007). A biological review of Australian marine turtle species. 5. Flatback turtle, Natator depressus (Garman). The State of Queensland. Environmental Protection Agency.

Limpus, C.J. (2008a). A biological review of Australian marine turtle species. 1. Loggerhead turtle, Caretta caretta (Linneaus). The State of Queensland. Environmental Protection Agency, Australia.

Limpus, C.J. (2008b). A biological review of Australian marine Turtles 2.Green Turtle Chelonia mydas (Linnaeus).The State of Queensland, Environmental Protection Agency, Australia.

Limpus, C.J. (2009a). A biological review of Australian marine turtle species.3. Hawksbill turtle, Eretmochelys imbricata. The State of Queensland. Environmental Protection Agency, Australia.

Limpus, C.J. (2009b). A biological review of Australian marine turtle species. 6. Leatherback turtle, Dermochelys coriacea (Vandelli). The State of Queensland. Environmental Protection Agency, Australia.

Limpus, C. and Kamrowski, R.L. (2013). Ocean-finding in marine turtles: the importance of the low horizon elevation as an orientation cue. Behaviour, Vol. 150, issue 8.

Lindquist, D.C., Shaw, R.F. and Hernandez Jr, F.J. (2005). Distribution patterns of larval and juvenile fishes at off shore petroleum platforms in the north central Gulf of Mexico. Estuarine, Coastal and Shelf Science 62: 655-665.

Long, S.M. and Holdway, D.A., 2002. Acute toxicity of crude dispersed oil to Octopus pallidus (Hoyle, 1885) hatchlings. Water Research, 36(1): 2769-2776.

Marchant, S. and Higgins, P.J. (eds) (1990). Handbook of Australian, New Zealand and Antarctic Birds. Volume One - Ratites to Ducks. Melbourne, Victoria: Oxford University Press.

Marine Pest Sectoral Committee (2018). National Biofouling Management Guidelines for the Petroleum Production and Exploration Industry. A WWW publication accessed at https://www.marinepests.gov.au/sites/default/files/Documents/petroleum-exploration-biofouling-guidelines.pdf on 15 June 2019. Department of Agriculture and Water Resources, Canberra, ACT.

Marquenie, J., Donners, M., Poot, H., Steckel, W., de Wit, B. and Nam, A. (2008). Adapting the spectral composition of artificial lighting to safeguard the environment. Petroleum and Chemical Industry Conference Europe – Electrical and Instrumentation Applications.5th PCIC Europe. pp. 1-6.

May, R.F., Lenanton, R.C.J. and Berry, P.F. (1983). Ningaloo Marine Park: Report and Recommendations by the Marine Park Working Group. Report 1. National Parks Authority, Perth.

McAuley, R. (2004). Western Australian Grey Nurse Shark Pop Up Archival Tag Project. Final Report to Department of Environment and Heritage.

McCauley, R.D. (1994). The environmental implications of offshore oil and gas development in Australia – seismic surveys. In: Swan, J. M., Neff, J. M. and Young, P. C. (eds.), Environmental Implications of Offshore Oil and Gas Development in Australia.

McCauley, R.D. (1998). Radiated underwater noise measured from the drilling rig Ocean General, rig tenders Pacific Ariki and Pacific Frontier, fishing vessel Reef Venture and natural sources in the Timor Sea, Northern Australia. Report to Shell Australia.

McCauley, R.D., Fewtrell, J., Duncan, A.J. and Adhitya, A. (2002). Behavioural, physiological and pathological responses of fishes to air-gun noise. Bioacoustics, the International Journal of Animals Sound and its Recording. 12, 318-321.

McCauley, R.D. and Salgado-Kent, C. (2008). Sea Noise Logger Deployment 2006–2008 Scott Reef – Whales, Fish and Seismic Surveys. Report for URS/Woodside Energy by Centre for Marine Science and Technology (CMST). Project CMST 639–2 and 688. Report No. R2008-36. Unpublished report for Woodside.

McCauley, R., Bannister, J., Burton, C., Jenner, C., Rennie, S. and Salgado-Kent, C. (2004). Western Australian Exercise Area Blue Whale Project. Final summary report, Milestone 6. Report produced for Australian Defence.

McCauley, R.D. (2011). Woodside Kimberley sea noise logger program, Sept-2006 to June-2009: Whales, fish and man-made noise. Report produced for Woodside Energy Ltd, 86 pp.

McCook, L.J., Klumpp, D.W. and McKinon, A.D. (1995). Seagrass communities in Exmouth Gulf, Western Australia. A preliminary survey. Journal of the Royal Society of Western Australia 78: 81–87.

Meekan, M.G., Wilson, S.G., Halford, A. and Retzel, A. (2001). A comparison of catches of fishes and invertebrates by two light trap designs, in tropical NW Australia. Marine Biology. Vol 139, pg. 373–381.

Meekan, M.G., Bradshaw, C.J.A., Press, M., McLean, C., Richards, A., Quasnichka, S. and Taylor, J.A. (2006). Population size and structure of whale sharks (Rhincodon typus) at Ningaloo Reef, Western Australia. Marine Ecology Progress Series 319: 275-285.

Meekan, M.G., Jarman, S.N., McLean, C. and Schultz, M.B. (2009). DNA evidence of whale sharks (Rhincodon typus) feeding on red crab (*Gecarcoidea natalis*) larvae at Christmas Island, Australia. Marine and Freshwater Research. 60:607-609.

Milicich, M.J., Meekan, M.G. and Doherty, P.J. (1992). Larval supply: a good predictor of recruitment of three species of reef fish (*Pomacentridae*). Marine Ecology Progress Series. Vol. 86: 153-166.

MMC (2007). Marine Mammals and Noise: A Sound Approach to Research and Management. A report to Congress from the Marine Mammal Commission, March 2007.

National Marine Fisheries Service (NMFS) (2001). Fisheries Statistics and Economics Division, Silver Spring, MD.

NOAA (2001). Toxicity of oil to Reef-Building Corals: A Spill Response Perspective. National Oceanic and Atmospheric Administration. U.S. Department of Commerce. Gary Shigenaka, Seattle, Washington.

Norman, B. (2005). Rhincodon typus. In: IUCN 2012. IUCN Red List of Threatened Species. Version 2012.2. <www.iucnredlist.org>. Downloaded on 21 December 2012.

Norwegian Geotechnical Institute Pty Ltd (NGI), 2018. Corvus-2 Drilling Campaign: Desktop Study for Jack-Up Performance. Prepared for Quadrant Energy.

NRC (2003). Ocean Noise and Marine Mammals, Summary Review for the National Academies, National Research Council, The National Academies Press, Washington DC. 208pp.

NRC (2005). Oil Spill Dispersants: Efficacy and Effects. National Research Council, Washington DC.

NRDAMCME (1997). The CERCLA Type A Natural Resource Damage Assessment Model for Coastal and Marine Environments (NRDAMCME) Technical Documentation Vol 4, 14–42. A WWW publication accessed at http://www/doi.gov/oepc/oepcbb.html. US Department of Interior, Washington, D.C.

Olsen, K. (1990) Fish behaviour and acoustic sampling. Raupp.P-v.Reun.Cons. int. Explor. Mer 189: 147-158.

OSPAR Commission (2009). Overview of the impacts of anthropogenic underwater sound in the marine environment. Biodiversity Series, http://qsr2010.ospar.org/media/assessments/p00441_Noise_background_document.pdf

Otway, N.M. and Parker, P.C. (2000). The Biology, Ecology, Distribution, Abundance and Identification of Marine Protected Areas for the Conservation of Threatened Grey Nurse Sharks in South-east Australian Waters. NSW Fisheries Office of Conservation.

Pace, C.B., Clark, J.R. and Bragin, G.E. (1995). Comparing crude oil toxicity under standard and environmentally realistic exposures. Proceedings, 1995 International Oil Spill Conference. American Petroleum Institute, Washington, D.C., 13 p.

Pendoley, K.L. (2005). Sea Turtles and the Environmental Management of Industrial Activities in North West Western Australia, PhD Thesis, Murdoch University, Australia. 310pp.

Pendoley, K. (2007). Sea Turtle nesting site survey of Forty Mile Beach, report prepared for Apache Energy Limited.

Pendoley, K. (2009). Marine Turtle Beach survey Forty Mile Beach, North East and South West Regnard Islands, report prepared for Apache Energy Limited.

Peverell, S. (2007). Dwarf Sawfish Pristis clavata. Marine Education Society of Australasia website. [Online]. Available at: http://www.mesa.edu.au/seaweek2008/info_sheet05.pdf [Accessed 24 September 2013].

Pogonoski, J.J., Pollard, D.A. and Paxton, J.R (2002). Conservation Overview and Action Plan for Australian Threatened and Potentially Threatened Marine and Estuarine Fishes, Environment Australia, Canberra.

Pollard, D.A., Lincoln-Smith, M.P., and Smith, A. (1996). The biology and conservation status of the grey nurse shark (Carcharias taurus, Rafinesque 1810) in New South Wales, Australia. Aq. Conserv. 6, 1-20.

Prince, R.I.T. (1994). Status of the Western Australian Marine Turtle Populations: The Western Australian Marine Turtle Project 1986–1990. Report prepared for the Queensland Department of Environment and Heritage and Australian Nature Conservation Agency.

Reid, T.A., Hindell, M.A., Eades, D.W. and Newman, M. (2002). Seabird Atlas of South-east Australian Waters. Royal Australasian Ornithologists Union Monograph 4. Melbourne, Victoria: Birds Australia.

Richardson, W.J. and Malme, C.I. (1993). Man-made noise and behavioural responses. In: Bruns, J. J., Montague, J. J. and Cowles, C. J. (eds), The Bowhead Whale. Spec. Publ. 2, Soc Mar. Mamm., Lawrence, KS, pp. 631.

Richardson, W.J., Fraker, M.A., Würsig, B. and Wells, R.S. (1985). Behavior of bowhead whales, *Balaena mysticetus*, summering in the Beaufort Sea: Reactions to industrial activities. Biological Conservation, 32(3), 195-230.Richardson, W.J., Greene, Jnr. C.R., Malme, C.I. and Thomson, D.H. (1995) Marine Mammals and Noise. Academic Press, California.

Rogers, M. J., and the Rarities Committee (2005). Report on rare birds in Great Britain in 2004. Brit. Birds 98: 628–694.

RPS BBG (2005). Gudrun-2, Bambra-5, Bambra-6 Post-drilling seabed survey. Report to AEL, October 2005.

RPS (2008). Marine Baseline Studies - Apache Devil Creek Development Project, report prepared for Apache Energy Limited.

RPS (2010). Marine Mammals Technical Report. Technical Appendix O12 for the Wheatstone Project EIS/ERMP. Unpublished report by RPS for Chevron Australia, May 2010.

Rudnick, D.L., Davis, R.E., Eriksen, C.C., Fratantoni, D.M. and Perry, M.J. (2004). Underwater Gliders for Ocean Research. Marine Technology Society Journal, Vol. 38, No. 1, Spring 2004. http://auvac.com/uploads/publication_pdf/mts_glider.pdf

Sainsbury, K.J., Kailola, R.J. and Leyland, G.G. (1985). Continental Shelf Fishes of Northern and Northwestern Australia. An Illustrated Guide. John Wiley and Sons, London.

Salmon, M. and Wyneken, J. (1994). Orientation by hatchling sea turtles: mechanisms and implications. Herpetological Natural History, vol. 2, pp. 13–24.

Santos WA (2019). RE-02-RI-10002 Reindeer blowout modelling Technical File Note Rev 0 (Reissued 15 Mar 2019). Santos WA Northwest Pty Ltd, Perth, WA.

Semeniuk, V. (1997). Selection of Mangrove Stands for Conservation in the Pilbara Region of Western Australia – a Discussion 30th June 1997 (updated 28th July 1997). Unpublished report to the Department of Resources Development. V & C Semeniuk Research Group, Perth.

SEWPaC (2011a). The Ningaloo Coast, Western Australia. Online database for Department of Sustainability, Environment, Water, Population and Communities. Available at http://environment.gov.au/heritage/places/world/ningaloo/values.html [Accessed 13 August 2013].

SEWPaC (2011b). National Heritage Places List. Online database for the Department of Sustainability, Environment, Water, Population and Communities. Available at http://www.environment.gov.au/heritage/places/national/index.html [Accessed 20 August 2013]

SEWPaC (2012). The North-west Marine Region Bioregional Plan – Bioregional Profile. Department of Sustainability, Environment, Water, Populations and Communities, Canberra, Australia.

SEWPaC (2013a). Balaenoptera musculus – Blue whale. . Department of Sustainability, Environment, Water, Population and Communities online database. Available at http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=36 [Accessed 24 September 2013].

SEWPaC (2013b). Eubalaena australis – Southern Right Whale. Department of Sustainability, Environment, Water, Population and Communities online database. Available at http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=40 [Accessed 24 September 2013].

SEWPaC (2013c). Carcharodon carcharias – Great White Shark. Department of Sustainability, Environment, Water, Population and Communities online database. Available at http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=64470 [Accessed 24 September 2013].

SEWPaC (2013d). Australian Heritage Database. Ningaloo Marine Area - Commonwealth Waters, Ningaloo, WA, Australia. Department of Sustainability, Environment, Water, Population and Communities. Available at http://www.environment.gov.au/cgi-bin/ahdb/search.pl?mode=place_detail;search=state%3DWA%3Blist_code%3DCHL%3Blegal_status

%3D35%3Bkeyword_PD%3D0%3Bkeyword_SS%3D0%3Bkeyword_PH%3D0;place_id=105548 [Accessed 20 August 2013].

SEWPaC (2013e). Australian National Shipwreck Database. Online database for the Department of Sustainability, Environment, Water, Population and Communities. Available at https://apps5a.ris.environment.gov.au/shipwreck/public/wreck/searchSubmit.do [Accessed on 20 August 2013].

Shaw, R.F., Lindquist, D.C., Benfield, M.C., Farooqi, T. and Plunket, J.T. (2002) Offshore petroleum platforms: functional significance for larval fish across longitudinal and latitudinal gradients. Prepared by the Coastal Fisheries Institute, Louisiana State University. U.S. Department of the Interior, Minerals Management Service, Gulf of Mexico OCS Region, New Orleans, LA. OCS Study MMS 2002-077, p. 107.

Simmonds, M., Dolman, S. and Weilgart, L. (eds) (2004). Oceans of noise. A Whale and Dolphin Society Science Report, Chippenham, UK. 169pp.

Smith, R.L., Huyer, A., Godfrey, J.S. and Church, J.A. (1991). The Leeuwin Current of Western Australia, 1986-1987. Journal of Physical Oceanography, Vol. 21, pg 323-345.

Southall, B.L., Schusterman, R.J., Kastak, D. and Kastak, C.R. (2004). Underwater hearing thresholds in pinnipeds measured over a 6-year period. The Journal of the Acoustical Society of America, 116, 2504.

Southall, B.L., Bowles, A.E., Ellison, W.T., Finneran, J.J., Gentry, R.L., Greene, Jr C.R., Kastak, D., Ketten, D.R., Miller, J.H., Nachtigall, P.E., Richardson, W.J., Thomas, J.A. and Tyak, P.L. (2007). Marine mammal noise exposure criteria: initial scientific recommendations. Aquatic Mammals, vol. 33, no. 4, pp. 411-521.

SSE (1991). Normal and extreme environmental design criteria. Campbell and Sinbad locations, and Varanus Island to Mainland Pipeline. Volume 1. Prepared for Hadson Energy Limited by Steedman Science and Engineering. Report E486. March 1991.

SSE (1993). Review of oceanography of North West Shelf and Timor Sea regions pertaining to the environmental impact of the offshore oil and gas industry. Vol I prepared for Woodside Offshore Petroleum and the APPEA Review Project of Environmental Consequences of Development Related to the Petroleum Production in the Marine Environment: Review of Scientific Research, Report E1379, October 1993.

Stevens, J.D., Pillans, R.D. and Salini, J. (2005). Conservation Assessment of Glyphis sp. A (Speartooth Shark), Glyphis sp. C (Northern River Shark), *Pristis microdon* (Freshwater Sawfish) and Pristis zijsron (Green Sawfish). [Online]. Hobart, Tasmania: CSIRO Marine Research. Available from: http://www.environment.gov.au/coasts/publications/pubs/assessment-glyphis.pdf.

Storr, G.M., Smith, L.A. and Johnstone, R.E. (2002). Snakes of Western Australia. Perth: Western Australia: Western Australian Museum.

Surman, C. (2002). Survey of the marine avifauna at the Laverda-2 appraisal well (WA-271-P) Enfield Area Development and surrounding waters. Report prepared for Woodside Energy Ltd., Perth.

Swan, J.M., Neff, J.M. and Young, P.C. (Eds) (1994). Environmental Implications of Offshore Oil and Gas Development in Australia: The findings of an independent scientific review. Australian Petroleum Production Exploration Association (APPEA).

The Ecology Lab (1997). Macroalgal Habitats of the Lowendal/Montebello Island Region. Prepared for AEL, September 1997.

Thorburn, D.C., Morgan, D.L., Rowland, A.J. and Gill, H.S. (2007). Freshwater sawfish Pristis microdon Latham, 1794 (*Chondrichthyes: Pristidae*) in the Kimberley region of Western Australia. Zootaxa 1471: 27–41.

UNESCO (2013). Ningaloo Coast. United Nations Educational, Scientific and Cultural Organization. Available at http://whc.unesco.org/en/list/1369 [Accessed 20 August 2013].

URS (2009). Report Annual Marine Monitoring – Macroalgae. Report to AEL by URS, August 2009.

V & C Semeniuk Research Group (VCSRG) (1988). The Mangroves of the Lowendal Islands and Montebello Islands. Harriet Oilfield development triennial report, October 1988, 65 pp.

Veron, J.E.N. and Marsh, L.M. (1988). Hermatypic corals of Western Australia. Records and annotated species list. Records of the Western Australian Museum Supplement No. 29: 1–136.

Wahlberg, M., Jensen, F.H., Soto, N.A., Beedholm, K., Bejder, L., Oliveira, C., Simon, M., Villadsgaard, A. and Madsen, P.T (2011). Source parameters of echolocation clicks from wild bottlenose dolphins (Tursiops aduncus and Tursiops truncates), Journal of the Acoustic Society of America, Vol. 130, No. 4, October 2011.

WAM (1993). A Survey of the Marine Fauna and Habitats or the Montebellos Islands. Berry, PF (ed). A Report to the Department of Conservation and Land Management, and the Western Australian Museum.

WAOWRP (2014). Western Australian Oiled Wildlife Response Plan. Department of Parks and Wildlife, Perth, WA, and Australian Marine Oil Spill Centre Pty Ltd, Geelong, Victoria.

Weise, F.K., Montevecchi, W.A., Davoren, G.K., Huettmann, F., Diamond, A.W. and Linke, J. (2001). Seabirds at risk around offshore platforms in the North-west Atlantic. Marine Pollution Bulletin Vol. 42, No. 12, pp. 1285-1290.

Wenz, G.M. (1962). Acoustic ambient noise in the ocean: spectra and sources. J. Acoust. Soc. Am., Vol. 34, pp. 1936-1956.

Wilson, S.G., Polovina, J.J., Stewart, B.S. and Meekan, M.G. (2006). Movements of Whale Sharks (Rhincodon typus) tagged at Ningaloo Reef, Western Australia. Marine Biology. 148:1157-1166.

Witherington, B.E. and Martin, R.E. (2003). Understanding, assessing, and resolving light-pollution problems on sea turtle nesting beaches. Third Edition. Florida Marine Research Institute Technical Report TR-2: 73, St. Petersburg, Florida. 73pp.

Woodside (2008) Browse LNG Development. Torosa South-1 Pilot Appraisal Well EP. Woodside Energy Ltd., Perth.

Woodside (2010). Greater Western Flank Survey Programme Geophysical, Geotechnical, Metocean and Environmental Surveys: Environment Plan Summary. Woodside Energy Ltd, Perth, March 2010.

Appendix A: Environmental Management Policy

Environmental Management

Policy

Our commitment

We share the community's concern for the proper care and custody of our environment for present and future generations. At Santos protecting the environment and valuing cultural heritage are an integral part of the way we do business.

Our objective is to implement best environmental practices wherever practical to do so. We are committed to demonstrating leadership in environmental management and ensuring that our actions are performed in a manner which has acceptable impact on the land, sea and air.

We will comply with all applicable environmental legislation and regulations relevant to our business.

We will promote continuous improvement in energy efficiency, greenhouse gas emission reduction and innovation to reduce our carbon footprint and energy use.

Our actions

Wherever we operate we will:

+ Maintain open community and government consultation regarding our activities and our environmental performance
+ Educate, train and encourage our workforce to conduct activities in an environmentally responsible manner
+ Identify, assess and control risks to the environment and the surrounding community in order to manage the potential for unacceptable pollution and impacts
+ Develop and implement systems to manage all activities which have the potential to affect the surrounding natural environment
+ Measure our environmental performance and set targets for continual improvement; and
+ Conduct monitoring of the surrounding natural environment thereby contributing to knowledge of natural systems and enabling any impacts to be detected.

Governance

This policy has been reviewed and endorsed by the Santos WA Energy Holdings Board of Directors and management who foresee benefits in, and take responsibility for, its successful implementation.

By accepting employment with Santos, each employee and contractor acknowledges that they are responsible for the application of this policy.

K. T. Gallagher

Kevin Gallagher
Managing Director & CEO

APPROVED 28 November 2018

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Santos

Appendix B: Legislation

Commonwealth and State Legislation

Commonwealth Legislation	Summary	Relevant to activity?	Administering Authority	Relevant aspects of the activity	EP Section
Aboriginal and Torres Strait Islander Heritage Protection Act 1984	This Act provides for the preservation and protection from injury or desecration areas and objects that are of significance to Aboriginal people, under which the Minister may make a declaration to protect such areas and objects. The Act also requires the discovery of Aboriginal remains to be reported to the Minister.	Yes	Commonwealth – Department of Environment and Energy	No planned activity being undertaken on land or near shore. No known sites of Aboriginal Heritage Significance within the operational area or EMBA. May be relevant in the event of a hydrocarbon spill requiring shoreline access (e.g., shoreline clean-up).	**Section 6.7** – Spill response operations
Australian Ballast Water Requirements, Version 7	Australian Ballast Water Management Requirements outline the mandatory ballast water management requirements to reduce the risk of introducing harmful aquatic organisms into Australia's marine environment through ballast water from international vessels. These requirements are enforceable under the *Biosecurity Act 2015*.	Yes	Commonwealth – Department of Agriculture and Water Resources	Potential internationally sourced vessel operating in Australian Waters which could have the potential for introduction of Invasive Marine Species and potential ballast water exchange	**Section 7.1** – Introduction of invasive marine species
Australian Heritage Council Act 2003	This Act identifies areas of heritage value listed on the Register of the National Estate and sets up the Australian Heritage Council and its functions.	Yes	Australian Heritage Council	There are no national heritage places found on the National Heritage List, within the operational area. The Dampier Archipelago and The Ningaloo Coast national heritage places	**Section 3.2.3 –** Protected and Significant areas

Commonwealth Legislation	Summary	Relevant to activity?	Administering Authority	Relevant aspects of the activity	EP Section
				are within the regional area.	
Australian Maritime Safety Authority Act 1990 (AMSA Act)	This Act specifies that the Australian Maritime Safety Authority's (AMSA) role includes protection of the marine environment from pollution from ships and other environmental damage caused by shipping. AMSA is responsible for administering the Marine Orders in Commonwealth waters. AMSA is the spill control agency for shipping sourced spill in Commonwealth waters. Facilitates international cooperation and mutual assistance in preparing and responding to a major oil spill incident and encourages countries to develop and maintain an adequate capability to deal with oil pollution emergencies. Requirements are given effect through AMSA. AMSA is the lead agency for responding to oil spills in the marine environment and is responsible for the Australian National Plan for Maritime Environmental Emergencies.	Yes	Commonwealth - Department of Infrastructure, Regional Development and Cities	Vessel movements. Marine Orders administration. Spill control agency (in Commonwealth waters).	**Section 7.8** – Surface release of diesel
Marine Orders	Marine Orders (MO) are subordinate rules made pursuant to the Navigation Act 2012 and Protection of the Sea (Prevention of Pollution from Ships) Act	Yes	AMSA	Vessel movements, safety, discharges and emissions	**Section 6** and **7 –** planned and unplanned events

Commonwealth Legislation	Summary	Relevant to activity?	Administering Authority	Relevant aspects of the activity	EP Section
	1983 affecting the maritime industry. They are a means of implementing Australia's international maritime obligations by giving effect to international conventions in Australian law.				
Maritime Powers Act 2013	Protects the heritage values of shipwrecks and relics for shipwrecks over 75 years. It is an offence to interfere with a shipwreck covered by this Act. Available historic shipwreck locations covered by international conventions enacted by this legislation have been identified and assessed (as applicable) within this EP.	Yes	The Department of Immigration and Border Protection	No planned interaction or interference. Potential impact could be due to a hydrocarbon spill.	**Section 7.5, 7.6, 7.7, 7.8 –** unplanned hydrocarbon spills
Biosecurity Act 2015 Biosecurity Regulations 2016	This Act provides the Commonwealth with powers to take measures of quarantine, and implement related programs as are necessary, to prevent the introduction of any plant, animal, organism or matter that could contain anything that could threaten Australia's native flora and fauna or natural environment. The Commonwealth's powers include powers of entry, seizure, detention and disposal. This Act includes mandatory controls on the use of seawater as ballast in ships and the declaration of sea vessels	Yes	Commonwealth – Department of Agriculture and Water Resources	Potential internationally-sourced vessel operating in Australian Waters which could have the potential for introduction of Invasive Marine Species and potential ballast water exchange	**Section 7.1** – Introduction of invasive marine species

Commonwealth Legislation	Summary	Relevant to activity?	Administering Authority	Relevant aspects of the activity	EP Section
	voyaging out of and into Commonwealth waters. The Regulations stipulate that all information regarding the voyage of the vessel and the ballast water is declared correctly to the quarantine officers.				
Environment Protection and Biodiversity Conservation Act 1999 Environment Protection and Biodiversity Conservation Amendment Regulations 2006	A new streamlined approach for offshore petroleum and greenhouse gas activity environmental approvals came into effect on 28 February 2014. The National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) is now the sole assessor for offshore petroleum activities in Commonwealth waters. Under the new arrangements, environmental protection will be met through NOPSEMA's decision-making processes. Where activities have existing approvals under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), these will continue to apply. The Act aims to: • Protect matters of national environmental significance (MNES); • Provides for Commonwealth environmental assessment and approval processes; and	Yes	Commonwealth – Department of Environment and Energy	The activity involves: - Interaction with marine fauna (MNES which are threatened and migratory species, - Light emissions - Underwater noise - Liquid waste discharges - Operational discharges - Vessel movements - Unplanned hydrocarbon/chemical release and response activities including activities within AMPs	**Section 6.1** – Acoustic disturbance to marine fauna **Section 6.2** – Light emissions **Section 6.4** – Seabed and benthic habitat disturbance **Section 6.6 –** Operational discharges **Section 7.2 –** Marine fauna interaction **Section 7.3, 7.4, 7.5, 7.6, 7.7, 7.8** – for unplanned releases

Commonwealth Legislation	Summary	Relevant to activity?	Administering Authority	Relevant aspects of the activity	EP Section
	• Provides an integrated system for biodiversity conservation and management of protected areas.				
Environment Protection and Biodiversity Conservation Act 1999 - Proclamation – Ningaloo Marine Park (Commonwealth Waters)	The Declaration of Ningaloo Marine Park in Commonwealth Waters.	Yes	Commonwealth – Department of Environment and Energy	Unplanned hydrocarbon/chemical release	**Section 7.3, 7.4, 7.5, 7.6, 7.7, 7.8** – for unplanned releases
Historic Shipwrecks Act 1976 *Historic Shipwrecks Regulations 2018*	This Act protects shipwrecks that have lain in territorial waters for 75 years or more. It is an offence to interfere with any shipwreck covered by the Act. *Note Act and Regulations planned to be repealed on commencement of Underwater Cultural Heritage Act 2018*	Yes	Commonwealth – Department of Environment and Energy	No planned interaction or interference. Potential impact could be due to a hydrocarbon spill but the credible spill is to surface, and therefore shipwrecks are highly unlikely to be impacted. Twelve shipwrecks identified within EMBA.	**Section 7.5, 7.6, 7.7, 7.8–** unplanned hydrocarbon spills
Underwater Cultural Heritage Act 2018	This Act extends protection provided under the *Historic Shipwrecks Act 1976* to other wrecks such as submerged aircraft and human remains. It also increases penalties applicable to damaged sites. Commencement date of Act to be	Yes		No planned interaction or interference to shipwrecks. Potential impact could be due to a hydrocarbon spill but the credible spill is to surface, and therefore shipwrecks are highly unlikely to be impacted.	**Section 7.5, 7.6, 7.7, 7.8–** unplanned hydrocarbon spills

Commonwealth Legislation	Summary	Relevant to activity?	Administering Authority	Relevant aspects of the activity	EP Section
	proclaimed but will commence at latest on 24 August 2019.			Twelve shipwrecks identified within EMBA.	
National Greenhouse and Energy Reporting Act 2007	Introduces a single national reporting framework for the reporting and dissemination of information about greenhouse gas emissions, greenhouse gas projects and energy use and production of corporations.	Yes	Commonwealth – Department of Environment and Energy; and Climate Change Authority	Atmospheric emissions through combustion engine use to operate the vessels. To reduce impact of GHG emissions, Santos WA will comply with MARPOL Annex VI (Marine Orders Part 97: Marine Pollution Prevention – Air Pollution) And require the use of low sulphur fuel	**Section 6.3** – Atmospheric emissions
Maritime Legislation Amendment (Prevention of Air Pollution from Ships) Act 2007	This Act implements the requirements of MARPOL 73/78 Annex VI for shipping in Commonwealth waters.	Yes	Commonwealth, Department of Infrastructure, Regional Development and Cities	Atmospheric emissions through combustion engine use to operate the vessels. To reduce impact of GHG emissions, Santos WA will comply with MARPOL Annex VI (Marine Orders Part 97: Marine Pollution Prevention – Air Pollution) And require the use of low sulphur fuel	**Section 6.3** – Atmospheric emissions
Navigation Act 2012	An act regulating navigation and shipping including Safety of Life at Sea (SOLAS). A number of Marine Orders enacted under this Act apply directly to	Yes	Commonwealth, Department of Infrastructure, Regional	Vessel movements, marine safety and shipping movements.	**Section 6.5** – Interaction with other marine users

Commonwealth Legislation	Summary	Relevant to activity?	Administering Authority	Relevant aspects of the activity	EP Section
	offshore petroleum exploration and production activities: • Marine Orders - Part 17: Liquefied gas carriers and chemical tankers • Marine Orders - Part 21: Safety of navigation and emergency procedures • Marine Orders - Part 30: Prevention of collisions • Marine Orders - Part 47: Mobile Offshore Drilling Units • Marine Orders - Part 50: Special purpose ships • Marine Orders - Part 57: Helicopter Operations • Marine Order - Part 59: Off-shore industry vessel operations • Marine Orders - Part 60: Floating Offshore facilities		Development and Cities		
Offshore Petroleum and Greenhouse Gas Storage Act 2006 Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009	Petroleum exploration and development activities in Australia's offshore areas are subject to the environmental requirements specified in the OPGGS Act and associated Regulations. The OPGGS Act contains a broad requirement for titleholders to operate in accordance with "good oil-field practice". Specific environmental provisions relating to work practices essentially	Yes	NOPSEMA	Undertaking activity is a petroleum activity regulated by NOPSEMA. The EP is developed to meet the environment regulations	**Section 6** and **7**

Commonwealth Legislation	Summary	Relevant to activity?	Administering Authority	Relevant aspects of the activity	EP Section
	require operators to control and prevent the escape of wastes and petroleum. The Act also requires that activities are carried out in a manner that does not unduly interfere with other rights or interests, including the conservation of the resources of the sea and sea-bed, such as fishing or shipping. In some cases, where there are particular environmental sensitivities or multiple use issues it may be necessary to apply special conditions to an exploration permit area. The holder of a petroleum title must maintain adequate insurance against expenses or liabilities arising from activities in the title, including expenses relating to clean-up or other remedying of the effects of the escape of petroleum. The OPGGS Environment Regulations provide an objective based regime for the management of environmental performance for Australian offshore petroleum exploration and production activities in areas of Commonwealth jurisdiction. Key objectives of the Environment Regulations are to ensure that any petroleum activity or greenhouse gas activity carried out in an offshore area is: (a) carried out in a manner consistent with the principles of ecologically sustainable development set out in section 3A of the EPBC Act; and				

Commonwealth Legislation	Summary	Relevant to activity?	Administering Authority	Relevant aspects of the activity	EP Section
	(b) carried out in a manner by which the environmental impacts and risks of the activity will be reduced to as low as reasonably practicable; and (c) carried out in a manner by which the environmental impacts and risks of the activity will be of an acceptable level.				
Offshore Petroleum and Greenhouse Gas Storage (Environment) Amendment (Financial Assurance) Regulations 2014	Requirement for titleholders to maintain sufficient financial assurance to meet the costs, expenses and liabilities that may arise in connection with carrying out petroleum activities among other things. Under section 571(2) of the Offshore Petroleum and Greenhouse Gas Storage Act 2006, titleholders are required to have sufficient financial assurance to meet the costs, expenses and liabilities that may arise in connection with carrying out petroleum activities, particularly in the event of a major oil spill.	Yes	NOPSEMA (Regulations) DIIS (Act)	Confirmation of financial assurance	Submitted with Environment Plan submission
Ozone Protection and Synthetic Greenhouse Gas Management Act 1989	Regulates the manufacture, importation and use of ozone depleting substances (typically used in fire-fighting equipment and refrigerants). Applicable to the handling of any ozone-depleting substance.	Yes	Commonwealth - Department of Environment and Energy	No import, export or manufacture activities of ozone-depleting substances. Ozone-depleting substances are being phased out and are rarely found on a vessel's or mobile offshore drilling unit's refrigeration system.	**Section 6.3** – Atmospheric emissions

Commonwealth Legislation	Summary	Relevant to activity?	Administering Authority	Relevant aspects of the activity	EP Section
Protection of the Sea (Powers of Intervention) Act 1981 Protection of the Sea (Powers of Intervention) Regulations 1983	The Act authorises the Commonwealth to take measures for the purpose of protecting the sea from pollution by oil and other noxious substances discharged from ships and provides legal immunity for persons acting under an AMSA direction.	Yes	Commonwealth, Department of Infrastructure, Regional Development and Cities	Vessel discharges Vessel movements Only relevant to the extent that Santos WA will comply with MARPOL through the following relevant Marine Orders relating to marine pollution prevention have been put in place to give effect to relevant regulations of Annexes I, II, III, IV, V and VI of MARPOL 73/78: • Marine Orders - Part 91: Marine Pollution Prevention - Oil • Marine Orders - Part 93: Marine Pollution Prevention - Noxious Liquid Substances • Marine Orders - Part 95: Marine Pollution Prevention – Garbage • Marine Orders - Part 96: Marine Pollution Prevention – Sewage • Marine Orders - Part 98: Marine Pollution - Anti-fouling Systems	**Section 6.5** – Interaction with other marine users **Section 6.6** – Operational discharges **Section 7.3, 7.4, 7.5, 7.6, 7.7, 7.8** – for unplanned releases **Section 7.1** – Introduction of invasive marine species

Commonwealth Legislation	Summary	Relevant to activity?	Administering Authority	Relevant aspects of the activity	EP Section
Protection of the Sea (Prevention of Pollution from Ships) Act 1983 Protection of the Sea (Prevention of Pollution from Ships) (Orders) Regulations 1994	This Act relates to the protection of the sea from pollution by oil and other harmful substances discharged from ships. This Act disallows any harmful discharge of sewage, oil and noxious substances into the sea and sets the requirements for a shipboard waste management plan. The following Marine Orders relating to marine pollution prevention have been put in place to give effect to relevant regulations of Annexes I, II, III, IV, V and VI of MARPOL 73/78: • Marine Orders - Part 91: Marine Pollution Prevention - Oil • Marine Orders - Part 93: Marine Pollution Prevention - Noxious Liquid Substances • Marine Orders - Part 94: Marine Pollution Prevention - Harmful Substances in Packaged Forms • Marine Orders - Part 95: Marine Pollution Prevention – Garbage • Marine Orders - Part 96: Marine Pollution Prevention – Sewage • Marine Orders - Part 97: Marine Pollution Prevention - Air Pollution • Marine Orders - Part 98: Marine Pollution - Anti-fouling Systems	Yes	Commonwealth, Department of Infrastructure, Regional Development and Cities	Vessel discharges. Vessel movements. Only relevant to the extent that Santos WA will comply with MARPOL through the following relevant Marine Orders relating to marine pollution prevention have been put in place to give effect to relevant regulations of Annexes I, II, III, IV, V and VI of MARPOL 73/78: • Marine Orders - Part 91: Marine Pollution Prevention - Oil • Marine Orders - Part 93: Marine Pollution Prevention - Noxious Liquid Substances • Marine Orders - Part 95: Marine Pollution Prevention – Garbage • Marine Orders - Part 96: Marine Pollution Prevention – Sewage • Marine Orders - Part 98: Marine Pollution - Anti-fouling Systems	**Section 6.5** – Interaction with other marine users **Section 6.6** – Operational discharges **Section 7.3, 7.4, 7.5, 7.6, 7.7, 7.8** – for unplanned releases **Section 7.1** – Introduction of invasive marine species

Commonwealth Legislation	Summary	Relevant to activity?	Administering Authority	Relevant aspects of the activity	EP Section
Protection of the Sea (Civil Liability of Bunker Oil Pollution Damage) Act 2008	This Act implements the requirements for the International Convention on Civil Liability for Bunker Oil Pollution Damage.	Yes	Commonwealth, Department of Infrastructure, Regional Development and Cities	Refuelling may be undertaken at sea	**Section 7.4** – Hazardous liquid releases
Protection of the Sea (Harmful Antifouling Systems) Act 2006	This Act relates to the protection of the sea from the effects of harmful anti-fouling systems. It prohibits the use of harmful organotins in ant-fouling paints used on ships.	Yes	Commonwealth, Department of Infrastructure, Regional Development and Cities	Vessel movements in Australian Waters. Vessels are required to have biofouling systems in place to prevent introduction of Invasive Marine Species / Harmful Impact on Australian biodiversity.	**Section 7.1** – Introduction of invasive marine species
State Legislation					
Fish Resources Management Act 1994 Fish Resources Management Regulations 1995.	This Act establishes a framework for management of fishery resources and is the nominated lead agency responsible for implementing Western Australian marine biosecurity management requirements through implementation of the *Fish Resources Management Act 1994* (FRMA 1994) and associated regulations.	Yes	Department of Primary Industries and Regional Development (DPIRD)	Introduction of invasive marine species.	**Section 7.1** – Introduction of invasive marine species

Santos

International Agreements and Conventions

International Agreements and Conventions	Summary	Relevant to Activity?	Relevant Aspects	EP Section
1996 Protocol To The Convention On The Prevention Of Marine Pollution By Dumping Of Wastes And Other Matter, 1972.	Implemented in WA *Marine (Sea Dumping) Act* and *Environmental Protection (Sea Dumping) Act 1981.*	Yes	Sewage and wash-down water generated from the Reindeer WHP during visits; Sewage, grey water, and putrescible wastes generated from support vessels; Deck drainage/deck wash-down, cooling, brine, ballast and bilge water from support vessels; Hydraulic fluid released by valve operation on subsea infrastructure; and Various discharges from planned maintenance activities.	**Section 6.6** – Operational discharges
Agreement Between the Government of Australia and the Government of Japan for the Protection of Migratory Birds in Danger of Extinction and Their Environment 1974 (commonly referred to as the Japan Australia Migratory Bird Agreement or JAMBA)	This agreement recognises the special international concern for the protection of migratory birds and birds in danger of extinction that migrate between Australia and Japan. Implemented in EPBC Act 1999.	Yes	Only relevant in so far as the credible spill scenario may result in impact to migratory seabirds foraging in area.	**Section 7.5, 7.6, 7.7, 7.8–** unplanned hydrocarbon spills
Agreement Between the Government of Australia and the Government of the People's Republic of China for the Protection of Migratory Birds and Their Environment 1986 (commonly referred to as the	This agreement recognises the special international concern for the protection of migratory birds and birds in danger of extinction that migrate between Australia and China. Implemented in EPBC Act 1999.	Yes	Only relevant in so far as the credible spill scenario may result in impact to migratory seabirds foraging in area.	**Section 7.5, 7.6, 7.7, 7.8–** unplanned hydrocarbon spills

International Agreements and Conventions	Summary	Relevant to Activity?	Relevant Aspects	EP Section
China Australia Migratory Bird Agreement or CAMBA)				
Convention for the Control of Transboundary Movements of Hazardous Wastes and Their Disposal 1989 (Basel Convention)	This convention deals with the transboundary movement of hazardous wastes, particularly by sea. Implemented in *Hazardous Waste (Regulation of Exports and Imports) Act 1989.*	No	Activity does not involve transboundary movement of hazardous wastes.	N/A
United Nations Convention on Biological Diversity -1992	An international treaty to sustain life on earth.	Yes	Relevant only insofar as the activity may interact with MNES (threatened and migratory species) protected under the EPBC Act.	**Section 6.1** – Acoustic disturbance to marine fauna **Section 6.2** – Light emissions **Section 6.4** – Seabed and benthic habitat disturbance **Section 7.2 –** Interaction with marine fauna **Section 7.3, 7.4, 7.5, 7.6, 7.7, 7.8** – for unplanned releases
Convention on Oil Pollution Preparedness, Response and Co-operation 1990 (OPRC 90)	This convention comprises national arrangements for responding to oil pollution incidents from ships, offshore oil facilities, sea ports and oil handling. The convention recognises that in the event of pollution incident, prompt and effective action is essential.	Yes	In the event that worse-case credible spill scenarios may enact a national arrangement for response.	**Section 7.5, 7.6, 7.7, 7.8–** unplanned hydrocarbon spills **Section 6.7 –** Hydrocarbon spill response

International Agreements and Conventions	Summary	Relevant to Activity?	Relevant Aspects	EP Section
Convention on the Conservation of Migratory Species of Wild Animals 1979 (Bonn Convention)	The Bonn Convention aims to improve the status of all threatened migratory species through national action and international agreements between range states of particular groups of species.	Yes	Only relevant in so far as the credible spill scenario may result in impact to MNES protected migratory species.	**Section 7.5, 7.6, 7.7, 7.8** – Unplanned hydrocarbon spills **Section 6.7 –** Hydrocarbon spill response
International Convention for the Establishment of an International Fund for Compensation for Oil Pollution Damage (Fund 92)	This convention ensures compensation is provided for damage caused by oil pollution.	No	Relevant to oil tankers, not supply or support vessels.	N/A
International Convention for the Prevention of Pollution from Ships 1973/1978 (MARPOL 73/78)	This Convention and Protocol (together known as MARPOL 73/78) build on earlier conventions in the same area. MARPOL is concerned with operational discharges of pollutants from ships. It contains five Annexes, dealing respectively with oil, noxious liquid substances, harmful packaged substances, sewage and garbage. Detailed rules are laid out as to the extent to which (if at all) such substances can be released in different sea areas. The legislation giving effect to MARPOL in Australia is the Protection of the Sea (Prevention of Pollution from Ships) Act 1983, the Navigation Act 1912 and several Parts of Marine Orders made under this legislation.	Yes	Already dealt with through the *Protection of the Sea (Prevention of Pollution from Ships) Act 1983* – refer to legislation table above	N/A
International Convention for the Safety of Life at Sea 1974	This convention is generally regarded as the most important of all international treaties concerning	Yes	Only relevant in so far as SOLAS relates to safety aspects of the activity, such as navigation aids which reduce	**Section 6.5** – Interaction with other marine users

International Agreements and Conventions	Summary	Relevant to Activity?	Relevant Aspects	EP Section
	the safety of merchant ships Implemented in the *Air Navigation Act 1920.*		potential for vessel collision and hydrocarbon release to the environment.	
International Convention on Civil Liability for oil pollution damage (1969)	This convention provides a mechanism for ensuring the payment of compensation for oil pollution damage.	No	Relevant to oil tankers	N/A
International Convention for the Control and Management of Ships' Ballast Water and Sediments (Ballast Water Convention) 2004	The IMO has been addressing the problem of invasive marine species in ship's ballast water since the 1980s. Ballast water and sediments guidelines were adopted in 1991 and the ballast water convention was adopted in 2004. Recent accession by Finland has triggered the final entry into force of these international requirements. As a result, the International Convention for the Control and Management of Ships Ballast Water and Sediment will enter into force on 8th September 2017 (IMO Briefing 22 2016). It aims to prevent the spread of harmful aquatic organisms from one region to another, by establishing standards and procedures for the management and control of ships' ballast water and sediments. Ballast Water Management systems must be approved by the Administration in accordance with this IMO Guidelines.	Yes	Potential internationally sourced vessel operating in Australian Waters which could have the potential for introduction of Invasive Marine Species and potential ballast water exchange	**Section 7.1** – Introduction of invasive marine species

International Agreements and Conventions	Summary	Relevant to Activity?	Relevant Aspects	EP Section
United Nations Convention on the Law of the Sea (UNCLOS) (1982)	Part XII of the convention sets up a general legal framework for marine environment protection. The convention imposes obligations on State Parties to prevent, reduce and control marine pollution from the various major pollution sources, including pollution from land, from the atmosphere, from vessels and from dumping (Articles 207 to 212). Subsequent articles provide a regime for the enforcement of national marine pollution laws in the many different situations that can arise. Australia signed the agreement relating to the implementation of Part XI of the Convention in 1982, and UNCLOS in 1994.	Yes	Only relevant to the extent that Santos WA will comply with MARPOL through the following relevant Marine Orders relating to marine pollution prevention have been put in place to give effect to relevant regulations of Annexes I, II, III, IV, V and VI of MARPOL 73/78: • Marine Orders - Part 91: Marine Pollution Prevention - Oil • Marine Orders - Part 93: Marine Pollution Prevention - Noxious Liquid Substances • Marine Orders - Part 95: Marine Pollution Prevention – Garbage • Marine Orders - Part 96: Marine Pollution Prevention – Sewage • Marine Orders - Part 97: Marine Pollution Prevention - Air Pollution • Marine Orders - Part 98: Marine Pollution - Anti-fouling Systems	**Section 6.6**–Operational discharges **Section 7.3, 7.4, 7.5, 7.6, 7.7, 7.8** – for unplanned releases **Section 7.1** – Introduction of invasive marine species
United Nations Framework Convention on Climate Change (1992)	The objective of the convention is to stabilise greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous interference with the climate system. Australia ratified the convention in December 1992 and it came into force on 21 December 1993.	Yes	Only relevant in to the extent that to reduce impact of GHG emissions associated with vessel use, Santos WA will comply with MARPOL Annex VI (Marine Orders Part 97: Marine Pollution Prevention – Air Pollution) And require the use of low sulphur fuel.	**Section 6.3** – Atmospheric emissions

Appendix C: Description of the Environment

Contents

Figures

Tables

Appendices

1. Introduction

Santos WA Energy Limited (Santos WA)) is the titleholder of multiple petroleum titles for exploration, development and operational activities located in marine waters off north-western Western Australia. This document describes the existing environment that may be affected (EMBA) by these petroleum activities and includes details of the particular relevant values and sensitivities of that environment as required by the Commonwealth *Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009* and State *Western Australian Petroleum (Submerged Lands) (Environment) Regulations 2012.* This document is informed by a search of the protected matters search tool (PMST) provided by the Department of Environment and Energy (DoEE) dated 24/11/2018; provided in **Appendix A** as well as published scientific literature and studies where applicable. Descriptions of all fauna are provided, with a focus on protected species that are threatened and migratory.

1.1 Geographical Extent

The Australian 'area of interest', for the purposes of this document, includes the coastal waters and shoreline habitats of Western Australia (WA), encompassing the south west of WA in the south and the Northern Territory (NT) border in the north (**Appendix A**). This area largely approximates the Commonwealth North-west Marine Region (NWMR), the South-west Marine Region (SWMR) and the North Marine Region (NMR) (DEWHA 2008, 2008a). Based on the Integrated Marine and Coastal Regionalisation of Australia (IMCRA) Version 4.0, there are sixteen bioregions that occur which are based on fish, benthic habitat and oceanographic data (IMCRA v. 4.0). Where relevant, the physical, biological and social environments within the area of interest are discussed with reference to the IMCRA Provincial Bioregions. The provinces of most relevance (**Figure 1-1**) are:

North-west Marine Region

- Northwest Shelf Transition;
- Timor Province;
- Northwest Transition;
- Northwest Province;
- Northwest Shelf Province;
- Central Western Transition;
- Central Western Shelf Transition; and
- Central Western Shelf Province.

South-west Marine Region

- Central Western Province;
- Southwest Shelf Transition;
- Southwest Transition; and
- Southwest Shelf Province.

North Marine Region

- Northwest Shelf Transition (as above).

Other IMCRA 4.0 bioregions of interest include: Christmas Island Province.

The international waters of south west Indonesia and Timor Leste (in part) are also an area of interest and described where relevant throughout thisdocument.

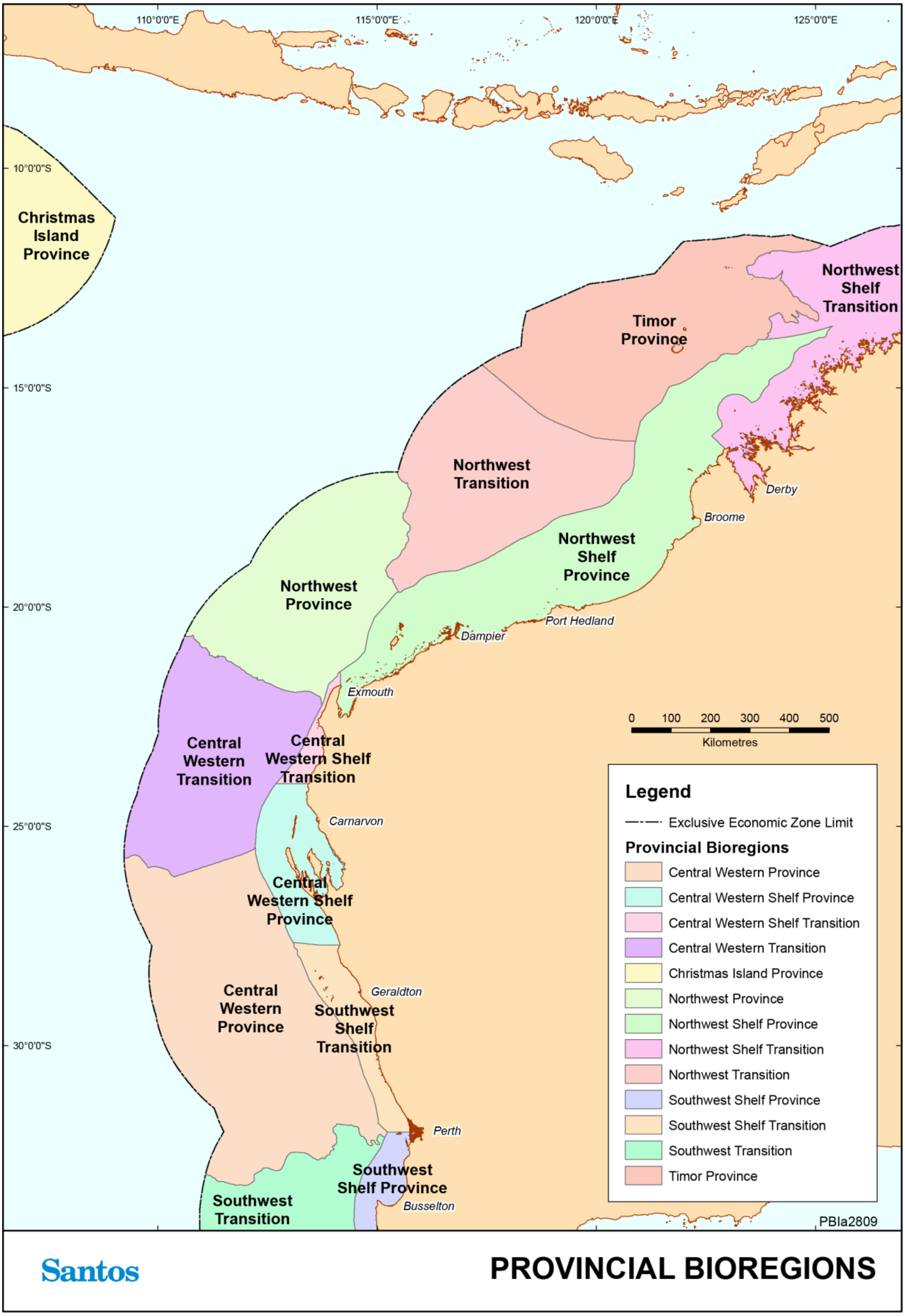


Figure 1-1: Area of interest within IMCRA 4.0 Provincial Bioregions

2. Physical Environment

2.1 Geomorphology

2.1.1 Formation History

Approximately 550–160 million years ago, the area of interest formed part of the northern margin of Gondwana. About 300 million years ago, crustal stretching, rifting and breakup initiated development of an extensive basin that became the site for deposition of sediments (Baker *et al*. 2008 in DEWHA 2008). Approximately 135 million years ago the continent broke up resulting in the separation of greater India and Australia. Ocean spreading associated with the continental break-up resulted in the creation of the Argo and Cuvier abyssal plains. Subsidence of the rifted margin resulted in the formation of the Exmouth and Scott plateaux and the Rowley Terrace. The narrow shelf south of North West Cape was formed approximately 130 million years ago as a result of the separation of India and seafloor spreading (Baker *et al*. 2008 in DEWHA 2008).

The South-west region has been relatively stable throughout its recent geological past. This has shaped a continental shelf that has high wave exposure and is punctuated with coastal features such as island groups and fringing coastal reefs providing sheltered habitats for marine communities (2008a).

2.1.2 Present Day Geological Features

The area of interest consists of four major landform features: continental shelf, continental slope, continental rise and abyssal plain. The majority of the area consists of either continental shelf or continental slope (DEWHA 2008).

Limited surveys have shown that the continental slope in the area of interest comprises diverse geological features such as canyons, plateaux, terraces, ridges, reefs, banks and shoals (Source: DEWHA (2008)) (**Figure 2-1** and **Figure 2-2**). These features are significant in that over half of the total area of banks and shoals across Australia's entire marine jurisdiction occurs in the Commonwealth waters from the South Australian border to the Northern Territory border, as well as 39% of terraces and 56% of deeps, holes and valleys (DEWHA 2008).

An important characteristic of the area of interest is the significant narrowing of the continental shelf around North West Cape from the broad continental shelf in the north (**Figure 2-3**). For example, in the Joseph Bonaparte Gulf (at the Northern Territory boundary), the continental shelf is around 400 km wide, whereas at North West Cape the shelf is only 7 km wide – the narrowest of anywhere on the Australian continental margin (DEWHA 2008). Shelf width affects oceanography with flow on effects to productivity and ecosystem functioning.

The continental shelf north of Cape Leveque is characterised by a rimmed ramp where the waters over the outer margins of the shelf (approximately 50 to 100 m waters depth) are shallower than the middle portions (up to 150 m water depth). The rim at its outer edge is the site of a number of coral reefs including Ashmore, Cartier, Scott and Seringapatam (DEWHA 2008).

The Indonesian archipelago lies between the Pacific and Indian oceans, and bridges the continents of Asia and Australia. The archipelago is divided into several shallow shelves and deep-sea basins.

2.1.3 Sediments

Terrestrial environments are not a major source of sediment in the area and terrigenous sediments tend to be confined to the inner shelf (generally less than 100 m water depth), particularly in areas adjacent to rivers. Sediments in the area generally become finer with increasing water depth, ranging from sand and gravels on the shelf to mud on the slope and abyssal plain. Joseph Bonaparte Gulf is an exception to this pattern, as sediments with high mud content extend across the inner and mid shelf within the Gulf, graduating to sands and gravels in the Bonaparte Depression.

The distribution and resuspension of sediments on the inner shelf is strongly influenced by the strength of tides across the continental shelf as well as episodic events such as cyclones. Further offshore, on the mid to outer shelf and on the slope itself, sediment movement is primarily influenced by ocean currents and internal tides. Internal tides describe the tidal movement across a slope of water stratified by marked differences in density. Internal tides cause resuspension and net down-slope deposition of sediments on the North West Shelf (DEWHA 2008).

Surveys conducted over the North West Shelf indicate that similar sediments occur extensively over this geographic region, but with spatial variation in the grain size and origin of the surface sediments.

The ecology of the southwest is also greatly influenced by the lack of river discharge into the Region. The few significant rivers adjacent to the Region flow intermittently and their overall discharge is low. The low discharge of rivers and the generally low rate of biological productivity also results in low turbidity (suspended sediments), making the waters of the Region relatively clear (McLoughlin & Young 1985). Surface sediments in the area are predominantly composed of skeletal remains of marine fauna, with lenses of weathered sands (McLoughlin & Young 1985).

Several geomorphic formations have been associated with Key Ecological Features (DEWHA 2008) and these are discussed in **Section 10**.

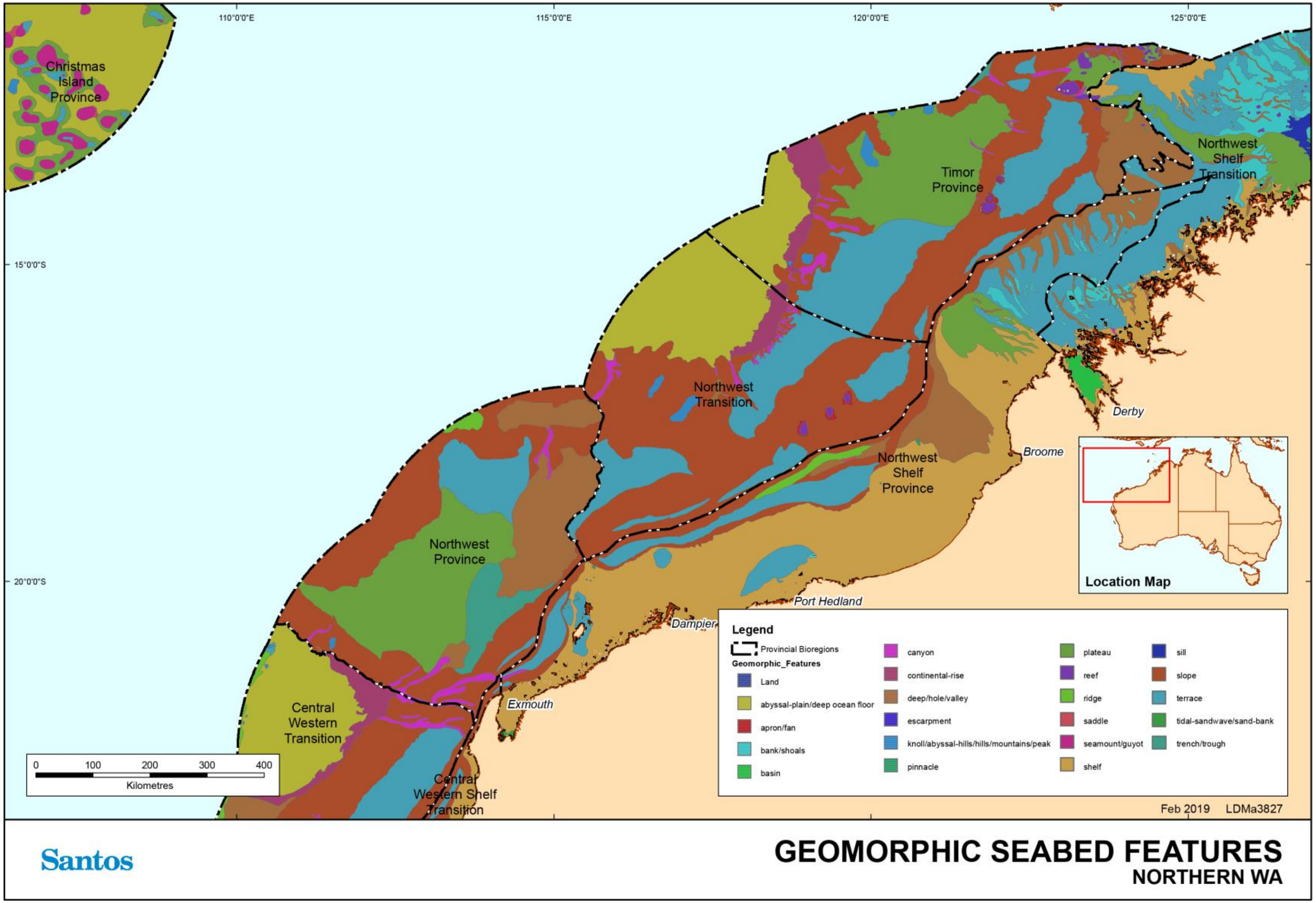


Figure 2-1: Geomorphic/seafloor features of Northern WA

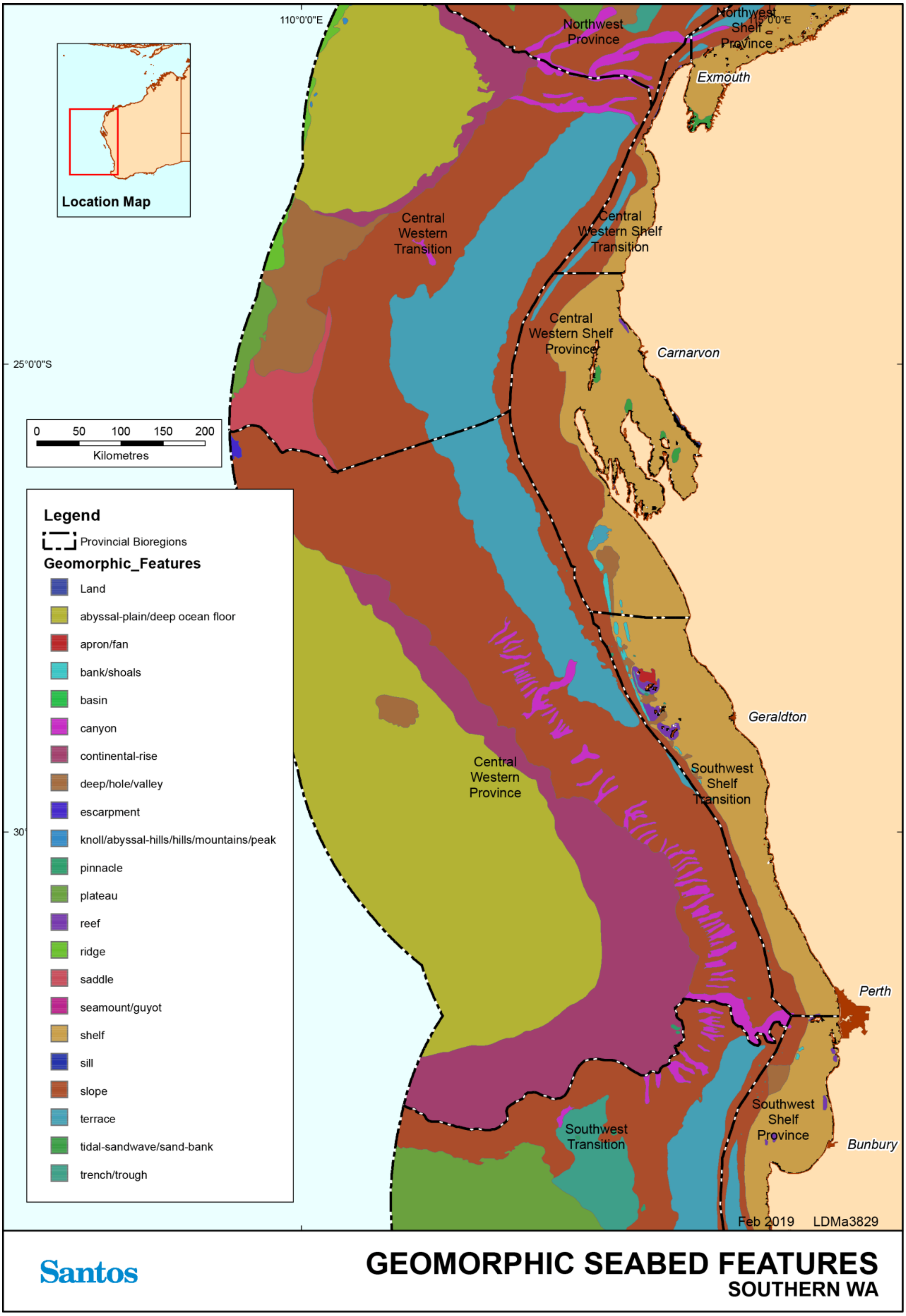


Figure 2-2: Geomorphic/seafloor features of Southern WA

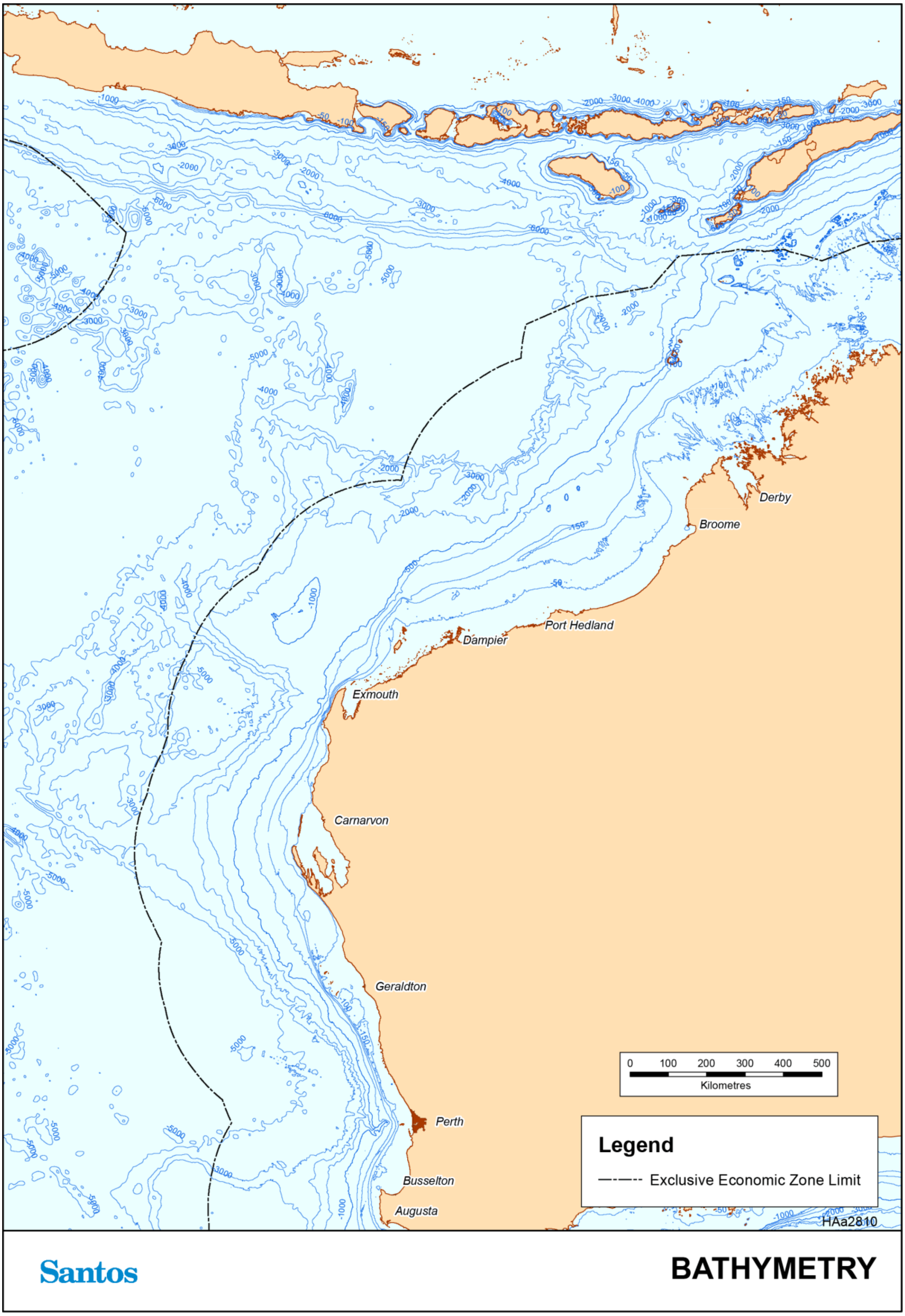


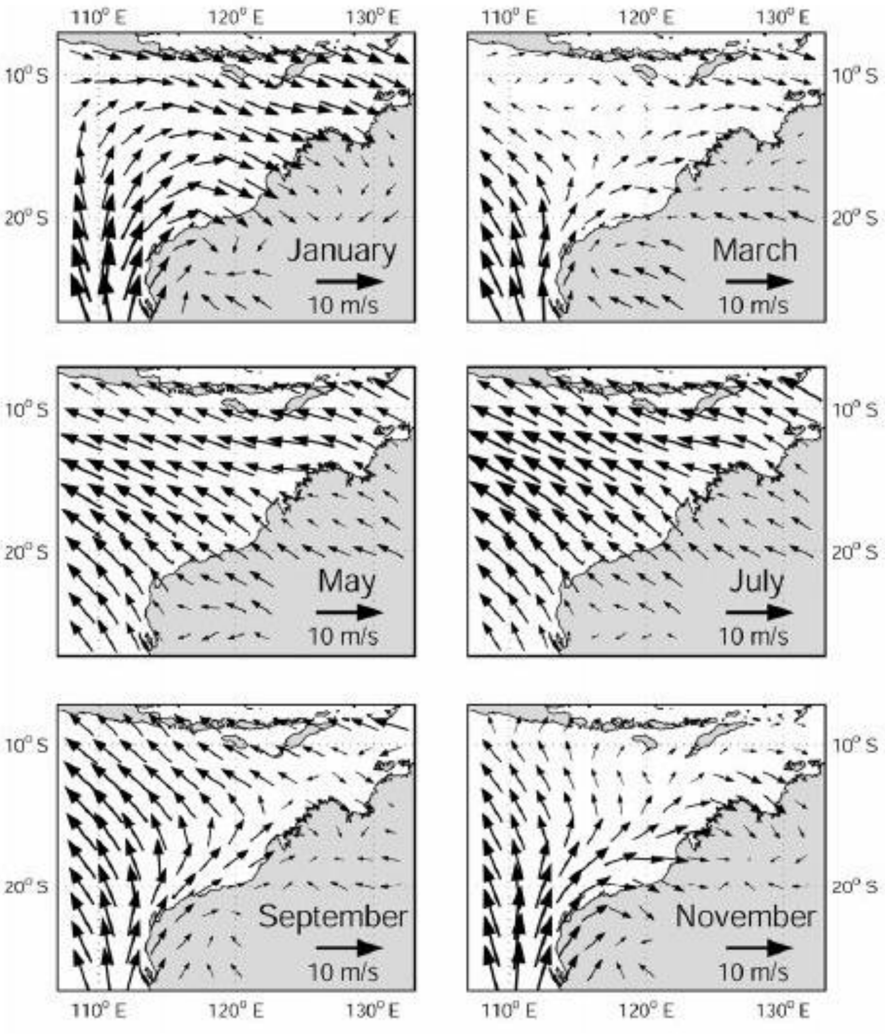
Figure 2-3: Bathymetry of area of interest

2.2 Climate

Waters in the northern extent of the area of interest predominantly lie in the arid tropics, experiencing high summer temperatures and periodic tropical cyclones in summer. Rainfall in the region is low, although intense rainfall may occur during the passage of summer tropical cyclones and thunderstorms (Condie et al. 2006). Mean air temperatures range from a minimum of 11°C in winter to a maximum of 36°C in summer (Condie et al. 2006). Due to the arid climate, daytime visibility in the area is generally greater than 5 nautical miles (SSE 1991).

The summer and winter seasons fall into the periods September–March and May–July, respectively. Winters are characterised by clear skies, fine weather, predominantly strong east to southeast winds and infrequent rain (calculated from NCEP-NCAR dataset measured from 1982 to1999; Condie et al. (2006); **Figure 2-4**).

Summer winds are more variable, with strong south-westerlies dominating. Transitional wind periods, during which either pattern may predominate, can be experienced in April–May and September of each year.



Calculated from NCEP-NCAR dataset measured from 1982 to 1999. Source: Condie *et al*. (2006)

Figure 2-4: Seasonally averaged winds at 10 m above mean sea level

Tropical cyclones generate the most significant storm conditions in the area (SSE 1993). These clockwise-spiralling storms have generated wind speeds 50–120 knots (SSE 1991). Tropical cyclones develop in the eastern Indian Ocean, and the Timor and Arafura Seas during the summer months. Three to four cyclones per year are typical, with the official cyclone season being November through to April (BoM 2013). In Indonesia, the main variable in climate is not temperature or pressure, but rainfall, which varies greatly by month and place, ranging from 997 millimetres (mm) to 4,927 mm.

The South West bioregion experiences a Mediterranean style climate that is characterised by cool, wet winters and hot, dry summers. In winter, wind patterns are characterised by a prevailing westerly wind stream. This enables winter cold fronts and strong westerly winds to regularly penetrate the south-west, with cold fronts crossing the coast every week or so. Apart from the passage of storms, typically lasting one day or less, the weather is otherwise mild in winter with winds variable and relatively weak. In summer, cold fronts rarely penetrate into the south of the state with any strength and hot easterly winds prevail.

2.3 Oceanography

Major drivers of marine ecosystems include ocean currents, tides, waves, temperature and salinity. The dominant offshore sea surface current is the Leeuwin Current (**Figure 2-5**), which carries warm tropical water south along the edge of Western Australia's continental shelf, reaching its peak strength in winter and becoming weaker and more variable in summer (Condie et al. 2006). The current is typically located seaward of the shelf break (200 m isobath) and is a narrow, surface current, extending to a depth of 150 m (BHPB 2005, Woodside 2005) and a width of 50–100 km (DEWHA 2008). The formation of meanders and eddies are also a feature of the Leeuwin Current and a number of eddies occur south of Shark Bay (DEWHA 2008). The strength of the Leeuwin Current is influenced by seasonal variability in the pressure gradient (DEWHA 2008).

The nearshore Ningaloo Current flows northwards opposite to the Leeuwin Current, along the outside of the Ningaloo Reef and across the inner shelf from September to mid-April, (BHPB 2005, Woodside 2005). The Indonesian Throughflow is the other important current influencing the upper 200 m of the outer North West Shelf (Woodside 2005). This current brings warm and relatively fresh water to the region from the western Pacific via the Indonesian Archipelago (**Figure 2-5**). Modelling undertaken by Woodside and CSIRO Marine and Atmospheric Research indicates that significant east–west flows occur across the North West Shelf to the north of the North West Cape, possibly linking water masses in the area (Woodside 2005, Condie et al. 2006).

Currents in the coastal zone and over the inner to mid-shelf are largely driven by tides and winds, whereas offshore, over the continental shelf, slope and rise are influenced by large scale regional circulation (DEWHA 2008).

Tides increase in amplitude from south to north, corresponding with the increasing width of the shelf (Holloway 1983). Tides in the area are generally semi-diurnal (i.e. two high tides and two low tides per day) with a spring/neap cycle. The northern area experiences some of the largest tides in the world. In the Kimberley, the daily tidal range is up to 10 m during spring tides and less than 3 m during some neap tides. Mid-shelf tidal currents are predicted to have average speeds of approximately 0.25 knots during neap tides and up to 0.5 knots during spring tides (NSR 1995, WNI 1995).

The wave climate in the northwest is composed of locally-generated wind waves (seas) and swells that are propagated from distant areas (WNI 1995). In summer the seas typically approach from the west and southwest, while in winter the seas typically approach from the south and east. Mean sea wave heights are typically less than 1 m and peak heights of less than 2 m are experienced in all months of the year (WNI 1995).

Indonesian waters, especially the eastern part of the archipelago, play an important role in the global water mass transport system, in which warm water at the surface conveys heat to the deeper cold water in what is known as the great ocean conveyor belt (refer **Figure 2-5**). The eastern archipelago is the only place in the Pacific Ocean that connects with the Indian Ocean at lower latitudes. The water mass transport from the Pacific to the Indian Ocean through various channels in Indonesia is called Arlindo (Arus Lintas Indonesia), also known as the Indonesian Throughflow (ADB 2014). Surface currents in

Indonesian waters are more strongly influenced by circulation from the Pacific Ocean than from the Indian Ocean. The currents are also greatly influenced by the winds of the prevailing monsoon.

Average swell heights are low, around 0.4–0.6 m in all months. The greatest exposure to swells is from the west (SSE 1993). Tropical cyclones have generated significant swell heights of up to 5 m in this area, although the predicted frequency of swells exceeding 2 m is less than 5% (WNI 1996). In the open ocean, sustained winds result in wind-forced currents of approximately 3% of the wind speed (Holloway & Nye 1985).

Tides in the South West Capes area are mixed (i.e. diurnal and semi-diurnal) and generally less than one metre, with a typical daily range of about 0.7 m during spring tides and about 0.5 m during neap tides. Tides of this magnitude produce weak currents compared to wind and wave driven flows (Hill & Ryan 2002 cited in DEC 2013).

Waters on the continental shelf are usually thermally-stratified, with a marked change in water density at approximately 20 m (SSE 1993). Surface temperatures vary annually, being warmest in March (32°C) and coolest in August (19°C). Vertical gradients are related to the seasonality of sea surface temperatures, and are greatest during the warm-water season (SSE 1991). Near-bottom water temperature on the North West Shelf is approximately 23°C, with no discernible seasonal variation.

Salinity is relatively uniform at 34–35 ppt throughout the water column and across the North West Shelf. Due to the low rainfall there is little freshwater run-off from the adjacent mainland (Blaber *et al*. 1985).

Pronounced shifts in water column characteristics can occur following the passage of tropical cyclones (McKinnon *et al*. 2003). Changes in water temperature and salinity characteristics can result from changes in local heating and evaporation following the southward movement of warmer water due to southward-moving cyclones, and can have flow-on effects to primary and secondary productivity (McKinnon *et al*. 2003).

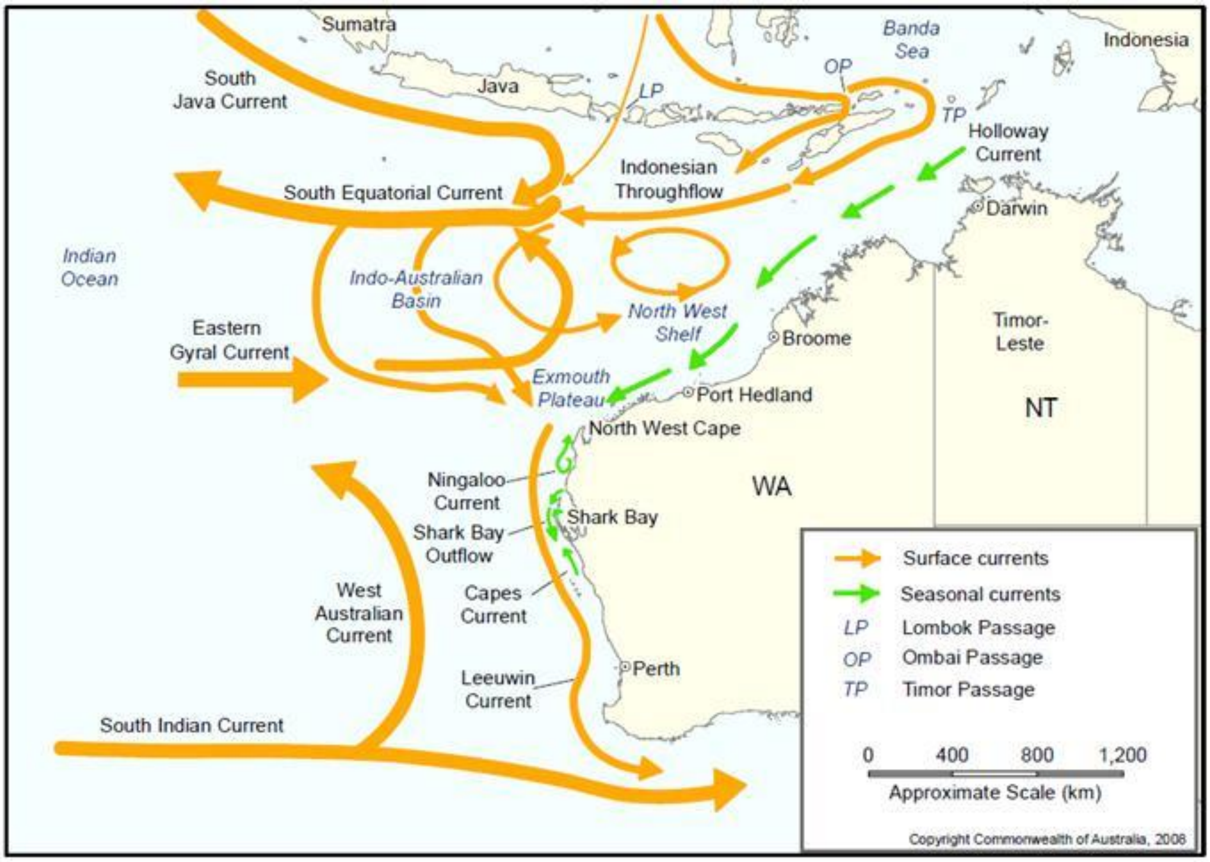


Figure 2-5: Surface currents in WA

Source: DEWHA (2008a)

3. Benthic & Pelagic Habitats

Benthic habitats are defined as those subtidal habitats lying below the lowest astronomical tide (LAT). The benthic habitats within waters in the area of interest lie at depths ranging from LAT down to more than 6,000 m at Argo and Cuvier abyssal plains (DEWHA 2008, 2008a).

Benthic habitats are partially driven by light availability. Primary producers (photosynthetic corals, seagrasses and macroalgae) are limited to the photic zone, whereas benthic invertebrates including filter feeding communities may be found in deeper waters. The depth of the photic zone varies spatially and temporally and is predominantly dependent on the volumes of suspended material in the water column. The photic zone in the offshore Pilbara is approximately 70 m whereas in oceanic waters in the northwest and coastal waters of the southwest the photic zone may extend to 120 m (2008a).

The following section broadly categorises benthic habitats as four biological communities; coral, seagrasses, macroalgae and non-coral benthic invertebrates. These communities are discussed in terms of the twelve IMCRA v. 4.0 bioregions, with only the bioregions which intersect the the *Reindeer Wellhead Platform & Offshore Gas Supply Pipeline Operations Environment Plan* EMBA detailed below.

Some broad scale benthic habitat mapping exists for the Northwest and Central Western Shelf Provinces and this is shown in **Figure 3-1** and **Figure 3-2**.

3.1 Coral Reefs

Corals are both primary producers and filter feeders and thus play a role in the provision of food to marine fauna and in nutrient recycling to support ecosystem functioning (CALM & MPRA 2005a).

Corals create settlement substrate and shelter for marine flora and fauna. Studies have shown that declines in the abundance, or even marked changes in species composition of corals, has a marked impact on the biodiversity and productivity of coral reef habitats (Pratchett *et al*. 2008). As part of the reef building process, scleractinian corals are also important for protection of coastlines through accumulation and cementation of sediments and dissipation of wave energy (CALM & MPRA 2005a).

The waters in the area of interest contain extensive coral communities. Coral reefs in the area fall into two general groups: the fringing reefs around coastal islands and the mainland shore; and large platform reefs, banks and shelf-edge atolls offshore (Woodside 2011). The distribution of corals in area is governed by the availability of hard substrate for attachment and light availability.

Coral reefs are dynamic environments that regularly undergo cycles of disturbance and recovery. Depending on how frequent and severe the disturbances are, recovery can take a few years or more than a decade. Disturbances can include bleaching, cyclones and disease outbreaks (AIMS 2011).

Corals in the northwest and central provinces have experienced bleaching events and subsequent recovery. Bleaching is the process where symbiotic algae are expelled from the coral tissue, often leading to the death of the colony. Causes of bleaching include high temperatures (Scott Reef; 1998), anoxic conditions (Bill's Bay; 2008) or smothering (Waples & Hollander 2008, AIMS 2011). Coral susceptibility to bleaching and their ability to recover is an important consideration in the context of potential anthropogenic impacts.

Four bioregions (Northwest Province, Northwest Transition, Central Western Province and Central Western Shelf Transition) lie in deep waters below the photic zone. Two bioregions (Southwest Transition and Southwest Shelf Province) occur in waters that are too cold to support tropical coral reefs species. Photosynthetic corals are not present in either of these locations and hence these bioregions are not discussed further.

3.1.1 Central Western Shelf Transition

A significant proportion of this bioregion is covered by the Ningaloo Reef. The Ningaloo Reef is unique in that it is the largest fringing reef in Australia and is the only large reef found on the western side of a continent in the southern hemisphere.

A 300 km section of the coast, from Red Bluff to North West Cape and extending to Bundegi in Exmouth Gulf, is included in the Ningaloo Marine Park. Ningaloo Reef supports variable lagoonal, intertidal and subtidal coral communities along its length. Ningaloo Reef is characterised by a high diversity of hard corals with at least 217 species representing 54 genera of hermatypic (reef building) corals recorded to date (Veron & Marsh 1988). The most diverse coral communities are found in the shallow relatively clear water, high energy environment of the fringing barrier reef and low energy lagoonal areas to the west of North West Cape (CALM & MPRA 2005a).

Coral diversity reduces with increasing depth, and corals are uncommon at depths greater than 40 m (Waples & Hollander 2008). At depths between 20 and 30 m hard corals have been found to be more dominant in the northern areas of the Ningaloo Marine Park, whereas in southern areas other sessile invertebrates such as sponges, as more prevalent (Waples & Hollander 2008).

3.1.2 Northwest Transition

This bioregion lies mostly over the continental slope and the abyssal plain in deep waters that preclude photosynthetic coral growth (DEWHA 2008). However, in contrast with the surrounding area, the Rowley Shoals are three distinct reef systems (Mermaid, Clerke and Imperieuse Reefs) approximately 30–40 km apart that rise vertically to the surface from depths of between 500 and 700 m. The marine reef fauna of the Rowley Shoals is considered to be exceptionally rich and diverse, including species typical of the oceanic coral reef communities of the Indo-West Pacific. As many of these species are not found in the inshore tropical waters of northern Australia, such populations are of regional significance (DEWHA 2008).

A 1993 survey at Mermaid Reef recorded 214 species of scleractinian corals (Done *et al*. 1994). The survey found that coral assemblages of the Rowley Shoals are broadly comparable to those found on the reefs of the outer Great Barrier Reef and in the Coral Sea. While the coral fauna is similar to Scott Reef, it differs considerably from that of north-western Australia (Veron 1986). Veron (1986) notes that the clear water of the Rowley Shoals allows coral communities to exist over a great range of depths, while the strong wave action on the outer coral slopes and the wide tidal range result in distinct patterns of zonation.

3.1.3 Northwest Shelf Province

This province contains numerous small coastal islands in addition to larger archipelago and offshore island groups. Many of these features are surrounded by shallow waters with small barrier and fringing reefs that support coral communities. Key areas recognised for coral communities in this bioregion are discussed below.

The Dampier Archipelago supports coral reefs in shallow waters near islands and submerged pinnacles. The most significant coral reefs have formed along the seaward slopes of Delambre Island, Hamersley Shoal, Sailfish Reef, Kendrew Island and north-west Enderby Island (CALM & MPRA 2005b). Field trips in the Dampier Archipelago between 1972 and 1998 recorded 229 species of corals from 57 genera (Griffith 2004). Surveys of the Dampier Port and inner Mermaid Sound recorded approximately 120 coral species from 43 genera (Blakeway & Radford 2005) with coral reefs dominated by acroporids and pocilloporids. The greatest coral cover (up to 70%) was recorded in the eastern half of the archipelago (Wells *et al*. 2003).

The Montebello, Lowendal and Barrow Islands include 315 islands associated with extensive coral reefs, the most significant of which occur in the sheltered waters on the eastern side of the islands. Examples of these significant reefs include Dugong Reef, Batman Reef and reefs along the Lowendal Shelf (DEC & MPRA 2007a). Dominant corals include acroporids and poritids, with greater than 70% cover recorded for some areas (Chevron 2010). Subtidal coral reef communities around the islands are highly diverse, with at least 150 species of hard corals recorded from fringing and patch coral reef areas (DEC & MPRA 2007a).

Coral distribution near the mainland is restricted by lack of light due to natural turbidity. Corals may exist as sparse coral colonies in some locations, rather than extensive coral communities. Within Exmouth

Gulf, coral communities are less common but are present on fringing reefs surrounding islands, as solitary corals distributed across areas of hard substrate, or on larger isolated patch reefs.

An epibenthic dredge survey of nearshore areas north of Broome identified 14 species of hard corals from six families (Keesing *et al*. 2011). Limited coral surveys conducted at Broome (15 species) and the Lacepede Islands (ten species) (Veron & Marsh 1988) suggest the species diversity in this locality may be low. However, low species diversity observed during the dredge survey may reflect the limited sampling frequency, limited depth range (11–23 m) or inadequate sampling in habitats considered favourable for the proliferation of hard corals (hard substrate). In contrast, other surveys of nearshore locations in the region have recorded much higher levels of species diversity. Veron and Marsh (1988) stated that 102 species of hard corals have been recorded from the Kimberley coast and nearshore reefs and Cairns (1998) recorded 87 species of azooxanthellate hard coral species from north-western Australian waters.

3.2 Seagrasses

Seagrasses are biologically important for four reasons:

1. As sources of primary production;
2. As habitat for juvenile and adult fauna such as invertebrates and fish;
3. As a food resource; and
4. For their ability to attenuate water movement and trap sediment (Masini *et al*. 2009).

Twenty-five species of seagrass have been recorded in Western Australia, the highest diversity in the world (Masini *et al*. 2009). Waters extending from Busselton to the Northern Territory border support predominantly tropical species although temperate species are also found, particularly between Busselton and Exmouth (Walker 1987). One species, *Cymodocea angustata*, is endemic to Western Australia (DPAW 2013).

The main seagrasses of the region are small, ephemeral species that grow on soft sediments and have a seed bank in the surficial sediments that allows them to recover quickly from disturbance (Walker 1989). Small, ephemeral species of seagrass tend to form mixed associations with macroalgae (CALM & MPRA 2005b, DEC & MPRA 2007a, BHPBIO 2011) and usually covers less than 5% of the substrate (BHPBIO 2011, van Keulen & Langdon 2011).

Areas occupied by seagrass vary markedly both seasonally and interannually and it is not clear why some areas of suitable substrate will support seagrass in one year but not the next. It appears that recruitment to what may otherwise be suitable substrate is haphazard, lending weight to the descriptions of these seagrass communities as ephemeral (CALM & MPRA 2005b, DEC & MPRA 2007a).

Two bioregions (Northwest Province and Central Western Transition) lie entirely in deep waters below the photic zone. Seagrasses are not present hence these bioregions are not discussed further.

3.2.1 Central Western Shelf Transition

Nine species of seagrasses have been found throughout Ningaloo Reef (van Keulen & Langdon 2011). Some delineation of temperate and tropical species exists; however, several species were found throughout the Ningaloo Reef. Halophila ovalis was the most commonly found seagrass at Ningaloo and was generally found growing in sandy patches between coral bomboras. Amphibolis antarctica is a large meadow forming species that has been found growing in large clumps in Bateman Bay, north of Coral Bay (van Keulen & Langdon 2011).

3.2.2 Northwest Transition

The Rowley Shoals provide the only suitable shallow substrate for seagrasses in this predominantly deep bioregion. Sparse seagrass is found within subtidal coral reef communities of the Rowley Shoals but is not a major habitat type. Two species of seagrass, *Thalassia hemprichii* and *Halophila ovalis*, have been recorded at Mermaid Reef (Huisman *et al*. 2009). Earlier studies at Mermaid and Imperieuse

Reef recorded the above two species and a third species; *Thalassodendron ciliatum* (Walker & Prince 1987).

3.2.3 Northwest Shelf Province

In the Northwest Shelf Province, seagrasses are present but sparsely distributed to depths of approximately 30 m (LEC & Astron 1993, URS 2009, CALM 2005a). The abundance and distribution of tropical (and subtropical) seagrass species can vary greatly due to seasonal changes in water quality (turbidity, light penetration) and conditions (wave action, temperature), with biomass tending to peak in summer (Lanyon & March 1995).

Studies between Quondong and Coulomb Points north of Broome identified seagrass communities of *Halophila* spp. patchily distributed across large areas, from the lower intertidal and out to a depth of approximately 20 m (DEC 2008, Fry *et al*. 2008). Similarly, *Halophila decipiens* was the only seagrass collected from epibenthic dredge studies at five localities near Broome from Gourdon Bay to Packer Island (Keesing *et al.* 20011).

Roebuck Bay is located south of Broome and includes large areas of intertidal mudflats. Extensive seagrass meadows occur in the northern regions of Roebuck Bay and are dominated by *Halophila ovalis* and *Halodule uninervis*. *Halophila minor* and *Halodule pinifolia* have also been reported at this location (Prince 1986, Walker & Prince 1987, Seagrass-Watch 2013).

In the proposed Dampier Archipelago Marine Park and Regnard Marine Management Area, seagrass occurs in the larger bays and sheltered flats of the area (CALM & MPRA 2005b). Six species of seagrass, including three Halophila species, have been recorded on the subtidal soft sediment habitats (CALM & MPRA 2005b). Seagrasses do not form extensive meadows within the proposed reserves, but rather form interspersed seagrass/macroalgal beds. The largest areas of seagrass are found between Keast and Legendre islands, and between West Intercourse Island and Cape Preston (CALM & MPRA 2005b).

Surveys near Onslow found that *Halophila* spp. were the most widespread of the seagrasses in that region. Seagrasses were found to be generally sparsely distributed (<10% cover), occurring in small patches within larger areas of suitable substrate. Small areas of higher (>50%) seagrass cover occurred in shallow clear water areas but were not common (URS 2009, URS 2010b, Chevron 2010).

Similarly, in the Montebello/Barrow Islands Marine Conservation Reserves, seagrasses appear not to form extensive meadows but are sparsely interspersed between macroalgae. Seven seagrass species have been recorded in the Reserves (DEC & MPRA 2007a) with *Halophila* spp. the most common seagrass species on shallow soft substrates and sand veneers. Distributions of these species extend from the intertidal zone to approximately 15m water depth (DEC & MPRA 2007a). Surveys to the northwest and southeast of Barrow Island from 2002 to 2004 did not identify any significant seagrass meadows but confirmed the presence of sparse coverage of *Halophila* and *Halodule* spp. in shallow areas east of Barrow Island (RPS BBG 2005).

A significant meadow of large seagrasses at Mary Anne Reef east of Onslow was identified almost 30 years ago and its presence today is unconfirmed. The meadow was several hundred hectares of *Cymodocea angustata* at 30–50% cover, occurring primarily at a depth of 2–3 m (Walker & Prince 1987).

3.3 Macroalgae

Macroalgae are important contributors to primary production and nutrient cycling in the region, providing food and habitat for vertebrate and invertebrate fauna. Macroalgae are also recognised for their role in spatial subsidies; the movement of nutrients or energy between neighbouring habitats. Spatial subsidies involving macroalgae include the movement of wrack from macroalgal beds to bare substrates and shorelines (Orr 2004).

Macroalgae are primarily associated with hard substrates. They occur in moderate to high cover on exposed hard substrates, but typically have lower cover on hard substrates that are covered with a veneer of sediment (SKM 2009, BHPBIO 2011). Macroalgae exhibit very high seasonal and interannual variation in biomass (Heyward *et al*. 2006) and distribution, abundance and biodiversity (Rio Tinto 2009, BHPBIO 2011). The distribution of hard substrates therefore indicates areas that may support macroalgal communities, although abundance and diversity may fluctuate annually.

Macroalgae are susceptible to disturbance from factors such as sedimentation, scouring and turbidity but the marked seasonality in biomass, abundance, diversity and distribution suggests macroalgae are likely to be resilient to acute, short-term disturbance acting at local scales. Macroalgae may be more susceptible to impacts acting over longer time scales (years) and at certain times of the year, where recruitment at a regional scale could be affected. Indirect impacts affecting the numbers, distribution and community structure of herbivorous fish can also be expected to have impacts (either positive or negative) on macroalgal habitats (Vergès *et al*. 2011).

Two bioregions (Northwest Province and Central Western Transition) lie entirely in deep waters below the photic zone. Benthic macroalgae are not present hence these bioregions are not discussed further.

3.3.1 Northwest Transition

Although macroalgae is present at the Rowley Shoals, it is not recognised as a key habitat component in the Mermaid Reef Marine National Nature Reserve Plan of Management (EA 2000) or the Rowley Shoals Marine Park Management Plan (DEC & MPRA 2007b).

There is nothing to suggest that the algal flora of the Rowley Shoals is unique within the Indo-Pacific (Huisman *et al*. 2009). A study of macroalgae at 16 locations at Mermaid Reef recorded over 100 species (Huisman *et al*. 2009). The algal flora recorded at the Rowley Shoals represents a small portion of the highly diverse Indo-Pacific flora. The majority of species that were recorded at Mermaid Reef had been previously recorded from mainland north-western Australia or from Indonesia (Huisman *et al*. 2009).

3.3.2 Northwest Shelf Province

Macroalgae are diverse and widespread throughout the Northwest Shelf Province. They are restricted to depths where sufficient light penetrates to the substrate and therefore tend to be most common in shallow subtidal waters down to approximately 20 m depth.

In the nearshore regions of the Pilbara, macroalgae are often a dominant component of the mosaic of benthic organisms found on hard substrates in shallow water. In these shallow waters, regular disturbance to reef habitats from seasonal changes in sedimentation/ erosion patterns and the less frequent impacts of cyclones and storms through sedimentation and scouring may substantially alter the distribution and composition of the benthic communities associated with reefs, including macroalgal habitats (BHPBIO 2011).

Macroalgae dominate shallow (<10 m) submerged limestone reefs and also grow on stable rubble and boulder surfaces in the proposed Dampier Archipelago Marine Park and Regnard Marine Management Area (CALM & MPRA 2005b). Huisman and Borowitzka (2003) reported approximately 200 species of macroalgae from the Dampier Archipelago. Low relief limestone reefs that are dominated by macroalgae, account for 17% (approximately 35,460 ha) of the marine habitats within the proposed Marine Management Area (CALM 2005a).

Epibenthic dredge surveys along the coastline north of Broome identified 43 species of algae from 22 families (Keesing *et al*. 2011). The lower species diversity collected by this study is attributed to the method of collection and limited depth range (11–23 m) (Keesing *et al*. 2011).

Macroalgae occur around the numerous small offshore islands within this bioregion (including Thevenard Island, Airlie Island and Serrurier Island) associated with limestone pavement and protected areas of soft sediments. Dominant species are consistent with those described for the Dampier Archipelago (Woodside 2011).

In the shallow offshore waters of the Pilbara region, macroalgae are the dominant benthic habitat on hard substrates in both the Montebello and Barrow Islands Marine Parks and are the main primary producers (DEC & MPRA 2007a, Chevron 2010). Shallow water habitats outside these marine parks are also likely to support substantial areas of macroalgal habitat wherever conditions are suitable.

Macroalgae occupy approximately 40% of the benthic habitat area in the Montebello/ Lowendal/ Barrow Island region (CALM 2005b). At least 132 macroalgal taxa occur around Barrow Island, with most thought to be widely distributed in the tropical Indo-Pacific region (Chevron 2005).

Macroalgae monitoring around the Lowendal and Montebello Islands since 1996 (The Ecology Lab 1997, IRCE 2002 2003 2004 2006 2007, URS 2009) has found macroalgal cover and biomass to be naturally spatially and temporally variable. *Sargassum* spp. represented 70% of the macroalgal assemblage in 2009, compared to 96% in 2002 (URS 2009). Sargassum spp. cover as a percentage of total macroalgae cover was significantly lower in 2009 than in previous years, primarily due to an increase in filamentous algae at a number of sites (URS 2009).

3.4 Non-Coral Benthic Invertebrates

The offshore marine environment from Busselton to the Northern Territory border is overwhelmingly dominated by soft sediment seabeds; sandy and muddy substrates, occasionally interspersed with hard substrates covered with sand veneers, and rarely, exposed hard substrate. In shallow waters, non-coral benthic invertebrates may form part of the mosaic of benthic organisms found on hard substrates, alongside macrophytes and coral colonies. As light reduces with water depth, non-coral benthic invertebrates are the dominant community, albeit at low densities.

Non coral benthic invertebrates feed by filtering small particles from seawater, typically by passing the water over a specialised filtering structure. Examples of filter feeders are sponges, soft and whip corals and sea squirts.

3.4.1 Central Western Transition

The Central Western Transition extends from the shelf break to the continental slope with some parts of the bioregion occurring on the abyssal plain. Water depths range from 80 m to almost 6,000 m. Sediments are dominated by muds and sands that decrease in grain size with increasing depth. The present level of understanding of the marine environment in this bioregion is generally poor. The harder substrate of the slope in waters of 200–2,000 m deep is likely to support populations of epibenthic fauna including bryozoans and sponges. These support larger infauna and benthic animals such as crabs, cephalopods, echinoderms and other filter feeding epibenthic organisms. In the deeper waters of the abyss, the benthic communities are likely to be sparse (DEWHA 2008).

3.4.2 Central Western Shelf Transition

The Central Western Shelf Transition is located entirely on the continental shelf and is comprised mainly of sandy sediments in depths between 0 and 80 m (DEWHA 2008).

Some sponge species and filter-feeding communities found in deeper waters offshore from the Ningaloo Reef appear to be significantly different to those of the Dampier Archipelago and Abrolhos Islands, indicating that the Commonwealth waters have some areas of potentially high and unique sponge biodiversity (Rees *et al*. 2004).

3.4.3 Northwest Province

The Northwest Province is located entirely on the continental slope in water depths of predominantly between 1,000–3,000 m and is comprised of muddy sediments. Despite the present poor knowledge of the benthic communities on the Exmouth Plateau, information on sediments in the bioregion indicates that benthic communities are likely to include filter feeders and epifauna. Soft-bottom environments are likely to support patchy distributions of mobile epibenthos, such as sea cucumbers, ophiuroids, echinoderms, polychaetes and sea pens.

3.4.4 Northwest Transition

The Northwest Transition is located from the shelf break (200 m water depth) over the continental slope to depths of more than 1,000 m at the Argo Abyssal Plain. Benthic habitat mapping surveys and epibenthic sampling conducted by CSIRO at the continental slope (approximately 400 m water depth) showed that all survey sites predominantly comprised soft muddy sediment, which was often riffled. Gravel, boulders and small outcrops were occasionally recorded. Epifaunal abundance was similar all sites, with epifauna limited to sparsely distributed isolated individuals. Epifauna included isolated scattered sessile crinoids, anemones, glass sponges and seapens. Occasional non-sessile fauna included urchins, prawns and other decapods, holothurians and sea stars. Modelling indicated a 1 km long beam trawl across the continental shelf (~400 m water depth) would be expected to yield sparse (<20 individuals) and low diversity (<10 species) of epibenthic fauna (≥1 cm body size) (Williams *et al*. 2010). Deeper on the continental slope at ~700 m and ~1,000 m, habitats were similar to those observed at 400 m (Williams *et al*. 2010).

Although soft sediment habitat may appear monotonous and featureless, there is likely to be some marked differences in terms of ecological functioning and faunal composition between shelf and deep-sea areas, with the 200 m isobath widely believed to represent a key boundary (Wilson 2013, Brewer *et al*. 2007, Gage & Tyler 1992). Beyond the 200 m isobath, deep-sea benthic communities rely exclusively on the settling of organic detritus from the overlying water column as a food source. The spatial and temporal distribution of benthic fauna depends on factors such as sediment characteristics, depth and season (Wilson 2013).

Due to contrasting depths, the Rowley Shoals supports a diverse marine invertebrate community including a number of endemic species. Invertebrate species (excluding corals) at the Rowley Shoals include sponges, cnidarians (jellyfish, anemones), worms, bryozoans (sea mosses), crustaceans (crabs, lobsters, etc.), molluscs (cuttlefish, baler shells, giant clams, etc.), echinoderms (starfish, sea urchins) and sea squirts (DEC & MPRA 2007b).

3.4.5 Northwest Shelf Province

This bioregion is located primarily on the continental shelf in water depths from 0 to 200 m (DEWHA 2008). The sandy substrates on the shelf within this bioregion are thought to support low density benthic communities of bryozoans, molluscs and echinoids (DEWHA 2008). Sponge communities are also sparsely distributed on the shelf, but are found only in areas of hard substrate. The region between Dampier and Port Hedland has been described as a hotspot for sponge biodiversity (Hooper & Ekins 2004).

Epibenthic dredge surveys in nearshore areas around Broome covered 1,350 m^2 of seabed in depths between 11 and 23 m. The survey recorded 357 taxa comprising 52 sponges, 30 ascidians, 10 hydroids, 52 cnidarians (not including scleractinian corals), 69 crustaceans, 73 molluscs and 71 echinoderms. The most important species on soft bottom habitats in terms of biomass was the heart urchin *(Breynia desorii)*, whilst sponges were the dominant fauna by biomass on hard bottom habitats. The biomass of other filter feeders, especially ascidians, soft corals, gorgonians was also high, indicating the importance of these groups in characterising hard bottom habitats.

In 2007, CSIRO conducted extensive benthic habitat mapping surveys and epibenthic fauna (living on the surface and ≥1 cm body size) sampling in deep waters (100–1,000 m) spanning thirteen sites between Barrow Island and Ashmore Reef running along the continental shelf and across the continental slope of the North West Shelf (Williams *et al*. 2010). At the continental shelf margin (~100 m water depth) Williams *et al*. (2010) reported that similar benthic habitats occurred at each survey site across the breadth of the North West Shelf. Benthic habitats at this depth comprised a mix of riffled muddy sand (sometimes as a veneer over rocky subcrops) together with gravel to pebble-sized rubble, cobbles, boulders and some rock outcrops. Typical epifauna found at these depths included scattered isolated hydroids, sea fans and soft corals and often small sponges. Other fauna observed at some of the sites included scattered isolated sea whips, crinoids, sea pens, urchins and anemones. Epibenthic fauna along the continental shelf margin were quantified as sparse and low diversity (Williams *et al*.

2010). Modelling indicated that a trawl sample of 1 km length would generally be expected to yield approximately 80 individuals represented by 15 species (Williams *et al*. 2010) in 100 m depth waters.

At the shelf edge (~200 m water depth), two sites were surveyed. Both sites were similar to the continental shelf margin, except the northern site mainly comprised coarse material. Epifauna observed at the northern site was similar at 200 m as at 100 m. At the southern site, epifauna included sparse and scattered individual soft corals, anemones, glass sponges and stalked crinoids (Williams et al. 2010). Modelling indicated epibenthic fauna were sparse and had low diversity, numbering approximately 20–40 individuals in a 1 km long trawl sample represented by approximately 5–10 species (Williams *et al*. 2010).

Baseline studies undertaken in nearshore areas of the Pilbara (SKM 2009, Rio Tinto 2009, BHPBIO 2011) and offshore areas around Barrow Island (Chevron 2010) have shown that filter feeder communities are a dominant component of benthic habitats in depths >10 m where reduced light appears to inhibit extensive development of hard corals and macroalgae. The pavement habitats between Barrow Island and the mainland are covered by a sediment veneer that appears to periodically move, exposing areas of pavement reef. Sessile benthic organisms that require hard substrates for attachment, such as gorgonians, are frequently seen emerging through a shallow veneer of sand. This type of substrate (sediment veneer) with sparse filter feeder communities is common throughout this area (SKM 2009, Rio Tinto 2009, BHPBIO 2011).

3.5 Plankton

Plankton abundance and distribution is patchy, dynamic and strongly linked to localised and seasonal productivity (Evans *et al.* 2016). Fluctuations in abundance and distribution occur both vertically and horizontally in response to tidal cycles, seasonal variation (light, water temperature and chemistry, currents and nutrients) and cyclonic events. As a key indicator for ecosystem health and change, Plankton distribution and abundance has been measured for over a century in Australia (Richardson *et al.* 2015). The compilation of this data has been made publicly available through the Australian Ocean Data Network (Australian Ocean Data Network 2017) and has recently been used in the Australia State of the Environment 2016 report (Jackson *et al.* 2017) to nationally assess marine ecosystem health. According to their findings, warming ocean temperatures has extended the distribution of tropical phytoplankton species (which have a lower productivity), further south resulting in a decline in primary productivity in oceanic waters north of 35°C, especially the North West Shelf (Evans *et al.* 2016). Trends of primary productivity across Australia are however variable with the South West of Australia experiencing an increase in productivity and northern Australia experiencing no change between 2002-2016 (Evans *et al.* 2016).

Within the area of interest, peak primary productivity varies on a local and regional scale. For example, peak phytoplankton biomass in waters surrounding Broome has been observed in May with a high variability recorded in August, whereas recorded phytoplankton biomass in waters surrounding Geographe Bay has been found to peak during winter and is localised close to the coast (Bloundeau-Patissier *et al.* 2011). In general, these peaks are linked to mass coral spawning events, peaks in zooplankton and fish larvae abundance and periodic upwelling. Regional upwelling is most common close to the coast and where surface waters diverge. Despite the suppression of major upwelling along the WA coast by the Leeuwin Current, known key upwelling regions include the Ningaloo region (Hanson & McKinnon 2009) & Cape Mentelle (Pattiaratchi 2007). It is also expected that a high abundance of plankton will occur within areas of localised upwelling in the area of interest where the seabed disrupts the current flow.

In waters surrounding Indonesia, seasonal peaks in phytoplankton biomass is linked to monsoon related changes in wind. When the winds reverse direction (offshore vs. onshore), nutrient concentrations decrease/increase because of the suppression/enhancement of upwelling (NASA 2017). Annual variability of phytoplankton productivity in waters surrounding Indonesia is heavily influenced by the El Niño-Southern Oscillation climate pattern (NASA 2017). For example, phytoplankton productivity around Indonesia increases during El Niño events.

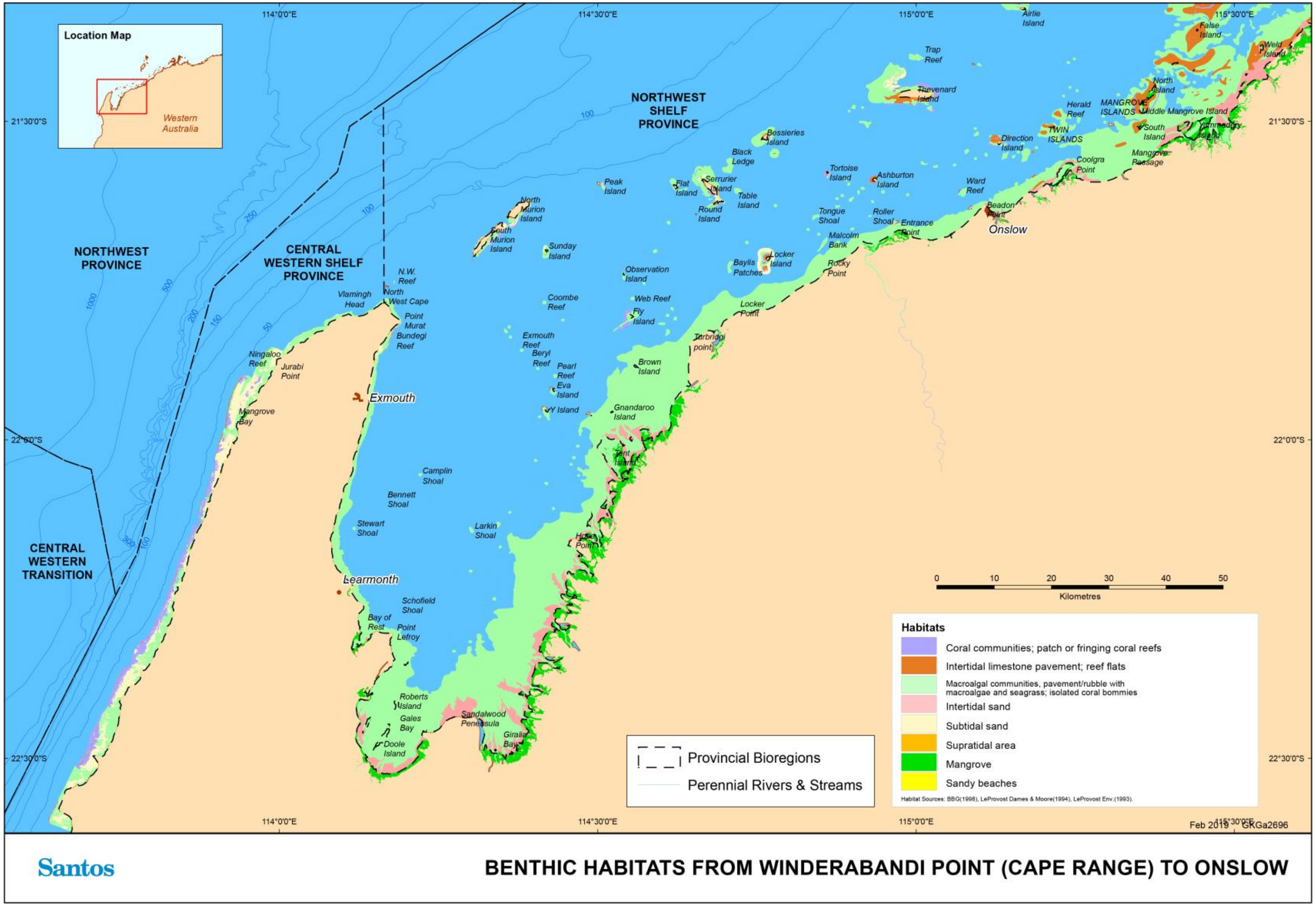


Figure 3-1: Benthic habitats from Winderabandi Point to Onslow

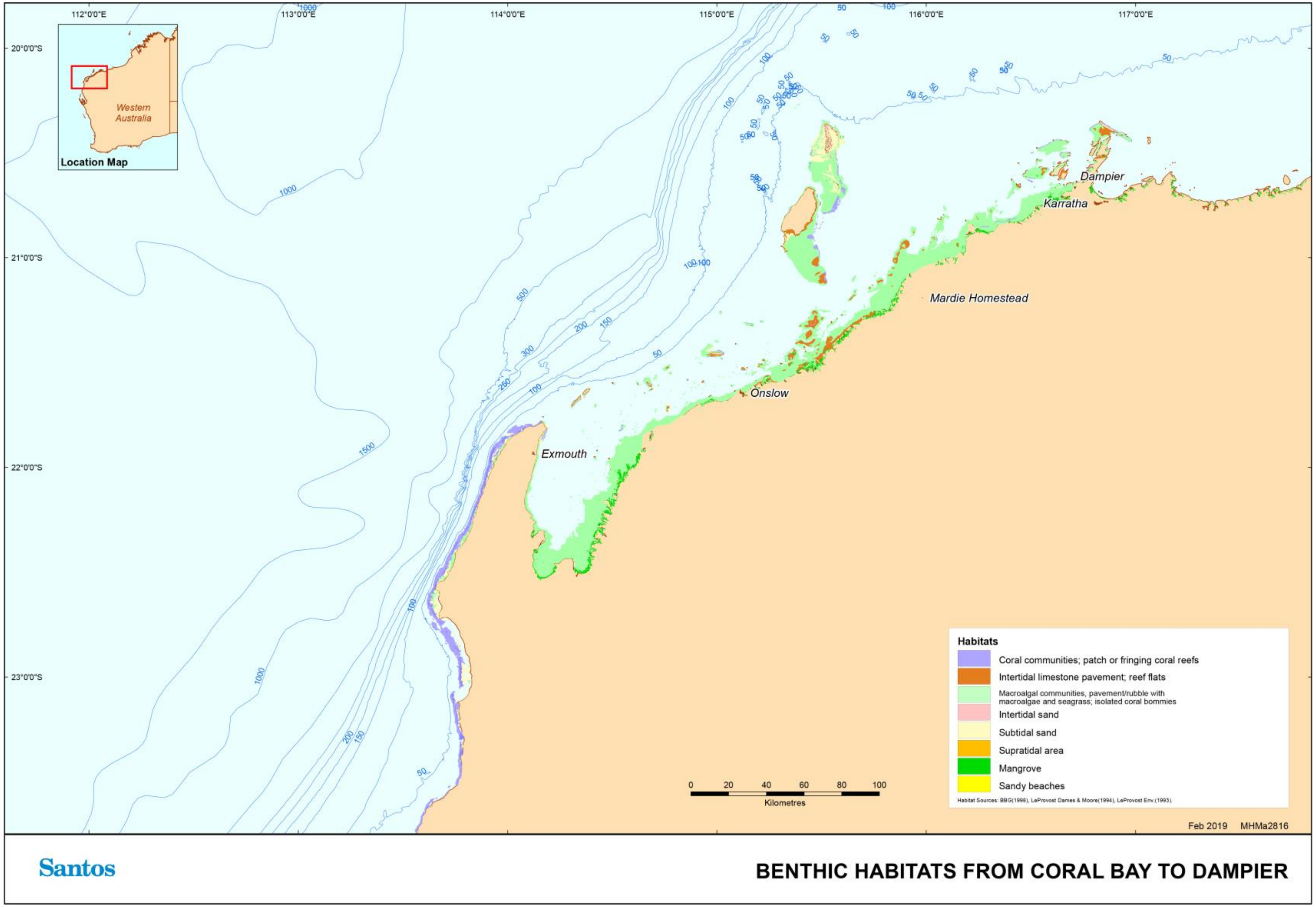


Figure 3-2: Benthic habitats from Coral Bay to Dampier

4. Shoreline Habitats

Shoreline habitats are defined as those habitats that are adjacent to the water along the mainland and of islands that occur above the LAT and most often in the intertidal zone.

The following section broadly categorises shoreline habitats as the following biological communities; mangroves, intertidal mud/sand banks, beaches, and rocky shores. These communities are discussed in **Sections 4.1- 4.5**, in terms of the 13 IMCRA v. 4.0 bioregions where relevant and where information is available. Only the bioregions which intersect the the *Reindeer Wellhead Platform & Offshore Gas Supply Pipeline Operations Environment Plan* EMBA are described below.

Figure 3-1 and **Figure 3-2** broadly illustrate these habitats within the Northwest Shelf Province and Central Western Shelf Transition.

4.1 Mangroves

Mangroves commonly occur in sheltered coastal areas in tropical and sub-tropical latitudes (Kathiresan and Bingham, 2001). Up to eight species of mangroves are found further north in the Central Western Shelf Transition region, but at most locations the dominant mangrove (in terms of area of intertidal zone occupied) is *Avicennia marina*, with the stilt rooted mangrove *Rhizophora stylosa* often occurring as thin zones of dense thickets within the broad zone of *A. marina*. Mangroves are found wherever suitable conditions are present including wave dominated settings of deltas, beach/dune coasts, limestone barrier islands and ria/archipelago shores (Semeniuk 1993). Mangrove plants have evolved to adapt to fluctuating salinity, tidal inundation and fine, anaerobic, hydrogen sulfide rich sediment (Duke *et al.* 1998).

Mangroves are important primary producers and have a number of ecological and economic values.

For example, they play a key role in reducing coastal erosion by stabilising sediment with their complex root systems (Kathiresan and Bingham 2001). They are also recognised for their capacity to help protect coastal areas from the damaging effects of erosion during storms and storm surge. Mangroves are also important in the filtration of run-off from the land which helps maintain water clarity for coral reefs which are often found offshore in tropical locations (NOAA 2010). The intricate matrix of fine roots within the soil also binds sediments together.

Mangroves play an important role in connecting the terrestrial and marine environments (Alongi 2009). Numerous studies (e.g. Nagelkerken *et al.* 2000, Alongi 2002, 2009, Kathiresan and Bingham 2001) have shown mangroves to be highly productive and an important breeding and nursery areas for juvenile fish and crustaceans, including commercially important species (Kenyon *et al*. 2004). They also provide habitat for many juvenile reef fish species.

Mangroves also play an important ecosystem role in nutrient cycling and carbon fixing (NOAA 2010). The trees absorb carbon dioxide from the atmosphere and the organic matter such as fallen leaves forms nutrient rich sediments creating a peat layer that stores organic carbon (Alongi 2009, Ayukai 1998). For these reasons the EPA of Western Australia recognise mangroves as Benthic Primary Producer Habitat (BPPH), defined as “functional ecological communities that play important roles in maintaining the integrity of marine ecosystems and the supply of ecological services” (EPA 2009 p10).

The muddy sediments that occur in mangrove forests are home to a variety of epibenthic, infaunal and meiofaunal invertebrates (Kathiresan and Bingham 2001). Crustaceans known to inhabit the mud in mangrove systems include fiddler crabs, mud crabs, shrimps and barnacles. Within the water channels of the estuary, various finfish are found from the smaller fish such as gobies and mudskippers (which are restricted to life in the mangroves) through to larger fish such as barramundi (*Lates calcarifer*) and the mangrove jack (*Lutjanus argentimaculatus).* Mangroves and their associated invertebrate-rich mudflats are also an important habitat for migratory shorebirds from the northern hemisphere, as well as some avifauna that are restricted to mangroves as their sole habitat (Garnet and Crowley 2000).

The three key State regulatory documents relevant to the protection and management of mangroves in Western Australia are:

- EPA (2001) Guidance Statement for Protection of Tropical Arid Zone Mangroves along the Pilbara Coastline. Guidance Statement No. 1;
- EPA (2011) Guidance for the assessment of benthic primary producer habitat loss in and around Port Hedland; and
- EPA (2016) Technical Guidance – Protection of Benthic Communities and Habitats.

4.1.1 Central Western Shelf Province

Shark Bay (in the Central Western Shelf Province) supports the southern-most area of substantial mangrove habitat in Western Australia (Rule *et al*. 2012). The mangroves of Shark Bay comprise only one species, the white mangrove *Avicennia marina*, and these trees occur around the coastline in widely dispersed and often isolated stands of varying size.

4.1.2 Central Western Shelf Transition

The regional mangroves from Exmouth to Broome (within the Central Western Shelf Transition and southern part of the Northwest Shelf Province) represent Australia's only 'tropical-arid' mangroves. The most significant stand of mangroves in the Central Western Shelf Transition is Mangrove Bay on the western side of the Cape Range Peninsula in the Ningaloo Marine Park. This small area of mangrove (37 ha) represents the largest area of mangrove habitat within the Ningaloo Marine Park and is considered extremely important from a biodiversity conservation perspective (CALM 2005).

4.1.3 Northwest Shelf Province

In the Pilbara region, the coast is a complex of deltas, limestone barrier islands and lagoons, with a variable suite of substrates. As a result, mangroves in this region form relatively diverse fringing stands, albeit often stunted in stature but at times quite extensive in area. The mangroves along the Pilbara coastline are the largest single unit of relatively undisturbed tropical arid zone habitats in the world. The area has nine mangrove taxa and a total of 632 km^2 mangroves (MangroveWatch 2013). As with most arid zone mangroves, Pilbara mangroves are characterised by open woodlands and shrublands that are of relatively lower productivity than the mangrove communities of the wet tropics because of the extreme water and salinity stresses that affect the intertidal zone in the Pilbara (EPA 2001). Significant stands of mangroves in the Pilbara include:

- Exmouth Gulf: mangrove assemblages within the Bay of Rest on the western shore of the Gulf and the extensive mangrove system on the eastern shore of the Gulf that extends as a series of tidal flats and creek channels from Giralia Bay to Yanrey Flats (Astron 2014). These areas of mangrove are also designated as 'regionally significant' by the EPA (2001). The importance of these mangroves to the Exmouth Prawn Fishery is discussed in Kangas et al. (2006);
- Mainland coast and nearshore islands: mangrove assemblages at Ashburton River Delta, Coolgra Point, Robe River Delta, Yardie Landing, Yammadery Island and the Mangrove Islands are all designated as 'regionally significant' by the Western Australian EPA (2001) and the EPA will give these mangrove formations the highest degree of protection with respect to geographical distribution, biodiversity, productivity and ecological function; and
- Montebello, Barrow and Lowendal Islands: mangrove assemblages all lay within designated reserves. The mangrove communities of the Montebello Islands are considered globally unique as they occur in lagoons of offshore islands (DEC 2007). Mangrove stands identified on Varanus Island occur on the west coast in discrete patches within the tidal and supratidal zones, at South Mangrove Beach and a small embayment (Astron 2016). Mangrove stands on Varanus Island have been identified as healthy, with similar stands also identified as present on Bridled Island to the north of Varanus Island (Astron 2016).

The mangroves of the Kimberley are particularly diverse and relatively untouched. They occupy a variety of coastal settings including rocky shores, beaches and tidal flats (Cresswell and Semeniuk 2011). They belong to the Indo-Malaysian group of Old World Mangroves centred in the Indian-Pacific area (Cresswell and Semeniuk 2011). Of the eighteen species of mangrove plants known to Australia all are represented in the Kimberley including *Avicennia marina, Aegialitis annulata, Aegiceras corniculatum, Rhizophora stylosa, Ceriops tagal, Osbornia octodonta, Bruguiera exaristata, Camptostemon schultzii, Excoecaria agallocha, Sonneratia alba,* and *Xylocarpus australasicus* (Pendretti and Paling, 2001; Waples, 2007). Of these, ten occur only in the Kimberley (Waples 2007). *Rhizophora stylosa* and *Avicennia marina* are the most common mangrove species along the Western Australian Coast.

Mangroves line much of the coastal area within the western Kimberley (and within the proposed Horizontal Falls Marine Park area). They are known to line the shore in the upper reaches of Talbot Bay and to fringe many of the islands of the Buccaneer Archipelago. There are large stands in the southern section of Dugong Bay. Kingfisher Islands has been noted to exhibit extensive mangroves where 10 species of mangrove have been recorded (Wilson 2013). Mangroves line the shores of the southern coast of Collier Bay and large tracts are found in Walcott Inlet and Secure Bay (Duke *et al.*, 2010). The mangroves on the eastern side of the inlet extend about 30 km inland (Gueho 2007, Pendretti and Paling 2001, Zell 2007)). Further along the coast mangroves have been identified lining much of the shores of Doubtful Bay. Mangroves are also known to line the shores of the Sale River and have been identified in George Water. For detailed maps of mangrove distribution refer to Pendretti and Paling (2001).

4.2 Intertidal Mud/Sand Flats

Intertidal mudflats form when fine sediment carried by rivers and the ocean is deposited in a low energy environment. Tidal mudflats are highly productive components of shelf ecosystems responsible for recycling organic matter and nutrients through microbial activity. This microbial activity helps stabilise organic fluxes by reducing seasonal variation in primary productivity which ensures a more constant food supply (Robertson 1988). Intertidal sand and mudflats support a wide range of benthic infauna and epifauna which graze on microscopic algae and microbenthos, such as bivalves, molluscs, polycheate worms and crustaceans (Zell 2007).

The high abundance of invertebrates found in intertidal sand and mudflats provides an important food source for finfish and shellfish which swim over the area at high tide. Mudflats have also been shown to be significant nursery areas for flatfish. During low tide, these intertidal areas are also important foraging areas for indigenous and migratory shorebirds. Mudflats also play a vital role in protecting shorelines from erosion (Wade and Hickey 2008).

4.2.1 Northwest Shelf Province

Within Northwest Shelf Province both Roebuck Bay and Eighty Mile beach are areas with significant intertidal mudflats that are used by birds in spring and summer including species listed as threatened under the WC Act or EPBC Act, or listed on the IUCN Red List of Threatened Species (2009). Intertidal mudflats are also an important feature of the Kimberley coast forming in many bays and inlets of the region (Waples 2007). The sediments that dominate these flats are generally of terrigenous origin (Wilson 2013).

The mudflats of the Kimberley coast have been shown to be important for migratory birds of the East Asian-Australasian Flyway, which is estimated to support more than five million migratory shorebirds (Barter 2002, Bennelongia Pty Ltd 2010, Wade and Hickey 2008). The migratory birds visit the mudflats of the Kimberley coast to feed on benthic organisms prior to embarking on a 10,000–15,000 km migration to their breeding grounds in the Artic (Wade and Hickey 2008).

4.2.2 Northwest Shelf Transition

Extensive mud flats are located in Collier Bay, where the highest tidal range in Australia is found. (Wilson 2013, Zell 2007). A study by (Duke *et al*. 2010, Masini *et al*. 2009) also identified fringing mudflats around Walcott Inlet, and Doubtful Bay. The tidal mudflats of Walcott Inlet are up to 5 km wide and support a rich intertidal invertebrate community (Gibson and Wellbelove, 2010). These invertebrate communities in turn also support large numbers of waterbirds (Wilson 1994).

Extensive intertidal mudflats occur in Prince Frederick Harbour and are generally backed by mangroves. The mudskipper is known to feed on these mudflats at low tide. Intertidal flats are also a feature of the estuary of the Mitchell River. The mudflats of Port Warrender are known to support 20 shorebird species and tern species and it is likely the other mudflats in the region also support high numbers of birds. The ecological significance of the wetlands of the Mitchell River has been recognised in *A Directory of Important Wetlands in Australia*. Mud and sand flats are also known to surround much of Deep Bay and Napier Broome Bay.

Intertidal sand and mudflats are a common feature of the East Kimberley. Large sand bars are present on the river mouths of the King George River, Berkeley River and Lyne River and intertidal mudflats are extensive along the edges of the Cambridge Gulf. The estuary is wide and very shallow in some sections, and the silt and clay is continually picked up and redeposited by strong tidal currents (Robson *et al.* 2008). The tidal flats of the Ord River in the Cambridge Gulf have been listed as a wetland of international importance for the conservation of waterbirds under the RAMSAR convention. The area supports a variety of fauna including shorebirds and mudskippers. Tidal mudflats are also extensive along the coast between the Cambridge Gulf and the Western Australian-Northern Territory Border.

4.3 Intertidal Platforms

Intertidal platforms are areas of hard bedrock and/ or limestone with or without a sediment veneer of varying thickness. These platforms can vary from low to high relief and provide a habitat for a diverse range of intertidal organisms (Morton and Britton in Jones 2004, SKM 2009, 2011, Hanley and Morrison 2012) and some species of shore birds (Garnet and Crowley 2000). They are common within each of the coastal bioregions within the area of interest.

4.3.1 Central Western Shelf Transition

Limestone pavements extend out from the beach into subtidal zones, e.g. along the Ningaloo Coast and North West Cape; and higher relief platforms (>0.5 m off high water mark) are also present at a number of headlands along the North West Cape.

4.3.2 Northwest Shelf Province and Northwest Shelf Transition

Large tidal regimes are likely to be the defining environmental factor influencing the distribution of intertidal flora and fauna in the Northwest Shelf Province and Northwest Shelf Transition. The intertidal area of the Kimberley has an extreme tidal range (hypertidal) which creates unique environmental conditions and habitats not seen else anywhere else in the world. As a remote area many of the habitats are untouched and they are recognised as having significant conservation value (DPaW 2013). DPaW (2013) reports that as a result of the monsoonal influxes of freshwater and land-derived nutrients distinctive tropical marine ecosystems have occurred.

4.4 Sandy Beaches

Sandy beaches are those areas within the intertidal zone where unconsolidated sediment has been deposited (and eroded) by wave and tidal action. Sandy beaches can vary from low to high energy zones; the energy experienced influences the beach profile due to varying rates of erosion and accretion. Sandy beaches are found across the area of interest and vary in length, width and gradient. They are interspersed among areas of hard substrate (e.g. sandstone) that form intertidal platforms and rocky outcrops. There is a wide range of variation in sediment type, composition, and grain size along the area of interest.

Sandy beaches provide habitat to a variety of burrowing invertebrates and subsequently provide foraging grounds for shorebirds (Garnet and Crowley 2000). The number of species and densities of benthic macroinvertebrates that occur in the sand are typically inversely correlated with sediment grain-size and exposure to wave action, and positively correlated with sedimentary organic content and the amount of detached and attached macrophytes (Wildsmith *et al.* 2005). However, the distributions of these faunas among habitats will also reflect differences in the suite of environmental variables that characterize those habitats (Wildsmith *et al.* 2005).

Sandy habitats are important for both resident and migratory seabirds and shorebirds (refer **Section 8**). While sand flats and beaches generally support fewer species and numbers of birds than mudflats of similar size; some species such as the beach thick knee (*Esacus giganteus*) a crab eater, are commonly associated with sandy beaches (Garnet and Crowley 2000). Sandy beaches can also provide an important habitat for turtle nesting and breeding (see marine reptile turtle **Section 6**).

4.4.1 Northwest Shelf Province

Eighty Mile Beach Marine Park is one of the Australia's largest uninterrupted sandy beaches (stretching 220 km) and is an important feeding grounds for small wading birds that migrate to the area each summer, travelling from countries thousands of kilometres away (DEC 2012). It is also a listed Ramsar wetland (see **Section 8.4** on Protected Areas).

4.5 Rocky Shorelines

Rocky shorelines are found across the area of interest and are often indicative of high energy areas (wave action) where sand deposition is limited or restricted (perhaps seasonally or during a cyclone). They are formed from limestone pavement extending out from the beach into subtidal zones, for example along the Ningaloo Coast and North West Cape; higher relief platforms (>0.5 m off high water mark) are also present at a number of headlands along the North West Cape. This habitat is also widespread heading south towards Perth.

Rocky shores can include pebble/ cobble, boulders, and rocky limestone cliffs (often at the landward edge of reef platforms). Rocky outcrops typically consist of hard bedrock, but some of the coastline has characteristic limestone karsted cliffs with an undercut notch. Rocky shorelines can vary from habitats where there is bedrock protruding from soft sediments to cliff like structures that form headlands. Rocky shorelines are an important foraging area for seabirds and habitat for invertebrates found in the intertidal splash zone (Morton and Britton in Jones 2004). For example, oyster catchers and ruddy turnstones feed along beaches and rocky shorelines (see seabirds in **Section 8.2.2**).

5. Fish and Sharks

Fish distributions in the area of interest are discussed with respect to the IMCRA Provincial Bioregions which were defined using CSIRO's 1996 regionalisation of demersal fish on the continental shelf to the shelf break, and their 2005 regionalisation of demersal fish on the continental slope to approximately 1,200 m depth (DEH 2006). The EPBC species listed as threatened and migratory found in the area of interest, according to the Protected Matters search ((**Appendix A**), are shown in **Table 5-1** along with their WA conservation listing (as applicable) and discussed in **Section 5.2** below. Refer to the *Reindeer Wellhead Platform & Offshore Gas Supply Pipeline Operations Environment Plan* for Protected Matters searches of the EMBA and Operational Area.

The following WA conservation codes apply to WA fauna:

+ Threatened Species (listed under Biodiversity Conservation Act 2016):
  - Critically Endangered
  - Endangered
  - Vulnerable
+ Specially protected species (listed under Biodiversity Conservation Act 2016):
  - Migratory
  - Species of special conservation interest (conservation dependant fauna)
  - Other specially protected species
+ Priority species (non-statutory state based administrative process):
  - Priority 1, 2 and 3: poorly-known species – possible threatened species that do not meet survey criteria or are otherwise data deficient. Ranked in order of priority. In urgent need of further survey.
  - Priority 4: species that are adequately known, are either: rare but not threatened; meet criteria for near threatened; or delisted as threatened species within last five years for reasons other than taxonomy. Requiring regular monitoring.

A detailed account of commercial and recreational fisheries that operate in the region is provided in in the Commercial Fisheries **Section 14.6** and detailed in *The State of the Fisheries Report* 2016/2017 (Gaughan and Santoro, 2018).

Table 5-1: EPBC listed fish and shark species in the area of interest

Species	Conservation Status			Likelihood of occurrence in area of interest	Biologically important area in area of interest
	Environment Protection and Biodiversity Conservation Act 1999	*Biodiversity Conservation Act 2016* [1]	Other WA Conservation Code		
Blind gudgeon (*Milyeringa veritas)*	Vulnerable	Vulnerable	-	Species or species habitat known to occur within area.	None - No BIA defined
Balstons pygmy perch (*Nannatherina balstoni*)	Vulnerable	Vulnerable	-	Species or species habitat likely to occur within area.	None - No BIA defined
Blind cave eel (*Ophisternon candidum)*	Vulnerable	Vulnerable	-	Species or species habitat known to occur within area.	None - No BIA defined
Grey nurse shark (*Carcharias taurus*)	Vulnerable	Vulnerable	-	Species or species habitat known to occur within area.	None - BIA not found in area of interest
Great white shark (*Carcharodon carcharias*)	Vulnerable & Migratory	Vulnerable	-	Foraging, feeding or related behaviour known to occur within area	Yes – Refer to **Table 5-2**
Whale shark (*Rhincodon typus*)	Vulnerable & Migratory	Specially protected (species otherwise in need of special protection)	-	Foraging, feeding or related behaviour known to occur within area	Yes – Refer to **Table 5-2**
Northern river shark (*Glyphis garricki)*	Endangered		Priority 1	Breeding likely to occur within the area.	None - BIA not found in area of interest
Dwarf sawfish	Vulnerable & Migratory		Priority 1	Breeding known to occur within area	Yes – Refer to **Table 5-2**

[1] The Wildlife Conservation (Specially Protected Fauna) Notice 2018 has been transitioned under regulations 170, 171 and 172 of the Biodiversity Conservation Regulations 2018 to be the lists of Threatened, Extinct and Specially Protected species under Part 2 of the Biodiversity Conservation Act 2016.

Species	Conservation Status			Likelihood of occurrence in area of interest	Biologically important area in area of interest
	Environment Protection and Biodiversity Conservation Act 1999	*Biodiversity Conservation Act 2016* [1]	Other WA Conservation Code		
(*Pristis clavata)*					
Freshwater sawfish (*Pristis pristis)*	Vulnerable & Migratory		Priority 3	Species or species habitat known to occur within area.	Yes – Refer to **Table 5-2**
Narrow sawfish (*Anoxypristis cuspidate)*	Migratory	-	-	Species or species habitat known to occur within area.	None - No BIA defined
Green sawfish (*Pristis zijsron)*	Vulnerable & Migratory	Vulnerable	-	Breeding known to occur within area	Yes – Refer to **Table 5-2**
Shortfin mako *(Isurus oxyrinchus)*	Migratory	-	-	Species or species habitat likely to occur within area	None - No BIA defined
Longfin mako *(Isurus paucus)*	Migratory	-	-	Species or species habitat likely to occur within area	None - No BIA defined
Reef manta ray *(Manta alfredi)*	Migratory	-	-	Species or species habitat known to occur within area	None - No BIA defined
Giant manta ray *(Manta birostris)*	Migratory	-	-	Species or species habitat known to occur within area	None - No BIA defined
Porbeagle *(Lamna nasus)*	Migratory	-	-	Species or species habitat may occur within area	None - No BIA defined

In addition a review of conservation dependent species[2] identified five species of fish / sharks that may occur in the area of interest:

- Orange roughy (Hoplostethus atlanticus);
- Southern Blue Fin Tuna (Thunnus maccoyii);
- Southern Dogfish (Centrophorus zeehaani);
- School Shark (Galeorhinus galeus); and
- Scalloped Hammerhead (Sphyrna lewini).

5.1 Regional Surveys

Within the 'area of interest' a number of important geographical areas for fish exist, including Ningaloo Marine Park, Montebellos/Barrow Island Marine Park and the Rowley Shoals.

5.1.1 Central Western Shelf Transition

Ningaloo is the largest fringing coral reef in Australia, forming a discontinuous barrier that encloses a lagoon that provides habitat for many fish species. Gaps that regularly intercept the main reef line provide channels for water exchange with deeper, cooler waters (CALM 2005). Ningaloo Reef is a well known biodiversity hotspot, supported by the direct link between the reef and the ancient reef systems found closer to the equator by the Leeuwin Current (Kemps 2010). Approximately 500 species of fish have been reported to inhabit the reef (Kemps 2010). The Piercam project from inception in 2005 to 2013, identified 165 fish species from 50 families at the Point Murat Navy Pier alone, located within the Ningaloo Marine Park (Whisson & Hoschke 2013).

Seasonal aggregations of whale sharks occur at Ningaloo each year (CALM 2005). There is limited data available on species diversity and distribution of sharks in the Ningaloo area as chondrichthyan biodiversity for the area has not been specifically recorded. Despite this, it is possible that the Ningaloo Reef Marine Park contains the largest and most diverse collection of sharks on the Australian coastline (Stevens *et al.* 2009). It was estimated in 2009 by Last and Stevens (cited in Stevens *et al.* 2009), that there are likely to be 118 species of chondrichthyan fishes occurring in the park. Of these species, 59 are shark species predicted to be found at depths of less than 200 m (Stevens *et al.* 2009).

The lagoon at Ningaloo Reef appears to provide a juvenile habitat and nursery area for shark species such as the grey nurse shark (*C. Taurus*), black-tipped reef shark (*Carcharhinus melanopterus*) and other reef sharks (Carcharhinidiae), (Stevens *et al.* 2009). A study conducted on the distribution and abundance of elasmobranches in the Ningaloo Marine Park, 2009, tracked the movements of six key shark species. Species such as *Galeocerdo cuvier* (tiger shark) and *Sphyrna mokarran* (great hammerhead) were found to remain for brief time periods in the park, in contrast to other species found to re-visit the Ningaloo area (Stevens *et al.* 2009). Several species of sharks within Ningaloo have been identified as key indicator species for the health of the system (Stevens *et al.* 2009).

Barrow Island includes Biggada Reef, an ecologically significant fringing reef, and the Montebello Islands comprise over 100 islands, the majority of which are rocky outcrops; providing fish habitat (DEC 2007a). Within the Barrow/Montebello region, at least 380 fish species have been recorded (de Lestang & Jankowski 2017). Most species exhibit wide distributions, with local species composition closely resembling that of the Dampier Archipelgao. Coral habitats support the most diverse fish community in this region, comprising, among others, many species of damselfish (*Pomacentridae*), parrotfish (*Scaridae*), snappers (*Lutijanidae*) and groupers (*Serranidae*) (de Lestang & Jankowski 2017). The region's macroalgal habitats are considered important nursery areas for a diverse range of fish species,

[2] Conservation dependent species are listed species under the EPBC Act and are considered as part of the Commonwealth marine area.

such as emperor (*Lethrinidae*), threadfin bream (*Nemipteridae*), tuskfish (*Labridae*) and trevally (*Carangidae*) (de Lestang & Jankowski 2017).

RAMSAR wetlands within the area (e.g. Eighty Mile Beach and Ashmore Reef National Nature Reserve) can also provide important habitat for fish (see section on RAMSAR wetlands).

5.1.2 Northwest Shelf Province and Northwest Province

The demersal zone of the North-west shelf (NWS) (which includes the Northwest Province and Northwest Shelf Province) hosts a diverse assemblage of fish of tropical Indo-west Pacific affinity, with up to 1,400 species known to occur, with a great proportion of these occurring in shallow coastal waters (Allen *et al*. 1988). Last *et al*. (2005) and Fox & Beckley (2005) described the North-west Province as being characterised by a high level of endemism and species diversity. Certain areas of increased biological activity (e.g. Glomar Shoals) attract demersal fish species such as Rankin cod, red emperor, crimson snapper and spangled emperor that are exploited by commercial trawl and trap fisheries (Sainsbury *et al*. 1992, Fletcher and Santoro 2013).

The shallow waters (<30 m) of the Dampier Archipelago, in the Northwest Shelf Province, support a characteristic and rich fish fauna of 650 species from a variety of habitats including coral and rocky reefs, mangroves, sand and silty bottoms and sponge gardens (Hutchins 2003 & 2004). The majority of these species are found over hard substrate, but significant numbers are also found from soft bottom and mangrove areas. The outer islands of the Archipelago are inhabited predominantly by coral reef fishes whereas inner areas close to the mainland are occupied by mangrove and silty-bottom dwellers. The inter-island passages have a relatively rich soft bottom fauna. EPBC Act protected fish species within the Dampier Archipelago include the dwarf sawfish (*Pristis clavata*).

The fish fauna of the archipelago is less diverse than the islands of the West Pilbara to the south, but are closely related to the fauna at the offshore Montebello Islands (Hutchins 2004). The fish fauna of Barrow/ Lowendal/ Montebello Islands are widespread throughout the Indo-west Pacific region.

Within the southern portion of the Northwest and Northwest Shelf Province, small pelagic fish (e.g. lantern fishes) comprise a third of the total fish biomass (Bulman 2006) and inhabit a range of marine environments, including inshore and continental shelf waters. These small pelagic fish play an important ecological role, not only for this particular area but for the entire North-west Marine Region. They feed on pelagic phytoplankton and zooplankton and provide a food source for a wide variety of predators such as marine mammals, sharks, large pelagic fish and seabirds, thus providing a vital link between many of the region's trophic systems (Mackie *et al*. 2007).

Pelagic fish in the Northwest and Northwest Shelf Province include tuna, mackerel, herring, pilchard and sardine, and game fish such as marlin and sailfish (BBG 1994, Brewer *et al*. 2007), some of which are targeted by both commercial and recreational fishers. In particular, adult and juvenile southern bluefin tuna are thought to migrate through the NWS on their way to and from spawning grounds in the north-eastern Indian Ocean. However, the timing of these migrations and the use of regional currents to assist their migration is still unclear. The oceanic waters of the NWS are also believed to provide important spawning and nursery grounds for a number of large pelagic fish species. **Table 5-2** provides a summary of the key fish species and likely timing of their spawning in the region (DoF correspondence).

5.2 Fish Species

Three species of fish listed as threatened under the EPBC Act (**Table 5-1**) were identified in the Protected Matters search (**Appendix A**):

+ Balston's pygmy perch (Nannatherina balstoni);
+ Blind gudgeon (Milyeringa veritas); and
+ Blind cave eel (Ophisternon candidum).

In addition the Barrow cave gudgeon *(Milyeringa justitia*) has been identified as relevant threatenedspecies under the Biodiversity Conservation Act 2016. This species is not listed under the EPBC Act.

5.2.1 Blind Gudgeon, Balston's Pygmy Perch and Blind Cave Eel

Both the blind gudgeon (*Milyeringa veritas*) and blind cave eel (*Ophisternon candidum*) are known to occur on the Cape Range Peninsula (in the Central Western Shelf Transition) (Humphreys and Feinberg 1995), and a related species of the genus Milyeringa, the Barrow cave gudgeon *(Milyeringa justitia*) has also been noted at Barrow Island (Humphreys 1999). The Barow cave gudgeon is listed as Vulnerable under the WA Biodiversity Conservation Act 2016. They have been recorded in waters ranging from fresh to seawater at depths of up to 33 m in caves and 50 m in wells and bores. Both species are restricted to either caves or groundwater (Humphreys and Blyth 1994) and are the only two vertebrate animals known from Australia for this (DoE 2014a). The Balston's pygmy perch distribution ranges from Moore River (75 km north of Perth) at the northern extent to Two Peoples Bay near Albany. This freshwater species is typically associated with shallow waters near riparian vegetation and is considered to have low salinity tolerance, making it unlikely to occur in estuarine conditions (DoEE, 2016).

5.2.2 Syngnathids

The EPBC Protected Matters search also identified 63 'listed marine species' of fish which are largely from the family Syngnathidae (**Appendix A**). Syngnathids are a group of bony fishes that include seahorses, pipefishes, pipehorses and sea dragons, although taxonomic uncertainty still surrounds a number of these (DEWHA 2012a). Knowledge about the distribution, abundance and ecology of syngnathids is limited.

5.3 Sharks, Rays and Sawfishes

The diversity of marine environments in the waters within the North-west Marine Region has led to a rich fauna of cartilaginous fish (sharks and rays). Of the approximately 500 shark species found worldwide, 19% (94) are found in the region (DEWHA 2008). The EPBC Act Protected Matters search (**Appendix A**) identified four species of shark, and three species of sawfishes listed as threatened within the area of interest between south west WA and N.T. border (**Table 5-1**), including:

- Grey nurse shark (Carcharias taurus);
- Great white shark (Carcharodon carcharias);
- Northern River shark (Glyphis garricki);
- Whale shark (Rhincodon typus);
- Dwarf sawfish (Pristis clavata);
- Freshwater sawfish (Pristis pristis); and
- Green sawfish (Pristis zijsron).

In addition, the narrow sawfish (Anoxypristis cuspidate), two species of ray, the reef manta ray (*Manta alfredi*) and giant manta ray (*Manta birostris*) and the longfin and shortfin mako sharks are listed as migratory within the area of interest (**Table 5-1)**.

The biologically important areas (BIAs) for relevant species detailed above are illustrated in **Figure 5-1, Figure 5-2** and **Figure 5-3**.

A Protected Matters search of the *Reindeer Wellhead Platform & Offshore Gas Supply Pipeline Operations Environment Plan* EMBA did not identify the northern river shark nor freshwater sawfish; further details on the species identified are included in the sections below.

5.3.1 Grey Nurse Shark

The grey nurse shark (*Carcharias taurus*) is listed as vulnerable under the EPBC Act and the *Biodiversity Conservation Act 2016* and may be found within the area of interest. In Australia, the grey nurse shark is now restricted to two populations, one on the east coast from southern Queensland to southern NSW and the other is predominantly found around the southwest coast of WA, but has been recorded on the North West Shelf (DEWHA 2012b, Pogonoski *et al*. 2002). It is believed that the east and west coast populations do not interact and ongoing research will probably confirm that the populations are genetically different (Last and Stevens 2009).

While it is thought that grey nurse sharks have a high degree of site fidelity, some studies (McCauley 2004) suggest that grey nurse sharks move between different habitats and localities, exhibiting some migratory characteristics. In certain areas grey nurse sharks are vulnerable to localised pressure due to high endemism. The status of the west coast population is poorly understood although they are reported to remain widely distributed along the WA coast and are still regularly encountered, albeit with low and indeterminate frequency (Chidlow *et al*. 2006).

Grey nurse sharks are often observed hovering motionless just above the seabed, in or near deep sandy-bottomed gutters or rocky caves, and in the vicinity of inshore rocky reefs and islands (Pollard *et al*. 1996). The species has been recorded at varying depths, but is generally found between 15–40 m (Otway & Parker 2000). Grey nurse sharks have also been recorded in the surf zone, around coral reefs, and to depths of around 200 m on the continental shelf (Pollard *et al*. 1996). Grey nurse sharks feed primarily on a variety of teleost and elasmobranch fishes and some cephalopods (Gelsleichter *et al*. 1999, Smale 2005).

No grey nurse shark BIAs were identified in the area of interest.

5.3.2 Great White Shark (White Shark)

The great white shark (*Carcharodon carcharias*) is listed as vulnerable and migratory under the EPBC Act and is listed as vulnerable under the *Biodiversity Conservation Act 2016* . In Australia, great white sharks have been recorded from central Queensland around the south coast to northwest WA, but may occur further north on both coasts (Last and Stevens 2009). There are no known aggregation sites for white sharks in the North-west marine region, but the species has been recorded in NWS waters during humpback migrations (DEWHA 2012). They are widely but not evenly distributed in Australian waters and are considered uncommon to rare compared to most other large sharks (CITES 2004).

Study into great white shark populations is difficult (Cailliet 1996) given the uncertainty about their movements, emigration, immigration and difficulty in estimating the rates of natural or fishing mortality.

Great white sharks can be found from close inshore around rocky reefs, surf beaches and shallow coastal bays to outer continental shelf and slope areas (Pogonoski *et al*. 2002). They also make open ocean excursions and can cross ocean basins (for instance from South Africa to the western coast of Australia and from the eastern coast of Australia to New Zealand). Great white sharks are often found in regions with high prey density, such as pinniped colonies (DEWHA 2009). The relevant great white shark BIAs in the area of interest are detailed in **Table 5-2** and is shown on **Figure 5-1**.

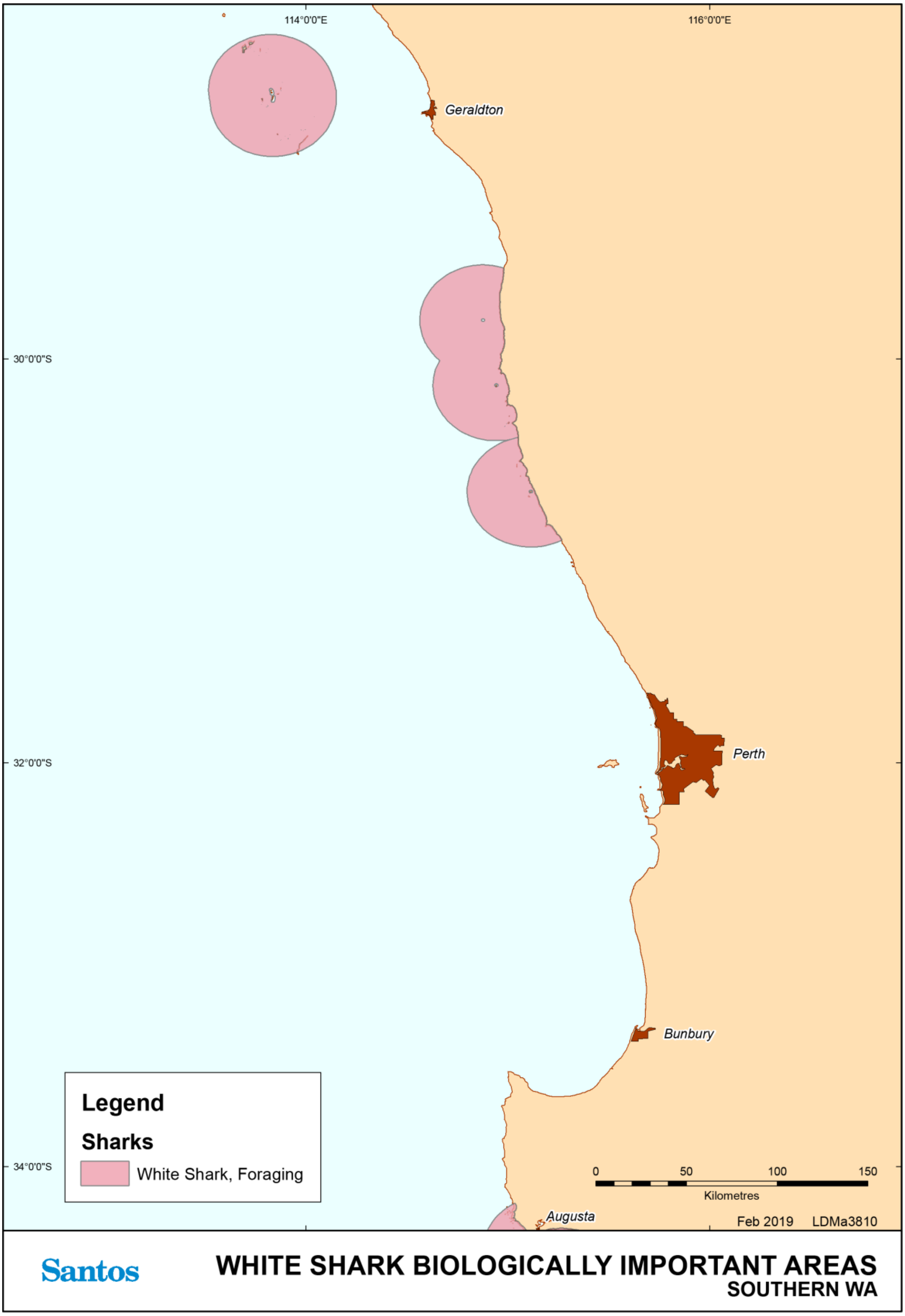


Figure 5-1: Biologically important area – great white shark

5.3.3 Whale Shark

The whale shark (*Rhincodon typus*) is listed as Vulnerable and Migratory under the EPBC Act and is also listed as a specially protected species under the *Biodiversity Conservation Act 2016 as a species of special conservation interest (conservation dependent fauna)*. It is the largest of all fish (>18 m; Borrell *et al*. 2011; Chen *et al*. 1997, Compagno 2001) and is a migratory species with worldwide geographical ranges between 30º N and 35º S (Last and Stevens 2009). There is a general lack of knowledge on many aspects of whale shark biology, including definitive migration patterns. The species is oceanic but often forms aggregations in coastal waters at sites throughout the tropics. Typically, these aggregations are seasonal and often coincide with specific productivity events that are a focus of feeding for the animals. For example, whale sharks aggregate to feed on dense swarms of copepods in Baja California (Clarke and Nelson 1997), fish spawn off Belize (Heyman *et al*. 2001) and red crab larvae at Christmas Island (Meekan *et al*. 2009).

One of the best known aggregation sites for whale sharks occurs along the central and NW coast of Western Australia from March to July and is focused at Ningaloo Reef, within the Exmouth region. The small size and general absence of female whale sharks from Ningaloo Reef suggests that the region may be important for feeding rather than breeding (Norman and Stevens 2007). The timing of this aggregation coincides with a pulse in seasonal productivity that results in large abundances of tropical krill on which these filter feeding sharks feed (Meekan *et al*. unpubl data, Jarman and Wilson 2004). At Ningaloo Reef, whale sharks are often found swimming close to the reef front, within a few kilometres of the shore and in water of less than 50 m deep. A tourist industry based on snorkelling with the sharks in this area has developed over the last 15 years and is now estimated to be worth over $4m annually to the local economy of the Ningaloo region.

Estimates of the size of the population participating in the Ningaloo aggregation are between 300 and 500 individuals (Meekan *et al*. 2006), but research indicates that the Ningaloo population of whale sharks is declining (Bradshaw *et al*. 2007).

Preliminary research on the migration patterns of whale sharks in the western Indian Ocean, and isolated and infrequent observations of individuals, indicate that a small number of the Western Australian population migrate through the NWS. Wilson *et al*. (2006) tagged 19 whale sharks in 2003 and 2004, with long term movements patterns successfully recorded from six individuals. All travelled northeast into the Indian Ocean after departing Ningaloo Reef, with one tracked to Ashmore Reef and another to Scott Reef. Whale sharks are occasionally observed from Santos WA's offshore oil and gas facilities on the NWS (Harriet Alpha and Stag platforms).

This species was listed as Vulnerable under the EPBC Act in 2001, and is also classified as Vulnerable on the World Conservation Union's Red List of Threatened Species (Norman 2005). In WA, whale sharks are protected under the*Biodiversity Conservation Act 2016*, the *Conservation and Land Management Act 1984* and the *Fish Resources Management Act 1994*. The relevant whale shark BIAs in the area of interest are detailed in **Table 5-2** and is shown on **Figure 5-2**.

The objective of the Whaleshark (Rhincodon typus) Recovery Plan 2005 – 2010, Commonwealth of Australia, 2005, is to maintain existing levels of protection for the whale shark in Australia while working to increase the level of protection afforded to the whale shark within the Indian Ocean and Southeast Asian region to enable population growth so that the species can be removed from the threatened species list of the EPBC Act.

DBCA has a wildlife management program to manage whaleshark interactions in reserves - *Whale shark management with particular reference to Ningaloo Marine Park, Wildlife Management Program no. 57 (2013).*

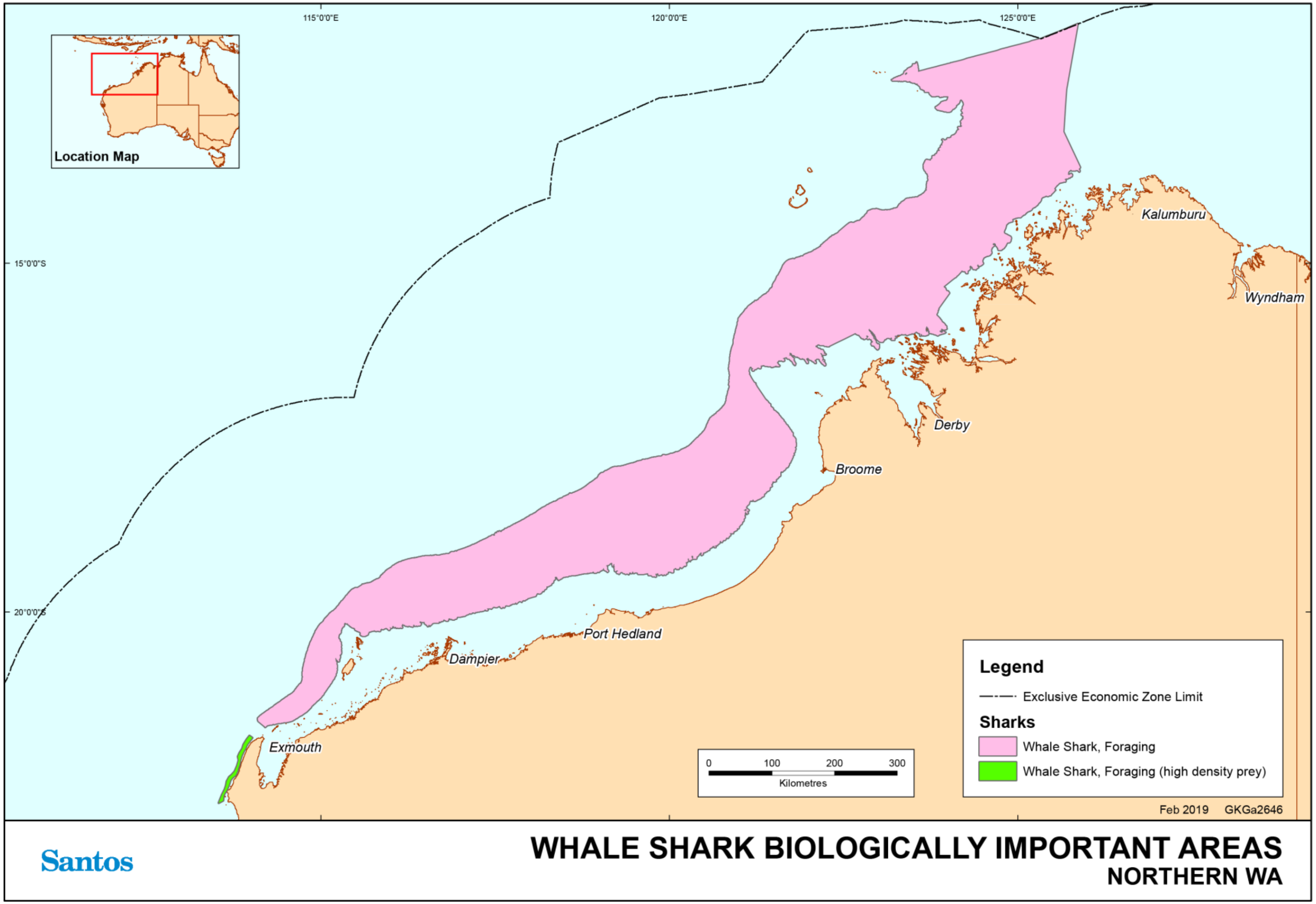


Figure 5-2: Biologically important area – whale shark

5.3.4 Dwarf Sawfish

The dwarf sawfish (*Pristis clavata*) is listed as vulnerable under the EPBC Act and thought to be restricted to Australia (DoE 2014b). It is also listed as a Priority 1 conservation species in WA. The Australian distribution of the dwarf sawfish is considered to extend across northern Australia and along the Kimberley and Pilbara coasts (Last and Stevens 2009, Stevens *et al*. 2005). However, the majority of records of dwarf sawfish in WA have come from shallow estuarine waters of the Kimberley region which are believed to be nursery (pupping) areas, with immature juveniles remaining in these areas up until three years of age (Thorburn *et al*. 2004). Adults are known to seasonally migrate back into inshore waters (Peverell 2007); although it is unclear how far offshore the adults travel as captures in offshore surveys are very uncommon. The species' range is restricted to brackish and salt water (Thorburn *et al*. 2007).

The recovery plan identifies pupping as known to occur in the King Sound, the Cambridge Gulf and 80 Mile Beach, with pupping likely to occur identified at a number of locations along the Pilbara and Kimberly Plan. Under the associated recovery plan all areas where aggregations of individuals have been recorded displaying biologically important behaviours such as breeding, foraging, resting or migrating are considered critical to the survival of the species unless population data suggests otherwise.

The relevant sawfish BIAs in the area of interest are detailed in **Table 5-2** and are shown on **Figure 5-3**.

5.3.5 Green Sawfish

The freshwater sawfish (*Pristis pristis)* and green sawfish (*Pristis zijsron)* are both listed as Vulnerable under the EPBC Act. The freshwater sawfish is listed as a Priority 1 conservation species in WA, while the green sawfish is listed as Vulnerable under the *Biodiversity Conservation Act 2016.*

Both species are wider-ranging than the dwarf sawfish and are also found in the Indo-west Pacific (DoE 2014c, DoE 2014d). Important areas for sawfishes include King Sound, and the Fitzroy, Durack, Robinson and Ord rivers for the freshwater sawfish; and Cape Keraudren for the green sawfish (Stevens *et al*. 2008, Thorburn *et al*. 2007, 2008).

Sawfishes generally inhabit inshore coastal, estuarine and riverine environments. The freshwater sawfish has been recorded in north-west Australia from rivers (including isolated water holes), estuaries and marine environments (Stevens *et al*. 2005). Newborns and juveniles primarily occur in the freshwater reaches of rivers and in estuaries, while most adult freshwater sawfish have been recorded in marine and estuarine environments (Peverell 2005, Thorburn *et al*. 2007). It is believed that mature freshwater sawfish enter less saline waters during the wet season to give birth (Peverell 2005) and freshwater river reaches play an important role as nursery areas (DoE 2014c).

The green sawfish has predominantly been recorded in inshore coastal areas, including estuaries and river mouths with a soft substrate, although there have been records of sawfish offshore in depths up to 70 m (Stevens *et al*. 2005). This species does not occupy freshwater habitats (DoE 2014d).

Short-term tracking has shown that green sawfish appear to have limited movements that are tidally influenced, and they are likely to occupy a restricted range of only a few square kilometres within the coastal fringe, with a strong association with mangroves and adjacent mudflats (Stevens et al. 2008). Sawfishes feed close to the benthos on a variety of teleost fishes and benthic invertebrates, including cephalopods, crustaceans and molluscs (Compagno & Last 1999, Last & Stevens 2009, Pogonoski *et al*. 2002, Thorburn *et al*. 2007, 2008).

The relevant sawfish BIAs in the area of interest are detailed in **Table 5-2** and are shown on **Figure 5-3**.

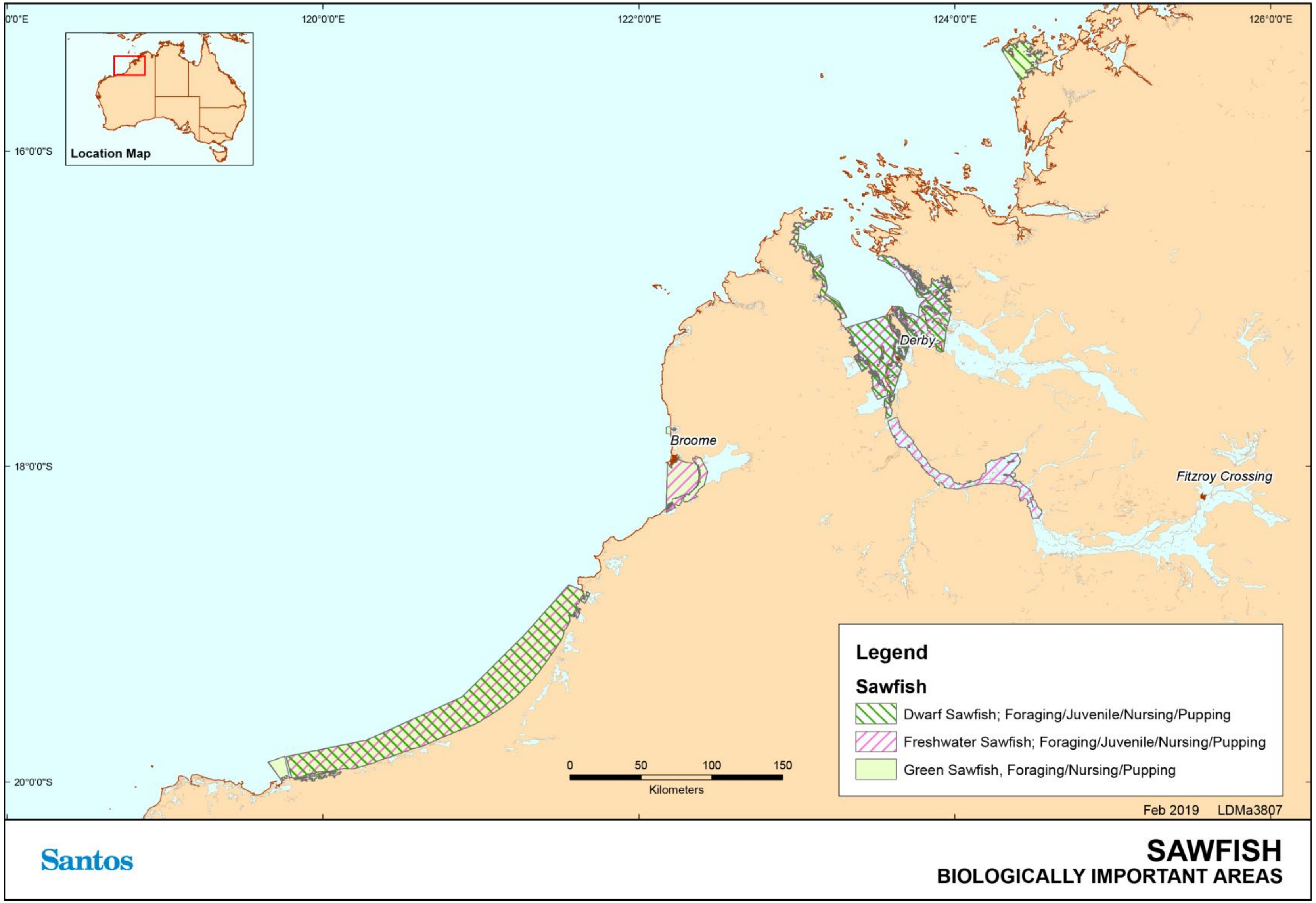


Figure 5-3: Biologically important areas – sawfish

5.3.6 Narrow Sawfish

The narrow sawfish (*Anoxypristis cuspidate*) is listed as Migratory under the EPBC Act. It is a marine or marginal (brackish water) species found from inshore waters to a depth of 40 m (Compagno *et al.* 2006). Though details of its ecology are not precisely known, it probably spends most of its time on or near the bottom in shallow coastal waters and estuaries. A study showed the narrow sawfish to be the most abundant amongst the sawfish sampled in the Gulf of Carpentaria (Peverell, 2005) which holds some consistency with the offshore distribution of the species as shown by a study of Northern Prawn Fishery by-catch. Peverell (2005) also used catch data of offshore surface net fisheries to conclude that narrow sawfish also inhabit the mid-water column and can thus be described as a benthopelagic animal. The narrow sawfish is known to form aggregations of mature females during the months of October to November. Its Australian distribution is unclear though it is most common in the Gulf of Carpentaria with southward ranges extending to Broad Sound in Queensland and the Pilbara Coast (circa 116°E), Western Australia (Last & Stevens, 2009).

5.3.7 Giant Manta Ray / Reef Manta Ray

The giant manta ray appears to be a seasonal visitor to coastal or offshore sites. Giant manta rays are often seen aggregating in large numbers to feed, mate, or clean. Sightings of these giant rays are often seasonal or sporadic but in a few locations their presence is a more common occurrence. This species is not regularly encountered in large numbers and, unlike some other rays do not often appear in large schools (>30 individuals) when feeding. Overall, they are encountered with far less frequency than the smaller manta species, despite having a larger distribution across the globe (IUCN, 2014b).

The giant manta ray occurs in tropical, sub-tropical and temperate waters of the Atlantic, Pacific and Indian Oceans. They are commonly sighted along productive coastlines with regular upwelling, oceanic island groups and particularly offshore pinnacles and seamounts. The giant manta ray is commonly encountered on shallow reefs while being cleaned or is sighted feeding at the surface inshore and offshore. It is also occasionally observed in sandy bottom areas and seagrass beds (IUCN, 2014b).

The Reef manta ray has a circumtropical and sub-tropical distribution, existing in the Pacific, Atlantic and Indian Oceans. Within this broad range, however, actual populations appear to be sparsely distributed and highly fragmented. This is likely due to the specific resource and habitat needs of this species.

Overall population size is unknown, but subpopulations appear, in most cases, to be small (about 100–2,000 individuals). A proportion of the individuals in some populations undertake significant coastal migrations (IUCN, 2016). Since the species is migratory it is possible that individuals may be encountered in the operational area, however, given that they generally don’t aggregate in large groups, high numbers are not expected to be encountered during the activities.

5.3.8 Shortfin Mako and Longfin Mako Sharks

The shortfin mako and longfin mako sharks are listed as Migratory under the EPBC Act. The longfin mako is widely distributed but rarely encountered oceanic shark that ranges from Geraldton around the north coast to at least Port Stephens in New South Wales (DSEWPaC, 2012). The shortfin mako is an oceanic and pelagic species, although they are occasionally seen inshore. They are found throughout temperate seas but are rarely found in waters colder than 16°C.

5.4 Biologically Important Areas / Critical Habitat – Fish

Biologically important areas (BIAs) are spatially defined areas where aggregations of individuals of a species are known to display biologically important behaviour such as breeding, foraging, resting or migration**.** BIA are identified by the DoEE, they have no legal status, but are designed to assist decision making under the EPBC Act. They are not designed to identify protected areas, but may inform such processes. **Table 5-2** below provides an overview of BIAs in the area of interest for fish.

The DoEE may make recovery plans for threated fauna listed under the EPBC Act. The EPBC Act requires that 'habitat critical to the survival of the listed threatened species' is identified in recovery plans, relevant recovery plans are listed in **Section 13.2**. BIAs may overlap these sites, but may be identified for other purposes. DoEE state that the criteria used to identify 'habitat critical to the survival of the species' are more complex than those used it identify BIA.

In addition, both the EPBC Act and WA Biodiversity Conservation Act 2016 and associated regulations (2018) provide for the listing of critical habitat - habitat 'critical to the survival of the threatened species'. To date no critical habitat in WA has been listed under either Act.

Refer to the *Reindeer Wellhead Platform & Offshore Gas Supply Pipeline Operations Environment Plan* for species' BIAs within the EMBA and Operational Area.

Table 5-2: Biologically important areas - fish

Species	Scientific name	Aggregation area and use	Specific geographic locations for species
Great white shark	*Carcharodon carcharias*	Foraging – associated with pinniped colonies in the mid-west and south west	Waters off pinniped colonies throughout the South-west Marine Region
Whale shark	*Rhincodon typus*	Foraging – Ningaloo Reef	Ningaloo Marine park and adjacent Commonwealth waters Northward from Ningaloo along 200 m isobath
Dwarf sawfish	*Pristis clavata*	Foraging – Eighty Mile Beach, King Sound, Camden Sound Nursing - Eighty Mile Beach, King Sound, Fitzroy River & May Robinson River Pupping – Eighty Mile Beach, King Sound, Fitzroy River & May Robinson River Juvenile – King Sound, Fitzroy River & May Robinson River	Eighty Mile Beach Camden Sound - eastern shore Fitzroy River Mouth, May & Robinson River - tidal tributaries King Sound (Inshore waters)
Green sawfish	*Pristis zijsron*	Pupping – Cape Keraudren, Eighty Mile Beach, Roebuck Bay, Willie Creek, Cape Leveque Foraging - Cape Keraudren, Roebuck Bay, Cape Leveque, Camden Sound Nursing - Cape Keraudren, Eighty Mile Beach	Eighty Mile Beach Camden Sound Cape Keraudren Cape Leveque Roebuck Bay Willie Creek

6. Marine Reptiles

Thirty-two species of listed marine reptiles under the Commonwealth *EPBC Act 1999* are known to occur in Australian waters in the area of interest, according to the Protected Matters search (**Appendix A**). An examination of the species profile and threats database (DoEE 2018) showed that some listed reptile species are not expected to occur in significant numbers in the marine and coastal environments in the area of interest due to their terrestrial distributions. Hence, these species are not discussed further.

Of the remaining reptile species identified in the Protected Matters search of the area of interest (**Appendix A**), eight are listed as threatened and seven are listed as migratory. These species are shown in **Table 6-1** along with their WA conservation listing (as applicable)[3]. BIAs within the area of interest area discussed in **Table 6-3.** Refer to the *Reindeer Wellhead Platform & Offshore Gas Supply Pipeline Operations Environment Plan* for Protected Matters searches of the EMBA and Operational Area.

Table 6-1: EPBC listed marine reptile species in the area of interest

Species	Conservation Status		Likelihood of occurrence in area of interest	Biologically important area in area of interest
	Environment Protection and Biodiversity Conservation Act 1999	*Biodiversity Conservation Act 2016*		
Green turtle *Chelonia mydas*	Vulnerable Migratory	Vulnerable	Breeding known to occur within area	Yes – refer to **Table 6-3**
Flatback turtle *Natator depressus*	Vulnerable Migratory	Vulnerable	Breeding known to occur within area	Yes – refer to **Table 6-3**
Hawksbill turtle *Eretmochelys imbricata*	Vulnerable Migratory	Vulnerable	Breeding known to occur within area	Yes – refer to **Table 6-3**
Loggerhead turtle *Caretta*	Endangered Migratory	Endangered	Breeding known to occur within area	Yes – refer to **Table 6-3**
Olive Ridley turtle *Lepidochelys olivacea*	Endangered Migratory	Endangered	Foraging feeding or related behaviour known to occur within area	Yes – refer to **Table 6-3**
Leatherback turtle *Dermochelys coriacea*	Endangered Migratory	Vulnerable	Foraging feeding or related behaviour known to occur within area	Yes – refer to **Table 6-3**
Short-nosed seasnake *Aipysurus apraefrontalis*	Critically Endangered	Critically Endangered	Species or species habitat known to occur within area	None - No BIA defined
Leaf-scaled seasnake *Aprasia rostrate rostrata*	Critically Endangered	Critically Endangered	Species or species habitat known to occur within area	None - No BIA defined

[3] An overview of WA fauna conservation codes is provided in **Section 5** (fish and sharks).

The Protected Matters search of the *Reindeer Wellhead Platform & Offshore Gas Supply Pipeline Operations Environment Plan* EMBA did not identify the Olive Ridley turtle nor leaf-scaled seasnake, hence these species have not been described in the sections below.

6.1 Marine Turtles

Six species of marine turtle occur in, use the waters, and nest on sandy beaches in Western Australia. These are the green turtle (*Chelonia mydas*), flatback turtle (*Natator depressus*), hawksbill turtle (*Eretmochelys imbricata*), loggerhead turtle (*Caretta caretta*), Olive Ridley turtle (*Lepidochelys olivacea)* and leatherback turtle (*Dermochelys coriacea*) (**Table 6-1**).

These six species are listed on the EPBC Act List of Threatened Species as either 'endangered' or 'vulnerable' and all six species are also listed as 'migratory'. They are also listed as threatened species under the *Biodiversity Conservation Act 2016.*

A summary of the different habitat types used during the various life stages of marine turtle species identified in the area of interest is given in **Table 6-2.**

Table 6-2: Summary of habitat types for the life stages of the six marine turtle species in the area of interest (DSEWPaC, 2012b)

Life Stage		Green turtle	Flatback turtle	Hawksbill turtle	Loggerhead turtle	Leatherback turtle
Post-hatchling		Open ocean pelagic habitats (poorly studied for Australian populations)	Coastal waters (poorly studied for Australian populations)	Open ocean pelagic habitats (poorly studied for Australian populations)	Pelagic (poorly studied for Australian populations)	Pelagic (no data for Australian populations)
Adult	Mating	Offshore from nesting beaches.	Currently unknown for North West Shelf region.	Offshore from nesting beaches.	Little is known for North West Shelf region but expected to occur either en-route or adjacent to nesting beaches.	Not recorded within North West Shelf region.
	Nesting	Typically, high energy, steeply sloped beaches with deep sand and deep water approach.	Typically, low-energy beaches that are narrow with a low to moderate slope. Beach approach obstructed by broad intertidal mud or limestone platforms.	Typically beaches close to nearshore coral reefs and sediment comprised of coarse sand and coral rubble.	Poorly studied for North West Shelf region by generally prefer high energy, relatively narrow, steeply sloped, coarse-grained beaches.	Not recorded within North West Shelf region.
	Internesting	Shallow coastal waters within several kms of nesting beach. Inter-nesting buffers of 20 km identified around all nesting habitats	Shallow nearshore waters within 5-60 km of nesting beach. Inter-nesting buffers of 40-60 km identified around all nesting habitats	Shallow coastal waters within several kms of nesting beach. Inter-nesting buffers of 20 km identified around all nesting habitats	Shallow coastal waters within several kms of nesting beach. Inter-nesting buffers of 20 km identified around all nesting habitats	Not recorded within North West Shelf region.
	Foraging	Neritic habitats associated with seagrass and algae, and mangrove habitats.	Turbid, shallow inshore waters, subtidal, soft-bottomed habitats of the continental shelf.	Subtidal and intertidal coral and rocky reef habitats of the continental shelf.	Subtidal and intertidal coral and rocky reefs, seagrass and deeper soft-bottomed habitats of the continental shelf.	Mostly pelagic but will forage close to shore and over continental shelf in temperate waters.

6.1.1 Loggerhead Turtle

The loggerhead turtle (*Caretta caretta*) has a worldwide distribution, living and breeding in subtropical to tropical locations (Limpus 2008). Breeding aggregations in Australia occur on both the east coast (Queensland and NSW) and the west. The annual nesting population in Western Australia is thought to be 3,000 females annually (Baldwin *et al*. 2003), and this is considered to support the third largest population in the world (Limpus 2008).

The WA distribution of sandy beach nesting areas extends from Shark Bay to the southern area of the NWS, with occasional late summer nesting crawls recorded as far north as Barrow and Varanus Island and the Lowendal and Rosemary Islands (DSEWPaC 2012d). Major nesting locations include the Muiron Islands, the Ningaloo Coast south to Carnarvon and the islands around Shark Bay, which includes Dirk Hartog Island, one of the principal nesting and inter-nesting sites in WA (Limpus 2008). The Recovery Plan for Marine Turtles in Australia (2017) identifies the Muiron Islands (as a principal rookery), and all waters within a 20 km radius as habitat critical to the survival of loggerhead turtles.

Estimates of up to 5,000 female loggerhead turtles have been predicted within the Ningaloo Marine Park and Muiron Islands Marine Management Area (Waayers 2010). Earlier surveys found higher proportions of nesting loggerheads in the southern areas of the reserves (CALM 2005a). Aerial surveys conducted in 2000 and 2001 in the Exmouth region recorded only 12 sightings in Commonwealth waters and these turtles were most likely loggerheads (BHP 2005). In a survey commissioned by Santos WA around the islands in the Exmouth Region, loggerhead turtles were recorded nesting on Flat Island north of the Exmouth Gulf which was the first time they had been recorded in that location (Astron 2014).

Loggerhead nesting and breeding occurs from November to March, with a peak in late December/ early January (Limpus 2008). However, there is variability each year as illustrated in a study by Santos WA (Astron 2014) around the islands in the Exmouth Region where higher numbers of nesting turtles were recorded in October 2013 than in the subsequent January 2014 surveys.

Foraging areas are widespread for loggerhead turtle populations and migrations from nesting to feeding grounds can stretch thousands of kilometres, including feeding grounds as far north as the Java Sea of Indonesia for the WA population (Limpus 2008). Shark Bay has been identified as a critical feeding habitat for loggerhead turtles (Environment Australia 2003). Loggerhead turtles are carnivorous and feed primarily on benthic invertebrates from depths of up to approximately 50 m to near shore tidal areas including areas of rocky and coral reef, muddy bays, sand flats, estuaries and seagrass meadows (Limpus 2008).

Figure 6-1 illustrates the BIAs and critical habitats (draft) for loggerhead turtles (as defined in the Recovery Plan for Marine Turtles in Australia (Commonwealth of Australia 2017)).

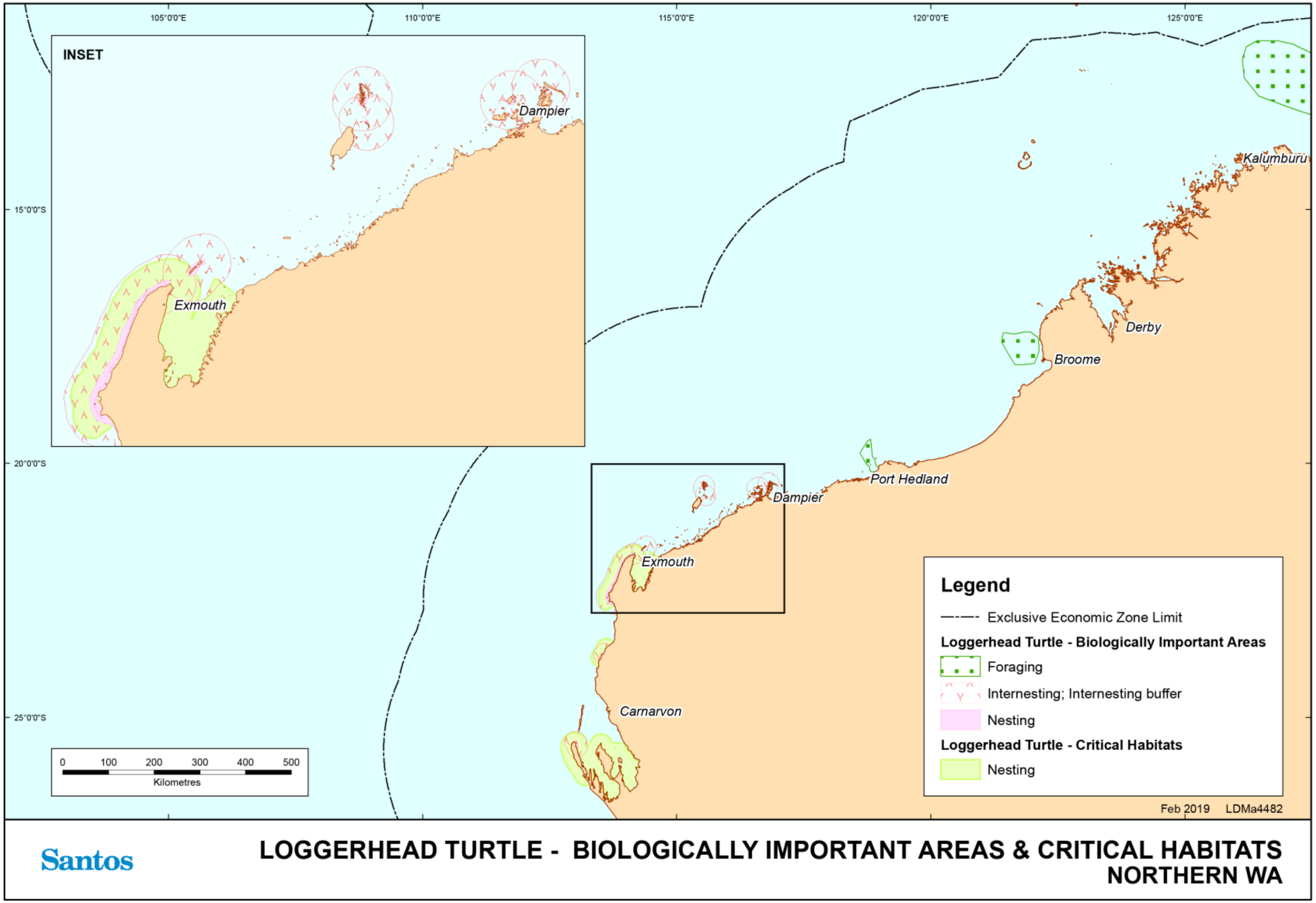


Figure 6-1: Biologically Important Areas and Critical Habitats – Loggerhead Turtle

6.1.2 Green Turtle

Australian population of green turtles is estimated to be approximately 70,000 and is divided into seven genetically distinct breeding aggregations. The species is widespread and abundant in WA waters with an estimated 20,000 individuals occurring, arguably the largest population in the Indian Ocean (Limpus 2008b). There are three distinct breeding stocks in western Australian waters which include: the North West Shelf (NWS) stock, the Scott Reef stock and the Ashmore Stock (Dethmers *et al*. 2006, Limpus 2008a).

The NWS population is one of the largest in the world and the most significant rookery is the western side of Barrow Island (Prince 1994, Limpus 2008a). Other principal rookeries include the Lacepede Islands, Montebello Islands, Dampier Archipelago, Browse Island and North West Cape (Prince 1994, Limpus 2008a, DSEWPaC 2012b). See **Table 6-3** for a complete list.

Surveys by Waayers (2010) within the Ningaloo Marine Park and Muiron Islands Marine Management Area estimated up to 7,500 female green turtles used these areas. In 2014, Santos WA commissioned a survey of the islands in the Exmouth Region which found that North and South Muiron Islands were significant nesting sites for green turtles with over 100 green turtles nesting overnight on one beach at North Muiron Island (Astron 2014). The green turtle is also known to breed in large numbers in the dunes above the extensive beaches found on Serrurier Island, with counts indicating the island supports the second largest rookery in the Pilbara (Oliver 1990).

Lower density green turtle nesting has also been recorded on Jurabi coast, Thevenard Island, Lowendal Islands and in Exmouth Gulf (Limpus 2008a). Only low numbers of green turtles have been observed nesting on Varanus Island, as well as Airlie Island (Pendoley Environmental 2011). From monitoring undertaken in 2016/17 by Santos WA on Varanus Island; three green turtles were observed to nest over a four week tagging effort (Astron 2017).

Green turtle nesting abundance and timing fluctuates significantly from year to year depending on environmental variables, locality and food availability (Pendoley Environmental 2011). Nesting of green turtles has been recorded from August to March on Serrurier Island (Woodside 2002), from December to March along coast adjacent to Ningaloo (CALM 2005a) and from October to February on Varanus Island (Pendoley Environmental 2011). On Barrow Island, mating aggregations may commence from October with peak nesting from December to January, with hatchlings emerging through summer and early autumn. However, nesting on Barrow Island has been recorded all year round (Chevron 2005 and 2008, Pendoley 2005). Nesting on the Scott Reef-Sandy Islet and Browse Island has been observed all year round with peaks between December and January (Commonwealth of Australia 2017). The re-nesting period for female green turtles is approximately five years (Hamann *et al*. 2002).

Green turtles spend the first five to ten years of their life drifting on ocean currents, before moving to reside in shallower benthic habitats, including tropical coral and rocky reefs and seagrass beds. Green turtles have been known to migrate more than 2600 km between feeding and breeding grounds (Limpus 2008a).

Green turtles are omnivores, mainly feeding in shallow benthic habitats on seagrass and/ or algae, but are also known to feed on sponges, jellyfish and mangroves (Limpus 2008a). Green turtles are unlikely to forage or dwell within deeper off shore waters due to the water depths; however, they may occasionally migrate through it.

Figure 6-2 illustrates the BIAs and critical habitats (draft) for green turtles (as defined in the Recovery Plan for Marine Turtles in Australia (Commonwealth of Australia 2017)).

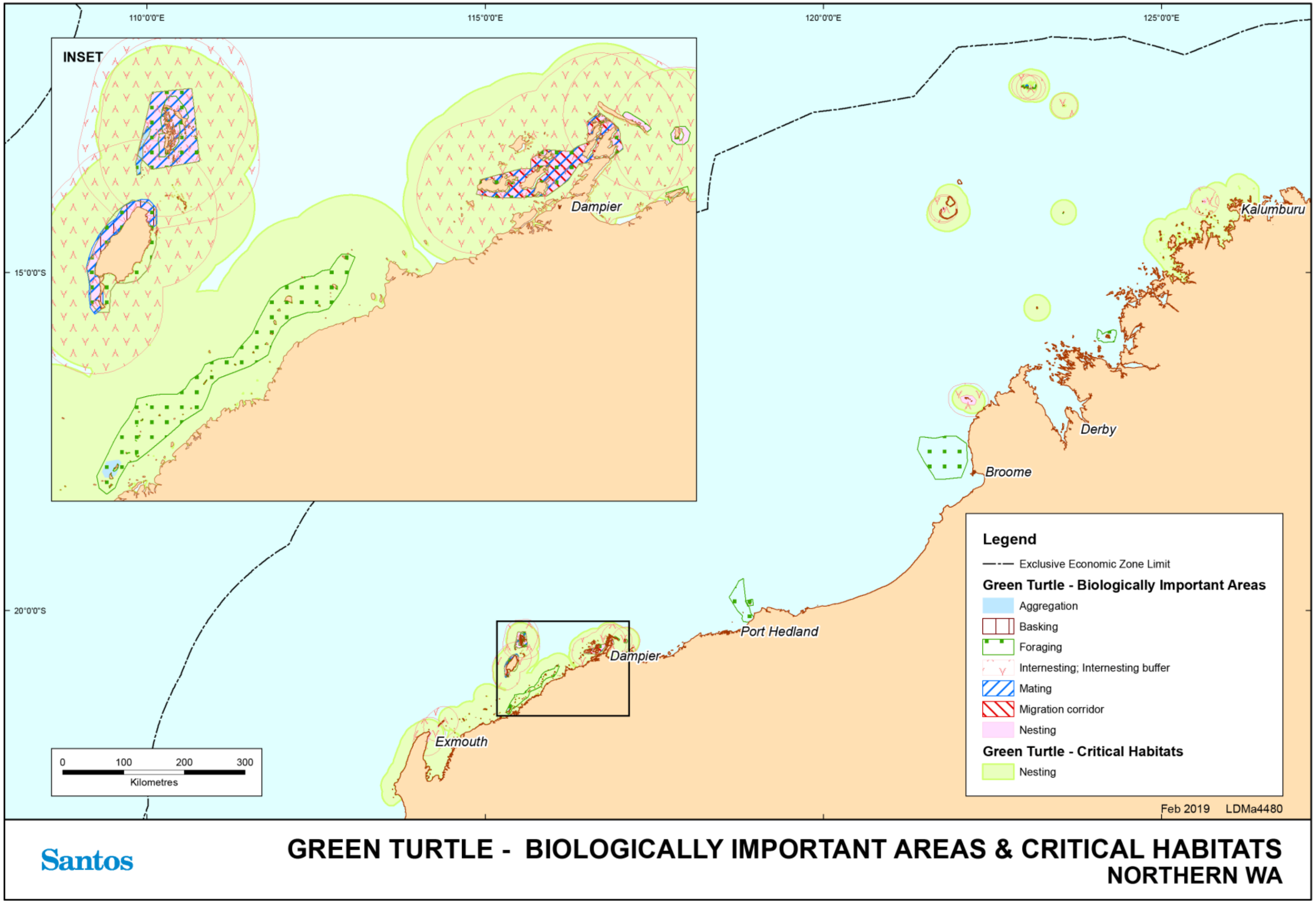


Figure 6-2: Biologically Important Areas and Critical Habitats – Green Turtle

6.1.3 Hawksbill Turtle

Hawksbill turtles (*Eretmochelys imbricata*) have a global distribution throughout tropical and sub-tropical marine waters. The Western Australian stock is concentrated on the NWS (Dampier Archipelago) (Limpus 2009a), and is considered to be one of the largest hawksbill populations remaining in the world. The estimated number of nesting hawksbill turtles in WA waters is between 2,000 and 4,500 individuals (Morris 2004).

In WA, their nesting range is relatively small and extends from the Muiron Islands to the Dampier Archipelago, a distance of approximately 400 km. The most significant breeding areas, that support hundreds of nesting females annually, are around sandy beaches within the Dampier Archipelago, Montebello Islands, Lowendal Islands and Barrow Island (Pendoley 2005, Limpus, 2009a).

The largest known nesting area for the NWS population is the sandy shoreline of Rosemary Island, within the Dampier Archipelago, particularly on the north-western side of the Island. It is believed that the Rosemary Island rookery may support up to 1,000 nesting females annually (Limpus 2009). Low density nesting is also known from Barrow Island, Airlie Island, Muiron Islands and North West Cape/ Ningaloo coast (Cape Range) (Limpus 2009a). Nesting hawksbills have also been found on NE Regnard Island and SW Regnard Island, confirming the Regnard Islands as hawksbill rookeries (Pendoley Environmental 2009).

The hawksbill turtle nesting population within the Exmouth region is also considered important as the populations in Western Australia represent the largest remaining population in the Indian Ocean (CALM 2005). The best estimate of numbers within the Ningaloo Marine Park and Muiron Islands Marine Management Area is between 20–700 individuals (Waayers 2010).

A snapshot survey of Varanus Island and the Lowendal Islands conducted for Santos WA during October 2012 found the five most frequented beaches by hawksbills, based on the track counts, were Beacon Island (*n*=43), Parakeelya (*n*=41), Kaia (*n*=40), Rose (*n*=30) and Pipeline (*n*=28). Results of the October 2012 three-day track census program showed that Beacon Island also hosted the highest daily number of overnight emergences by hawksbills and is therefore an important nesting beach for hawksbill turtles (Pendoley Environmental 2013).

On Varanus Island, hawksbills tend to nest in greater numbers on the eastern beaches (Pipeline Beach, Harriet Beach, and Andersons Beach) (Pendoley Environmental 2013). Between 1986 and 1999, approximately 350 individual hawksbills were tagged on Varanus Island (Apache 1999). Since 2005/2006 and 2012/2013 a total of 77 new turtles have been tagged, and 221 turtles recorded nesting, with the maximum of nesting turtles (42) tagged in 2008/2009 (Pendoley Environmental 2013). The turtle tagging program on Varanus Island in the 2012–2013 breeding season reported 17 hawksbills and six were newly tagged. Pipeline Beach remained the most frequented beach on Varanus Island (Pendoley Environmental 2013). Associated with monitoring efforts and results in 2016/17; the mean population estimate for hawksbill turtles stand at 289 (+/- 33), calculated from 16 seasons (Astron 2017). From 2016/17 monitoring, Pipeline Beach and Anderson Beach were still the more frequented beaches for hawksbill nesting, with hatch and emergence success reported within ranges for other hawksbill rookeries (Limpus 2009, Robinson 1990; cited in Astron 2017). The modelled hawksbill turtle population on Varanus Island has shown an increasing trend between 2012/13 and 2016/17 (Astron 2017).

Nesting is reported to occur between October and February in WA (Commonwealth of Australia 2017). Hawksbill turtles have been observed breeding on the NWS between July and March with peak nesting activity around the Lowendal Islands between October and December (Limpus 2009a).

Female hawksbills skip annual breeding opportunities (Kendall & Bjorkland 2001), presumably due to high energy demands of breeding (Chaloupka & Prince 2012).

Individuals may migrate up to 2,400 km between their nesting and foraging grounds (DSWEPaC 2012a). Satellite tracking of nesting turtles on Varanus Island (32 km) and Rosemary Island has shown adult turtles to feed between 50 and 450 km from their nesting beaches (DSWEPaC 2012a).

Adults tend to forage in tropical tidal and sub-tidal coral and rocky reef habitat where they feed on an omnivorous diet of sponges, algae, jelly fish and cephalopods (DSWEPaC 2012a). Hawksbill turtles are unlikely to spend significant time within off shore waters as it is too deep to act as a feeding ground. However, it is likely they may migrate through those areas.

Figure 6-3 illustrates the BIAs and critical habitats (draft) for hawksbill and olive ridley turtles (as defined in the Recovery Plan for Marine Turtles in Australia (Commonwealth of Australia 2017)).

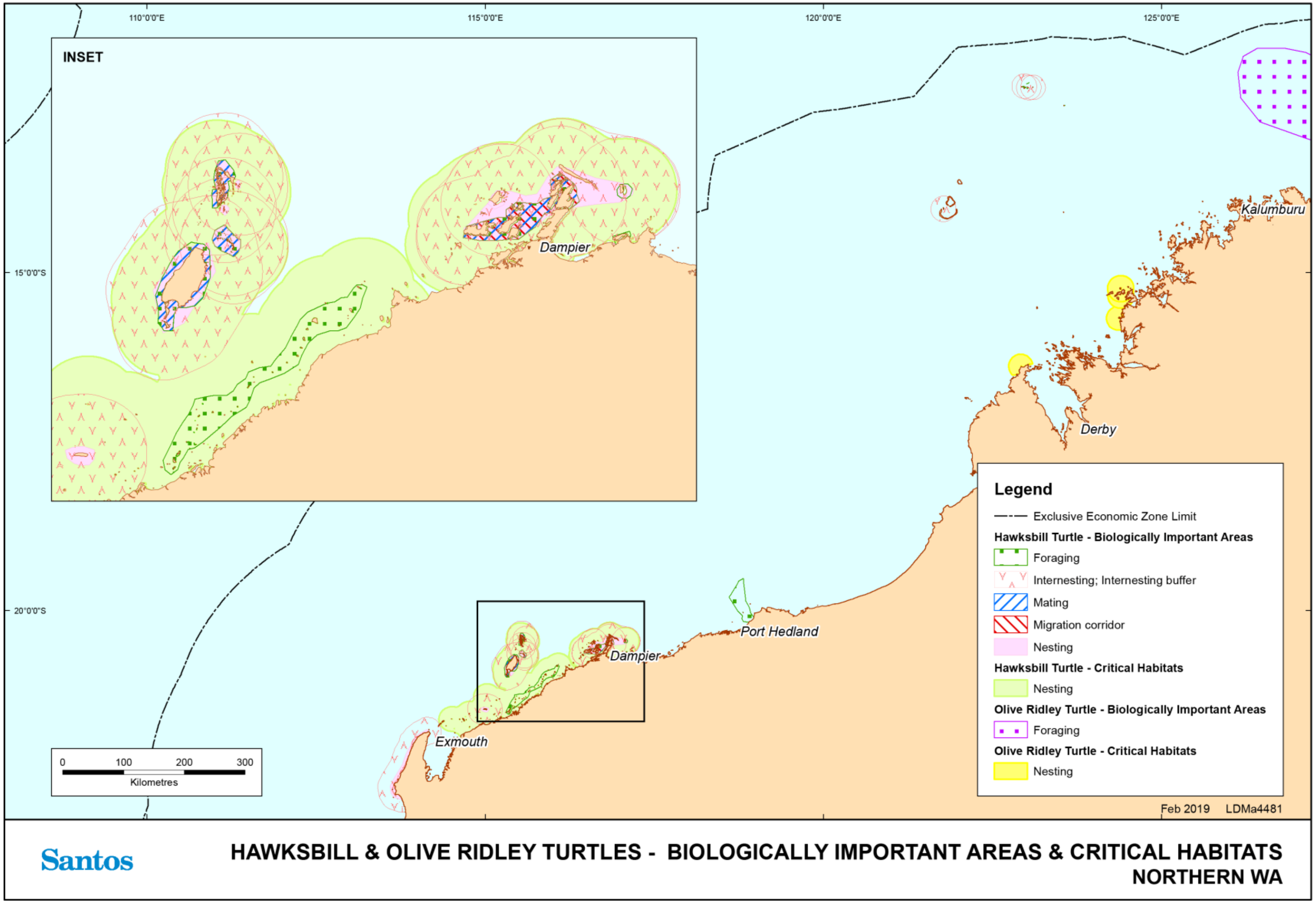


Figure 6-3: Biologically Important Areas and Critical Habitats – Hawksbill and Olive Ridley Turtle

6.1.4 Flatback Turtle

The flatback turtle (*Natator depressus*) has an Australasian distribution, with all recorded nesting beaches occurring within tropical to sub-tropical Australian waters. One third of the total breeding for the species occurs in Western Australia (WA) (Limpus, 2007). The management of the flatback turtle in Australia is broken up into four breeding units, with WA supporting two of these. The southern stock nests throughout the North West shelf (NWS) and is characterised by summer nesting, and the northern stock at Cape Domett which breeds mainly in winter (Limpus 2007).

The southern WA nesting population of flatback turtles occurs from Exmouth to the Lacepede Islands off the Kimberley coast (DSEWPaC 2012d). On the NWS, significant rookeries are centred on Barrow Island especially the east coast beaches (DSEWPaC 2012b).

Montebello Islands, Thevenard Island, Varanus Island, the Lowendal Islands, King Sound and Dampier Archipelago are also significant rookeries (Pendoley 2005, Limpus 2007, Pendoley Environmental 2011). Nesting is also widespread along the mainland beaches from Mundabullangana on the Pilbara coast north, including Cemetery Beach near Port Hedland, Eighty Mile Beach and to Broome (Limpus 2007, DSEWPaC 2012b).

There have been occasional records of nesting by flatback turtles on the Jurabi Coast and Muiron Islands (CALM 2005). During turtle surveys for Santos WA flatback turtle nesting was recorded on Bessieres Islands (Astron 2014), Serrurier, Flat, Table and Round Island in previous surveys (Pendoley Environmental 2009). Flatback turtle tracks have been seen on Forty Mile beach and evidence of flatback nesting was recorded on the same beach the next day (Pendoley Environmental 2009).

Previously the status of the flatback population(s) was undetermined and although not well quantified, it was estimated to be many thousands of females (Limpus 2007). However, Pendoley *et al*. (2014) reported both Barrow Island and Mundabullangana flatback turtles as substantial reproductive populations with 4,000 and 3,500 turtles tagged at each location between 2006/2006 and 2010/2011. Cemetery beach at Port Headland had approximately 350 turtles were tagged over two seasons of monitoring (2009/2010 and 2011/12).

Satellite tracking of adult (female) flatback turtles shows they use a variety of inshore and offshore marine areas off the east and west coasts of Barrow Island. Females inter-nest close to their nesting beaches, typically in 0–10 m of water (Chevron 2008). However, flatback turtles also travel approximately 70 km and inter-nest in shallow nearshore water off the adjacent mainland coast, before returning to Barrow Island to lay another clutch of eggs. The average inter-nesting period is 13–16 days.

From long-term tagging studies on Varanus Island and Pendoley's observations, it would appear that the nesting season for flatback turtles peaks in December and January with subsequent peak hatchling emergence in February and March. Flatbacks have been observed to nest on Varanus Island between November and February (Chevron 2008, Pendoley Environmental 2011 & 2013). Population monitoring of flatback turtles on Varanus Island, calculated from 16 seasons, indicates a mean population estimate of 226 (+/- 97). Modelled Flatback turtle populations have shown a slight decline from 2008/09 to 2016/17, which is considered to be part of fluctuations in the natural cycle (Astron 2017). Flatback turtles tend to nest on all beaches on Varanus Island (Astron 2017). Flatback hatching and emergence success is noted as higher compared to that reported for other Western Australian rookeries (Pendoley et al. 2014; cited Astron 2017).

Unlike other sea turtles, the flatback turtle lacks a wide oceanic dispersal phase and adults tend to be found in soft sediment habitats within the continental shelf of northern Australia (DSEWPaC 2012b). Little information is known on the diets of flatback turtles (DSEWPaC 2012b), however, they are believed to forage on primarily soft-bodied invertebrates (Commonwealth of Australia 2017).

Figure 6-4 illustrates the BIAs and critical habitats (draft) for flatback turtles (as defined in the Recovery Plan for Marine Turtles in Australia (Commonwealth of Australia 2017)).

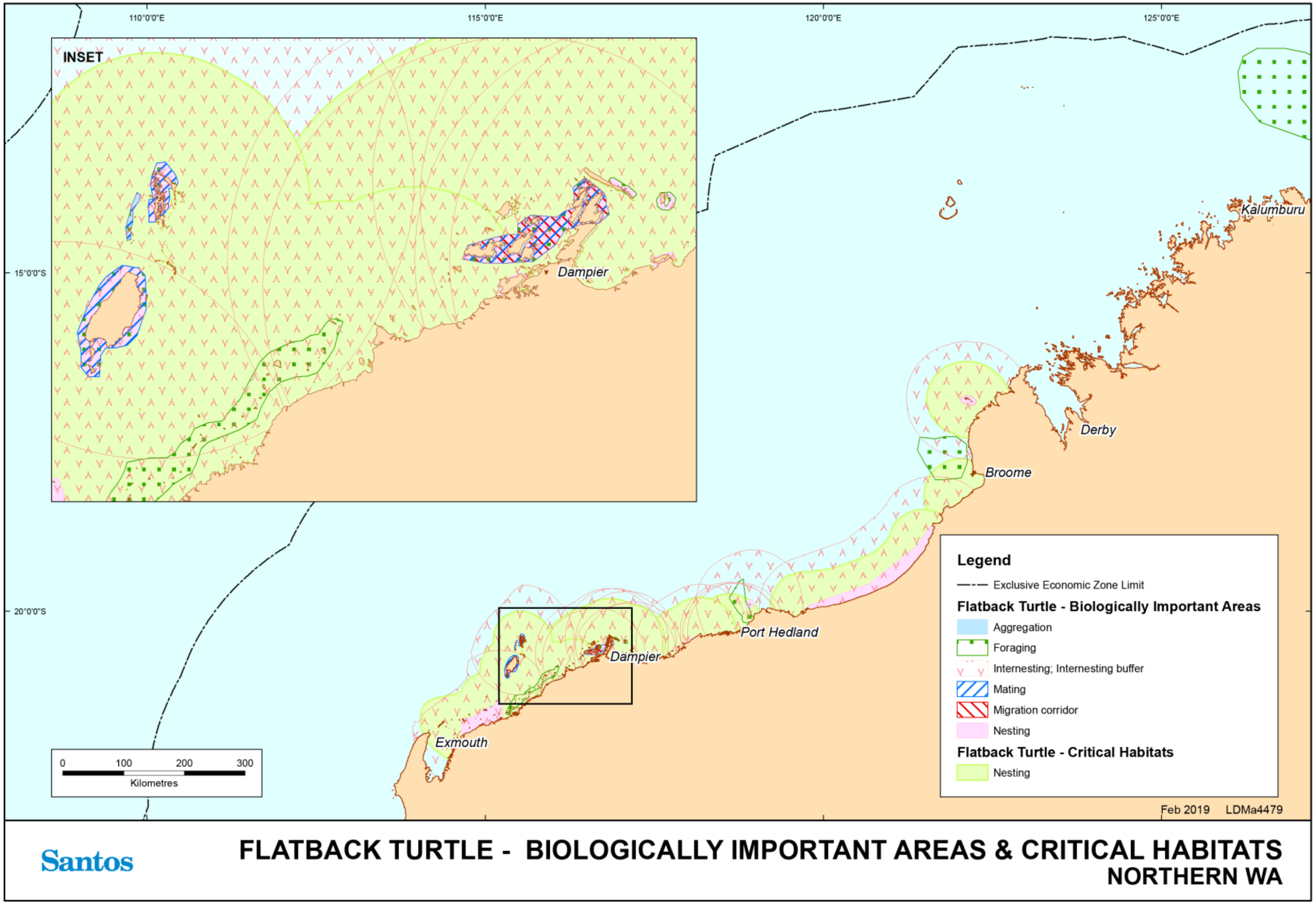


Figure 6-4: Biologically Important Areas and Critical Habitats – Flatback Turtle

6.1.5 Leatherback Turtle

The leatherback turtle (Dermochelys coriacea) has the widest distribution of any marine turtle, and can be found from tropical to temperate waters throughout the world (Márquez 1990). There are no major leatherback turtle centres of nesting activity that have been recorded in Australia, although scattered isolated nesting (one to three nests per annum) occurs in southern Queensland and the Northern Territory (Limpus and McLachlin 1994).

There have been several records of leatherback turtles off of the coast of WA, but no confirmed nesting sites (Limpus 2009b). Turtle observations have mainly occurred south of the NWS area and in open waters (>200 m deep) (Limpus 2009b). Due to the lack of nesting sites around Australian coastal waters, it is presumed that Leatherback turtles observed in Australian waters are migrating from neighbouring countries to utilise feeding grounds in Australia (Limpus 2009b).

The leatherback turtle will feed at all levels of the water column and is carnivorous feeding mainly on pelagic, soft-bodied marine organisms such as jellyfish, which occur in greatest concentrations in areas of upwelling or convergence (DSEWPaC 2012d). The leatherback turtle is a highly pelagic species with adults only going ashore to breed.

No leatherback turtle BIAs or critical habitats (draft) are found within the area of interest.

6.2 Seasnakes

Storr *et al*. (1986) estimate nine genera and 22 species of sea snakes occur in WA waters, with 25 listed marine seasnake species being recorded in the search area **Appendix A**. Little is known of the distribution of individual species, population sizes or aspects of their ecology. Sea snakes are essentially tropical in distribution, and habitats reflect influences of factors such as water depth, nature of seabed, turbidity and season (Heatwole and Cogger 1993). Sea snakes and kraits are widespread throughout waters of the NWS in offshore and nearshore habitats. They can be highly mobile and cover large distances or they may be restricted to relatively shallow waters and some species must return to land to eat and rest. In the north-west region of Western Australia, no BIAs have been designated for sea snakes. However, both Ashmore Reef and Cartier Island are characterized for both a high density and high diversity of sea snakes (DSEWPaC 2012b).

Two species of seasnakes listed as threatened under the EPBC Act were identified in the Protected Matters search of the area of interest (**Appendix A**):

+ Short-nosed seasnake (*Aipysurus apraefrontalis*); and
+ Leaf-scaled seasnake (*Aipysurus foliosquama*).

6.2.1 Short-nosed Seasnake

The short-nosed seasnake (*Aipysurus apraefrontalis*) is listed as critically endangered under the EPBC Act and the *Biodiversity Conservation Act 2016.* It is a fully aquatic, small snake and is endemic to WA. It has been recorded from Exmouth Gulf, WA to the reefs of the Sahul Shelf, in the eastern Indian Ocean. This species is believed to show strong site fidelity to shallow coral reef habitats in less than 10 m of water, with most specimens having been collected from Ashmore and Hibernia reefs (Minton & Heatwole 1975, Guinea and Whiting 2005).

The species prefers the reef flats or shallow waters along the outer reef edge in water depths to 10 m (McCosker 1975, Cogger 2000). The species has been observed during daylight hours, resting beneath small coral overhangs or coral heads in 1–2 m of water (McCosker 1975). Guinea and Whiting (2005) reported that very few short-nosed seasnakes moved even as far as 50 m away from the reef flat and are therefore unlikely to be expected in high numbers in off shore, deeper waters.

6.3 Biologically Important Areas/Critical Habitats – Marine Reptiles

Table 6-3 provides an overview of BIAs in the area of interest for reptiles, as identified by the DoEE (Cwth) and critical habitats identified in associated recovery plans. The DoEE may make recovery plans for threated fauna listed under the EPBC Act. The EPBC Act requires that 'habitat critical to the survival of the listed threatened species' is identified in recovery plans, relevant recovery plans are listed in **Section 13.2**[4].

In addition, both the EPBC Act and WA Biodiversity Conservation Act 2016 and associated regulations (2018) provide for the listing of critical habitat - habitat 'critical to the survival of the threatened species'. To date no critical habitat in WA has been listed under either Act.

Refer to the *Reindeer Wellhead Platform & Offshore Gas Supply Pipeline Operations Environment Plan* for species' BIAs within the EMBA and Operational Area.

[4] Further background information on BIA and identification of critical habitat in recovery plans is provided in Section 5.4

Table 6-3: Biologically important areas/critical habitats and geographic locations - reptiles

Species	Scientific name	Aggregation area and use	Biologically important areas within area of interest	Critical habitats within area of interest
Loggerhead turtle	*Caretta caretta*	Nesting, migration, foraging and internesting – Islands and coastline of the Kimberley region and islands of the North West Shelf	Cohen Island De Grey River Dirk Hartog Island Gnarloo Bay James Price Point Lowendal Island Montebello Island Murion Island Ningaloo Coast and Jurabi coast Rosemary Island Western Joseph Bonaparte Depression	Exmouth and Ningaloo coast Gnaraloo Bay and beaches Shark bay, all coastal and island beaches out the to the northern tip of Dirk Hartog Island
Green turtle	*Chelonia mydas*	Nesting, migration foraging and internesting – Offshore islands in the Browse Basin, North West Shelf and Kimberley/Pilbara coastlines Mating/nesting – Dampier Archipelago Basking – Middle Island	Ashmore Reef Barrow Island Browse Island Cartier Island Cassini Island Coral reef habitat west of the Montebello group. Extends the entire length of Montebellos Dampier Archipelago (islands to the west of the Burrup Peninsula) De Grey River area to Bedout Island Delambre Island Dixon Island	Mainland east of Mary island to mainland adjacent to Murrara Island including all offshore islands Ashmore Reef and Cartier Reef Browse Island Scott Reef Adele Island Lacepede Island Dampier Archipelago Barrrow Island Montebello Islands

Species	Scientific name	Aggregation area and use	Biologically important areas within area of interest	Critical habitats within area of interest
			Greens - inshore tidal and shallow subtidal areas around Barrow Island Hawksbills - shallow water coral reef and artificial reef (pipeline) habitat James Price Point Lacepede Island Legendre Island, Huay Island Middle Is. West Coast Barrow Island West Coast and North Coast Montebello Island - Hermite Island, NW Island, Trimouille Island Montebello Islands Montgomery Reef North and South Muiron Island North Turtle Island North West Cape Scott Reef Scott Reef - Sandy Islet Seringapatam Reef String of islands between Cape Preston and Onslow, inshore of Barrow Is	Serrier Island and Thevenard Island Exmouth Gulf and Ningaloo Coast
Hawksbill turtle	*Eretmochelys imbricata*	Nesting, migration, foraging and internesting – Offshore islands in the Browse Basin, North West Shelf and Kimberley/Pilbara coastlines Mating/nesting/internesting – Lowendal group, Montebello Islands	Ah chong and South East Is Ashmore Reef Barrow Island Cartier Island Dampier Archipelago (islands to the west of the Burrup Peninsula) De Grey River area to Bedout Is Delambre Island	Cape Preston to mouth of Exmouth Gulf (including Montebello Islands and Lowendal Islands) Dampier Archipelago (including Delambre Island and Rosemary Island)

Species	Scientific name	Aggregation area and use	Biologically important areas within area of interest	Critical habitats within area of interest
			Delambre Island (and other Dampier Archipelago Islands) Greens - inshore tidal and shallow subtidal areas around Barrow Island Hawksbills - shallow water coral reef and artificial reef (pipeline) habitat Lowendal Island Group Montebello Island - Hermite Island, NW Island, Trimouille Island Montebello Island, Trimoulle and NW islands Ningaloo coast and Jurabi coast Rosemary Island Scott Reef String of islands between Cape Preston and Onslow, inshore of Barrow Island Thevenard Island Varanus Island	
Flatback turtle	*Natator depressus*	Nesting, migration, foraging, internesting – Islands of the North West Shelf and the Pilbara/Kimberley coastlines Mating, nesting – Barrow Island	Eighty Mile beach Barrow Island Cape Domett Cape Thouin/ Mundabullangana/Cowrie Beach Coral reef habitat west of the montebello group. Extends the entire length of Montebellos Dampier Archipelago (islands to the west of the Burrup Peninsula) De Grey River area to Bedout Is Delambre Island Dixon Island Holothuria Zone (Northern Kimberley, Holothuria Banks)	Cape Domett and Lacrosse Island Lacepede Islands Eighty Mile beach Cemetary beach Eco Beach Mundabullangana Beach Dampier Archipelago Barrow Island, Montebello Island, coastal islands from Cape Preston to Locker Island

Species	Scientific name	Aggregation area and use	Biologically important areas within area of interest	Critical habitats within area of interest
			Intercourse Island James Price Point Lacepede Island Legendre Island, Huay Is Montebello Island - Hermite Island, NW Island, Trimouille Island North Turtle Island Port Hedland, Cemetery Beach Port Hedland, Paradise Beach Port Hedland, Pretty Pool String of islands between Cape Preston and Onslow, inshore of Barrow Is The main nesting beach at Cape Domett is a 1.9-km-long north-west-facing sandy beach on the east of the Cambridge Gulf, East Kimberley, Western Australia (14 48.10S, 128 24.50E), located ~80 km north-north-east of the nearest town, Wyndham. Thevernard Island - South coast West of Cape Lambert Western Joseph Bonaparte Depression	
Leatherback turtle	*Dermochelys coriacea*	None within area of interest	None within area of interest	None within area of interest

7. Marine Mammals

Forty-five species of listed marine mammals are known to occur in Australian waters in the area of interest, according to the Protected Matters search (**Appendix A**). An examination of the species profile and threats database (DoEE 2017a) showed that some listed mammal species are not expected to occur in significant numbers in the marine and coastal environments in the area of interest due to their terrestrial distributions. Hence, these species are not discussed further.

Of the remaining listed species, five are listed as threatened and migratory, one is listed as threatened and ten are listed as migratory under the Commonwealth *Environmental Protection and Biodiversity Conservation Act 1999* (BIAs for marine mammals are discussed in **Table 7-3**). These species are shown in **Table 7-1** along with their conservation listing under the WA Biodiversity Conservation Act 2016 (as applicable).

The section below gives further details on marine mammal species listed as threatened and migratory and a summary is presented in **Table 7-2**. Identified BIAs are presented in **Table 7-3**.

Refer to the *Reindeer Wellhead Platform & Offshore Gas Supply Pipeline Operations Environment Plan* for Protected Matters searches of the EMBA and Operational Area.

Table 7-1: Marine mammals listed as threatened or migratory under the EPBC Act

Scientific Name **Common Name**	Conservation Status		Likelihood of occurrence in area of interest	Biologically important area in area of interest
	Environmental Protection and Biodiversity Conservation Act 1999 (Cwth)	*Biodiversity Conservation Act 2016 (WA)*		
Balaenoptera borealis Sei whale	Vulnerable Migratory	Endangered	Foraging, feeding or related behaviour likely to occur within area	None - No BIA defined
Balaenoptera musculus Blue whale	Endangered Migratory	Endangered	Foraging, feeding or related behaviour known to occur within area	Yes – Refer to **Table 7-3**
Balaenoptera physalus Fin whale	Vulnerable Migratory	Endangered	Foraging, feeding or related behaviour likely to occur within area	None - No BIA defined
Eubalaena australis Southern right whale	Endangered Migratory	Vulnerable	Breeding known to occur within area	Yes – Refer to **Table 7-3**
Megaptera novaeangliae Humpback whale	Vulnerable Migratory	Specially Protected (special conservation interest)	Breeding known to occur within area	Yes – Refer to **Table 7-3**
Physeter macrocephalus	Migratory	Vulnerable	Foraging, feeding or related	Yes – Refer to **Table 7-3**

Scientific Name Common Name	Conservation Status		Likelihood of occurrence in area of interest	Biologically important area in area of interest
	Environmental Protection and Biodiversity Conservation Act 1999 (Cwth)	Biodiversity Conservation Act 2016 (WA)		
Sperm whale			behaviour known to occur within area	
Balaenoptera bonaerensis Antarctic minke whale	Migratory	-	Species or species habitat likely to occur within area	None - No BIA defined
Balaenoptera edeni Bryde's whale	Migratory	-	Species or species habitat likely to occur within area	None - No BIA defined
Caperea marginata Pygmy right whale	Migratory	-	Foraging, feeding or related behaviour likely to occur within area	None - No BIA defined
Orcinus orca Killer whale	Migratory	-	Species or species habitat may occur within area	None - No BIA defined
Sousa chinensis Indo-Pacific humpback dolphin	Migratory	-	Breeding known to occur within area	Yes – Refer to **Table 7-3**
Tursiops aduncus Spotted bottlenose dolphin (Arafura/ Timor Sea Populations)	Migratory	-	Species or species habitat likely to occur within area	Yes – Refer to **Table 7-3**
Orcaella brevirostris Irrawaddy dolphin (Australian snubfin dolphin)	Migratory	-	Species or species habitat known to occur within area	Yes – Refer to **Table 7-3**
Lagenorhynchus obscurus Dusky dolphin	Migratory	-	Species or species habitat likely to occur within area	None - No BIA defined
Neophoca cinerea Australian sea lion	Vulnerable	Vulnerable	Breeding known to occur within area	Yes – Refer to **Table 7-3**

Scientific Name Common Name	Conservation Status		Likelihood of occurrence in area of interest	Biologically important area in area of interest
	Environmental Protection and Biodiversity Conservation Act 1999 (Cwth)	Biodiversity Conservation Act 2016 (WA)		
Dugong dugon Dugong	Migratory	Specially protected (species otherwise in need of special protection)	Breeding known to occur within area	Yes – Refer to **Table 7-3**

In addition, the New Zealand fur-seal ***(Arctocephalus forsteri)***, has been identified as a species of relevance to the area of interest. The New-Zealand fur seal is listed as a protected species under WA Biodiversity Act 2016, but not listed as threatened under the EPBC Act.

The Protected Matters search of the *Reindeer Wellhead Platform & Offshore Gas Supply Pipeline Operations Environment Plan* EMBA did not identify the pygmy right whale, Irrawaddy dolphin, dusky dolphin, New Zealand fur seal nor Australian sea lion; the species identified have been described in the sections below.

7.1 Threatened & Migratory Species

7.1.1 Sei Whale

Sei whales have a worldwide, oceanic distribution, ranging from polar to tropical waters. Sei whales tend to be found further offshore than other species of large whales (Bannister *et al*. 1996).

Sei whales move between Australian waters and Antarctic feeding areas however they are only infrequently recorded in Australian waters (Bannister *et al*. 1996) and their movements and distribution in Australian waters is not well known (DoEE 2017a). There are no known mating or calving areas in Australian waters (Parker 1978 in DoEE 2017a). The National Conservation Values Atlas currently record no BIAs for this species (DoEE 2017b). Surveys of the Bonney Upwelling (outside of the area of interest) between 2000 and 2003 recorded sightings of sei whales feeding during summer and autumn, indicating that this is potentially an important feeding ground (DoEE 2017b).

7.1.2 Blue Whale

Two subspecies of blue whale are recorded in Australian waters; the southern (or true) blue whale (*Balaenoptera musculus intermedia*) and the pygmy blue whale (*Balaenoptera musculus brevicauda*). Southern blue whales are believed to occur in waters south of 60°S and pygmy blue whales occur in waters north of 55°S (i.e. not in the Antarctic) (DEWHA 2008). By this definition all blue whales in waters from Busselton to the Northern Territory border are assumed to be pygmy blue whales, and are discussed below.

Pygmy blue whales have a southern hemisphere distribution, migrating from tropical water breeding grounds in winter to temperate and polar water feeding grounds in summer (Bannister *et al*. 1996, Double *et al*. 2014). The Western Australian migration path takes pygmy blue whales down the Western Australian coast to coastal upwelling areas along southern Australia (Gill 2002) and south at least as far as the Antarctic convergence zone (Gedamke *et al*. 2007).

Tagging surveys have shown pygmy blue whales migrating northward relatively near to the Australian coastline (100 km) until reaching North West Cape after which they travelled offshore (240 km) to Indonesia. Passive acoustic data documented pygmy blue whales migrating along the Western Australian shelf break (Woodside 2012).

The northern migration passes the Perth Canyon from January to May and north bound animals have been detected off Exmouth and the Montebello Islands between April and August (Double *et al*. 2012, McCauley & Jenner 2010). During the southern migration, pygmy blue whales pass south of the Montebello Islands and Exmouth from October to the end of January, peaking in late November to early December (Double *et al*. 2012).

Recognised feeding areas of significance to this species, located within the area of interest include Ningaloo Reef and Perth Canyon (DEH 2005a). The Ningaloo Reef area has the capacity to offer feeding opportunities to pygmy blue whales through unique biophysical conditions able to support large biomasses of marine species (Double *et al*. 2014). Surface lunge feeding of pygmy blue whales has been observed at North West Cape and Ningaloo Reef in June (C. Jenner & M-N Jenner, unpublished data, 2001 in Double *et al*. 2014).

Breeding areas have not yet been identified, however, it is likely that pygmy blue whales calve in tropical areas of high localised production such as deep offshore waters of the Banda and Molucca Seas in Indonesia (Double *et al*. 2014, DoEE 2017b). There are no known breeding areas of significance to blue whales in waters from Busselton to the Northern Territory border.

The BIAs for blue whale and pygmy blue whale are detailed in **Table 7-3** and depicted in **Figure 7-1** and **Figure 7-2.**

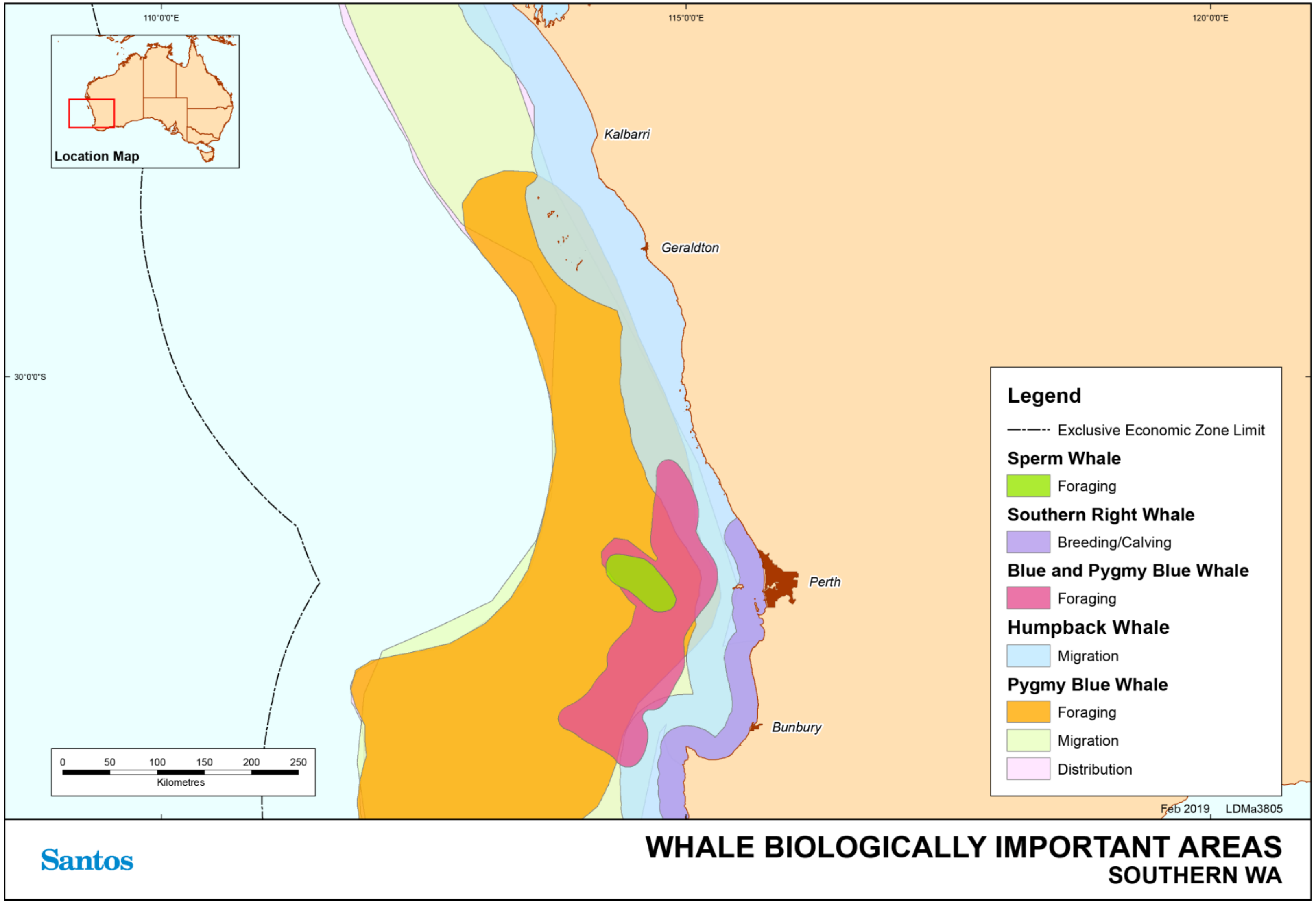


Figure 7-1: Biologically important areas – whales – Southern WA

Santos

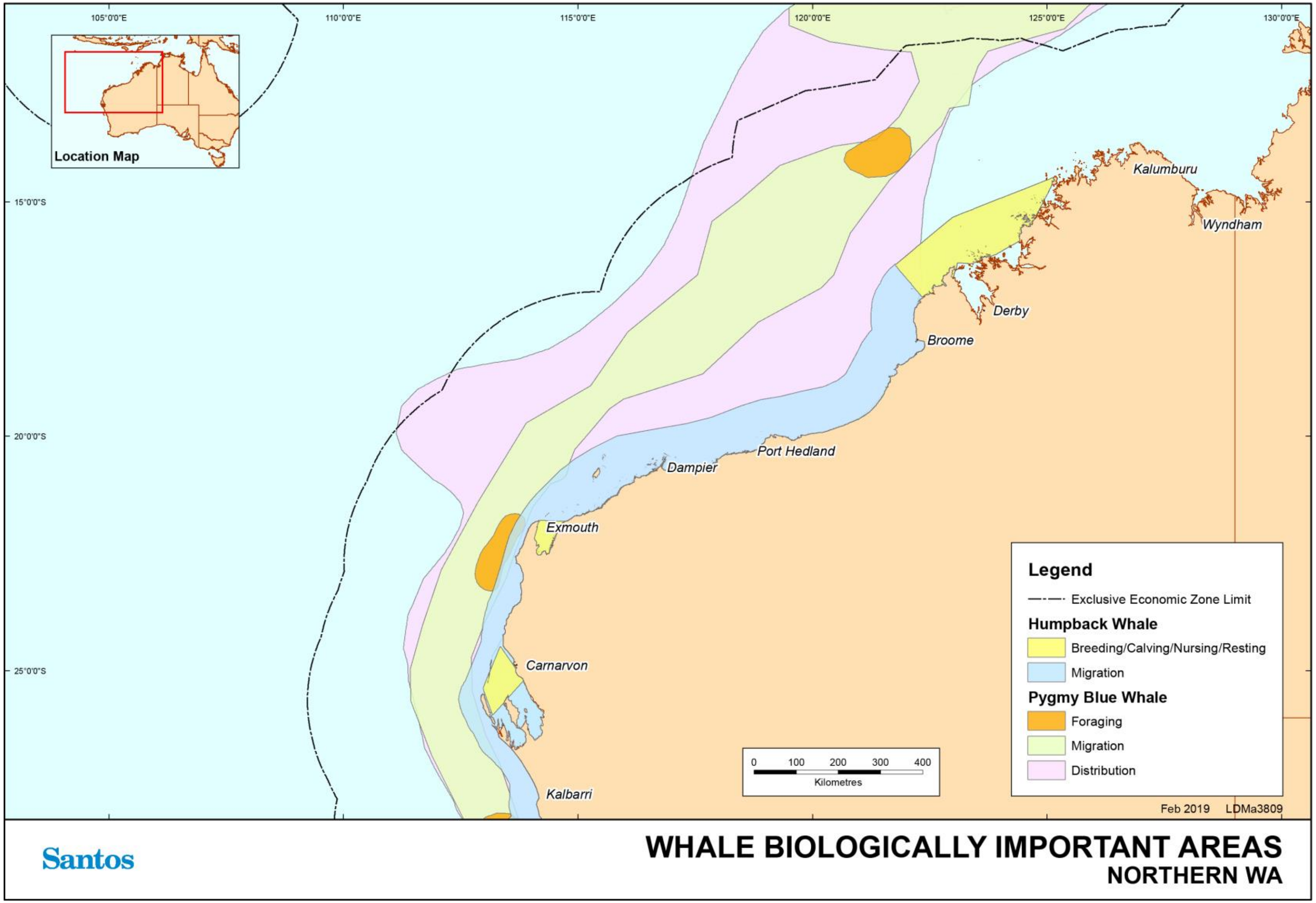


Figure 7-2: Biologically important areas – whales – Northern WA

7.1.3 Fin Whale

Fin whales have a worldwide distribution generally in deeper waters, with oceanic migrations between warm water breeding grounds and cold water feeding grounds.

The fin whale distribution in Australia is not clear due to the sparsity of sightings. Information is known primarily from stranding events and whaling records. According to the Species Profile and Threats database (DoEE 2017a); fin whales are thought to be present from Exmouth, along the southern coastline, to southern Queensland.

Migration paths are uncertain but are not thought to follow Australian coastlines (Bannister *et al*. 1996). There is insufficient data to prescribe migration times for fin whales. During summer and autumn this species has been recorded acoustically at the Rottnest Trench.

There are no known mating or calving areas in Australian waters (DoEE 2017a) and no BIAs for the fin whale are currently identified by the National Conservation Values Atlas (DoEE 2017b).

7.1.4 Southern Right Whale

The southern right whale is present in the southern hemisphere between approximately 30° and 60°S. The species feeds in the Southern Ocean in summer, moving close to shore in winter.

In Australian waters, southern right whales range from Perth, along the southern coastline, to Sydney. Sightings have been recorded as far north as Exmouth although these are rare (Bannister *et al*. 1996).

BIAs including calving and aggregation areas are recorded for this species along the southern coastline of Australia (DoEE 2017b). Details on the BIA for southern right whale are provided in **Table 7-3** and depicted in **Figure 7-1**.

7.1.5 Humpback Whale

Humpback whales have a worldwide distribution, migrating along coastal waters from polar feeding grounds to subtropical breeding grounds. Geographic populations are distinct and at least six southern hemisphere populations are thought to exist based on Antarctic feeding distribution and the location of breeding grounds on either side of each continent (Bannister *et al*. 1996). The population of humpback whales migrating along the Western Australian coastline was recently estimated to be greater than 33,000 whales and likely increasing at exceptionally high growth rates between 10–12% (Hedley *et al*. 2011, Salgado Kent *et al*. 2012).

The west coast Australian humpback whale population migrates from Southern Polar Ocean ‘summer’ feeding grounds to their northern tropical ‘winter’ calving/ breeding grounds in coastal waters of the Kimberley. The northern migration tends to follow deeper waters of the continental shelf, whilst the southward migration concentrates whales closer to the mainland (Jenner *et al*. 2001). Recent satellite tagging of southbound humpback whales indicate that whales generally migrated close to the coastline, within a few tens of kilometres of shore and in a corridor frequently less than 100 km (Double *et al*. 2010). Aerial surveys and noise logger recordings undertaken for Chevron’s Wheatstone Project indicated that the main distribution of humpback whales were sighted at an average distance of 50 km from the mainland during the northern migration and 35 km during the southbound migration (RPS 2010a).

The precise timing of the migration varies between years by up to six weeks, influenced by water temperature, sea ice distribution, predation risk, prey abundance and the location of feeding grounds (DEWR 2007).

Peak northward migration across the North West Shelf is identified as from late July to early August, and peak southward migration from late August to early September (DotE 2015c). Data collected between 1995 and 1997 by the Centre for Whale Research indicates that the period for peak northern migration into the calving grounds in the Kimberley is mid to late July. The peak for southern migration is in the first half of September (Jenner *et al* 2001). Actual timing of annual migration may vary by as much as three (3) weeks from year to year due to food availability in the Antarctic (DMP, 2003).

Details on the BIA for humpback whales are provided in **Table 7-3** and depicted in **Figure 7-1** and **Figure 7-2**.

7.1.6 Sperm Whale

Sperm whales typically occur in WA along the southern coastline between Cape Leeuwin and Esperance (Bannister et al. 1996). Sperm whales are distributed worldwide in deep waters (greater than 200 m) off continental shelves and sometimes near shelf edges, averaging 20 to 30 nautical miles offshore (Bannister et al. 1996). The sperm whale is known to migrate northwards in winter and southwards in summer, however, detailed information on the distribution of sperm whales is not available for the timing of migrations. Sperm whales have been recorded in deep water off the North West Cape on the west coast of Western Australia (RPS 2010b), and appear to occasionally venture into shallower waters in other areas (RPS 2010b). Details on the BIA for sperm whales are provided in **Table 7-3** and are shown in **Figure 7-1.**

7.1.7 Antarctic Minke Whale

The Antarctic minke whale is distributed throughout the Southern Hemisphere from 55°S to the Antarctic ice edge during the austral summer and has been recorded in all Australian States (Bannister et al. 1996; Perrin & Brownell 2002). Detailed information on timing and location of migrations and breading grounds on the west coast of Australia is largely unknown. However, it is believed that the Antarctic minke whale migrates up the WA coast to approximately 20°S during Australian winter to feed and possibly breed (Bannister *et al.* 1996).

7.1.8 Bryde's Whale

The Bryde's whale is found all year round in tropic and temperate waters (Kato 2002). Two forms are recognised: inshore and offshore Bryde's whales. It appears that the inshore form is restricted to the 200 m depth isobar whilst the offshore form is found in deeper waters of 500-1,000 m (DoEE 2017c). Both forms are expected to be found in zones of upwelling where they feed on shrimp like crustaceans (Bannister *et al.* 1996). Little is known about the population abundance of Bryde's whale, the location of exact breeding and calving grounds and large-scale migration patterns (DoEE 2017c). It is however, suggested that the offshore form migrates seasonally, heading towards warmer tropical waters during the winter.

7.1.9 Killer Whale

The killer whale has a widespread global distribution and has been recorded in waters of all Australian states/territories (Bannister *et al.* 1996). Whilst more commonly found in cold, deeper waters, killer whales have been observed along the continental slope, shelf and shallow coastal areas of WA. Killer whales are known to make seasonal movements and are most likely to follow the migratory routes of their prey.

7.1.10 Indo-Pacific Humpback Dolphin

The Indo-pacific humpback dolphin is typically found in water less than 20 m deep, but has been recorded in waters up to 40 m deep. This species is generally found in association with river mouths, mangroves, tidal channels and inshore reefs (DoEE 2016a). This species of dolphin is known to have resident groups that forage, feed, breed and calve in the state waters of Roebuck Bay, Dampier Peninsula, King Sound north, Talbot Bay, Anjo Peninsula, Vansittart Bay, Napier Broome Bay and Deception Bay (DoEE 2016a).

The Indo-Pacific humpback dolphin BIA in the area of interest is detailed in **Table 7-3** and shown on **Figure 7-3**.

7.1.11 Spotted Bottlenose Dolphin (Indo-Pacific bottlenose dolphin)

The spotted bottlenose dolphin (*Tursiops aduncus*) (Arafura / Timor Sea populations) is generally considered to be a warm water subspecies of the spotted bottlenose dolphin, occurring in shallow (often <10 m deep) inshore waters (Bannister et al., 1996; Hale et al., 2000). The known distribution of the spotted bottlenose dolphin extends from Shark Bay north to the western edge of the Gulf of Carpentaria in Australia (DoEE 2016b). The spotted bottlenose dolphin BIA in the area of interest is detailed in **Table 7-3** and shown on **Figure 7-3**.

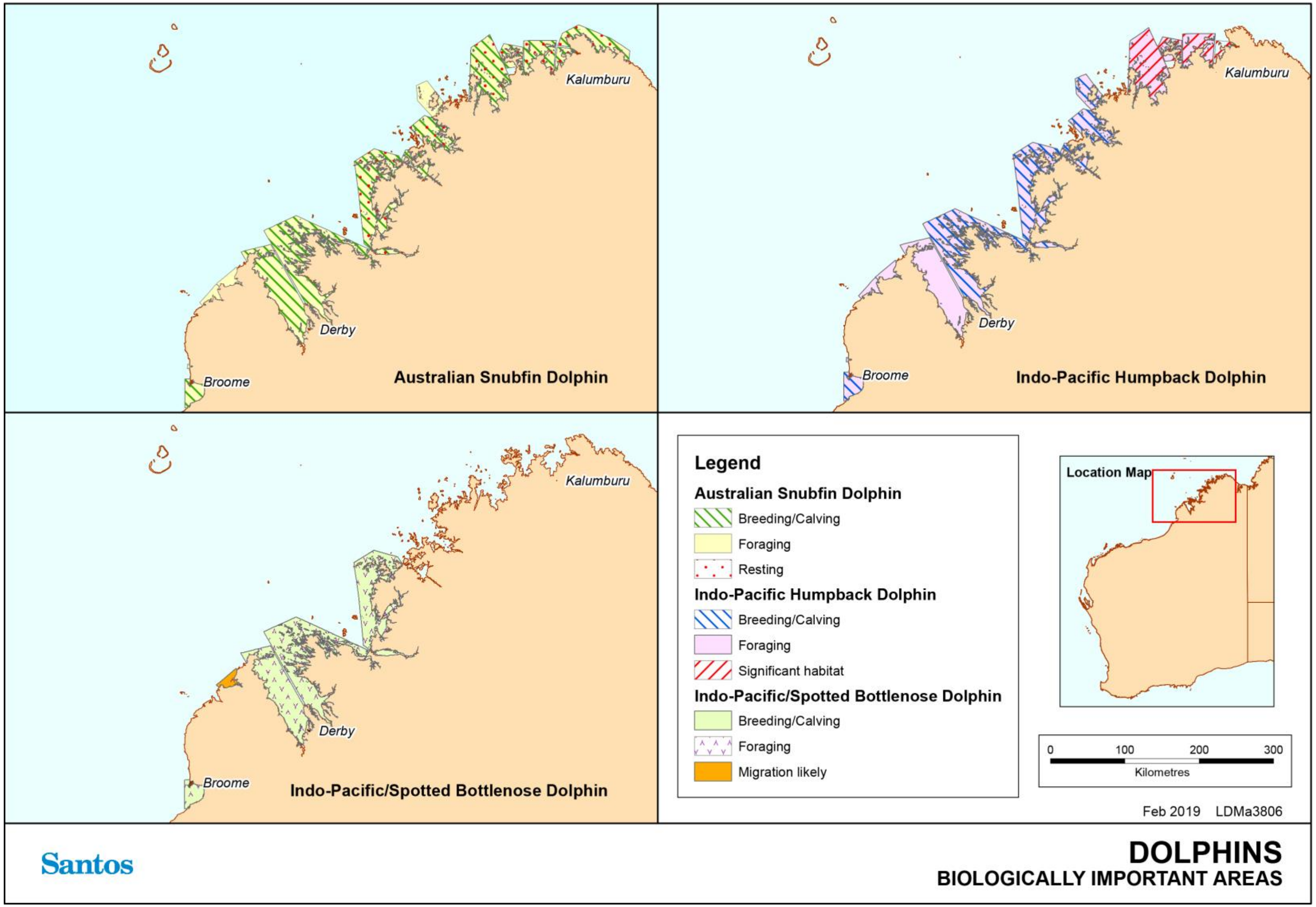


Figure 7-3: Biologically important areas – dolphins

7.1.12 Dugongs

Dugongs (*Dugong dugon*) are large herbivorous marine mammals (up to 3 metres) that feed off seagrass and generally inhabit coastal areas. Key populations along the WA coast are principally located at: Shark Bay (the largest resident population in Australia), Ningaloo Marine Park and Exmouth Gulf, the Pilbara coast and offshore areas including Montebello/Barrow/Lowendal Islands, and further north at Eighty Mile Beach and off the Kimberley Coast, particularly Roebuck Bay and Dampier Peninsula (Marsh *et al*. 2002; DSEWPaC 2012). Populations are also present at Ashmore Reef. Dugong distribution and movement is based on the abundance, size and species of seagrass meadow. Dugongs can migrate hundreds of kilometres between seagrass habitat. The dugong BIAs in the area of interest are detailed in **Table 7-3** and shown in **Figure 7-4**.

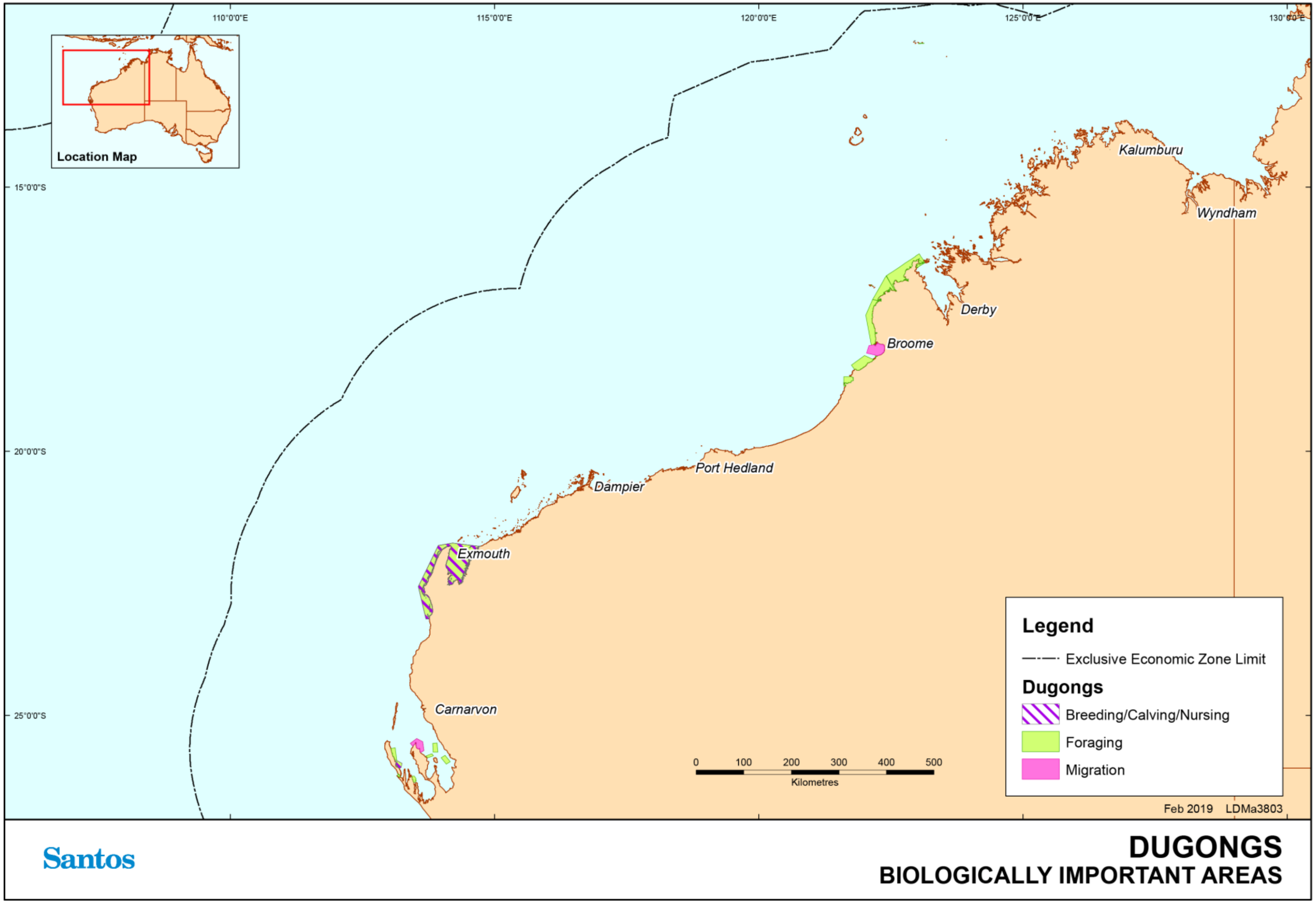


Figure 7-4: Biologically important areas – dugongs

Table 7-2: Summary of information for marine mammals listed as threatened under the EPBC Act

Aspect	Sei whale	Blue whale	Fin whale	Southern right whale	Humpback whale	Australian sea lion
Species expected in area	Unknown	Yes	Unknown	Unlikely, southern distribution	Yes	Unlikely, southern distribution
Migration depth (m)	Unknown, prefers offshore waters	500- 1,000	Unknown	n/a	Up to 100	n/a
Migration Seasonality	Unknown	Apr to Aug (north), Oct to Jan (south)	Unknown	n/a	Jun to Nov	n/a

7.2 Biologically Important Areas / Critical Habitat – Marine Mammals

Table 7-3 below provides an overview of BIAs in the area of interest for marine mammals

The DoEE may also make recovery plans for threated fauna listed under the EPBC Act. The EPBC Act requires that 'habitat critical to the survival of the listed threatened species' is identified in recovery plans, relevant recovery plans are listed in **Section 13.2**[5].

In addition, both the EPBC Act and WA Biodiversity Conservation Act 2016 and associated regulations (2018) provide for the listing of critical habitat - habitat 'critical to the survival of the threatened species'. To date no critical habitat in WA has been listed under either Act.

Refer to the *Reindeer Wellhead Platform & Offshore Gas Supply Pipeline Operations Environment Plan* for species' BIAs within the EMBA and Operational Area.

[5] Further background information on BIA and identification of critical habitat in recovery plans is provided in Section 5.4

Table 7-3: Biologically important areas – marine mammals

Species	Scientific name	Aggregation area and use	Biologically important areas within area of interest
Blue and pygmy blue whales	*Balaenoptera musculus*	Migration – along the continental shelf edge off the WA coastline, extending offshore near Scott Reef and into Indonesian waters Foraging – along Ningaloo reef, around Scott Reef, around the Perth canyon	Blue and pygmy blue whale - Head of the Perth Canyon Outer continental shelf from Cape Naturaliste to south of Jurien Bay Outer Perth Canyon Pygmy blue whale - Augusta to Derby. Tend to pass along the shelf edge at depths of 500 m to 1000 m; appear close to coast in the Exmouth-Montebello Islands area on southern migration. From Mandurah to south of Cape Naturaliste, seaward to the 50 metre depth contour Indonesia- Banda SeaNingaloo Perth Canyon Scott Reef
Southern right whale	*Eubalena australis*	Breeding/calving – along the south west and southern coastline of WA/SA	Bunbury area, WA Camac Island/Fremantle, WA Coast Cape Naturaliste to Cape Leeuwin Coast Perth region to Cape Naturaliste Geographe Bay, WA Perth to Kangaroo Island
Humpback whale	*Megaptera novaeangliae*	Breeding/calving/nursing/resting – Campden Sound, Exmouth Gulf, Shark Bay Migration - northern migration deeper waters of the continental shelf, southward migration – along the WA mainland	Cape Leeuwin to Houtman Abrolhos Cape Naturaliste Cape Naturaliste to Cape Leeuwin Exmouth Gulf

Santos

Species	Scientific name	Aggregation area and use	Biologically important areas within area of interest
			Flinders Bay Geographe Bay Houtman Abrolhos Islands Kimberley/Coastal North Lacepede Island, Camden Sound North of Houtman Abrolhos Shark Bay The migration corridor extends from the coast to out to approximately 100 km off shore in the Kimberley region extending south to North West Cape. From North West Cape to south of shark Bay the migration corridor is reduced to approximately 50 km. West coast - Lancelin to Kalbarri West coast- Bunbury to Lancelin including Rottnest Island
Sperm whale	*Physeter macrocephalus*	Foraging - west end of Perth Canyon	Western end of Perth canyon
Indo-Pacific humpback dolphin	*Sousa chinensis*	Breeding, calving, foraging – Kimberley coastal waters and islands Significant habitat – unknown behavior – Bougainville Peninsula Significant habitat - Vansittart Bay, Anjo Peninsula	Admiralty Gulf & Parry Harbour Bougainville Peninsula Camden Sound Area - Walcott Inlet, Doubtful Bay, Deception Bay, Augustus Island (Kuri Bay) Carnot & Beagle bay King Sound North and Yampi Sound and Talbot Bay Fjord area near Horizontal Falls King Sound Southern Sector Maret & Biggee Is. Pender bay Port Nelson, York Sound, Prince Frderick Harbour Prince Regent River Roebuck Bay

Species	Scientific name	Aggregation area and use	Biologically important areas within area of interest
			Vansittart Bay, Anjo Peninsula Willie Creek
Indo-Pacific/spotted bottlenose dolphin	*Tursiops aduncus*	Breeding, calving, foraging – Kimberley coastal waters and islands Migration – Pender Bay	Camden Sound Area - Walcott Inlet, Doubtful Bay, Deception Bay, Augustus Island (Kuri Bay) King Sound North and Yampi Sound and Talbot Bay Fjord area near Horizontal Falls King Sound Southern Sector Pender bay Roebuck Bay
Dugong	*Dugong dugon*	Foraging –Dampier Peninsula, Roebuck Bay, Shark Bay, Exmouth and Ningaloo coastline Migration – Roebuck Bay Breeding/calving/nursing – Exmouth and the Ningaloo coastline	Ashmore Reef - Far West Ashmore Reef - South (located on sea reef side only, not interior) Between Peron Peninsula & Faure Island, Shark Bay Dirk Hartog Island, Shark Bay East of Faure Island, Shark Bay Exmouth Gulf Kimberley coast, Dampier Peninsula Middle Island, Kimberley coast North East Peron Peninsula, Shark Bay North of Faure Island, Shark Bay Pilbara and Kimberley coast near Dampier Peninsula Pilbara and Kimberley coast near James Price Point Roebuck Bay, Broome South Passage, Shark Bay Useless Loop, Shark Bay

8. Birds

Marine waters and coastal habitat in the area of interest contain key habitats that are important to birds, including offshore islands, sandy beaches, tidal flats, mangroves and coastal and pelagic waters. These habitats support a variety of birds which utilise the area in different ways and at different times of the year (DSEWPaC 2012a). Birds can be broadly grouped according to their preferred foraging habitat as coastal/ terrestrial birds, seabirds and shorebirds.

Coastal or terrestrial species inhabit the offshore islands and coastal areas of the mainland throughout the year. These species are either primarily terrestrial, or they may forage in coastal waters. Resident coastal and terrestrial species include osprey (*Pandion haliaetus*), white-bellied sea eagle (*Haliaeetus leucogaster*), silver gull (*Larus novaehollandiae*) and eastern reef egret (*Egreta sacra*) (DEWHA 2008).

Seabirds include those species whose primary habitat and food source is derived from pelagic waters. These species spend the majority of their lives at sea, ranging over large distances to forage over the open ocean. Seabirds present in the area include terns, noddies, petrels, shearwaters, tropicbirds, frigatebirds boobies and albatrosses (DEWHA 2008).

Shorebirds, including waders, inhabit the intertidal zone and adjacent areas. Some shorebird species, including oystercatchers are resident (Surman & Nicholson 2013). Other shorebirds are migratory and include species that utilise the East Asian–Australasian Flyway, a migratory pathway for millions of migratory shorebirds that travel from Northern Hemisphere breeding grounds to Southern Hemisphere resting and foraging areas. Shorebirds that regularly migrate through the area include the *Scolopacidae* (curlews, sandpipers etc.) and *Charadriidae* (plovers and lapwings) families.

Surveys in the area by Santos WA and other agencies have built a picture of diverse avifauna. A summary of research is discussed below, followed by information on threatened and migratory birds. Wetlands of international importance are discussed in **Section 9.2**.

Only locations within the area of interest revelant to the *Reindeer Wellhead Platform & Offshore Gas Supply Pipeline Operations Environment Plan* have been described below.

8.1 Regional Surveys

8.1.1 North West Cape

Avifauna surveys of the North West Cape have recorded 144 bird species, one third of which are seabirds and shorebirds (resident and migratory) (May *et al*. 1983). Approximately 33 species of seabirds and shorebirds are found in the Ningaloo Marine Park with the main breeding areas at Mangrove Bay, Mangrove Point, Point Maud, the Mildura wreck site and Fraser Island (CALM & MPRA 2005a).

8.1.2 Murion Islands and Exmouth Gulf Islands

Murion Islands and Exmouth Gulf Islands are generally lacking in published bird observations data. Early indications from surveys commissioned by Santos WA in 2013/14 indicate that South and North Murion Islands are regionally significant in terms of wedge-tailed shearwater (*Puffinus pacificus*) nesting, whilst Bessiers and Fly islands are also significant (Surman pers comm. 2013). Nine coastal/terrestrial species and 21 shorebirds were identified on the Murion and Exmouth Gulf Islands during the first of these surveys and seven bird species were recorded nesting (Surman 2013).

8.1.3 Dampier Archipelago/Cape Preston Region

The Dampier Archipelago/Cape Preston region is a nesting area for at least 16 species of seabirds. Many of the islands and rocks in the area are known breeding grounds for birds, including wedge-tailed shearwaters (*Puffinus pacificus*), Caspian terns (*Sterna caspia*), bridled terns (*Sterna anaethetus*) and roseate terns (*Sterna dougallii*). Small islands and islets such as Goodwyn Island, Keast Island and Nelson Rocks provide important undisturbed nesting and refuge sites and Keast Island provides one of the few nesting sites for pelicans in WA (CALM & MPRA 2005b).

8.1.4 Barrow Island and Lowendal Island Group

Barrow Island and surrounding islands have a diverse avifauna comprising at least 110 species, including 11 resident land birds, eight resident seabirds, 17 seabirds, 22 species of migratory waders, six resident shorebirds and 43 irregular visitors (Surman 2003). The avifauna of Barrow Island is thus poor in terms of land birds and waterfowl compared to mainland areas of the Pilbara, but rich in migratory waders and seabirds. Compared to other nearby offshore islands, Barrow Island has substantially more migratory waders but fewer breeding seabirds (Surman 2003).

The Lowendal Island Group has a diverse avifauna comprising 89 recorded species (Dinara Pty Ltd. 1991, Burbidge *et al*. 2000). Six species of resident land birds and six species of raptors have been recorded at the Lowendal Islands (Surman & Nicholson 2012). Up to fourteen seabird species have been observed at any one time during annual surveys of the Lowendal Islands between 2004 and 2012. Surveys at the Montebello Islands have recorded 70 bird species. This includes 12 species of seabirds and 14 species of migratory shorebirds (Burbidge *et al*. 2000).

8.2 Threatened Species

A Protected Matters search of the area of interest identified forty-five bird species (**Appendix A**) listed under the EPBC Act as threatened.

An examination of the species profile and threats database (DoEE 2017a) and The Action Plan for Australian Birds (Garnet 2011) showed that some listed bird species are not expected to occur in significant numbers in the marine and coastal environments in the area of interest due to their terrestrial or southern distributions. Hence, these species are not discussed further.

EPBC Act threatened species expected to occur in the area are listed in **Table 8-1** along with their WA conservation status (as applicable) and discussed below. BIAs for birds are detailed in **Table 8-5** and depicted in **Figure 8-1**.

Refer to the *Reindeer Wellhead Platform & Offshore Gas Supply Pipeline Operations Environment Plan* for species' BIAs within the EMBA and Operational Area.

Table 8-1: Birds listed as threatened under the EPBC Act

Scientific Name **Common Name**	**Conservation Status**		**Likelihood of occurrence in area of interest**	**Biologically important area in area of interest**
	Biodiversity Conservation Act 2016	**Environmental Protection and Biodiversity Conservation Act 1999**		
Shorebirds				
Calidris canutus Red knot	Endangered	Endangered	Species or species habitat known to occur within area	None - No BIA defined
Calidris ferruginea Curlew sandpiper	Critically endangered	Critically endangered	Species or species habitat known to occur within area	None - No BIA defined
Calidris tenuirostris Great knot	Critically endangered	Critically endangered	Roosting known to occur within area	None - No BIA defined
Charadrius leschenaultia Greater sand plover	Specially protected (migratory)	Vulnerable	Roosting known to occur within area	None - No BIA defined
Charadrius mongolus Lesser sand plover	Endangered	Endangered	Roosting known to occur within area	None - No BIA defined
Limosa lapponica baueri Western Alaskan bar-tailed godwit	Vulnerable	Vulnerable	Species or species habitat known to occur within area	None - No BIA defined
Limosa lapponica menzbieri Northern Siberian bar-tailed godwit	Critically endangered	Critically endangered	Species or species habitat known to occur within area	None - No BIA defined
Numenius madagascariensis Eastern curlew	Critically endangered	Critically endangered	Species or species habitat known to occur within area	None - No BIA defined
Botaurus poiciloptilus Australasian bittern	Endangered	Endangered	Species or species habitat known to occur within area	None - No BIA defined
Rostratula australis Australian painted snipe	Endangered	Endangered	Species or species habitat may occur within area	None - No BIA defined
Seabirds				
Anous tenuirostris melanops Australian lesser noddy	Endangered	Vulnerable	Breeding known to occur within area	Yes – refer to **Table 8-5**

Scientific Name Common Name	Conservation Status		Likelihood of occurrence in area of interest	Biologically important area in area of interest
	Biodiversity Conservation Act 2016	Environmental Protection and Biodiversity Conservation Act 1999		
Pachyptila tutur subantarctica Fairy piron (southern)	-	Vulnerable	Species or species habitat known to occur within area	None - No BIA defined
Diomedea epomophora Southern royal albatross	Specially protected (migratory)	Vulnerable	Foraging, feeding or related behaviour likely to occur within area	None - No BIA defined
Diomedea sanfordi Northern royal albatross	Endangered	Endangered	Foraging, feeding or related behaviour likely to occur within area	None - No BIA defined
Diomedea amsterdamensis Amsterdam albatross	Critically endangered	Endangered	Species or species habitat may occur within area	None - No BIA defined
Phoebetria fusca Sooty Albatross	Endangered	Vulnerable	Species or species habitat may occur within area	None - No BIA defined
Diomedea dabbenea Tristan albatross	Critically endangered	Endangered	Species or species habitat may occur within area	None - No BIA defined
Diomedea exulans Wandering albatross	Specially protected (migratory)	Vulnerable	Foraging, feeding or related behaviour likely to occur within area	None - BIA not found in area of interest
Fregata andrewsi Christmas island frigatebird	Specially protected (migratory)	Endangered	Foraging, feeding or related behaviour known to occur within area	None - No BIA defined
Macronectes giganteus Southern giant petrel	Specially protected (migratory)	Endangered	Species or species habitat may occur within area	None - BIA not found in area of interest
Macronectes halli Northern giant petrel	Specially protected (migratory)	Vulnerable	Species or species habitat may occur within area	None - BIA not found in area of interest
Papasula abbotti Abbott's booby	-	Endangered	Species or species habitat likely to occur within area	None - No BIA defined

Scientific Name Common Name	Conservation Status		Likelihood of occurrence in area of interest	Biologically important area in area of interest
	Biodiversity Conservation Act 2016	Environmental Protection and Biodiversity Conservation Act 1999		
Pterodroma mollis Soft-plumaged petrel	-	Vulnerable	Foraging, feeding or related behaviour known to occur within area	Yes – refer to **Table 8-5**
Halobaena caerulea Blue Petrel	-	Vulnerable	Species or species habitat may occur within area	None - No BIA defined
Sternula nereis Australian fairy tern	Vulnerable	Vulnerable	Breeding known to occur within area	Yes – refer to **Table 8-5**
Thalassarche carteri Indian yellow-nosed albatross	Specially protected (migratory)	Vulnerable	Foraging, feeding or related behaviour may occur within area	Yes – refer to **Table 8-5**
Thalassarche cauta Shy albatross	Endangered	Vulnerable	Foraging, feeding or related behaviour likely to occur within area	None - BIA not found in area of interest
Thalassarche cauta steadi White-capped albatross	Specially protected (migratory)	Vulnerable	Foraging, feeding or related behaviour likely to occur within area	None - BIA not found in area of interest
Thalassarche melanophris Black-browed albatross	Endangered	Vulnerable	Species or species habitat may occur within area	None - BIA not found in area of interest
Thalassarche impavida Campbell albatross	Specially protected (migratory)	Vulnerable	Species or species habitat may occur within area	None - BIA not found in area of interest
Phaethon lepturus fulvus Christmas Island white-tailed tropicbird	-	Endangered	Species or species habitat may occur within area	None - No BIA defined

Only birds identified in the Protected Matters search of the *Reindeer Wellhead Platform & Offshore Gas Supply Pipeline Operations Environment Plan* EMBA have been described in the sections below.

8.2.1 Shorebirds

Red Knot (New Siberian Islands and north-eastern Siberia)

The red knot is a migratory shorebird and the species includes five subspecies, including two found in Australia, Calidris canutus piersmai and Calidris canutus rogersi. The red knot breeds in Siberia and spends the non-breeding season in Australia and New Zealand. Non breeding season is spent on tidal mudflats or sandflats where they feed on intertidal invertebrates, especially shellfish (Garnet et al. 2011).

Curlew Sandpiper

This species is a migratory shorebird that breeds in north Siberia and spends the non-breeding season from western Africa to Australia (Bamford et al. 2008). The curlew sandpiper occurs around coastal Australia and preferred habitats include coastal brackish lagoons, tidal mud and sand flats, estuaries, saltmarshes and less often inland. Their diet is mainly comprised of polychaete worms, molluscs and crustaceans (Higgins & Davies 1996 in Garnet et al. 2011).

Great Knot

The great knot is a migratory shorebird with a global distribution, breeding in north-east Siberia and spending the non-breeding season along coasts from Arabia to Australia. Non breeding birds migrate to inlets, bays, harbours, estuaries and lagoons with large intertidal mud and sand flats where they feed on bivalves, gastropods, crustaceans and other invertebrates (Higgins & Davies 1996 in Garnet et al. 2011).

Greater Sand Plover and Lesser Sand Plover

The greater sand plover and lesser sand plover are cogeners that breed in China, Mongolia and Russia. The greater sand plover spends the non-breeding season along coasts from Japan through southeast Asia to Australasia, while the lesser sand plover spends the non-breeding season along coasts from Taiwan to Australasia (Banford *et al*. 2008). Non breeding birds occur along all Australian coasts, especially in the north for the greater sand plover (DoEE 2017a) and in the east for the lesser sand plover (DoEE 2017a).

Non breeding birds forage on beaches, salt-marshes, coastal bays and estuaries, and feed on marine invertebrates including molluscs, worms, crustaceans and insects (Marchant & Higgins 1993 in Garnet *et al*. 2011).

Bar-tailed Godwit (Western Alaskan and Northern Siberian Subspecies)

Two subspecies of the bar-tailed godwit exist, as determined by their breeding locations in Siberia and Alaska (Bamford *et al*. 2008). Non-breeding birds migrate to the coasts of Australia. The western Alaskan subspecies occurs especially on the north and east coasts of Australia whilst the northern Siberian subspecies occurs especially along the coasts of north Western Australia (DoEE 2017b).

Non breeding birds are found on muddy coastlines, estuaries, inlets, mangrove-fringed lagoons and sheltered bays, feeding on annelids, bivalves and crustaceans (Higgins and Davies 1996 in Garnet *et al*. 2011).

Eastern Curlew

The eastern curlew is a migratory shorebird that breeds in Siberia, Kamchatka and Mongolia and migrates to coastal East Asia and Australia. The South Korean Yellow Sea is an important staging post for this species. Non breeding birds occur around coastal Australia, are more common in the north and have disappeared or become much rarer at many sites along the south coast (Garnet 2011).

Non breeding birds are present at estuaries, mangroves, saltmarshes and intertidal flats, particularly those with extensive seagrass (Zosteraceae), where they feed on marine invertebrates, especially crabs and small molluscs (Higgins & Davies 1996 in Garnet 2011).

Australian Painted Snipe

The Australian painted snipe has been recorded at wetlands in all states of Australia (DoE 2014g). The Australian painted snipe generally inhabits shallow terrestrial freshwater (occasionally brackish) wetlands, including temporary and permanent lakes, swamps and claypans. They also use inundated or waterlogged grassland or saltmarsh, dams, rice crops, sewage farms and bore drains. Typical sites include those with rank emergent tussocks of grass, sedges, rushes or reeds, or samphire; often with scattered clumps of lignum Muehlenbeckia or canegrass or sometimes tea-tree (*Melaleuca*). The Australian painted snipe sometimes utilises areas that are lined with trees, or that have some scattered fallen or washed-up timber (DoE 2014g).

White-winged Fairy Wren

The white-winged fairy wren (Barrow Island) is listed as Vulnerable under the EPBC Act. It is only found on Barrow Island (Garnett & Crowley 2000; Schodde & Mason 1999 in DEWHA, 2008), and occurs in grasslands and low shrublands. It is most common in *Triodia*-dominated habitats on shallow soil on limestone ridges and rises, but it also occurs on sand dunes in coastal and inland areas (including on sand-loam soils in valleys and on plains), and occasionally on clay pans. The bird is considered to be resident (i.e. present throughout the year) on Barrow Island (Sedgwick 1978; in DEWHA, 2008). It may also be sedentary given that, with the possible exception of a single unconfirmed record of a White-winged Fairy-wren (of unknown subspecies) on Trimouille Island in the Montebello Islands group, it has not been recorded on any nearby islands or on the mainland (Garnett & Crowley 2000; Higgins *et al*. 2001; Schodde & Mason 1999 in DEWHA, 2008).

There are no clear immediate threats to the White-winged Fairy-wren (Barrow Island) (Garnett & Crowley 2000 in DEWHA, 2008). The subspecies was considered to be vulnerable by Garnett and Crowley (2000, in DEWHA, 2008) on the basis that some of the natural features of Barrow Island, namely the narrow shape of the island and the uniformity of its habitat, make the resident population of fairy-wrens vulnerable to catastrophic events such as a severe cyclone or an extensive wildfire.

8.2.2 Seabirds

Australian Lesser Noddy

This species is usually found only around its breeding islands in the Houtman Abrolhos Islands in Western Australia (Storr *et al*. 1986). The Australian lesser noddy occupies coral-limestone islands that are densely fringed with white mangrove *Avicennia marina*, and it occasionally occurs on shingle or sandy beaches (Higgins & Davies 1996 in DoEE 2017a). This species is thought to be sedentary or resident, staying near to its breeding islands in the non-breeding season. It may leave nesting islands for short periods during the non-breeding season, and probably forages widely (Higgins & Davies 1996 in DoEE 2017a).

Breeding apparently occurs only on Morley, Wooded and Pelsaert Islands at the Houtman Abrolhos Islands (Higgins and Davies 1996 in DoE 2014b). Mangrove stands support approximately 68,000 breeding pairs spread over the three islands (Surman & Nicholson 2006). Breeding may also occur on Ashmore Reef (Stokes & Hinchey 1990). The breeding season extends from mid-August to early April (Higgins & Davies 1996 in DoE 2014b).

The National Conservation Values Atlas identifies BIAs for this species in the area of the Houtman Abrolhos islands (**Table 8-5**). The National Recovery Plan for Ten Species of Seabirds 2005-2010 (DEH 2005) states that Ashmore Island could possibly be important habitat, however the Species Group Report Card – Seabirds (DSEWPaC 2012b) states that the entire Australian population of this species breeds in the South-west Marine Region, south of Busselton.

Albatrosses

A Protected Matters search of the waters in the area of interest (**Appendix A**) identified several albatross species that may occur in the area, comprised of the southern royal albatross, northern royal albatross, Amsterdam albatross, Tristan albatross, sooty albatross, wandering albatross, Indian yellow-nosed albatross, shy albatross, white-capped albatross, black-browed albatross and Campbell albatross. All these species predominantly occur in subantarctic to subtropical waters and breed on islands in the southern oceans (DoEE 2017a).

The National Conservation Values Atlas (DoEE 2017b) and the National Recovery Plan for Threatened Albatrosses and Giant Petrels 2011-2016 (DSEWPaC 2011) do not identify any BIAs for these species in the area from Busselton to the Northern Territory border. However, a BIA for the Indian yellow-nosed albatross is identified for foraging north to Shark bay and extending east into Bass Strait.

Southern Giant Petrel

The southern giant petrel is a highly migratory bird with a large natural range. This species occurs from Antarctic to subtropical waters and breeds on the Antarctic continent, peninsular and islands and on subantarctic islands and South America. Breeding occurs annually between August and March (DoEE 2017a).

The National Conservation Values Atlas (DoEE 2017b) and the National Recovery Plan for Threatened Albatrosses and Giant Petrels 2011-2016 (DSEWPaC 2011) do not identify any BIAs for this species in the area from Busselton to the Northern Territory border.

Northern Giant Petrel

The northern giant petrel occupies the Antarctic Polar Front. In summer, it occurs predominantly in sub-Antarctic to Antarctic waters, usually between 40 and 64° The northern giant-petrel breeds on sub-Antarctic islands. Its breeding range extends into the Antarctic zone at South Georgia. It nests in coastal areas where vegetation or broken terrain offers shelter, on sea-facing slopes, headlands, in the lee of banks, under or against vegetation clumps, below cliffs or overhanging rocks, or in hollows. On Campbell Island, it nests on the edge of the coastal plateau. Tussock-grass is widespread at many breeding sites. Its nests are built in secluded, coastal sites, sheltered by heavy vegetation. On Antipodes Island, it nests under *Senecio antipoda* (DoE 2014d).

The National Conservation Values Atlas (DoEE 2017b) does not identify any BIAs for this species in area spanning SW WA to the Northern Territory border.

Soft-Plumaged Petrel

The soft-plumaged petrel is generally found over temperate and subantarctic waters in the South Atlantic, Southern Indian and western South Pacific Oceans. The species breeds colonially on islands in the southern oceans. Breeding occurs from August to May (Marchant & Higgins 1990 in DoEE 2017a).

A BIA for this species is identified for foraging in seas north to 21°30'S off of WA.

Abbott's Booby

Currently, Abbott's booby is only known to breed on Christmas Island and to forage in the waters surrounding the island (DoE 2014f). Within Christmas Island, most nests are found in the tall plateau forest on the central and western areas of the island, and in the upper terrace forest of the northern coast.

The National Conservation Values Atlas (DoEE 2017b) does not identify any BIAs for this species in area spanning SW WA to the Northern Territory border.

Australian Fairy Tern

The fairy tern is distributed in a large geographic range between Australia, New Zealand and New Caledonia. Three subspecies have been identified, one of which is found in Australia. The Australian fairy tern occurs along the coasts of Victoria, Tasmania, South Australia and Western Australia; occurring as far north as the Dampier Archipelago (DoEE 2017a). The subspecies has been found in embayments of a variety of habitats including offshore, estuarine or lacustrine islands, wetlands and mainland coastline (Higgins & Davies 1996 in DoE 2014b, Lindsey 1986).

Australian fairy terns nest on sheltered sandy beaches, spits and banks above the high tide line and below vegetation. The Australian fairy tern breeds from August to February depending on the location of the breeding colony (Higgins & Davies 1996 in DoEE 2017a). They generally nest in small colonies of up to 100 birds, although larger colonies of more than 1400 pairs have been reported in Western Australia (Hill *et al*. 1988).

The National Conservation Values Atlas (DoEE 2017b) identifies the vicinity of the lower north-west coast (north to Dampier Archipelago) and west coast (south to Peel inlet) as BIAs for foraging. Biologically important breeding areas were also identified scattered along the coast between Shark Bay and the Pilbara (**Table 8-5**).

Christmas Island White-tailed Tropicbird

The Christmas Island white-tailed tropicbird is endemic to Christmas Island and leaves the island to forage in the warm waters of the Indian Ocean (Garnett 2011). The white-tailed tropicbird roots at sea; only incubating or brooding adults remain on nests on the island at night (Stokes 1988).

The National Conservation Values Atlas (DoEE 2017b) does not identify any BIAs for this species within the area of interest.

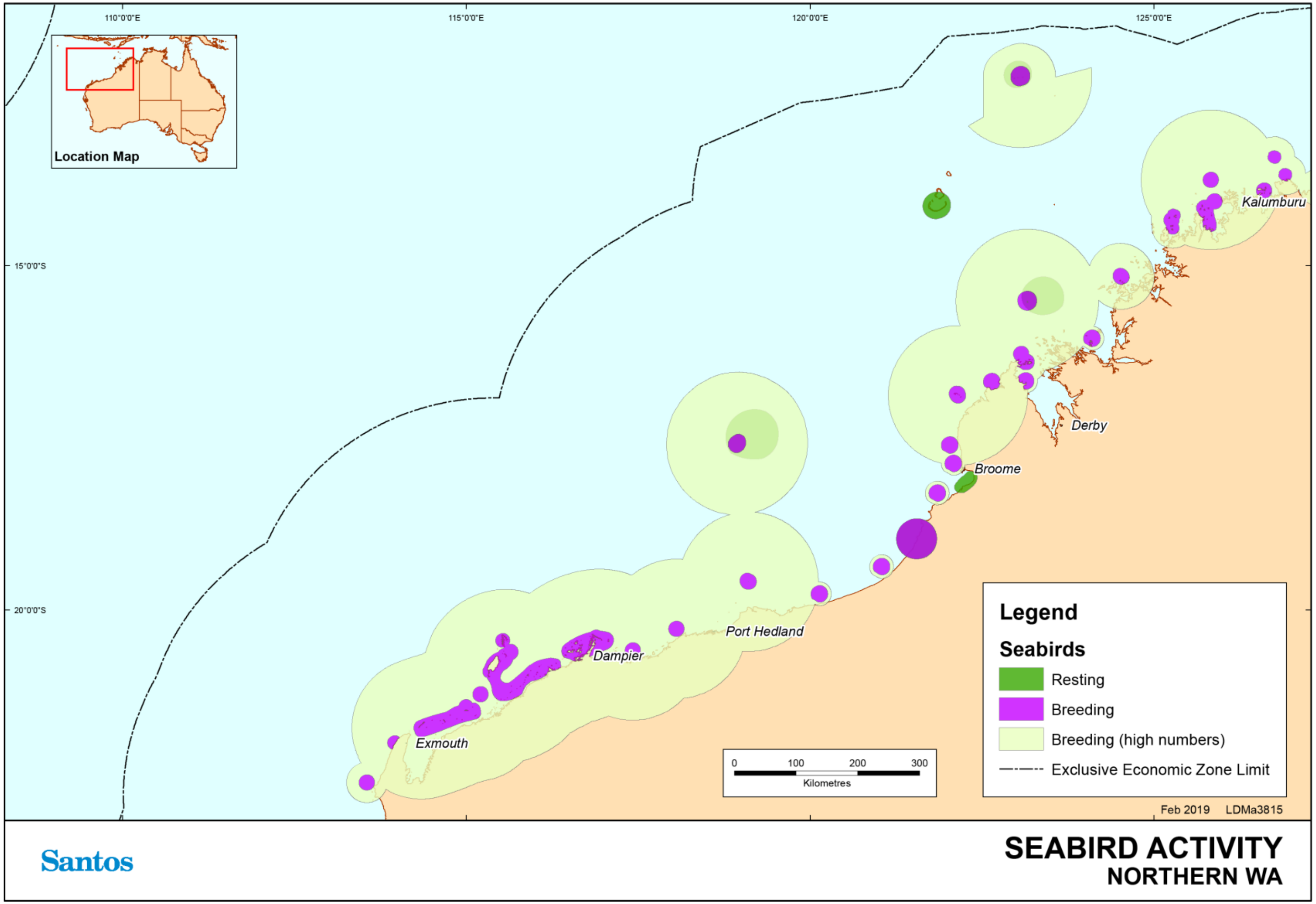


Figure 8-1: Biological important areas – birds – Northern WA

Table 8-2: Summary of information for birds listed as threatened under the EPBC Act that may be in the area.

Species	Species Expected in Area of Interest	Breeding in the Area /Seasonality	Foraging
Shorebirds			
Red knot	Yes	No	Intertidal invertebrates
Curlew sandpiper	Yes	No	Polychaete worms, molluscs and crustaceans taken from shorelines
Great knot	Yes	No	bivalves, gastropods, crustaceans and other invertebrates taken from shorelines
Greater sand plover/lesser sand plover	Yes	No	marine invertebrates taken from shorelines
Bar-tailed godwit	Yes	No	annelids, bivalves and crustaceans taken from shorelines
Eastern curlew	Yes	No	marine invertebrates associated with seagrass
Australasian bittern	Yes	No	other small animals, insects, snails and spiders
Australian painted snipe	Yes	No	Seeds and small invertebrates
Seabirds			
Australian lesser noddy	May forage from Kalbarri to Shark Bay	No	Small fish taken from marine and coastal waters (DoE 2014b)
Albatross spp.	Low densities	No	Cephalopods, fish and crustaceans taken from marine and coastal waters.
Southern & Northern giant petrel	Low densities	No	Scavenges penguin, seal and whale carcasses. Hunts live birds, penguin chicks' cephalopods and krill. Marine and coastal waters (DoE 2014b)
Soft-plumaged petrel	Low densities	No	Cephalopods, fish and crustaceans taken from marine and coastal waters (DoE 2014b)
Australian fairy tern	Yes	Yes Aug to Feb	Bait fish taken from coastal waters
Fairy piron (southern)	Very low densities	No	Small pelagic crustaceans, small fish and squid
Christmas Island frigatebird	Low densities	No	Planktonic crustaceans, fish and squid
Abbott's booby	Low densities	No	Fish and squid
Blue petrel	Low densities	No	Crustaceans, small fish and squid

Species	Species Expected in Area of Interest	Breeding in the Area /Seasonality	Foraging
Christmas Island white-tailed tropicbird	Very low densities	No	Squid and flying fish

8.3 Migratory Species

Australia is signatory to three international treaties with China, Japan and the Republic of Korea to safeguard migratory bird species, predominantly shorebirds. To facilitate observance of the three agreements, 36 species of migratory shorebirds have been listed as specially protected under both the Commonwealth EPBC Act and the WA *Biodiversity Conservation Act 2016.*

Three internationally recognised areas that support shorebird migrations are protected as wetlands of international importance; Ashmore Reef, Eighty-mile Beach and Roebuck Bay. These wetlands are discussed further in **Section 9.2**.

The EPBC Act policy statement 3.21 sets out criteria for determining the significance of sites to migratory shorebirds based on the number of migratory species and the proportion of a species population that is supported by the site (DEWHA 2009). Site significance can be difficult to assess, particularly for ephemeral inland wetlands. These areas may be used rarely, depending weather conditions, but still provide important habitat for migratory shorebird species.

Migratory shorebirds require a particular conservation approach due to their migration patterns that take them across international boundaries (Bamford *et al*. 2008). These species and their habitats are sensitive to threats due to their high site fidelity, tendency to aggregate, high energy demands and the need for habitat networks containing both roosting and foraging sites (DEWHA 2009). Migratory shorebirds are known to use networks of connected sites (also known as site complexes). They move within these networks depending on the time of day, availability of resources and environmental conditions at the site (DEWHA 2009).

The types of habitat used by migratory shorebirds in Australia vary across the species identified in the PMST search. Migratory shorebirds use both coastal and inland habitats that most commonly include:

+ Coastal habitats: coastal wetlands, estuaries, mudflats, rocky inlets, reefs and sandy beaches, sometimes supporting mangroves; and
+ Inland habitats: inland wetlands, floodplains and grassland areas, often with ephemeral water sources (DEWHA 2009).

Feeding guilds provide an explanation for much of the shorebird distribution pattern in the north Western Australia. For example, Rogers (1999) classified shorebirds (and others) in Roebuck Bay as belonging to seven guilds on the basis of prey choice and foraging method. In order of abundance; these are summarised in **Table 8-3**.

Table 8-3: Feeding guilds based on prey choice and foraging method (Rogers 1999) adapted from DEC (2003) and Bennelongia (2008)

Feeding Habitat	Feeding Guild	Species
Sea edge	tactile hunters of macrobenthos	Great knot, red knot, bar-tailed godwit, black-tailed godwit, Asian dowitcher
Along sandy sea edges or near tidal creeks	tactile hunters of microbenthos	Curlew sandpiper, red-necked stint, broad-billed sandpiper, marsh sandpiper, sharp-tailed sandpiper

Feeding Habitat	Feeding Guild	Species
Reefs or mangrove fringes	visual hunters of slow surface-dwelling prey	Common sandpiper, sooty oystercatcher, pied oystercatcher, silver gull, ruddy turnstone
Sandier western parts of Roebuck Bay, often near-shore	visual hunters of small fast prey	Grey plover, red-capped plover, greater sand plover, lesser sand plover, grey-tailed tattler, terek sandpiper
Soft mudflats in N.E. Roebuck Bay	visual hunters of fast large prey	Eastern curlew, whimbrel, greenshank, striated heron and black-necked stork
Soft mudflats in N.E. Roebuck Bay	kleptoparasites	Gull-billed tern (robs large crabs from whimbrels)
Creek-lines in eastern Roebuck Bay	pelagic hunters of nekton (animals of the pelagic zone) and neuston (animals that live on the surface film)	Black-winged stilt, red-necked avocet, reef egret, little egret, great white egret, white-faced heron, royal spoonbill

The Wildlife Conservation Plan (DoE, 2015) for Migratory Shorebirds provides a framework to guide the conservation of migratory shorebirds and their habitat in Australia and, in recognition of their migratory habits, outlines national activities to support their appreciation and conservation throughout the East Asian-Australasian Flyway (EAAF).

The following migratory shorebird species are subject to the Wildlife Conservation Plan 2015.

Table 8-4: Birds subject to the Wildlife Conservation Plan 2015.

Migratory Species	DoEE SPRAT information on distribution within the Area of Interest
Common Sandpiper	WA distribution + Roebuck Bay + Nuytsland Nature Reserve
Sharp-Tailed Sandpiper	They are widespread from Cape Arid to Carnarvon, around coastal and subcoastal plains of Pilbara Region to south-west and east Kimberley Division (Higgins & Davies 1996).
Oriental Practincole	Internationally important site + Eighty Mile Beach (2.88m birds). The species occurs at numerous and widespread sites in northern Australia, especially near the Pilbara and Kimberley coasts of northern Western Australia.
Oriental Plover	Internationally important marine sites + Eighty Mile Beach (~60,000 birds). + Roebuck Bay (Approximately 8500 birds)
Fork-tailed swift	In Western Australia, there are sparsely scattered records of the Fork-tailed Swift along the south coast, ranging from near the Eyre Bird Observatory and west to Denmark. They are widespread in coastal and subcoastal areas between Augusta and Carnarvon, including some on nearshore and offshore islands. They are scattered along the coast from south-west Pilbara to the north and east Kimberley region, near Wyndham. There are sparsely scattered inland records, especially in

Migratory Species	DoEE SPRAT information on distribution within the Area of Interest
	the Wheatbelt, from Lake Annean and Wittenoom. They are found in the north and north-west Gascoyne Region, north through much of the Pilbara Region, and the south and east Kimberley (Higgins 1999).
Streaked Shearwater	Exmouth Gulf to the north.

Shorebird migration patterns are seasonal and vary according to species (DSEWPaC 2012). Generally, shorebirds migrate to northern Australia in August to November. Many birds remain in northern Australia but others disperse southwards (Bennelongia 2011). Migratory shorebird numbers on northern beaches peak in November then again in March as the majority of birds begin their return to the northern hemisphere between March and May. Most migratory shorebirds don't breed in Australia and juvenile birds may spend several years in Australia before reaching maturity and returning north to breed (DEWHA 2009).

8.4 Biologically Important Areas / Critical Habitat – Birds

Table 8-5 below provides an overview of BIAs in the area of interest for birds. The DoEE may make recovery plans for threated fauna listed under the EPBC Act. The EPBC Act requires that 'habitat critical to the survival of the listed threatened species' is identified in recovery plans, relevant recovery plans are listed in **Section 13.2**[6].

In addition, both the EPBC Act and WA Biodiversity Conservation Act 2016 and associated regulations (2018) provide for the listing of critical habitat - habitat 'critical to the survival of the threatened species'. To date no critical habitat in WA has been listed under either Act.

Refer to the *Reindeer Wellhead Platform & Offshore Gas Supply Pipeline Operations Environment Plan* for species' BIAs within the EMBA and Operational Area.

[6] Further background information on BIA and identification of critical habitat in recovery plans is provided in Section 5.4

Table 8-5: Biologically important areas - birds

Species	Scientific name	Aggregation area and use	Specific geographic locations for species
Common noddy	*Anous stolidus*	Foraging	Around Houtman Abrolhos Around Lancelin Island
Australian lesser noddy	*Anous tenuirorstris melanops*	Foraging - Houtman Abrolhos Islands	Houtman Abrolhos Islands
Flesh footed shearwater	*Ardenna carneipes*	Foraging, aggregation (pre-migration) - Kimberley, Pilbara and Gascoyne coasts and islands including Ashmore Reef	Foraging from Cape Naturaliste to Eyre, 1-150 km offshore. Pre departure zone in some years from Rottnest Island to Bunbury.
Wedge-tailed shearwater	*Ardenna pacifica*	Breeding, foraging – west coast from Ashmore Reef to Carnac I. Kimberley, Pilbara, Gascoyne coasts, Ashmore reef	Breeding (in hundreds of thousands) off west coast from Ashmore Reef (12º15'S) to Carnac I. (32º07'S), and ranging in western seas between 12º00'S and 33º20'S. Kimberley, Pilbara and Gascoyne coasts and islands including Ashmore Reef
Little penguin	*Eudyptula minor*	Foraging - Perth to Bunbury	Perth to Bunbury
Lesser frigatebird	*Fregata ariel*	Breeding, foraging – Kimberley and Pilbara coasts and islands also Ashmore Reef.	Kimberley and Pilbara coasts and islands also Ashmore Reef.
Greater frigatebird	*Fregata minor*	Breeding, foraging - Kimberley and Ashmore Reef	Kimberley and Ashmore Reef
Caspian tern	*Sterna caspia*	Foraging - mainly islands (as far offshore as Adele, Bedout, Trimouille and the Houtman Abrolhos)	In Western Australia found on most coasts, mainly islands (as far offshore as Adele, Bedout, Trimouille and the Houtman Abrolhos) and at Lake Argyle, Lake Gregory and Lake MacLeod; accidental elsewhere in the interior.
Pacific gull	*Larus pacificus*	Foraging –west coast and islands	West coast and islands from Point Quobba (24º30'S) south to Wedge I. (formerly south to Warnbro Sound and at Cape Naturaliste); casual further north (Point Cloates and Lake MacLeod).

Species	Scientific name	Aggregation area and use	Specific geographic locations for species
Bridled tern	*Sterna anaethetus*	Foraging - West coast of Western Australia and around to Recherche Archipelago	West coast of Western Australia and around to Recherche Archipelago including offshore waters
Sooty tern	*Sterna fuscata*	Foraging – Timor sea	Timor Sea S to 14º30, off NW coast from Lacepede I SW to 117ºE inc Abrolhos, Fisherman & Lancelin Is, accidental on lower west coast to Hamelin Bay. Breeding visitor (late Aug - early May) Abrolhos & Lancelin Is; casual winter (Nov - Apr) to Fisherman
White-tailed tropic bird	*Phaethon lepturus*	Breeding, foraging - Kimberley, Pilbara and Gascoyne coasts and islands including Ashmore Reef	Kimberley, Pilbara and Gascoyne coasts and islands including Ashmore Reef
Great-winged petrel	*Pterodroma macroptera*	Foraging - Offshore south of Shark Bay	Offshore south of Shark Bay, extending around south-west corner of WA and east past Kangaroo Island
Soft plumage petrel	*Pterodroma mollis*	Foraging - seas north to 21°30'S	In WA found in seas north to 21°30'S.
Little shearwater	*Puffinus assimilis*	Foraging - From Kalbarri to Eucla	From Kalbarri to Eucla including offshore waters
Roseate tern	*Sterna dougallii*	Breeding, foraging – Islands and coastline in the Kimberley, Pilbara and Gascoyne regions Resting – Eighty Mile Beach	Eighty Mile Beach (northern end) Kimberley, Pilbara and Gascoyne coasts and islands including Ashmore Reef Low Rocks and Stern Island in Admiralty Gulf North-east and North-west Twin Islets near the mouth of King sound North-western and west coasts and islands from Sir Graham Moore Is (13°50'S), south to Mandurah (32°32'S) and as far offshore as Ashmore Reef, Bedout I. and the Houtman Abrolhos.
Little tern	*Sternula albifrons*	Breeding, foraging, resting - Kimberley, Pilbara and Gascoyne coasts and islands including Ashmore Reef Resting - Roebuck Bay	Kimberley, Pilbara and Gascoyne coasts and islands including Ashmore Reef Roebuck Bay Ramsar site

Species	Scientific name	Aggregation area and use	Specific geographic locations for species
Australian fairy tern	*Sternula nereis*	Foraging – Kimberley, Pilbara and Gascoyne coasts and islands	Found in the vicinity of lower north-west coast (north to Dampier Archipelago), west coast (south to Peel Inlet) and south coast (from Flinders Bay east to Israelite Bay), including islands (as far offshore as Trimouille I. and Houtman Abrolhos. Pilbara and Gascoyne coasts and islands
Brown Booby	*Sula leucogaster*	Breeding, foraging - Kimberley and northern Pilbara coasts and islands also Ashmore Reef.	Kimberley and northern Pilbara coasts and islands also Ashmore Reef.
Red-footed Booby	*Sula sula*	Breeding, foraging - north west Kimberley and Ashmore reef	North west Kimberley and Ashmore reef
Indian Yellow-nosed Albatross	*Thalassarche carteri*	Foraging - south-west marine region, north to Shark Bay and extending east into Bass Strait	Throughout offshore waters of south-west marine region, north to Shark Bay and extending east into Bass Strait
Lesser crested tern	*Sterna bengalensis*	Breeding, foraging - Kimberley, Pilbara and Gascoyne coasts and islands including Ashmore Reef	Kimberley, Pilbara and Gascoyne coasts and islands including Ashmore Reef

9. Protected Areas

A number of areas in the area of interest are protected under state and federal legislation. Protected areas include World Heritage Areas (WHAs), Wetlands of International Importance (Ramsar), Wetlands of National Importance, National and Commonwealth Heritage Places, and terrestrial conservation reserves (National Parks, Nature Reserves and Conservation Parks) that bound marine waters. These areas are listed in **Table 9-1**, and shown in **Figure 9-1**, and discussed below. Other protected areas include Key Ecological Features (discussed in **Section 10**) and State and Commonwealth Marine Parks/Reserves (discussed in **Section 11** and **Section 12**). A Protected Matters search of the area of interest (**Appendix A**) identified several protected areas which were deemed to be irrelevant to Santos WA's petroleum activities due to their terrestrial location (e.g. Forrestdale and Thomsons Lakes – Ramsar wetland).

Only protected areas relevant to the *Reindeer Wellhead Platform & Offshore Gas Supply Pipeline Operations Environment Plan* have been described in detail in the sections below.

The Register of the National Estate (RNE) provides a listing of more than 13,000 natural, historic and indigenous sites of significance. However, in 2012 all references to the RNE were removed from the EPBC Act and the *Australian Heritage Council Act 2003*.The RNE is now maintained on a non-statutory basis as a publicly available archive and educational resource. A protected matters search of the area from the South Australian border to the Northern Territory border listed 197 places on the RNE, although it is recognised that not all indigenous sites may be listed (**Appendix A**). The RNE places are not discussed further here but are listed in **Appendix A**.

Table 9-1: Summary of protected areas in waters within the area of interest

Area type	Title
World Heritage Area	Shark Bay
	The Ningaloo Coast
Wetland of International Importance (Ramsar)	Eighty Mile Beach
	Roebuck Bay
	Ashmore Reef National Nature Reserve
	Becher Point
	Peel-Yalgorup System
	Vasse-Wonnerup System
Wetlands of National Importance	Ashmore Reef
	Mermaid Reef
	Vasse-Wonnerup Wetland System
National Heritage Place	HMAS Sydney II and HSK Kormoran Shipwreck Sites
	Batavia Shipwreck Site and Survivor Camps Area 1629-Houtman Abrolhos
	The West Kimberley
	The Ningaloo Coast
	Shark Bay
Commonwealth Heritage Place	HMAS Sydney II and HSK Kormoral Shipwreck Sites
	Ningaloo Marine Area - Commonwealth Waters

Area type	Title
	Mermaid Reef - Rowley Shoals
	Ashmore Reef National Nature Reserve
	Scott Reef and Surrounds – Commonwealth Area
	Garden Island
Threatened Ecological Communities	Monsoon Vine Thickets on the ridge on the coastal sand dunes of Dampier Peninsula
	Roebuck Bay mudflats
Terrestrial Conservation Reserves e.g. national parks, nature reserves, and conservation parks.	Numerous bounding marine waters – refer to **Section 9.5**.

9.1 World Heritage Areas

There are two World Heritage Areas (WHAs) located in marine waters of WA, both of which occur in the waters from the South Australian border to the Northern Territory border: the Ningaloo Coast and Shark Bay (DEC 2012).

9.1.1 Shark Bay

Shark Bay was included on the World Heritage List in 1991 and is one of the few properties inscribed for all four outstanding natural universal values:

- An outstanding example representing the major stages in the earth's evolutionary history;
- An outstanding example representing significant ongoing ecological and biological processes;
- An example of superlative natural phenomena; and
- Containing important and significant habitats for in situ conservation of biological diversity.

Since 1997, an agreement established the joint management of the Shark Bay WHA by the Australian Commonwealth government and the Western Australian state government, with the operational responsibility by the Western Australian agencies (DEWHA 2008). This agreement also created a Community Consultative Committee and a Scientific Advisory Committee, both of which provide advice as required. The entire WHA encompasses islands and peninsulas, with an area of approximately 2.2 million hectares (70% of which is marine waters), and includes the following areas (UNESCO 2014):

- Hamelin Pool Marine Nature Reserve;
- Francois Peron National Park;
- Shell Beach Conservation Park;
- Monkey Mia Reserve;
- Monkey Mia Conservation Park;
- Zuytdorp Nature Reserve;
- Bernier, Dorre and Koks Islands Nature Reserves;
- Dirk Hartog Island National Park; and
- Various pastoral leases.

The marine environment of the Shark Bay WHA is protected as a State Marine Reserve and is discussed further in **Section 9.3.2**.

9.1.2 The Ningaloo Coast

The Ningaloo Coast was included on the World Heritage List in 2011 and was inscribed for outstanding natural universal values as follows:

+ An example of superlative natural phenomena and areas of exceptional natural beauty and aesthetic importance;
+ outstanding examples representing major stages of Earth's history, including the record of life, significant on-going geological processes in the development of landforms, or significant geomorphic or physiographic features; and
+ the most important and significant natural habitats for in situ conservation of biological diversity, including those containing threatened species of outstanding universal value from the point of view of science or conservation.

The Ningaloo Coast WHA includes (DEWHA 2010):

+ Ningaloo Marine Park (Commonwealth waters);
+ Ningaloo Marine Park (Western Australia state waters);
+ Muiron Island Marine Management Area (including the Muiron Islands);
+ Jurabi Coastal Park;
+ Bundegi Coastal Park;
+ Cape Range National Park; and
+ Learmonth Air Weapons Range.

The Ningaloo Coast World Heritage Area (including the Murion Islands) is managed under a plan that is consistent with the World Heritage Convention and Australia's World Heritage management principles. World Heritage Management principles are set out in regulations and cover matters relevant to the preparation of management plans, the environmental assessment of actions that may affect the property and community consultation processes.

The Australian World Heritage management principles are outlined under Schedule 5 of the EPBC regulations (2000). The objective is to ensure that any likely impact of an action on the World Heritage values of the property should be considered. Any action should be consistent with the protection, conservation, presentation or transmission to future generations of the World Heritage values of the property.

The marine environment of the Ningaloo Coast WHA is protected as a State Marine Park, a Commonwealth Marine Park, and is discussed further in **Section 11.1.1** and **Section 12.2.1**, respectively.

9.2 Wetlands of International Importance (Ramsar)

There are nine wetlands of international importance (Ramsar wetlands) in waters from the South Australian border to the Northern Territory border; all were listed in 1990 with the exception of Becher Point which was listed in 2001 and the dales which was listed in 2002. The Ashmore Reef National Nature Reserve (listed in 2002) is also a Commonwealth Marine Park. No wetlands of International Importance occur within the operational area or EMBA.

9.3 National Heritage Places

Natural, historic and indigenous places that are of outstanding heritage value to the Australian nation are recorded as National Heritage Places. Eleven National Heritage Places are found in waters from the South Australian border to the Northern Territory border. Shark Bay and The Ningaloo Coast are listed as both World Heritage Areas and National Heritage Places and are discussed in **Section 9.1**.

9.3.1 The Ningaloo Coast

See the Ningaloo Coast World Heritage Area (**Section 9.1.2**).

9.3.2 Shark Bay

See Shark Bay World Heritage Area (**Section 9.1.1**).

9.4 Commonwealth Heritage Places

The Commonwealth Heritage Places List comprises natural, indigenous and historic heritage places which are either entirely within a Commonwealth area, or outside the Australian jurisdiction and owned or leased by the Commonwealth or a Commonwealth Authority. One natural Commonwealth Heritage Place was found in or adjacent to the EMBA area. The Ningaloo Marine Area – Commonwealth Waters is found in Marine Parks and is discussed further in **Section 12**. The HMAS Sydney II and HSK Kormoran Shipwreck Sites is listed under both National and Commonwealth Heritage Lists and discussed in **Section 14.5**.

9.4.1 Ningaloo Marine Area – Commonwealth Waters

See the Ningaloo Coast World Heritage Area (**Section 9.1.2**).

9.5 Coastal Terrestrial Conservations Reserves – bound by marine waters

Conservation reserves are created under the Land Administration Act 1997, and once reserved and set aside for conservation purposes are regulated under the Conservation and Land Management Act (CALM) 1984. Most conservation reserves in WA are vested in (owned) by the WA Conservation and Parks Commission, an independent statutory body established by the CALM Act 1984, and most are managed by the Department of Biodiversity Parks Conservation and Attractions – Parks and Wildlife Service.

In WA there are three main types of terrestrial conservation reserves with legislative protection:

+ Nature reserves – established for wildlife and landscape conservation; scientific study; and preservation of features of archaeological, historic or scientific interest
+ National parks – as above but also to be used for enjoyment by the public. Have national or international significance
+ Conservation parks – as above but have local or regional significance.

Nature reserves can have an extra classification applied to them and become ‘A class’ reserves, which generally require an Act of Parliament to alter.

There are numerous terrestrial conservation reserves located adjacent to the coast in the area of interest. The oceanward boundary of the reserves varies. In some cases, the reserves extend to the low water mark, i.e. including the inter-tidal zone (particularly applicable to older gazetted reserves and terrestrial reserves not surrounded by a marine reserve). While in other cases, the terrestrial reserves extend to the high-water mark e.g. Lowendal Islands Nature Reserve (particularly applicable to terrestrial reserves adjacent to more recently gazetted marine parks). In other cases, the seaward boundary of the reserves is not defined. Management plans also contain the caveat for further consideration of the most appropriate tenure for intertidal areas and management arrangements.

Further information on coastal terrestrial reserves is provided below in **Section 9.5.1** (national parks) and **Section 9.5.2** (nature reserves and conservations parks).

9.5.1 Coastal National Parks

Protected coastal national parks managed under the CALM Act 1984 in the area of interest are listed in **Table 9-2** . The table also includes: any applicable management plan; whether the park includes the inter-tidal area; and the name of any adjacent state marine reserve. All National Parks are WA Class A reserves and IUCN Class 2.

Table 9-2: Coastal National Parks – coastal boundary in relation to inter-tidal zone

National Park	IBRA Bioregion[7]	Management Plan	Includes inter-tidal zone	Adjacent Marine Management Park (see Section 11)
Reserves of Northern WA (see Figure 9-2)				
Lawley River	Northern Kimberley	-	No [8]	Kimberley Marine Park
Mitchell River		-		
Prince Regent		-		
Reserves of North-West WA (see Figure 9-3)				
Murujuja	Pilbara	Murujuga National Park management plan 78 (DEC 2013)	Yes [9]	-
Cape Range	Carnarvon	Cape Range National Park Management Plan (DEC 2010)	No	Ningaloo Marine Park
Reserves of Southern WA				
Francois Peron	Carnarvon	Shark Bay Terrestrial Reserves and Proposed Reserve Additions Management Plan (2012)	No	Shark Bay Marine Park and Hamelin Pool Marine Nature Reserve
Dirk Hartog	Yalgoo		Yes – intertidal zone on western side of Dirk Hartog is included (as no marine park on western side of island)	
Kalbarri	Geraldton Sandplains	Kalbarri National Park Management Plan (DPAW 2015)	Yes [9]	-
Namburg	Geraldton Sandplains	Namburg National Park Management Plan (1998)	Yes	-
Yalgorup	Swan Coastal Plain	Yalgorup National Park Management Plan (CALM 1995)	Yes [9]	-
Leeuwin - Naturaliste	Warren	Leeuwin-Naturaliste Capes Area Parks and Reserves Management Plan (DPAW 2015)	No	Ngari Capes Marine Park

[7] The Interim Biogeograhic Regionalisation for Australia (IBRA) classifies Australia's landscapes into large geographically distinct bioregions based on common climate, geology, landform, native vegetation and species information (DoEE 2012).

9.5.2 Coastal Nature Reserves and Conservation Parks

Protected coastal nature reserves and conservation parks managed under the CALM Act 1984 in the area of interest are listed in **Table 9-3** and shown in **Figure 9-2** and **Figure 9-3** for the north, north-west and south of WA respectively. The table also includes: reserve class; IUCN classification; any applicable management plan; whether the reserve includes the inter-tidal area; and the name of any adjacent state marine reserve (may also describe inter-tidal areas values).

The CALM Act does not require management plans to be in place for conservation reserves at all time, instead they are required to be made as is reasonably practicable regarding resources. This means some conservation reserves do not have a management plan, or do not have a recent management plan.

Table 9-3: Nature Reserves (NR) and Conservation Parks (CP) in area of interest

Reserve Name and Type	Reserve Class (WA)	IUCN	Management Plan	Includes inter-tidal zone	Adjacent Marine Park (see Section 11)
Reserves of Northern WA (see Figure 9-2)					
Ord River NR	-	1a	-	No [8]	North Kimberley Marine Park
Pelican Island NR	-	1a			
Leseur Island NR	A	1a			
Low Rocks NR	A	1a			
Browse Island NR	A	1a	-	Yes [9]	-
Scott Reef	-	1a	-	Yes [9]	-
Adele Island NR	A	1a	-	Yes [9]	-
Tanner Island NR	A	1a	-	Yes [9]	-
Lacepede Islands NR		1a	-	Yes [9]	-
Colomb Point NR	A	1a	-	Yes [9]	-
Yawaru Birragun CP; Yawuru Northern Intertidal Area	- & A	2 & 6	Yawaru Birragun Conservation Park Management Plan (DPAW 2016). *Yawuru Intertidal Area management plan is not yet available*.	Yes	-
Jinmarnkur CP	C	-	Parks and reserves of the south-west Kimberley and north-west Pilbara Draft Management Plan (DPAE 2016). *Covers 80 Milebeach coastal reserves*.	No	Eighty Mile Beach Marine Park
Jinmarnkur Kulja NR	A	-			
Kujungurru Warrarn NR	A	1a			
Kujungurru Warrarn CP	C	-			
Unamed	A	-			
Jarrkunpungu NR	A				
Bedout Island NR	A	1a	-	Yes [9]	-
North Turtle Island NR	A	1a	-	Yes [9]	-

[8] Inferred as adjacent marine park boundary is the high water mark and dual tenure cannot exist.

[9] Conservatively inferred as no adjacent marine park

Reserve Name and Type	Reserve Class (WA)	IUCN	Management Plan	Includes inter-tidal zone	Adjacent Marine Park (see Section 11)
Reserves of North-West WA (see Figure 9-3)					
Unnamed (Dampier Archipelago) NR	A	1a	Dampier Achipelago Management Plan (CALM 1990). *Covers 25 of the islands*	Yes	-
Unamed NR		1a	-	Yes [9]	-
North Sandy Island NR	A	1a	-	Yes [9]	-
Montebello Islands CP	A	2	-	Partially [10]	Montebello Islands Marine Park
Lowendal Island NR		1a	-	No	Barrow Island Marine Management Area and Marine Park. Lowendal Island NR only partially bounded
Barrow Island NR	A	1a	Barrow Island Group Nature Reserves (DPAW 2015)	Yes	
Boodie, Double and Middle Islands NR	-	1a		Yes	
Great Sandy Island NR	B	1a	-	Yes	Barrow Island Marine Management Area
Weld Island NR	-	1a	-	Yes [9]	-
Little Rocky Island NR	A	1a	-	Yes [9]	-
Airlie Island NR	-	1a	-	Yes [9]	-
Thevenard Island Nature	-	1a	-	Yes [9]	-
Bessieres Island NR Reserve	A	1a	-	Yes [9]	-
Serruier Island NR	-	1a	-	Yes [9]	-
Round Island NR	-	1a	-	Yes [9]	-
Locker Island	A	1a	-	Yes [9]	-
Rocky Island NR	-	1a	-	Yes [9]	-
Gnardaroo Island NR	A	1a	-	Yes [9]	-

[10] Reserve R42197 includes the inter-tidal zone and reserve R42196 does not.

Reserve Name and Type	Reserve Class (WA)	IUCN	Management Plan	Includes inter-tidal zone	Adjacent Marine Park (see Section 11)
Victor Island NR	-	1a	-	Yes [9]	-
Y Island NR	-	1a	-	Yes [9]	-
Tent Island NR	-	1a	-	Yes [9]	-
Burnside and Simpson Island NR	-	1a	-	Yes [9]	-
Whalebone Island NR		1a	-	Yes [9]	-
Whitmore, Roberts, Doole Islands & Sandalwood Landing NR	-	1a	-	Yes [9]	-
Muiron Islands NR	-	1a	Jarabi and Bundegi Coastal Parks and Muiron Islands (CALM 1999)	No [8]	Murion Islands Marine Management Area
OneTree Point NR	A	1a	-	Yes [9]	
Reserves of Southern WA					
Koks Island NR	A	1a	Shark Bay Terrestrial Reserves and Proposed Reserve Additions Management Plan (DPAW 2012) -	Yes [9]	-
Bernier And Dorre Islands NR	A	4			
Shell Beach CP	-	3		No	Shark Bay Marine Park
Freycinet, Double Islands Etc NR	A	1a			Shark Bay Marine Park
Zuytdorp NR	-	1a		Yes [9]	-
Beekeepers NR	-	1a	-	Yes [9]	-
Beagle Islands NR	A	1a	Turquoise Coast Nature Reserve Management Plan (CALM 2004). *Covers chain of approximately 40 protected islands lying between Lancelin and Dongara.*	Yes	-
Lipfert, Milligan, etc Islands NR	A	1a			-
Fisherman Islands NR	A	1a			Jurien Bay Marine Park: extends from Greenhead south to Wedge Island
Sandland Islands NR	A	1a			
Boullanger, Whitlock, Favourite, Tern and Osprey Islands NR	A	1a			
Escape Island NR	A	1a			

Reserve Name and Type	Reserve Class (WA)	IUCN	Management Plan	Includes inter-tidal zone	Adjacent Marine Park (see Section 11)
Essex Rocks NR	A	1a			
Outer Rocks NR	A	1a			
Ronsard Rocks NR	A	1a			
Cervantes Islands NR	A	1a			
Buller, Whittell and Green Islands NR	A	1a			
Wedge Island NR	A	1a			
Lancelin and Edwards Islands NR	A	1a			-
Southern Beekeeper's NR	-	1a	Namburg National Park Management Plan (CALM 1998)	No	-
Wanagarren NR	-	1a		Yes	
Nilgen NR	-	1a		Yes	
Unnamed CP (R 49994) west of Wilbinga	-	2		Yes [9]	-
Unnamed CR (R 42469) at Woodman Point	-	-	Woodman Park Regional Park Management Plan (DEC 2010)	No	-
Unnamed CP at Woodman Point (R 49220)	-	2		No	-
Carnac Island	A	1a	Carnac Island Nature Reserve Management Plan (CALM 2003)	Yes	-
Penguin Island CP	A	3	Shoalwater Islands Management Plan (CALM 2002)	No	Shoalwater Islands Marine Park
Shoalwater Islands NR	A	1a		Yes	
Port Kennedy Scientific Park	A	1a	Rockingham Lakes Regional Park (DEC 2015)	No	-
Leschenault Peninsula CP	A	2	Leschenault Peninsula Management Plan (CALM 1998)	Yes	-
Sugar Loaf Rock NR	A	1a	Leeuwin-Naturaliste Capes Area Parks and Reserves Management Plan (DPAW 2015)	Yes	Ngari Capes Marine Park
Hamelin Island NR	A	1a		Yes	
Seal Island NR	A	1a		Yes	

Reserve Name and Type	Reserve Class (WA)	IUCN	Management Plan	Includes inter-tidal zone	Adjacent Marine Park (see Section 11)
St Alouarn Island NR	A	1a		Yes	
Flinders Bay NR	A	1a		Yes	

Further information is provided below in relation to Varanus Island and Airlie Island Nature Reserves. Santos WA's Varanus Island Processing Hub and Airlie Island (operations ceased) co-exist with the reserves.

Lowendal Islands Nature Reserve - Varanus Island

Varanus Island is part of the Lowendal Islands group, a Nature Reserve (Class C). The Lowendal Islands comprise more than 40 limestone islands, islets and rocky stacks. There is not currently a DBCA Management Plan covering the Lowendal Islands Nature Reserve. Varanus Island is the largest island in the Lowendal Islands and is approximately 2.5 km long and 600m wide at its widest point. Its highest point is approximately 30m above sea level.

Described ecological conservation values of marine relevance include: Wedge-t ailed Shearwater nesting (see **Section 8.2**); Loggerhead and Hawksbill Turtle nesting (see **Section 6.1.1** and **Section 6.1.3**), Flatback Turtle nesting (**Section 6.1.4**). The Lowendal Islands are described as particularly important for tern breeding (DEC 2002), further information on terns is provided in **Section 8.2**.

Airlie Island Nature Reserve

Airlie Island Nature Reserve is an ungazetted 'C' class nature (Reserve identifier: 40323, Crown Lease 1901/100) located on Airlie Island. Airlie Island is a small sand cay (26 Ha) located 35 km NNE of Onslow. It is part of the Pilbara Inshore Islands chain. A management plan for the nature reserves of the Pilbara Inshore Islands is currently under development (DBCA 2019) i.e. there is not currently a DBCA Management Plan covering Airlie Island Nature Reserve.

Described ecological conservation values of marine relevance include: a Wedge-tailed Shearwater nesting (see **Section 8.2**); Silver Gull nesting (see **Section 8.2**) and low levels of Green Turtle and Hawksbill Turtle nesting (see **Section 6.1.2** and **6.1.3**).

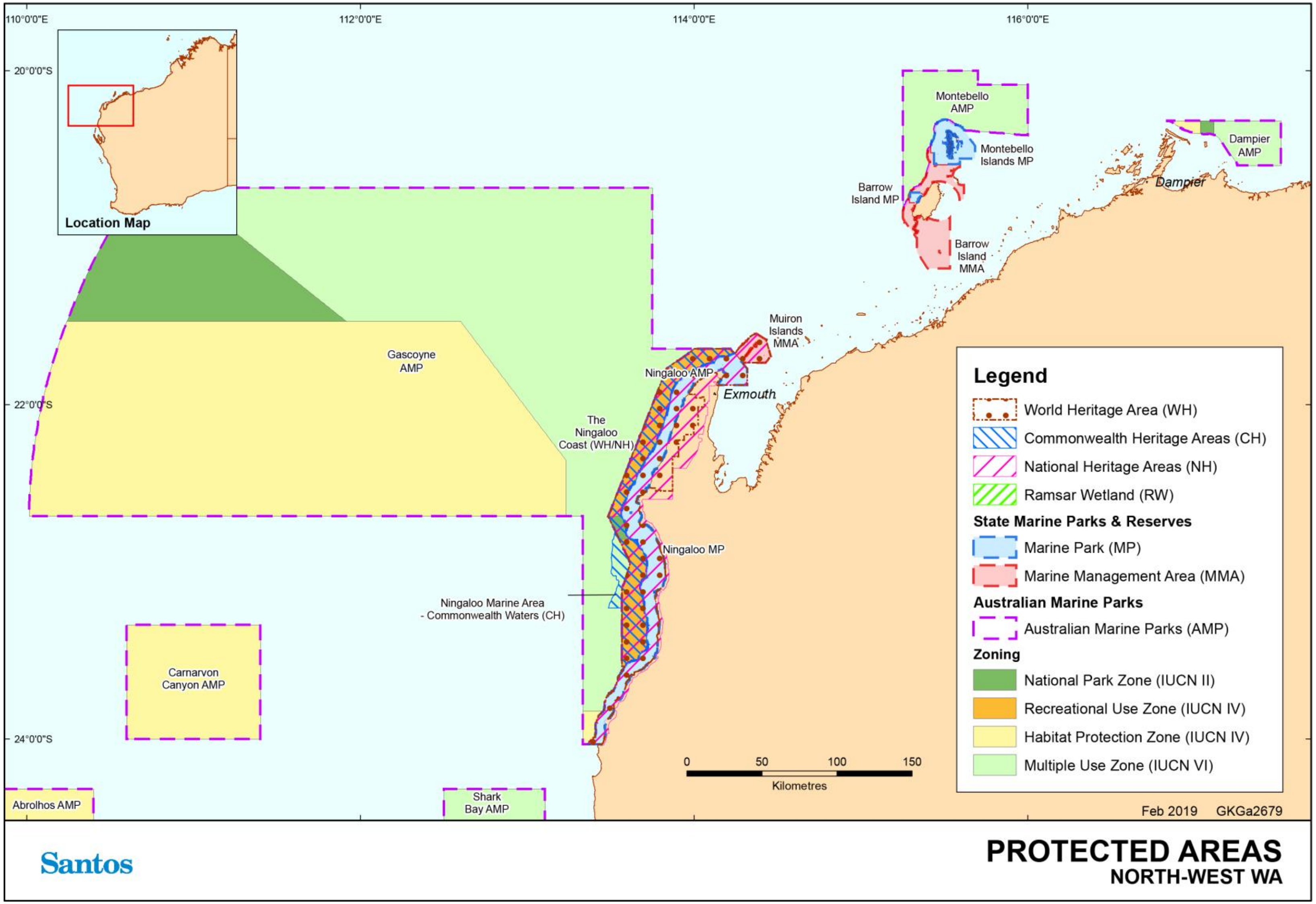


Figure 9-1: Protected areas in North-West WA

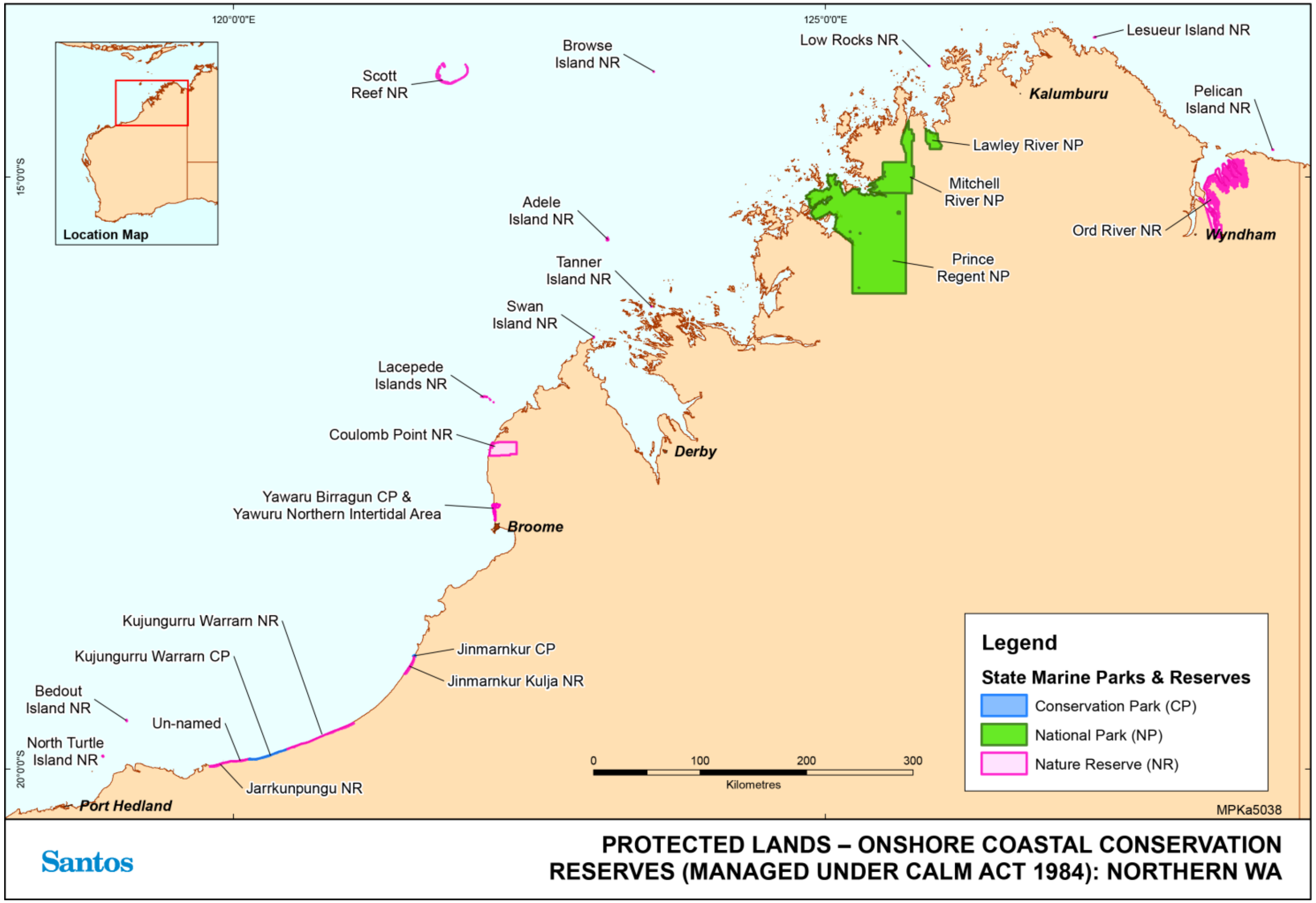


Figure 9-2: Protected Lands (CALM Act 1984) – terrestrial conservation reserves bounding marine waters in northern WA[11]

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[11] Yawaru Minyirr Buru Conservation Reserve (adjacent to Roebuck Bay) not shown as exact spatial extent unavailable, however the adjacent inter-tidal waters are managed under adjacent Roebuck Bay Marine Park.

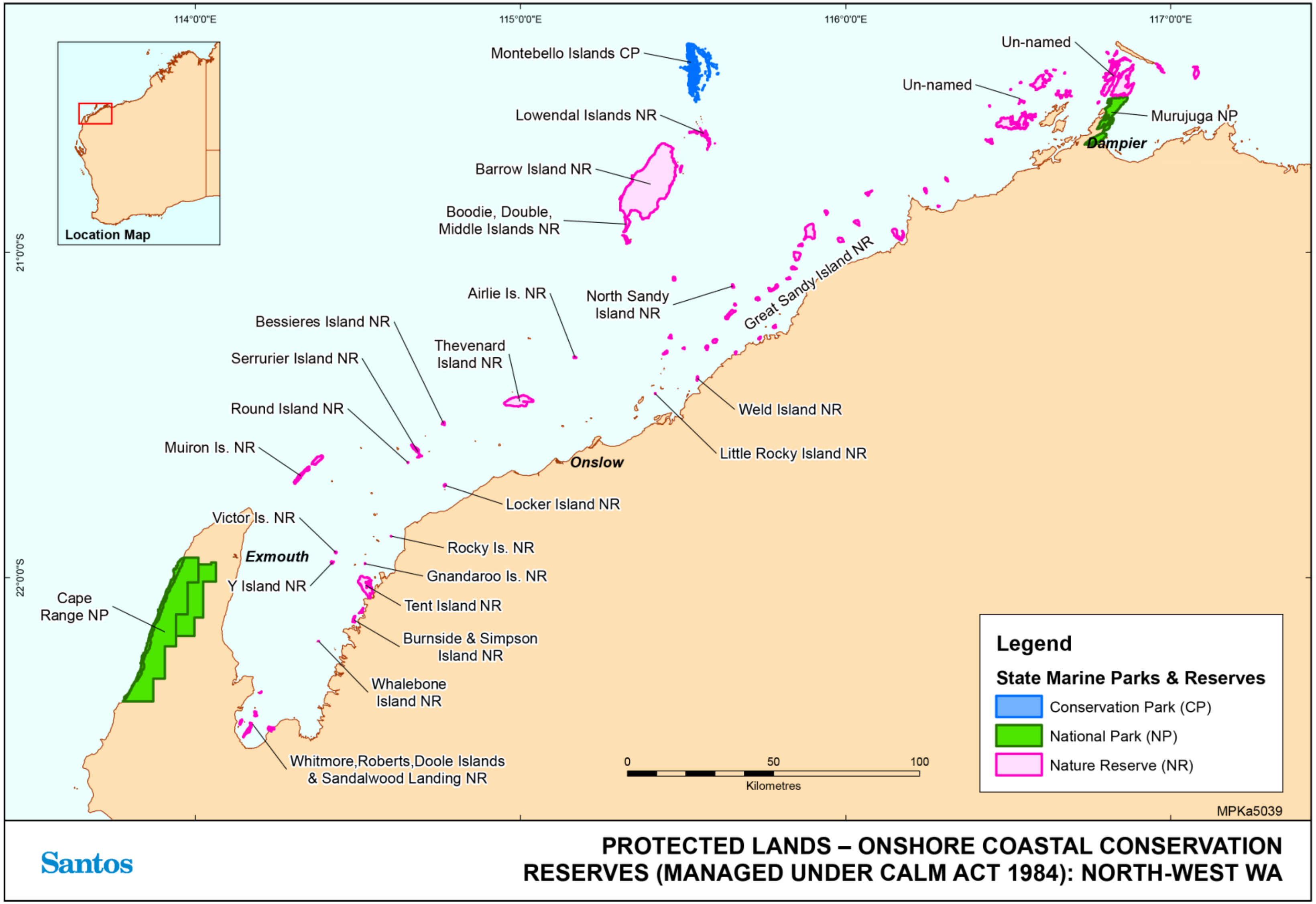

Figure 9-3: Protected Lands (CALM Act 1984) – terrestrial conservation reserves bounding marine waters in North-West WA

10. Key Ecological Features

10.1 Introduction

Key ecological features are elements of the Commonwealth marine environment that are considered to be of regional importance for either a region's biodiversity or its ecosystem function and integrity. Key ecological features meet one or more of the following criteria (DSEWPaC 2012):

+ A species, group of species or a community with a regionally important ecological role;
+ A species, group of species or a community that is nationally or regionally important for biodiversity;
+ An area or habitat that is nationally or regionally important for:
  - Enhanced or high biological productivity;
  - Aggregations of marine life; or
  - Biodiversity and/or endemism
+ A unique seafloor feature with ecological properties of regional significance.

Twenty-one key ecological features of the Commonwealth waters in the area of interest (covering the North Marine Region, the North-west Marine Region and the South-West Marine Region) have been identified in the protected matters search (**Figure** 10-1). Key ecological features identified which intersect the the *Reindeer Wellhead Platform & Offshore Gas Supply Pipeline Operations Environment Plan* EMBA are discussed in this section.

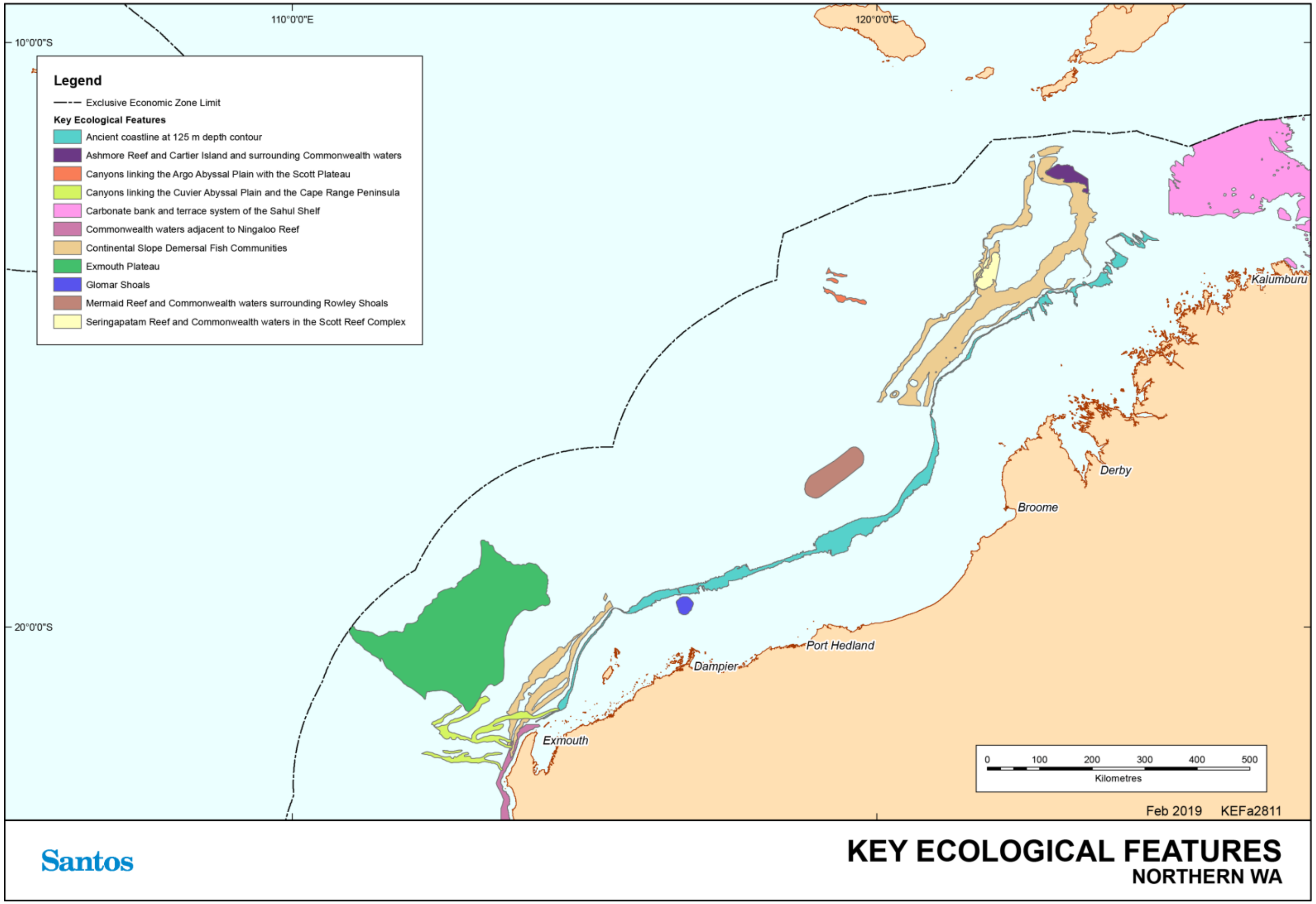

Figure 10-1: Key ecological features of Northern WA

10.1.1 Commonwealth Waters Adjacent to Ningaloo Reef

The Commonwealth Waters adjacent to Ningaloo Reef KEF is defined for high productivity and aggregations of marine life. The Ningaloo Reef extends almost 300 km along the Cape Range Peninsula to the Red Bluff and is globally significant as the only extensive coral reef in the world that fringes the west coast of a continent. Commonwealth waters adjacent to the reef are thought to support the rich aggregations of marine species at Ningaloo Reef through upwellings associated with canyons on the adjacent continental slope and interactions between the Ningaloo and Leeuwin currents (Brewer *et al*. 2007, DEWHA 2008c, DSEWPaC 2012). The narrow continental shelf (10 km at its narrowest) means that the nutrients channelled to the surface via canyons are immediately available to reef species. Terrestrial nutrient input is low, hence this deep-water source is a major source of nutrients for Ningaloo Reef and therefore very important in maintaining this system (DEWHA 2008b).

The reef is known to support an extremely abundant array of marine species including over 200 species of coral and more than 460 species of reef fish, as well as molluscs, crustaceans and other reef plants and animals (DEWHA 2008b). Marine turtles, dugongs and dolphins frequently visit the reef lagoon. The Commonwealth waters around Ningaloo include areas of potentially high and unique sponge biodiversity (DEWHA 2008b). Upwellings on the seaward side support aggregations such as whale sharks and manta rays (these waters are the main known aggregation area for whale sharks in Australian waters). Humpback whales are seasonal visitors to the outer reef edge and seasnakes, sharks, large predatory fish and seabirds also utilise the reef and surrounding waters.

The Ningaloo Marine Park includes this Key Ecological Feature and is discussed in **Section 12.2.1**.

10.1.2 Canyons Linking the Cuvier Abyssal Plain with the Cape Range Peninsula

The Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula are defined as a key ecological feature as they are unique seafloor features with ecological properties of regional significance.

Cape Range Peninsula and the Cuvier Abyssal Plain are linked by canyons, the largest of which are the Cape Range Canyon and Cloates Canyon. These two canyons are located along the southerly edge of Exmouth Plateau adjacent to Ningaloo Reef and are unique due to their close proximity to the North West Cape (DSEWPaC 2012). The Leeuwin Current interacts with the heads of the canyons to produce eddies resulting in delivery of higher nutrient, cool waters from the Antarctic intermediate water mass to the shelf (Brewer *et al*. 2007). Strong internal tides also create upwelling at the canyon heads (Brewer *et al*. 2007). Thus the canyons, the Exmouth Plateau and the Commonwealth waters adjacent to Ningaloo Reef interact to create the conditions for enhanced productivity seen in this region (Sleeman *et al*. 2007 in DSEWPaC 2012). The canyons are also repositories for particulate matter deposited from the shelf and sides of the canyons and serve as conduits for organic matter between the surface, shelf and abyssal plains (DSEWPaC 2012).

The soft bottom habitats within the canyons themselves are likely to support important assemblages of epibenthic species. Biological productivity at the head of Cape Range Canyon in particular, is known to support species aggregations, including whale sharks, manta rays, humpback whales, sea snakes, sharks, large predatory fish and seabirds. The canyons are thought to be significant contributors to the biodiversity of the adjacent Ningaloo Reef, as they channel deep water nutrients up to the reef, stimulating primary productivity (DEWHA 2008b).

10.1.3 Exmouth Plateau

The Exmouth Plateau is defined as a KEF as it is a unique seafloor feature with ecological properties of regional significance. The Exmouth Plateau covers an area of 49,310 km^2 and is located approximately 150 km northwest of Exmouth. The plateau ranges in water depths from 800 to 4,000 m (Heap & Harris 2008 in DSEWPaC 2012). The plateau's surface is rough and undulating at 800–1,000 m depth. The northern margin is steep and intersected by large canyons (e.g. Montebello and Swan canyons) with relief greater than 50 m. The western margin is moderately steep and smooth and the southern margin is gently sloping and virtually free of canyons (Falkner *et al*. 2009 in DSEWPaC 2012).

The Exmouth Plateau is a regionally and nationally unique tropical deep sea plateau. It that may serve an important ecological role by acting as a topographic obstacle that modifies the flow of deep waters that generate internal tides, causing upwelling of deeper water nutrients closer to the surface (Brewer *et al.* 2007). Sediments on the plateau suggest that biological communities include scavengers, benthic filter feeders and epifauna. Whaling records from the 19th century suggest that the Exmouth Plateau may have supported large populations of sperm whales (Bannister *et al*. 2007). Fauna in the pelagic waters above the plateau are likely to include small pelagic species and nekton (Brewer *et al.* 2007).

10.1.4 Glomar Shoals

The Glomar Shoals are a submerged feature situated at a depth of 33–77 m, approximately 150 km north of Dampier on the Rowley Shelf (Falkner *et al*. 2009 in DSEWPaC 2012). They consist of a high percentage of marine-derived sediments with high carbonate content and gravels of weathered coralline algae and shells (McLoughlin & Young 1985 in DSEWPaC 2012). The area's higher concentrations of coarse material compared to surrounding areas are indicative of a high energy environment subject to strong seafloor currents (Falkner *et al*. 2009 in DSEWPaC 2012).

Biological communities found at the Glomar Shoals have not been comprehensively studied, however the shoals are known to be an important area for a number of commercial and recreational fish species such as rankin cod, brown striped snapper, red emperor, crimson snapper, bream and yellow-spotted triggerfish. Catch rates at the Glomar Shoals are high, indicating that the area is a region of high productivity (Falkner *et al*. 2009, Fletcher & Santoro 2009 in DSEWPaC 2012). It is unclear if the removal of non-target species due to the commercial fishing over the shoals is having an impact on its value (DSEWPaC 2012).

The Glomar Shoals are regionally important for their potentially high biological diversity and localised productivity. Biological data specific to the Glomar Shoals is limited, however the fish of the shoals are probably a subset of reef-dependent species and anecdotal evidence suggests they are particularly abundant (DSEWPaC 2012).

10.1.5 Ancient Coastline at 125 m Depth Contour

The shelf of the North-west Marine Region contains several terraces and steps which reflect changes in sea level that occurred over the last 100,000 years. The most prominent of these features occurs at a depth of 125m as an escarpment along the North West Shelf and Sahul Shelf (DSEWPaC 2012). Where the ancient submerged coastline provides areas of hard substrate it may contribute to higher biological diversity. Little detailed knowledge is available, but the hard substrate of the escarpment is likely to support sponges, crinoids, molluscs, echinoderms (DSEWPaC 2012). It is understood that changes in topography at these depths are critical points for the generation of internal waves (Holloway *et al.* 2001 cited in DEWHA 2008b), playing a minor role in aiding localised upwelling or at least regional mixing associated with the seasonal changes in currents and winds. It is also believed that this prominent floor feature could be important as a migratory pathway for cetaceans and pelagic species such as the whale shark and humpback whale, as they move north and south between feeding and breeding grounds (DEWHA 2008b).

Parts of the ancient coastline are thought to provide biologically important habitats in areas otherwise dominated by soft sediments. The topographic complexity of these escarpments may also facilitate vertical mixing of the water column providing a relatively nutrient-rich environment for species present on the escarpment (DSEWPaC 2012). This enhanced productivity could potentially be attracting baitfish, which in turn provide food for the migratory species. The pressures of potential concern on the biodiversity value of this feature generally include ocean acidification as a result of climate change (DoEE 2017).

10.1.6 Continental Slope Demersal Fish Communities

The Australian Continental Slope provides important habitat for demersal fish communities, characterised by high endemism and species diversity. Specifically, the continental slope between North West Cape and the Montebello Trough is the most diverse slope bioregion in Australia with more than 500 fish species, 76 of which are endemic (Last *et al*. 2005 in DSEWPaC 2012).

The Continental Slope consists of two distinct community types, associated with the upper and mid slope, 225 – 500 m and 750 – 1000 m respectively. The Timor Province and Northwest Transition bioregions are the second-richest areas for demersal fish across the entire continental slope (DSEWPaC 2012). The bacteria and fauna that is present in the system on the Continental Slope are the basis for the food web for demersal fish and higher order consumers in the system. Further information of this system has been poorly researched, though it has been suggested that it is a detritus-based system, where infauna and epifauna become prey for a range of teleost fish, molluscs and crustaceans (Brewer *et al.* 2007). The higher order consumers supported by this system are likely to be carnivorous fish, deep water sharks, large squid and toothed whales (Brewer *et al.* 2007). The pelagic production is known to be phytoplankton based, with hotspots located around oceanic reefs and islands (Brewer *et al.* 2007).

It is believed that the loss of the benthic habitat along this continental shelf region would likely lead to a decline in the species diversity and endemism that this feature is associated with (DoEE 2017e). The endemism of the region is not supported by large data sets and is scarce. It is consequently not well understood what interactions exist between the physical processes and trophic structures that lead to this high diversity of fish and the suggested presence of endemic species in the region (DoEE 2017e).

11. State Marine Conservation Reserves

11.1 Introduction

Marine parks and reserves have been progressively established in Western Australia since 1987. The Conservation and Parks Commission (CPC) is the vesting authority for marine parks and reserves under the provisions of the Conservation and Land Management Act 1984. Parks and Wildlife, within the Department of Biodiversity, Conservation and Attractions (DBCA), is responsible for day to day management of the parks.

There are three categories of state marine conservation reserves: marine parks; marine management areas; and marine nature reserves.

Marine parks are created to protect natural features and aesthetic values while allowing recreational and commercial uses that do not compromise conservation values. There are currently sixteen marine parks within the area of interest (Refer **Figure 9-1**, **Figure 9-1** and **Figure 9-3**). State marine conservation reserves which intersect the the *Reindeer Wellhead Platform & Offshore Gas Supply Pipeline Operations Environment Plan* EMBA are discussed in the sections below.

Marine parks are multiple-use reserves that cater for a wide range of activities. Within marine parks there may be four types of management zones: recreation zones: general use zones; no-take areas known as sanctuary zones; and special purpose zones.

Each marine park has a 'management plan' that contains strategies to protect the high value assets in the park, as well as permitted activities tables. These tables provide explicit regulatory management.

Sanctuary zones are 'no-take' areas created primarily for conservation and scientific research and are designed to protect a particular significant ecosystem or habitat. Low-impact tourism may be permitted, but no recreational or commercial fishing, aquaculture, pearling, petroleum drilling or production is allowed.

Marine management areas provide an integrated management structure over areas that have high conservation value and intensive multiple-use. There are two marine management areas within the area of interest (described below).

There is currently only one state marine nature reserve: Hamelin Pool Nature Reserve part of the Shark Bay World Heritage Area (**Section 9.1.1**)

11.1.1 Ningaloo Marine Park

The Ningaloo Marine Park was declared in May 1987 under the National Parks and Wildlife Conservation Act 1975 (Cmlth). The Ningaloo Coast, incorporating both key marine and terrestrial values was later granted World Heritage Status in June 2011. In November 2012, the Ningaloo Marine Park (Commonwealth Waters) was renamed to be incorporated in the North-west Commonwealth Marine Reserves Network. The park covers an area of 263,343 km^2, including both State and Commonwealth waters, extending 25 km offshore.

The park protects a large portion of Ningaloo Reef, which stretches over 300 km from North West Cape south to Red Bluff. It is the largest fringing coral reef in Australia, forming a discontinuous barrier that encloses a lagoon that varies in width from 200 m to 7 km. Gaps that regularly intercept the main reef line provide channels for water exchange with deeper, cooler waters (CALM 2005). The Ningaloo Marine Park forms the backbone of the nature-based tourism industry, and recreational activities in the Exmouth region. Seasonal aggregations of whale sharks, manta rays, sea turtles and whales, as well as the annual mass spawning of coral attract large numbers of visitors to Ningaloo each year (CALM 2005).

The reef is composed of partially dissected basement platform of Pleistocene marine or Aeolian sediments or tertiary limestone, covered by a thin layer of living or dead coral or macroalgae. Key features that characterise the Ningaloo Reef include (CALM 2005):

+ Over 217 species of coral (representing 54 genera);
+ Over 600 species of mollusc (clams, oysters, octopus, cuttlefish, snails);
+ Over 460 species of fish;

- Ninety-seven species of echinoderms (sea stars, sea urchins, sea cucumbers);
- Habitat for numerous threatened species, including whales, dugong, whale sharks and turtles; and
- Habitat for over 25 species of migratory wading birds listed in CAMBA and JAMBA.

11.1.2 Muiron Islands Marine Management Area

The Ningaloo Marine Park Management Plan (CALM 2005) created a MMA for the Muiron Islands, immediately adjacent to the northern end of the Park. This is managed as an integrated area together with the Ningaloo Marine Park, but its status as a MMA means that some activities, including oil and gas exploration, are still permitted under a strict environmental assessment process involving DMIRS.

The Muiron Islands, located 15 km northeast of the North West Cape comprise the North and South Muiron Islands and cover an area of 1,400 ha (AHC 2006). They are low limestone islands (maximum height of 18 m above sea level (ASL)) with some areas of sandy beaches, macroalgae and seagrass beds in the shallow waters (particularly on the eastern sides) and coral reef up to depths of 5m, which surrounds both sides of South Muiron Island and the eastern side of North Muiron Island. The Muiron Islands MMA was WA's first MMA, gazetted in November 2004. It covers an area of 28,616 ha and occurs entirely within state waters (CALM 2005).

11.1.3 Barrow Island Marine Park

The Barrow Island Marine Park covers 4,169 ha, all of which is zoned as sanctuary zone (the Western Barrow Island Sanctuary Zone) (DEC 2007). It includes Biggada Reef, an ecologically significant fringing reef, and Turtle Bay, an important turtle aggregation and breeding area (DEC 2007). Representative areas of seagrass, macroalgal and deep water habitat are also represented within the marine park (DEC 2007). Passive recreational activities (such as snorkelling, diving and boating) are permitted but extractive activities such as fishing and hunting are not.

11.1.4 Barrow Island Marine Management Area

The Barrow Island Marine Management Area (MMA) is the largest reserve within the Montebello/Barrow Islands marine conservation reserves, covering 114,693 ha (DEC 2007). The MMA includes most of the waters around Barrow Island, the Lowendal Islands and the Barrow Island Marine Park, with the exclusion of the port areas of Barrow Island and Varanus Island.

The MMA is not zoned apart from one specific management zone: the Bandicoot Bay Conservation Area. This conservation area is on the southern coast of Barrow Island and has been created to protect benthic fauna and seabirds. It includes the largest intertidal sand/mudflat community in the reserves, is known to be high in invertebrate diversity and is an important feeding area for migratory birds.

As for the other reserves in the Montebello/Barrow Islands marine conservation reserves, the Barrow Island MMA includes significant breeding and nesting areas for marine turtles and the waters support a diversity of tropical marine fauna, important coral reefs and unique mangrove communities (DEC 2007). Green, hawksbill and flatback turtles regularly use the island's beaches for breeding, and loggerhead turtles are also occasionally sighted.

11.1.5 Montebello Islands Marine Park

Montebello/Barrow/Lowendal Islands are part of a shallow submarine ridge, which extends north from the mainland near Onslow. The ridge contains extensive areas of intertidal and shallow subtidal limestone pavement surrounding the numerous, mostly small islands which are found in the region. The seabed is generally less than 5 m deep and consists of sand veneered limestone pavement with patches of fringing coral reef (DEC, 2007).

The island chain lies entirely within WA State waters, with the State-Commonwealth boundary extending out to encompass the islands and waters 3 nm west of Barrow Island and north of the Montebello Islands. These islands are protected within as marine conservation reserves: Montebello Islands Marine Park, Barrow Islands Marine Park and Barrow Island Marine Management Area.

The Montebello Islands Marine Park (58,331 ha), consists of two sanctuary zones, two recreation zones, one special purpose zone for benthic protection, eleven special purpose zones for pearling and general use zones.

The Montebello Islands comprise over 100 islands, the majority of which are rocky outcrops; rocky shore accounts for 81% of shoreline habitat (DEC 2007a).

The ecological and conservation values of the Montebello and Barrow Islands Marine Conservation Reserve (MCR) include important habitats including corals reefs and bommies, mangroves, seagrass and macroalgae meadows, rocky shorelines and hard substrate, intertidal sand and mudflat communities. These habitats provide protection, food and habitat for a large diversity of species, including dugongs, turtles, whales, other protected cetaceans and birds as well as sea snakes and fish. The area is considered to have a high biodiversity. The islands also provide feeding and resting areas for migrating shorebirds and seabird nesting areas.

Socio-economic values of the Montebello and Barrow Islands MCR include hydrocarbon exploration and production, pearling, nature-based tourism, commercial and recreational fishing, water sports, European history and maritime heritage and scientific research (DEC, 2007)

Special purpose zones for pearling are established for the existing leaseholder to allow pearling to be the priority use of these areas (DEC 2007a). Commercial fishing includes a trap fishery for reef fishes, mainly in water depths of 30–100 m, and wet lining for reef fish and mackerel. Fish trawling also occurs in the waters near to the Montebello Islands. A tourist houseboat operates out of Claret Bay, at the southern end of Hermite Island, during the winter months. The Montebello Islands are becoming more frequently used by recreational boaters for camping, fishing and diving activities.

12. Australian Marine Parks

12.1 Introduction

In agreement with the States and Northern Territory governments, the Australian Commonwealth government was committed to establish Commonwealth marine reserves as a component of the National Representative System of Marine Protected Areas (DoE 2014) (See **Figure 9-1**). In November 2012, the Commonwealth Marine Reserves Network was proclaimed with the purpose of protecting the biological diversity and sustainable use of the marine environment (Director of National Parks 2012a). Commonwealth Marine Reserves were renamed as Australian Marine Parks in October 2017. Six marine regions are included in the Australian Marine Parks Network, including the Coral Sea, the South-west, the Temperate East, the South-east the North and the North-west. The South-east network 10-year Management Plan came into effect on 1 July 2013. The remaining networks 10-year Management Plans were approved and came into effect on 1 July 2018.

The new management plans establish the management and zoning of the designated marine parks. The marine park networks pertinent to the *Reindeer Wellhead Platform & Offshore Gas Supply Pipeline Operations Environment Plan* EMBA include:

+ The North-West Marine Parks Network.

The North-West Marine Parks Network comprises 13 marine parks which all occur in West Australian waters. Those pertinent to the *Reindeer Wellhead Platform & Offshore Gas Supply Pipeline Operations Environment Plan* EMBA are:

+ Shark Bay Marine Park;
+ Gascoyne Marine Park;
+ Ningaloo Marine Park;
+ Montebello Marine Park;
+ Dampier Marine Park; and
+ Argo-Rowley Terrace Marine Park.

The sizes of these marine parks range from 300—152,000 km^2, and the water depths within the marine parks vary from approximately 15—1,500 m deep. The EPBC Act requires that each management plan assign an International Union for the Conservation of Nature (IUCN) category to each marine park. Additionally, the Act also allows for the management plan to divide a marine park into zones and to assign a category to each zone, which may differ from the overall category of the marine park. Zoning takes into account the purposes for which the marine parks were declared, the objectives of the relevant management plans, the values of the marine park and requirements of the EPBC Act and EPBC Regulations.

12.2 North-West Marine Park Network

The North-West Marine Parks Network is aligned to the North-west Marine Region. The network covers 335, 341 km^2 and includes 13 marine parks (Director of National Parks, 2018b). Broad values of the Nouth-west Commonwealth Marine Reserves Network include:

+ Natural values;
+ Cultural values;
+ Heritage values; and
+ Socio-economic values.

Further detail on each of the marine parks relevant to the Reindeer Wellhead Platform & Offshore Gas Supply Pipeline Operations Environment Plan is provided below.

12.2.1 Ningaloo Marine Park

Ningaloo Marine Park stretches approximately 300 km along the west coast of the Cape Range Peninsula and is adjacent to the Western Australian Ningaloo Marine Park and Gascoyne Marine Park (Director of National Parks, 2018b). Ningaloo Reef is the longest fringing barrier reef in Australia forming a discontinuous barrier that encloses a lagoon that varies in width from 200 m to 7 km. Gaps that regularly intercept the main reef line provide channels for water exchange with deeper, cooler waters (CALM 2005). It is the only example in the world of extensive fringing coral reef on the west coast of a continent.

The Ningaloo Marine Park (Recreational Use Zone – IUCN Category II) covers an area of approximately 2,435 km^2 and protects the following conservation values (Director of National Parks 2018a):

- Important habitat (foraging areas) for vulnerable and migratory whale sharks;
- Areas used for foraging by marine turtles adjacent to important internesting sites;
- Part of the migratory pathway of the protected humpback whale;
- Foraging and migratory pathway for pygmy blue whales;
- Breeding, calving, foraging and nursing habitat for dugong;
- Shallow shelf environments which provides protection for shelf and slope habitats, as well as pinnacle and terrace seafloor features;
- Seafloor habitats and communities of the Central Western Shelf Transition;
- Three key ecological features; and
- The Ningaloo Coast World Heritage Property, the Ningaloo Coast National Heritage listing and Ningaloo Marine Area Commonwealth Heritage Listing.

Commercial tourism and recreation are important socio-economic values of the marine park (Director of National Parks 2018b).

12.2.2 Montebello Marine Park

The Montebello Marine Park is located offshore of Barrow Island and 80 km west of Dampier extending from the Western Australian state water boundary, and is adjacent to the Western Australian Barrow Island and Montebello Islands Marine Parks. The Montebello Marine Park (Multiple Use Zone – IUCN Category VI) covers an area of approximately 3,413 km^2 and protects the following conservation values (Director of National Parks 2018b):

- Foraging areas for migratory seabirds that are adjacent to important breeding areas;
- Areas used by vulnerable and migratory whale sharks for foraging;
- Foraging areas marine turtles which are adjacent to important nesting sites;
- Section of the north and south bound migratory pathway of the humpback whale;
- Shallow shelf environments with depths ranging from 15–150 m which provides protection for shelf and slope habitats, as well as pinnacle and terrace seafloor features;
- Seafloor habitats and communities of the Northwest Shelf Province provincial bioregions as well as the Pilbara (offshore) meso-scale bioregion; and
- One key ecological feature for the region is the ancient Coastline (a unique seafloor feature that provides areas of enhanced biological productivity).

Commercial tourism, commercial fishing, mining and recreation are important socio-economic values for the park.

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12.2.3 Dampier Marine Park

The Dampier Marine Park (Marine National Park Zone – IUCN Category I-73 km^2; Habitat Protection Zone – IUCN Category IV-104 km^2; Multiple Purpose Zone – IUCN Category VI-1,074 km^2) covers an area of approximately 1,252 km^2 and protects the following conservation values (Director of National Parks 2018b):

+ Foraging areas for migratory seabirds that are adjacent to important breeding grounds;
+ Important foraging areas for marine turtles adjacent to significant nesting sites;
+ Part of the migratory pathway of the protected humpback whale;
+ Protection for offshore shelf habitats and shallow shelf habitats adjacent to the Dampier Archipelago; and
+ Communities and seafloor habitats of the Northwest Shelf Province provincial bioregion as well as the Pilbara (nearshore) and Pilbara (offshore) meso-scale bioregions are included.

Port activities, commercial fishing and recreation are important activities in the marine park (Director of National Parks 2018b). No heritage listings apply to the marine park.

12.2.4 Argo-Rowley Terrace Marine Park

The Agro-Rowley Marine Park is located approximately 270 km north-west of Broome, Western Australia, and extends to the limit of Australia's exclusive economic zone. The Marine Park (Multiple Use Zone – IUCN Category VI-108,812 km^2; Marine National Park Zone – IUCN Category II-36,050 km^2; Special Purpose Zone – IUCN Category VI-1,141 km^2) covers an area of approximately 146,003 km^2 and protects the following conservation values (Director of National Parks 2018b):

+ Foraging areas that are important for migratory seabirds as well as the endangered loggerhead turtle;
+ Important habitat and foraging for sharks;
+ Migratory pathway for pygmy blue whales (Director of National Parks 2018b);
+ Protection for communities and habitats of the deeper offshore waters (220 m to over 5,000 m) of the region;
+ Seafloor features including aprons and fans, canyons, continental rise, knolls/abyssal hills and the terrace and continental slope;
+ Communities and seafloor habitats of the Northwest Transition and Timor Province provincial bioregions;
+ Connectivity between the existing Mermaid Reef Marine National Nature Reserve and reefs of the Western Australian Rowley Shoals Marine Park and the deeper waters of the region;
+ Two key ecological features in the reserve include:
    - The canyons linking the Argo Abyssal Plain with the Scott Plateau (unique seafloor feature with enhanced productivity and feeding aggregations of species); and
    - Mermaid Reef and the Commonwealth waters surrounding Rowley Shoals (an area of high biodiversity with enhanced productivity and feeding and breeding aggregations).

No heritage listings apply to this marine park (Director of National Parks 2018b). Commercial fishing, mining and recreation are important socio-economic values for the park.

13. Conservation Management Plans

In order to protect, maintain and enhance recovery of certain threatened species and ecological communities the DoEE may prepare conservation management plans in the form of Conservation Advice or Recovery Plans.

13.1 Conservation Advice

When a native species or ecological community is listed as threatened under the EPBC Act, conservation advice is developed to assist its recovery. Conservation advice provides guidance on immediate recovery and threat abatement activities that can be undertaken to ensure the conservation of a newly listed species or ecological community.

13.2 Recovery Plans

The Australian Government Minister for the Environment may make or adopt and implement recovery plans for threatened fauna, threatened flora (other than conservation dependent species) and threatened ecological communities listed under the Commonwealth EPBC Act. Recovery plans set out the research and management actions necessary to stop the decline of, and support the recovery of, listed threatened species or threatened ecological communities. The aim of a recovery plan is to maximise the long-term survival in the wild of a threatened species or ecological community.

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Table 13-1: Summary of EPBC Act recovery plans applicable to the area of interest

Taxa	Common Name	Recovery Plan / Conservation Advice	Threats
Bird	Red Knot	Approved Conservation Advice for *Calidris canutus* (Red knot) (2016)	Habitat loss and habitat degradation
			Over-exploitation of shellfish
			Pollution/contamination impacts
			Disturbance
			Direct mortality (hunting)
			Diseases
			Extreme weather events
			Climate change impacts
	Curlew Sandpiper	Approved Conservation Advice for *Calidris ferruginea* (Curlew Sandpiper) (2015)	Ongoing human disturbance
			Habitat loss and degradation from pollution
			Changes to the water regime
			Invasive plants
	Western Alaskan Bar-tailed Godwit	Approved Conservation Advice for *Limosa lapponica baueri* (Bar-tailed godwit (western Alaskan)) (2016)	Habitat loss and habitat degradation
			Over-exploitation of shellfish
			Pollution/contamination impacts
			Disturbance
			Direct mortality (hunting)
			Diseases
			Extreme weather events
			Climate change impacts
			Habitat loss and habitat degradation

Taxa	Common Name	Recovery Plan / Conservation Advice	Threats
	Northern Siberian Bar-tailed Godwit	Approved Conservation Advice for *Limosa lapponica menzbieri* (Bar-tailed godwit (northern Siberian)) (2016)	Over-exploitation of shellfish
			Pollution/contamination impacts
			Disturbance
			Direct mortality (hunting)
			Diseases
			Extreme weather events
			Climate change impacts
	Southern Giant Petrel	National recovery plan for threatened albatrosses and giant petrels 2011-2016 (2011)	Incidental catch resulting from fishing operations
			Competition with fisheries for marine resources
			Dependence on discards
			Marine pollution
			Climate change
			Intentional shooting/killing
			Feral pest species
			Human disturbance at the nest
			Parasites and diseases
			Loss of nesting habitat
			Competition for nest space
	Northern Giant Petrel	National recovery plan for threatened albatrosses and giant petrels 2011-2016 (2011)	Incidental catch resulting from fishing operations
			Competition with fisheries for marine resources
			Dependence on discards
			Marine pollution

Taxa	Common Name	Recovery Plan / Conservation Advice	Threats
			Climate change
			Intentional shooting/killing
			Feral pest species
			Human disturbance at the nest
			Parasites and diseases
			Loss of nesting habitat
			Competition for nest space
	Eastern Curlew	Approved Conservation Advice *for Numenius madagascariensis* (Eastern Curlew) (2015)	Ongoing human disturbance
			Habitat loss and degradation from pollution
			Changes to the water regime
			Invasive plants
	Abbott's Booby	Approved Conservation Advice for *Papasula abbotti* (Abbott's booby) (2015)	Clearance of about a third of the former nesting rainforest habitat
			Crazy ants
	Christmas Island White-tailed Tropicbird	Conservation Advice for *Phaethon lepturus fulvus* white-tailed tropicbird (Christmas Island) (2014)	Introduced predators on Christmas Island
			Crazy ants
	Soft-plumaged Petrel	Approved Conservation Advice for *Pterodroma mollis* (soft-plumaged petrel) (2015)	Accidental introduction of predators
	Australian Painted Snipe	Commonwealth Conservation Advice on *Rostratula australis* (Australian Painted Snipe) (2013)	Loss and degradation of wetlands, through drainage and the diversion of water for agriculture and reservoirs
	Australian Fairy Tern	Commonwealth Conservation Advice on *Sternula nereis nereis* (Fairy Tern) (2011)	Predation by introduced mammals and native birds
			Disturbance by humans, dogs and vehicles

Taxa	Common Name	Recovery Plan / Conservation Advice	Threats
			Increasing salinity in waters adjacent to Fairy Tern colonies
			Irregular water management
			Weed encroachment
			Oil spills, particularly in Victoria
	White-winged fairy wren	Approved Conservation Advice for *Malurus leucopterus edouardi* (white-winged fairy-wren (Barrow Island))	Introduction of non-endemic fauna, flora or pathogens
			Innapropriate fire regime
			Vegetation clearing
			Destruction of birds
			Degradation of habitat by fire and development
	Indian Yellow-nosed Albatross	National recovery plan for threatened albatrosses and giant petrels 2011-2016 (2011)	Incidental catch resulting from fishing operations
			Competition with fisheries for marine resources
			Dependence on discards
			Marine pollution
			Climate change
			Intentional shooting/killing
			Feral pest species
			Human disturbance at the nest
			Parasites and diseases
			Loss of nesting habitat
			Competition for nest space
	Shy Albatross		Incidental catch resulting from fishing operations
			Competition with fisheries for marine resources

Taxa	Common Name	Recovery Plan / Conservation Advice	Threats
		National recovery plan for threatened albatrosses and giant petrels 2011-2016 (2011)	Dependence on discards
			Marine pollution
			Climate change
			Intentional shooting/killing
			Feral pest species
			Human disturbance at the nest
			Parasites and diseases
			Loss of nesting habitat
			Competition for nest space
	White-capped Albatross	National recovery plan for threatened albatrosses and giant petrels 2011-2016 (2011)	Incidental catch resulting from fishing operations
			Competition with fisheries for marine resources
			Dependence on discards
			Marine pollution
			Climate change
			Intentional shooting/killing
			Feral pest species
			Human disturbance at the nest
			Parasites and diseases
			Loss of nesting habitat
			Competition for nest space
	Campbell Albatross		Incidental catch resulting from fishing operations
			Competition with fisheries for marine resources

Taxa	Common Name	Recovery Plan / Conservation Advice	Threats
		National recovery plan for threatened albatrosses and giant petrels 2011-2016 (2011)	Dependence on discards
			Marine pollution
			Climate change
			Intentional shooting/killing
			Feral pest species
			Human disturbance at the nest
			Parasites and diseases
			Loss of nesting habitat
			Competition for nest space
	Black-browed Albatross	National recovery plan for threatened albatrosses and giant petrels 2011-2016 (2011)	Incidental catch resulting from fishing operations
			Competition with fisheries for marine resources
			Dependence on discards
			Marine pollution
			Climate change
			Intentional shooting/killing
			Feral pest species
			Human disturbance at the nest
			Parasites and diseases
			Loss of nesting habitat
			Competition for nest space
Mammals	Sei Whale	Approved Conservation Advice for *Balaenoptera borealis* (sei whale) (2015)	Climate and oceanographic variability and change
			Anthropogenic noise and acoustic disturbance

Taxa	Common Name	Recovery Plan / Conservation Advice	Threats
			Habitat degradation including pollution (increasing port expansion and coastal development)
			Pollution (persistent toxic pollutants)
			Vessel strike
			Prey depletion due to fisheries (potential threat)
			Resumption of commercial whaling (potential threat)
	Blue Whale	Blue Whale Conservation Management Plan 2015 - 2025 (2015)	Whaling
			Climate Variability and Change
			Noise Interference
			Habitat Modification
			Vessel Disturbance
			Overharvesting of prey
	Fin Whale	Approved Conservation Advice for *Balaenoptera physalus* (fin whale) (2015)	Climate and oceanographic variability and change
			Anthropogenic noise and acoustic disturbance
			Habitat degradation including coastal development, port expansion and aquaculture
			Pollution (persistent toxic pollutants)
			Fisheries catch, entanglement and bycatch
			Vessel strike
			Resource depletion due to fisheries (potential threat)
			Resumption of commercial whaling (potential threat)
	Southern Right Whale		Entanglement

Taxa	Common Name	Recovery Plan / Conservation Advice	Threats
		Conservation Management Plan for the Southern Right Whale 2011 – 2021 (2012)	Vessel disturbance
			Whaling
			Climate variability and change
			Noise interference
			Habitat modification
			Overharvesting of prey
	Humpback Whale	Approved Conservation Advice for *Megaptera novaeangliae* (humpback whale) (2015)	Whaling
			Climate and Oceanographic Variability and Change
			Overharvesting of Prey
			Noise Interference
			Habitat degradation including coastal development and port expansion
			Entanglement
Reptiles	Short-nosed Seasnake	Commonwealth Conservation Advice on *Aipysurus apraefrontalis* (Short-nosed Seasnake) (2011)	Degradation of reef habitat
			Oil and gas exploration
			Incidental catch and death in commercial prawn trawling fisheries
	Loggerhead Turtle	Recovery plan for marine turtles in Australia 2017 – 2027 (2017)	Bycatch of marine turtles in fisheries
			Unknown levels of harvest by Indigenous Australians and unsustainable levels of harvest by people in neighbouring countries of the Asia/Pacific region
			Predation of turtle eggs by native and introduced animals
			Coastal development
			Deteriorating water quality

Taxa	Common Name	Recovery Plan / Conservation Advice	Threats
			Marine debris
			Loss of habitat and/or habitat modification
			Climate change and variability
			International take and/or illegal taking of turtles in Australian waters
			Light pollution
			Vessel disturbance
			Noise interference
			Recreational activities and human interactions
			Diseases and pathogens
			Cumulative impacts of threats
	Green Turtle	Recovery plan for marine turtles in Australia 2017 – 2027 (2017)	Bycatch of marine turtles in fisheries
			Unknown levels of harvest by Indigenous Australians and unsustainable levels of harvest by people in neighbouring countries of the Asia/Pacific region
			Predation of turtle eggs by native and introduced animals
			Coastal development
			Deteriorating water quality
			Marine debris
			Loss of habitat
			Climate change and variability
			International take and/or illegal taking of turtles in Australian waters
			Light pollution

Taxa	Common Name	Recovery Plan / Conservation Advice	Threats
			Vessel disturbance
			Noise interference
			Recreational activities and human interactions
			Diseases and pathogens
			Cumulative impacts of threats
	Leatherback Turtle	Commonwealth Conservation Advice on *Dermochelys coriacea* (2008)	Incidental capture in commercial fisheries
			Harvest of eggs and meat
			Ingestion of marine debris
			Boat strike
			Predation on eggs by wild dogs, pigs and monitor lizards
			Degradation of foraging areas
			Changes to breeding sites
		Recovery plan for marine turtles in Australia 2017 – 2027 (2017)	Bycatch of marine turtles in fisheries
			Unknown levels of harvest by Indigenous Australians and unsustainable levels of harvest by people in neighbouring countries of the Asia/Pacific region
			Predation of turtle eggs by native and introduced animals
			Coastal development
			Deteriorating water quality
			Marine debris
			Loss of habitat
			Climate change and variability

Taxa	Common Name	Recovery Plan / Conservation Advice	Threats
			International take and/or illegal taking of turtles in Australian waters
			Light pollution
			Vessel disturbance
			Noise interference
			Recreational activities and human interactions
			Diseases and pathogens
			Cumulative impacts of threats
	Hawksbill Turtle	Recovery plan for marine turtles in Australia 2017 – 2027 (2017)	Bycatch of marine turtles in fisheries
			Unknown levels of harvest by Indigenous Australians and unsustainable levels of harvest by people in neighbouring countries of the Asia/Pacific region
			Predation of turtle eggs by native and introduced animals
			Coastal development
			Deteriorating water quality
			Marine debris
			Loss of habitat
			Climate change and variability
			International take and/or illegal taking of turtles in Australian waters
			Light pollution
			Vessel disturbance
			Noise interference
			Recreational activities and human interactions

Taxa	Common Name	Recovery Plan / Conservation Advice	Threats
			Diseases and pathogens
			Cumulative impacts of threats
	Flatback Turtle	Recovery plan for marine turtles in Australia 2017 – 2027 (2017)	Bycatch of marine turtles in fisheries
			Unknown levels of harvest by Indigenous Australians and unsustainable levels of harvest by people in neighbouring countries of the Asia/Pacific region
			Predation of turtle eggs by native and introduced animals
			Coastal development
			Deteriorating water quality
			Marine debris
			Loss of habitat
			Climate change and variability
			International take and/or illegal taking of turtles in Australian waters
			Light pollution
			Vessel disturbance
			Noise interference
			Recreational activities and human interactions
			Diseases and pathogens
			Cumulative impacts of threats
Sharks	Grey Nurse Shark	Recovery Plan for the Grey Nurse Shark (*Carcharias taurus*) (2014)	Incidental capture by commercial and recreational fisheries
			Shark control programs
			Ecotourism

Taxa	Common Name	Recovery Plan / Conservation Advice	Threats
			Aquarium trade
			Pollution and disease
			Ecosystem effects - habitat modification and climate change
	Great White Shark	Recovery plan for the White Shark (*Carcharodon carcharias*) (2013)	Mortality related to being caught accidentally (bycatch) or illegally (targeted) by commercial and recreational fisheries, including issues of post release mortality
			Mortality related to shark control activities such as beach meshing or drumlining (east coast population)
			Illegal trade in white shark products
			Ecosystem effects as a result of habitat modification and climate change
			Ecotourism
	Dwarf Sawfish	Commonwealth Conservation Advice on *Pristis clavata* (Dwarf Sawfish) (2009)	Being caught as bycatch in commercial and recreational net fishing
			Illegal, unreported and unregulated (IUU) fishing
		Sawfish and River Sharks Multispecies Recovery Plan (2015)	Fishing activities including: being caught as by-catch in the commercial and recreational sectors; through indigenous fishing; and illegal, unreported and unregulated fishing
			Habitat degradation and modification
	Green Sawfish	Approved Conservation Advice for *Pristis zijsron* (Green Sawfish) (2008)	Capture as bycatch and byproduct in gillnet and trawl fisheries
			Illegal capture for fins and rostra
			Habitat degradation through coastal development
		Sawfish and River Sharks Multispecies Recovery Plan (2015)	Fishing activities including: being caught as by-catch in the commercial and recreational sectors; through indigenous fishing; and illegal, unreported and unregulated fishing
			Habitat degradation and modification

Taxa	Common Name	Recovery Plan / Conservation Advice	Threats
	Whale Shark	Approved Conservation Advice for *Rhincodon typus* (whale shark) (2015)	Intentional and unintentional mortality from fishing outside of Australian waters
			Boat strike from large vessels
			Habitat disruption from mineral exploration, production and transportation
			Disturbance from domestic tourism operations
			Marine debris
			Climate change

14. Social, Economic and Cultural Features

14.1 Industry

In 2012/13, Western Australia's petroleum industry was worth $24.5 billion per annum, making it the State's most valuable industry. In the last decade Western Australia's petroleum sales have increased by an average of nine percent each year, with much of these sales coming from liquefied natural gas. Currently Western Australia has three operating Liquefied Natural Gas (LNG) projects, the North West Shelf, Gorgon and Pluto, with three more under construction/commissioning, Wheatstone, Prelude and the Ichthys offshore LNG Facility. There area also a number of Floating Production and Storage Offtake (FPSO) facilities in the Timor Sea and North West Shelf, as denoted on **Figure 14-1**. Offshore development is focussed in the Carnarvon Basin, Browse Basin and on the North West Shelf (DMP 2014). There are also domestic gas plants on Varanus Island in the North West Shelf, Devil Creek Onshore Gas Plant and Macedon Gas Plant in the Pilbara region and an oil facility near Dongara called Cliff Head. There are several exploration and production permits and leases throughout the Western Australian and Commonwealth waters in the area of interest. Existing petroleum infrastructure, permits and licences are shown in **Figure 14-1**.

Various petroleum exploration and production activities have been undertaken within the NWS, however there are none in the vicinity of the operational area. Outside of the operational area, but within the permit area, the Pluto gas pipeline transects the southwest corner (~5 km from the operational area). Vessels servicing oil and gas operations in the region may pass through the area *en route* to facilities, however, since vessel transit is not classed as a petroleum activity, potential impacts to vessels are discussed under 'Shipping' above.

Commonwealth waters surrounding the Reindeer facilities are also used for petroleum exploration and development. The nearest production activities to the WHP include:

+ Onslow Prawn Managed Fishery;
+ Wandoo Production Platform located in Production Licence WA-14-L, approximately 20 km southeast;
+ Stag Terminal Platform, located in Production Licence WA-15-L, approximately 30 km southwest;
+ A gas pipeline that runs from North Rankin production platform to Dampier is located approximately 15 km east the Reindeer WHP and associated offshore pipeline; and
+ The Pluto to DC Supply Pipeline crosses the DC pipeline approximately 21 km to the south of the WHP.

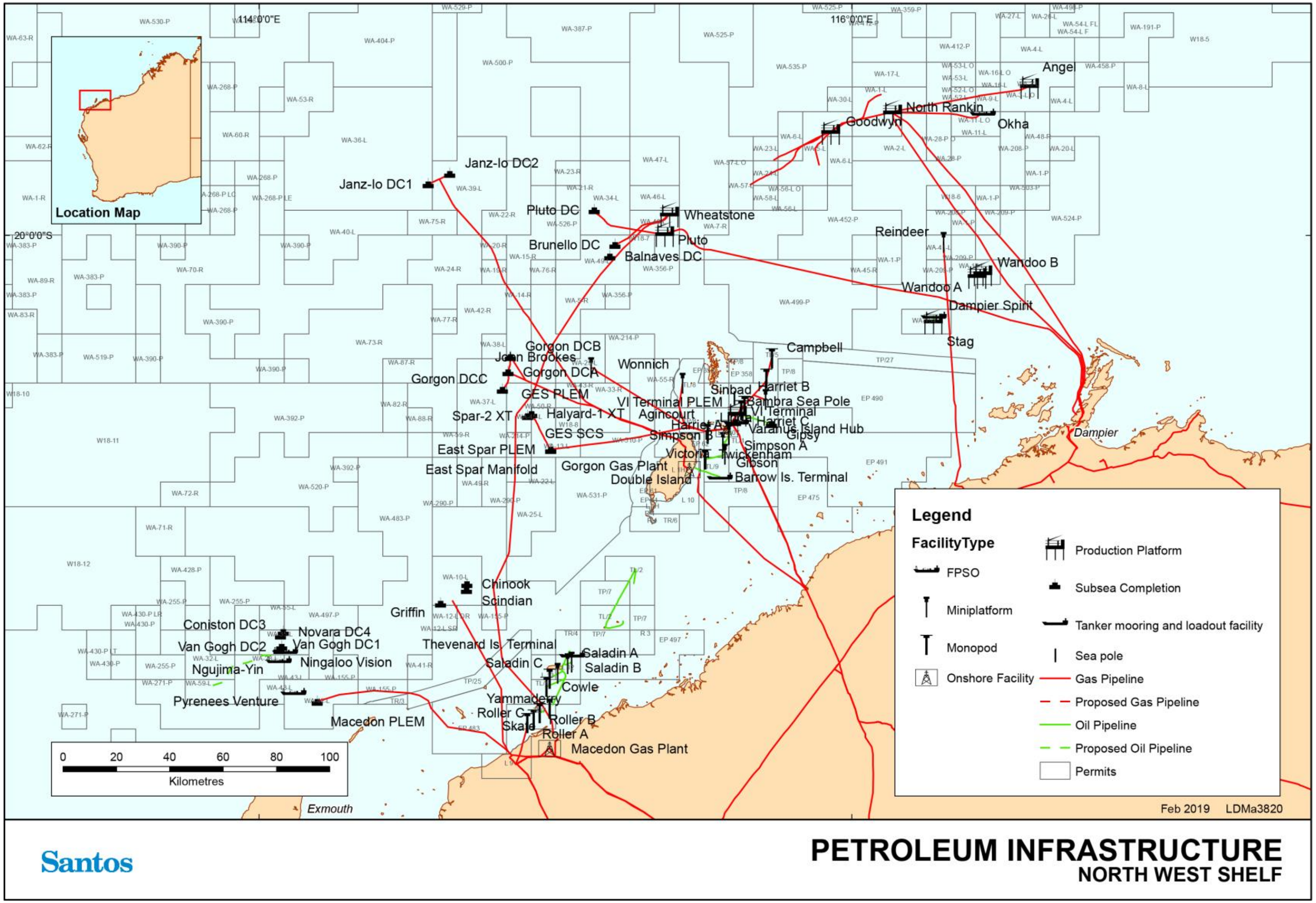


Figure 14-1: Existing petroleum infrastructure, permits and licences – North West Shelf

14.2 Shipping

The coastline from South Australia to the Northern Territory border supports twelve ports including the major ports of Dampier, Port Hedland and Broome which are operated by their respective port authorities. Large cargo vessels move through the region to and from Fremantle, transiting along coastline. Commercial shipping also moves to and from marine terminals associated with the oil and gas industry (see **Section 14.1**). Other large ports include Geraldton, Busselton, Albany and Esperance. Closer proximity shipping also includes construction vessels/barges/dredges, domestic support vessels, and offshore survey vessels.

The Australian Maritime Safety Authority (AMSA) has established a network of shipping fairways off the north-west coast of Australia to manage traffic patterns (AMSA 2013). The Shipping Fairways are designed to keep shipping traffic away from offshore infrastructure and aims to reduce the risk of collision (AMSA 2013).

Use of the fairways is strongly recommended but not mandatory. The International Regulations for *Preventing Collisions at Sea 1972* apply to all vessels navigating within or outside the shipping fairways. The use of these fairways does not give vessels any special right of way (AMSA 2012). Data from AMSA, collected from January to June 2015, indicates that from 1 to 3 bulk carriers a day may use the shipping fairways and therefore, may transit to Port Hedland.

Under the *Commonwealth Navigation Act 2012*, certain vessels operating in Australian waters are required to report their location on a daily basis to the Rescue Coordination Centre (RCC) in Canberra. This Australian Ship Reporting System (AUSREP) is an integral part of the Australian Maritime Search and Rescue system and is operated by Australian Maritime Safety Authority (AMSA) through the RCC. Vessels recorded in waters in the area of interest through the AUSREP system in 2017 are shown in **Figure 14-2**.

Commercial shipping moves through the offshore waters en route to or from the marine terminals at Thevenard, Barrow and Varanus islands. Shipping using NWS waters includes iron ore carriers, oil tankers and other vessels proceeding to or from the ports of Dampier, Port Walcott and Port Hedland; however, these are predominantly heading north from these ports. Large cargo vessels carrying freight bound or departing from Fremantle, transit along the WA coastline heading north and south in deeper waters.

The Reindeer facilities reside between two shipping fairways, located approximately 50 km to the east and west of the boundary of the WHP (AMSA 2012). There is also a shipping fairway approximately 25 km south of the Reindeer WHP which crosses the offshore gas pipeline. Additional shipping routes are located within the wider region and it is expected that local vessel traffic will pass through the area.

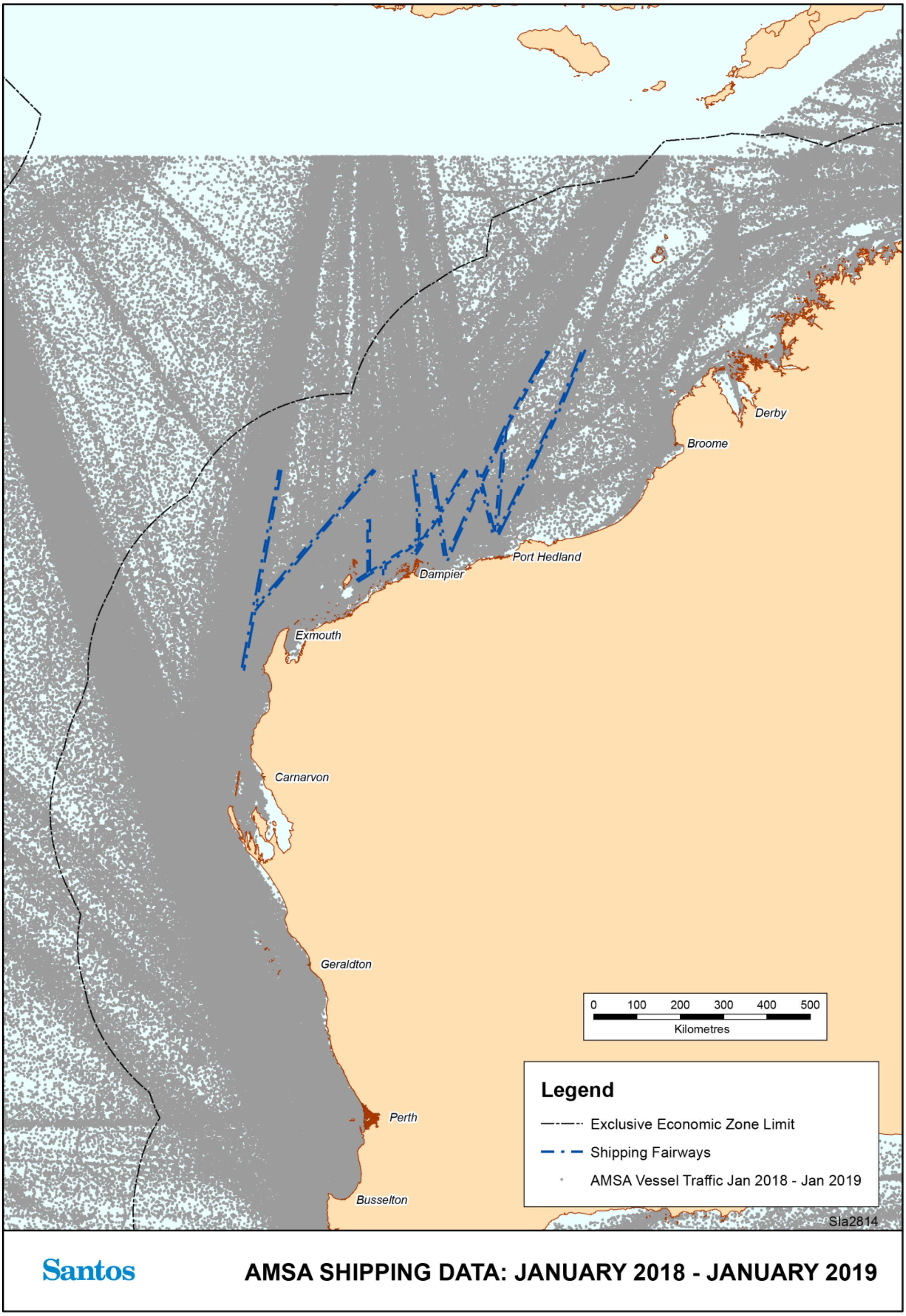


Figure 14-2: AMSA ship locations and shipping routes

14.3 Defence Activities

Key defence bases and facilities are illustrated in **Figure** 14-3**.**

The Naval Communication Station Harold E. Holt is located on the northwest coast of Australia, 6 km north of Exmouth. The town of Exmouth was built at the same time as the communications station to provide support to the base and to house dependent families of US Navy personnel (Shire of Exmouth 2014, DoE 2014).

The station provides very low frequency (VLF) radio transmission to US Navy and Royal Australian Navy ships and submarines in the western Pacific Ocean and eastern Indian Ocean. With a transmission power of 1 megawatt, it is the most powerful transmission station in the southern hemisphere (Shire of Exmouth 2014, DoE 2014).

Two Royal Australian Airforce (RAAF) bases are located in the northwest of Western Australia; Learmonth RAAF Base, near Exmouth and Curtin RAAF Base near Derby (RAAF 2014).

Designated military exercise areas occur over waters and airspace of the north west of Western Australia and may be activated following the required notifications.

In consultation with Defence Australia, they have advised no concerns with this proposed activity.

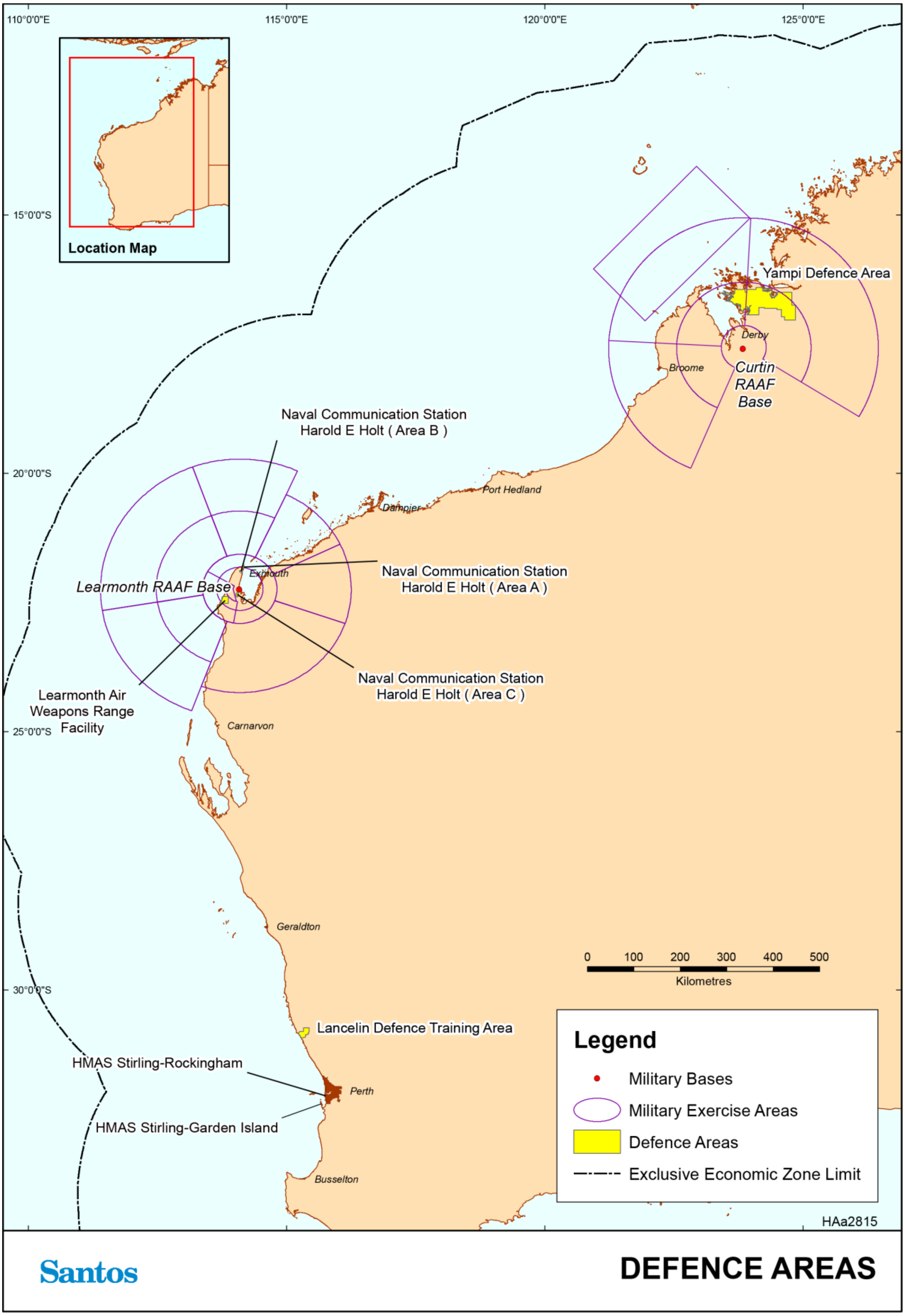


Figure 14-3: Defence activities in WA

14.4 Tourism

The Kimberley, Pilbara and Gascoyne regions are popular visitor destination for Australian and international tourists. Tourism is concentrated in the vicinity of population centres including Broome, Dampier, Exmouth, Coral Bay and Shark Bay.

Marine and coastal use is also clustered around major population centres along the Western Australian coastline including Perth, Bunbury, Geraldton, Margaret River, Jurien Bay, August and Albany.

Tourism contributes to local economies in terms of both income and employment and tourists include local, interstate and international visitors. Popular water based activities include fishing, swimming, snorkelling/ diving, surfing/windsurfing/kiting and boating, while popular land based activities include bushwalking, camping, bird watching and four-wheel driving.

Seasonal nature-based tourism such as humpback whale watching, whale shark encounters and tours of turtle hatching mainly occurring around Ningaloo Reef, Cape Range National Park, Broome and Perth (Tourism Western Australia). Seasonal aggregations of whale sharks, manta rays, sea turtles and whales, as well as the annual mass spawning of coral attract large numbers of visitors to Ningaloo each year (CALM 2005).

Within the North Coast Bioregion, recreational fishing is experiencing significant growth, with a distinct seasonal peak in winter when the local population increases significantly in Onslow and Dampier Archipelago regions (DoF 2011; DoF 2012). Creek systems, mangroves and rivers, and ocean beaches provide shore and small boat fishing for a variety of species including barramundi, tropical emperors, mangrove jack, trevallies, sooty grunter, threadfin, mud crabs and cods. Offshore islands, coral reefs and continental shelf provide species of major recreational interest including saddletail snapper, red emperor, cods, coral and coronation trout, sharks, trevally, tuskfish, tunas, mackerels and billfish.

Although no fishing is permitted within the 500 m petroleum safety zone of the WHP, commercial fishing and recreational fishing could occur in the vicinity. However, there is not expected to be recreational fishing effort in the vicinity of the WHP as it is not located in an important habitat for target species. A lack of natural seabed features (e.g. rocky or coral reef) in the area also supports that recreational fishing is unlikely to occur.

14.5 Cultural Heritage

Four places of cultural significance are protected as National Heritage Places in the waters from Busselton to the Northern Territory border. The Dampier Archipelago (including Burrup Peninsula), Batavia Shipwreck Site and Survivor Camps Area 1629 – Houtman Abrolhos, Dirk Hartog Landing Site 1616 – Cape Inscription area and the HMAS Sydney II and HSK Kormoran Shipwreck Site are discussed in **Section 9**. Additional Commonwealth Heritage Places denoted for their historic value in the area of interest are listed in **Appendix A**.

14.5.1 Indigenous Heritage

Indigenous people have a strong ongoing association with the area that extends from the beginning of human settlement in Australia some 50,000 years ago. The close, long standing relationship between Aboriginal peoples and the coastal and marine environments of the area is evident in indigenous culture today in addition to archaeological sites such as the Burrup Peninsula. The Indigenous peoples of the northwest continue to rely on coastal and marine environments and resources for their cultural identity, health and wellbeing, as well as their domestic and commercial economies (DEWHA 2008). With the area of interest, Barrow Island, Montebello Islands, Exmouth, Ningaloo Reef, Eighty Mile Beach, Roebuck Bay, Dampier Peninsula and the South West and the adjacent foreshores have a long history of occupancy by Indigenous communities. Areas that are covered by registered native title claims are likely to practice indigenous fishing techniques at various sections of the WA coast line; most notably in the Kimberley coastal region and islands.

Marine resource use by Indigenous people is generally restricted to coastal waters. Fishing, hunting and the maintenance of maritime cultures and heritage through ritual, stories and traditional knowledge continue as important uses of the nearshore region and adjacent areas. However, while direct use by Aboriginal people deeper offshore waters is limited, many groups continue to have a direct cultural interest in decisions affecting the management of these waters. The cultural connections Aboriginal people maintain with the sea may be affected, for example, by offshore fisheries and industries. In addition, some Indigenous people are involved in commercial activities such as fishing and marine tourism, so have an interest in how these industries are managed in offshore waters with respect to their cultural heritage and commercial interests (DEWHA 2008).

14.5.2 Maritime Heritage

Details of recorded shipwreck sites are available on the Australian National Shipwreck Database are managed by the DoEE although precise locations of the wrecks are sometimes unknown. A search of the Australian National Shipwreck Database in the area of interest identified 939 shipwrecks. Twelve shipwrecks were identified in the *Reindeer Wellhead Platform & Offshore Gas Supply Pipeline Operations Environment Plan* EMBA as listed in **Table 14-1** and shown in **Figure 14-4**.

(DEWHA 2008). Under the Commonwealth *Historic Shipwrecks Act 1976*[12] all shipwrecks older than 75 years are protected, while those dated pre-1900 are protected by WA law under the *Maritime Archaeology Act 1973*.

Table 14-1: Shipwrecks

Name	Description	Location
Bandicoot Bay	Pearling	Bandicoot Bay, Barrow Island
Chofuku Maru	Cargo ship of wheat	Point Cloates
Fairy Queen	115 t Singapore built brigantine	Point Murat, North West Cape
Fin	Early iron whaler	Frazer Island, Point Cloates
McCormack	Dredging barge	NE tip of Eaglehawk Island, Dampier Archipelago
McDermott Derrick Barge No 20	Dredging barge	NE tip of Eaglehawk Island, Dampier Archipelago
Mildura	Livestock cargo ship	North-west Cape
Parks Lugger	Abandoned at anchorage beginning WW1	Hermite Island, Montebello Islands
Perth	499 t, iron coastal steamship	Ningaloo Reef
Plym HMS	Destroyed by a bomb	Trimouille Island Island
Trial	English East Indiaman of about 500 t, wrecked c 1622	Trial (or Tryal) Rocks, 20 km northwest of the Montebello Islands
Zvir	Iron steamer	Frazer Island, Point Cloates

[12] Note that the *Underwater Culture Heritage Act 2018* has been passedon 24 August 2018, however it has yet to commence, due to commence prior to 24 August 2019. The new Act enables protection for other types of underwater culture e.g. aircraft wrecks.

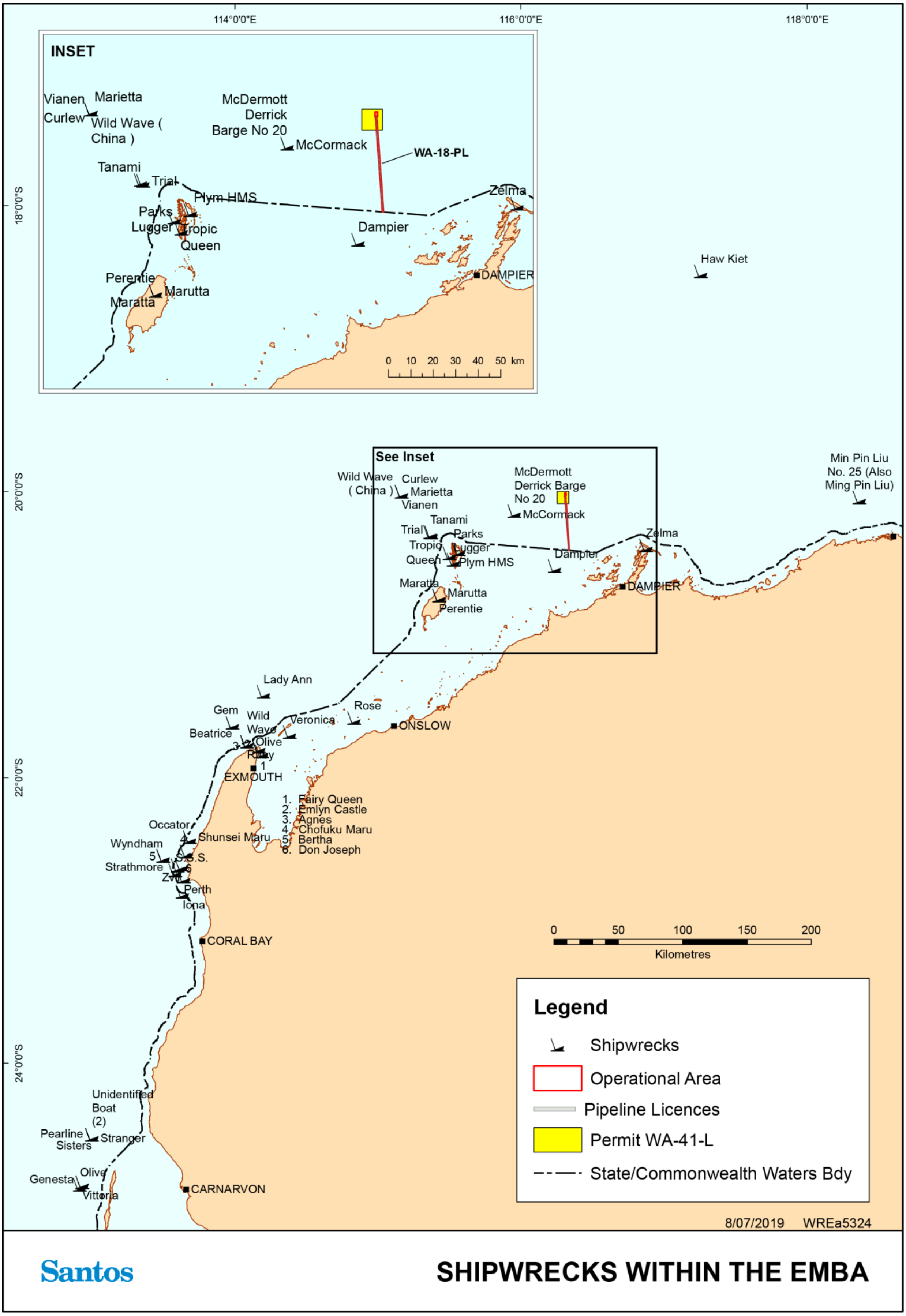


Figure 14-4: Shipwrecks – Northern WA

14.6 Commercial Fisheries

A valuable and diverse commercial fishing industry is supported by both the offshore and coastal waters in the North Coast, Gascoyne, West Coast and South Coast Bioregions between the Western Australian (WA) and Northern Territory (NT) and South Australian (SA) borders. The major fisheries in this area target tropical finfish, large pelagic fish species, crustaceans (prawns and scampi), Western Rock Lobster and pearl oysters (Fletcher and Santoro 2013). A number of smaller fisheries also exist in this area including the octopus and beche-de-mer fisheries.
A valuable and diverse commercial fishing industry is supported by both the offshore and coastal waters in the NWS Region, mainly dominated by the Pilbara fisheries. Commercial fisheries of the region are located within the North Coast Bioregion. The major fisheries in the Pilbara region target tropical finfish, large pelagic fish species, crustaceans (prawns and scampi) and pearl oysters (AFMA 2011; DoF 2011, 2012)

14.6.1 State Fisheries

State fisheries are managed by the WA Department of Fisheries (DoF) with specific management plans, regulations and a variety of subsidiary regulatory instruments under the *Fish Resources Management Act* 1994 (WA). The information on State managed fisheries has been derived from '*The State of the Fisheries'* Report 2015/2016 (Fletcher *et al*. 2017) and direct consultation with the DoF. Santos WA consults regularly with State fisheries relevant to activity operational areas, mainly by distribution of an Annual Consultation Update by post.

A summary of all commercial fisheries in the *Reindeer Wellhead Platform & Offshore Gas Supply Pipeline Operations Environment Plan* EMBA is given in **Table 14-2**. These are:

+ Onslow Prawn Managed Fishery (OPMF);
+ Pilbara Fish Trawl (Interim) Managed Fishery (PFTIMF);
+ Pilbara Trap Managed Fishery (PTMF);
+ Pilbara Line Fishery – not shown in Figure 14-5;
+ Mackerel Fishery (Area 1 – Kimberley and Area 2 – Pilbara);
+ Western Australian Pearl Oyster Fishery – referred to as Pearl Oyster Managed Fishery in **Figure 14-5**;
+ Pilbara Developmental Crab Fishery – not shown in Figure 14-5;
+ West Coast Deep Sea Crab (Interim) Managed Fishery.

Whole of State Fisheries

+ Marine Aquarium Fish Managed Fishery (MAFMF);
+ Specimen Shell Managed Fishery;
+ West Coast Deep Sea Crustacean Managed Fishery;
+ South West Coast Salmon Fishery[13];
+ Abalone Managed Fishery.

Some of the fisheries listed above will be more susceptible to impacts than others, particularly fisheries without the ability to escape impacts. For example, above average water temperatures over the last three years will have had an impact on prawn fisheries in Exmouth and scallops and blue swimmer crabs in Shark Bay which

[13] Although permitted to fish within the operational area and EMBA, the South West Coast Salmon Fishery is biogeographically limited to the South West Coast, therefore the fishery has not been described in Table 14-2.

have been significantly affected by the initial heat wave event of 2010/11 (Caputi *et al*. 2014). It is important that susceptibility of certain fisheries to environmental impacts be monitored going forward.

State fisheries are managed by the DPIRD with specific management plans, regulations and a variety of subsidiary regulatory instruments under the *Fish Resources Management Act 1994* (WA). The information on State managed fisheries has been derived from the *State of, Status Reports of the Fisheries and Aquatic Resources of Western Australia 2016/2017* (DPIRD 2018) and direct consultation with the fishing industry (**Section 4**). Nine State commercial fisheries have boundaries that overlie or are in close proximity to part or all of the Reindeer facilities in Commonwealth waters (**Figure 14-5**).

14.6.2 Commonwealth Fisheries

Commonwealth fisheries are those within the 200 nautical mile Australian Fishing Zone (AFZ) managed by Australian Fisheries Management Authority (AFMA) and are, on the high seas, and, in some cases, by agreement with the States and Territory, to the low water mark. Information on Commonwealth managed fisheries has been derived from '*Fishery Status'* Report 2017 (Patterson *et al*. 2018)

Commonwealth fisheries who have permits to operate in the EMBA include:

+ Southern Bluefin Tuna Fishery (SBFTF);
+ Western Tuna and Billfish Fishery (WTBF) (including Southern Tuna and Billfish Fishery shown in **Figure 14-6)**; and
+ Western Skipjack Tuna Fishery (STF).

Commonwealth commercial fisheries between Kalbarri (WA) and the Northern Territory Border are shown in **Figure 14-6** and summarised in **Table 14-2**.

Commonwealth fisheries are those within the 200 nautical mile Australian Fishing Zone (AFZ) managed by Australian Fisheries Management Authority (AFMA) and are, on the high seas, and, in some cases, by agreement with the States and Territory, to the low water mark. Commonwealth managed fisheries are permitted to operate within or adjacent to the Reindeer WHP operational area, but there is no current fishing effort in the vicinity of the operational area (AFMA 2018).

The North West Slope Trawl Fishery (NWSTF) is the only Commonwealth licensed fisheries with recent fishing effort operating on the NWS. One vessel actively fished in the NWSTF area during the 2010-2011 season (AFMA 2011) and the fishery is restricted to deep water (>200 m) offshore from the Reindeer operational area.

Other Commonwealth fisheries, such as the Western Tuna and Billfish Fishery (WTBF), Southern Bluefin Tuna Fishery (SBFTF) and the Western Skipjack Tuna Fishery (WSTF), although licenced to fish within the Reindeer operational area, have had no historical fishing effort reported from near the operational area (AFMA 2011).

14.7 Aquaculture

14.7.1 North Coast Bioregion

Aquaculture development in this region is dominated by the production of pearls from the species *Pinctada maxima.* A large number of pearl oysters for seeding is obtained from wild stocks and supplemented by hatchery-produced oysters with major hatcheries operating at Broome and the Dampier Peninsular. Pearl farm sites are located mainly along the Kimberley coast, particularly in the Buccaneer Archipelago, in Roebuck Bay and at the Montebello Islands. Developing marine aquaculture initiatives in this region include growing trochus and barrumundi. Marine production of barramundi is focussed in Cone Bay fishing (Fletcher and Santoro 2015).

The Pearl Oyster Fishery of Western Australia operates in shallow coastal waters (DoF 2006). All the leases are within the 35m diving depth. Through consultation the Pearl Producer's Association (PPA) have raised concern that spawning stock is found to the 100 m depth contour. However, this is not supported in the study by Condie *et al* (2006) who modelled oyster larva transport in the Eighty Mile Beach region and found that while some larvae travelled more than 60 km, most were transported less than 30 km. The model results suggest that spawning in the Eighty Mile Beach region is concentrated around the 8 to 15m depth range, with potential smaller contributions from the northeast. These spawning events are likely to lead to successful recruitment locally and alongshore to the southwest.

They also feed larvae into neighbouring shallow coastal environments (through tidal oscillations) and deeper waters to the west (>20 m). However, spat abundances seem to be low in these areas, suggesting that recruitment is strongly limited by habitat availability and possibly high mortality rates in shallow water. High local abundances of broodstock and spat observed occasionally in deeper water (<30 m) seem to be supported by intermittent larval transport from inshore populations. Spawning in this area seems to contribute little to recruitment in the inshore populations.

Further aquaculture operations are expected in the region with recent funding supporting the establishment of an aquaculture zone (Fletcher et al. 2017).

14.7.2 Gascoyne Coast Bioregion

Hatchery production of oysters is the core of the pearling industry in the Gascoyne region. Hatcheries in Carnarvon and Exmouth supply spat to pearl farms in the north-west and several hatcheries supply juveniles to the blac-lip pearl oyster to developing black pearl farms in the region. Pearl production is carried out on a small scale in Shark Bay and Exmouth Gulf. The local aquiculture sector is also focussing on the production of aquarium species.

14.8 Recreational Fisheries

Recreational fisheries are managed by the Department of Primary Industries and Regional Development (DPIRD). Within the North Coast Bioregion, where the operational area is located, recreational fishing is experiencing significant growth, with a distinct seasonal peak in winter when the local population increases significantly in Onslow and Dampier Archipelago regions (DoF 2011; DoF 2012). Creek systems, mangroves and rivers, and ocean beaches provide shore and small boat fishing for a variety of species including barramundi, tropical emperors, mangrove jack, trevallies, sooty grunter, threadfin, mud crabs and cods. Offshore islands, coral reefs and continental shelf provide species of major recreational interest including saddletail snapper, red emperor, cods, coral and coronation trout, sharks, trevally, tuskfish, tunas, mackerels and billfish.

Although no fishing is permitted within the 500 m petroleum safety zone around the WHP, commercial fishing and recreational fishing could occur in the vicinity. However, there is not expected to be commercial fishing effort in the vicinity of the WHP as it is not located in an important habitat for target species. A lack of natural seabed features (e.g. rocky or coral reef) in the area indicates that recreational fishing is also unlikely to occur.

14.8.1 North Coast Bioregion

The North Coast Bioregion (Pilbara/Kimberley) runs from the Ashburton River to the Western Australia/Northern Territory border (WAFIC 2016). The oceanography of this region includes waters of Pacific Ocean origin that enter through the Indonesian archipelago bringing warm, low salinity waters polewards via the Indonesian throughflow and Holloway currents which flow seasonally and interact with Indian ocean waters. Recreational fishing is experiencing a significant growth in this region, with a distinct seasonal peak in winter when the local population increases by significant numbers of metropolitan and inter-state tourists. This has been added to by the increased recreational fishing by those involved in the construction or operation of major developments in this region. Owing to the high tidal range, much of the angling activity is boat-based with beach fishing limited to periods of flood tides and high water. Numerous creek systems, mangroves, rivers and ocean beaches provide shore and small boat fishing for a variety of species including barramundi, tropical emperors, mangrove jack, trevallies, sooty grunter, threadfin, mud crabs and cods. Offshore islands, coral reef systems and continental shelf waters provide species of major recreational interest including saddetail snapper and red emperor, cods, coral and coronation trout, sharks, trevally, tuskfish, mackerals and billfish (WAFIC 2016).

14.8.2 Gascoyne Coast Bioregion

The Gascoyne Coast Bioregion extends from just north of Kalbarri to the Ashburton River, south of Onslow. The marine environment of this region represents a transition between the fully tropical waters of the north-west shelf of the north coast region and the temperate waters of the west coast region. This region has been identified as one of the 18 world 'hotspots' in terms of tropical reef endemism and the second most divers marine environment in the world in terms of tropical reef species. This region is a focal point for winter recreational fishing and is a key component of many tourist visits. Angling activities include beach and cliff fishing (e.g. Steep Point and Quobba), embayment and shallow-water boat angling (e.g. Shark Bay, Exmouth Gulf and Ningaloo lagoons), and offshore boat angling for demersal and larger pelagic species (e.g. off Ningaloo). The predominant target species include the tropical species such as emperors, tropical snappers, groupers, mackerals, trevallies and other game fish. Temperate species at the northern end of their ranges such as pink snapper, tailor and whiting also provide significant catches, particularly in Shark Bay (WAFIC 2016).

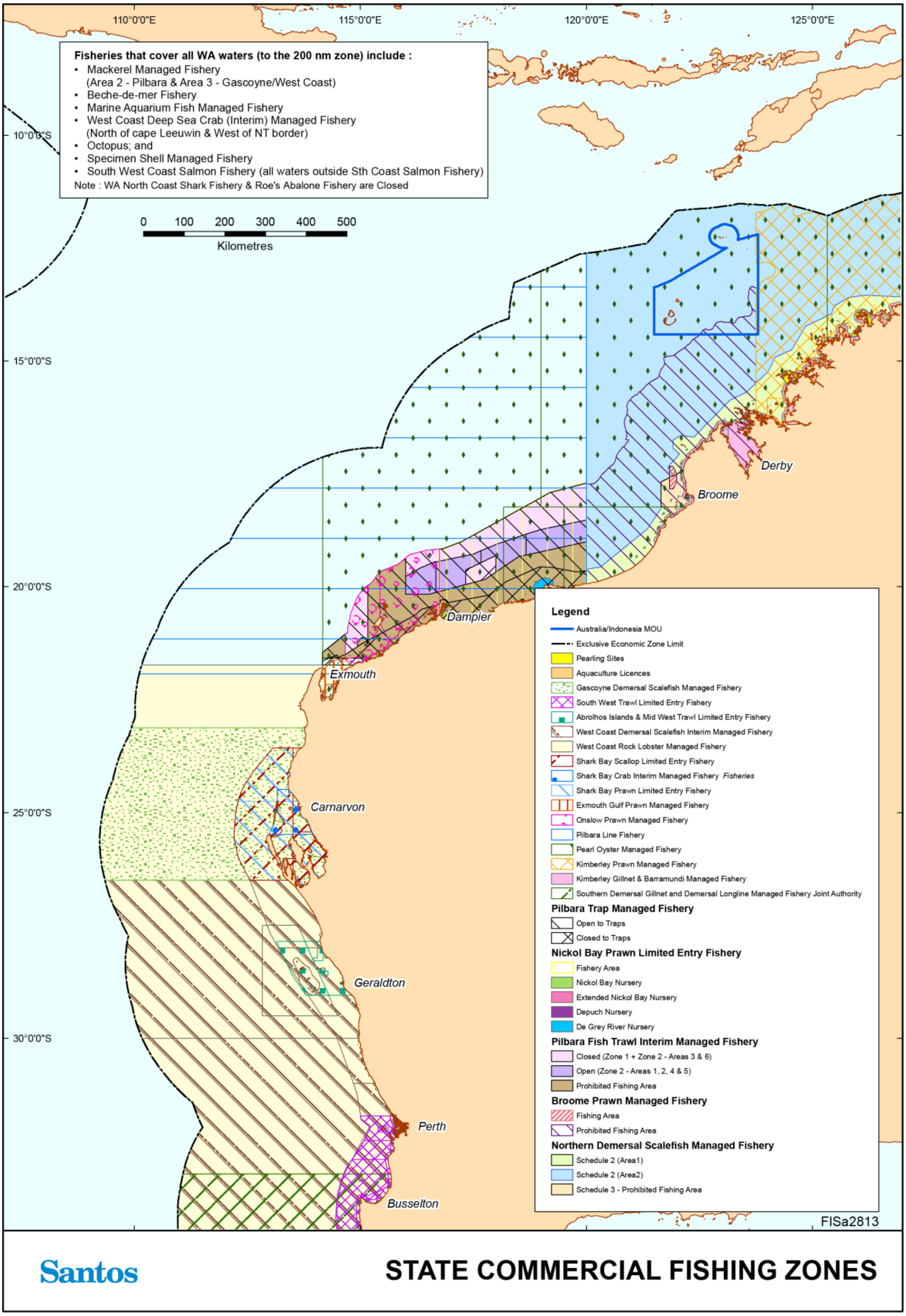


Figure 14-5: State commercial fishing zones

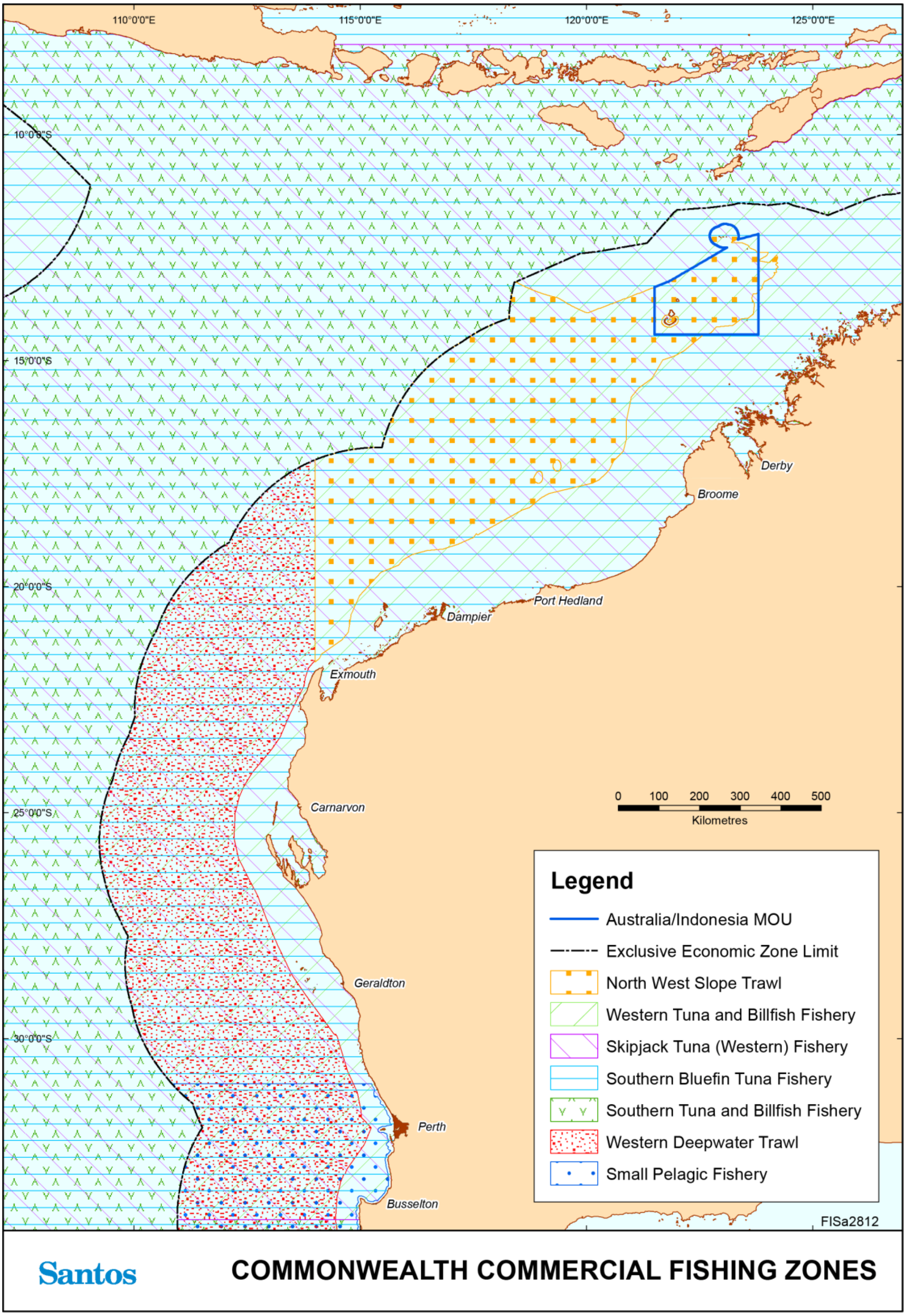


Figure 14-6: Commonwealth commercial fishing zones

Table 14-2: Commercial fisheries with permits to operate within the *Reindeer Wellhead Platform & Offshore Gas Supply Pipeline Operations Environment Plan* EMBA

Fishery	Target Species	Catch[1]	Fishing Method	Area Description
State Managed Fisheries				
Abalone Managed Fishery	Greenlip abalone (*Haliotis laevigata*) Brownlip abalone (*H. conicopora)*	2017/2018: 98 tonnes	Dive fishery The principal harvest method is a diver working off 'hookah' (surface supplied breathing apparatus) or SCUBA using an abalone 'iron' to prise the shellfish off rocks – both commercial and recreational divers employ this method.	Shallow coastal waters off the south-west and south coasts of Western Australia Covers all Western Australian coastal waters, which are divided into eight management areas. Commercial fishing for greenlip/brownlip abalone is managed in three separate areas.
Marine Aquarium Fish Managed Fishery (MAFMF)	Over 250 target species of finfish. (228 species caught in 2012). Fishermen can also take coral, live rock, algae, seagrass and invertebrates. The main fish species landed in 2012 were scribbled angelfish (*Chaetodontoplus duboulayi*) and green chromis (*Chromis cinerascens*) The main coral species landed in 2012 were the coral like anemones of the Corallimorpharia.	2016: Total catch of 15,424 fish, 3,514 hard kilograms of hard coral, 4, 298 kilograms of soft coral, 8, 621 kolograms of living rock and sand, 3, 972 sponges and 75 litres of algae/seagrasses	Hand harvest while diving or wading. Hand held nets	Dive based fishery operating all year throughout WA waters, but restricted by diving depths. The MAFMF is able to operate in all State waters (between the Northern Territory border and South Australian border). The fishery is typically more active in waters south of Broome with higher levels of effort around the Capes region, Perth, Geraldton, Exmouth and Dampier. Operators in the MAFMF are also permitted to take coral, live rock, algae, seagrass and invertebrates under the Prohibition on Fishing (Coral, 'Live Rock' and Algae) Order 2007 and by way of Ministerial Exemption (Gaughan & Santoro, 2018).

Fishery	Target Species	Catch[1]	Fishing Method	Area Description
Onslow Prawn Managed Fishery (OPMF)	Western king prawns (*Penaeus latisulcatus*), brown tiger prawns (*Penaeus esculentus*), endeavour prawns (*Metapenaeus* spp.)	2017/2018: Neglible (Minimal fishing occurred in 2017) (	Otter trawl	Operates along the western part of the North-West Shelf with most prawning activities concentrated in the shallower water off the main land. The boundaries of the OPMF are 'all the Western Australian waters between the Exmouth Prawn Fishery and the Nickol Bay prawn fishery east of 114º39.9' on the landward side of the 200 m depth isobath'.
Pilbara Developmental Crab Fishery	Blue Swimmer (*Portunus armatus)* Mud Crab (*Scylla* spp)	2016: total of 36.9 tonnes (total number includes Kimberley Developing Mud Crab Fishery)	Variety of gear but mostly commercial crab pots (Hourglass traps used in inshore waters from Onslow through to Port Hedland with most commercial and activity occurring in and around Nickol Bay) Recreational fishers use drop nets or scoop nets, with diving for crabs becoming increasingly popular	The majority of the commercially and recreationally-fished stocks are concentrated in the coastal embayments and estuaries between Geographe Bay in the south west and Nickol Bay in the north. Crabbing activity along the Pilbara coast is centred largely on the inshore waters from Onslow through to Port Hedland, with most commercial and recreational activity occurring in and around Nickol Bay (State of the Fisheries 2014/15).
Pilbara Fish Trawl (Interim) Managed Fishery (PFTIMF)	Variety of demersal scalefish including goldband snapper (*Pristipomoides multidens*), red emperor (*Lutjanus sebae*), bluespotted emperor (*Lethrinus punctulatus*), crimson snapper (*Lutjanus erythropterus*), saddletail snapper (*Lutjanus malabaricus*), Rankin cod (*Epinephelus*	2017/2018: 1780 tonnes	Demersal trawl	The Pilbara Fish Trawl (Interim) Managed Fishery is situated in the Pilbara region in the north west of Australia. It occupies the waters north of latitude 21°35'S and between longitudes 114°9'36"E and 120°E. The Fishery is seaward of the 50 m isobath and landward of the 200 m isobath.

Fishery	Target Species	Catch[1]	Fishing Method	Area Description
	multinotatus), brownstripe snapper (*Lutjanus vitta*), rosy threadfin bream (*Nemipterus furcosus*), spangled emperor (*Lethrinus nebulosus*) and frypan Moses' snapper (*Argyrops Lutjanusspinifer russelli*).			The Fishery consists of two zones; Zone 1 in the south west of the Fishery (which is closed to trawling) and Zone 2 in the North, which consists of six management areas.
Pilbara Trap Managed Fishery (PTMF)	Blue-spot emperor (*Lethrinus hutchinsi*), Red snapper (*Lutjanus erythropterus*), Goldband snapper (*Pristipomoides multidens*), Scarlet perch (*Lutjanus malabaricus*), Red emperor (*Lutjanus sebae*), Spangled emperor (*Lethrinus nebulosus*), Rankin cod (*Epinephelus multinotatus*)	2017/2018: 400 – 600 Tonnes	Use of rectangular traps with single opening and 50 mm x 70 mm rectangular mesh panels. Trap fishing normally targets areas around rocky outcrops and reefs	Permitted to operate within waters bounded by a line commencing at the intersection of 21°56´ S latitude and the high water mark on the western side of the North West Cape.
Pilbara Line Managed Fishery	Variety of demersal scalefish including goldband snapper (*Pristipomoides multidens*), red emperor (*Lutjanus sebae*), bluespotted emperor (*Lethrinus punctulatus*), crimson snapper (*Lutjanus erythropterus*), saddletail snapper (*Lutjanus malabaricus*), Rankin cod (*Epinephelus multinotatus*), brownstripe snapper (*Lutjanus vitta*), rosy threadfin bream (*Nemipterus furcosus*), spangled emperor (*Lethrinus	2017/2018: 50 - 115 tonnes	Line	The Pilbara Trap Managed Fishery lies north of latitude 21°44´ S and between longitudes 114°9´36´´ E and 120° E on the landward side of a boundary approximating the 200 m isobath and seaward of a line generally following the 30 m isobath.

Fishery	Target Species	Catch[1]	Fishing Method	Area Description
	nebulosus) and frypan snapper (*Argyrops spinifer*), Ruby snapper (*Etelis carbunculus*) and eightbar grouper (*Hyporthodus octofasciatus)*			
Specimen Shell Managed Fishery (SSF)	Shells (cowries, cones) The Specimen Shell Managed Fishery (SSF) is based on the collection of individual shells for the purposes of display, collection, cataloguing, classification and sale. Just under 200 (196) different Specimen Shell species were collected in 2012, using a variety of methods.	2016: 8,531 shells	Hand harvest while diving or wading along coastal beaches below the high water mark A new exemption method being employed by the fishery is using a remote controlled underwater vehicle at depths between 60 and 300 m.	Dive based fishery operating all year throughout WA waters, but restricted by diving depths. The fishing area includes all Western Australian waters between the high water mark and the 200 m isobath. While the fishery covers the entire Western Australian coastline, there is some concentration of effort in areas adjacent to population centres such as Broome, Karratha, Exmouth, Shark Bay, metropolitan Perth, Mandurah, the Capes area and Albany.
West Coast Deep Sea Crustacean (Interim) Managed Fishery	Crystal (Snow) crabs (*Chaceon albus*), Giant (King) crabs (*Pseudocarcinus gigas*) and Champagne (Spiny) crabs (*Hypothalassia acerba*).	2016 154 tonnes (Q); 61 k – 101.5 K potlifts	Baited pots operated in a longline formation in the shelf edge waters (>150 m)	North of latitude 34° 24' S (Cape Leeuwin) and west of the Northern Territory border on the seaward side of the 150 m isobath out to the extent of the AFZ, mostly in 500 to 800 m of water.
Western Australian Mackerel Managed Fishery (MMD)	Spanish mackerel (*Scomberomorus commerson*), grey mackerel (*S. semifasciatus*), with other species from the genera *Scomberomorus*, *Grammatorcynus* and	2016: Commercial: The commercial catch of Spanish mackerel was 276 tonnes in 2016	Trolling or handline Near surface trolling gear from vessels in coastal areas around reefs, shoals and headlands.	The fisery extends from the West Coast Bioregion to the WA/NT border, to the 200 nautical mile AFZ with most effort and catches recorded north of Geraldton, especially from the Kimberley and Pilbara coasts of the Northern Bioregion.

Fishery	Target Species	Catch[1]	Fishing Method	Area Description
	Acanthocybium also contributing to commercial catches.	(Gaughan & Santoro, 2018)	Jig fishing is also used to capture grey mackerel.	Restricted to coastal and shallower waters. Area 2 – Pilbara spans 114°E to 121°E.
Western Australian Pearl Oyster Managed Fishery	Indo- Pacific silver-lipped pearl oyster (*Pinctada maxima*).	2016: 541,260 shells	Drift diving restricted to shallow diveable depths. The collection of pearl oysters for the Pearl Oyster Managed Fishery is restricted to shallow diving depths below 35 m. Divers are attached to large outrigger booms on a vessel and towed slowly over the pearl oyster beds, harvesting legalised oysters by hand as they are seen.	The fishery is separated into four zones: Pearl Oyster Zone 1: NW Cape (including Exmouth Gulf) to longitude 119°30'E. There are five licensees in this zone. No fishing in this zone since 2008 Pearl Oyster Zone 2: East of Cape Thouin (118°20´ E) and south of latitude 18°14´ S. The 9 licensees in this zone also have full access to Zone 3. This zone is the mainstay of the fishery. Pearl Oyster Zone 3: West of longitude 125°20´ E and north of latitude 18°14´ S. The 2 licensees in this zone also have partial access to Zone 2. Pearl Oyster Zone 4: East of longitude 125°20´ E to the Western Australia/Northern Territory border. Although all licensees have access to this zone, exploratory fishing has shown that stocks in this area are not economically viable. However, pearl farming does occur.
Commonwealth Managed Fisheries				
Western Skipjack Tuna Fishery	Skipjack tuna (*Katsuwonus pelamis*)	2016-17: None in either zones	Purse seine	The Skipjack Tuna Fishery is split into two sectors; east and west. The Western Skipjack Tuna Fishery is located in all

Fishery	Target Species	Catch[1]	Fishing Method	Area Description
				Australia waters west of 142º 30' 00ºE, out to 200 nm from the coast. There has been no fishing effort in the Skipjack Tuna Fishery since the 2009 season, and in that season activity concentrated off South Australia (Patterson et al 2018).
Southern Bluefin Tuna Fishery	Southern bluefin tuna (*Thunnus maccoyii*).	2016-17: 5,334 tonnes.	Purse seine vessels primarily in Great Australian Bight all year round and longline off southern NSW in winter. Around 98% of Australia's SBT quota is taken by 5–10 purse seine vessels fishing for 13–25 kg southern bluefin tuna.	Fishery includes all waters of Australia, out to 200 nm from the coast. No current effort on NWS, fishing activity is concentrated in the Great Australian Bight and off South-east Australia (Patterson et al. 2018).
Western Tuna and Billfish Fishery	Broadbill swordfish (*Xiphias gladius*), albacore tuna (*Thunnus alalunga*), striped marlin (*Kajikia audax*), bigeye tuna (*T. obesus*) and yellowfin tuna (*T. albacares*).	2017: 322 tonnes	Pelagic, longline, minor line and purse seine.	Extends westward from Cape York Peninsula (142°30' E) off Queensland to 34° S off the WA west coast. It also extends eastward from 34° S off the west coast of WA across the Great Australian Bight to 141° E at the South Australian–Victorian border. In recent years, fishing effort has concentrated off south-west Western Australia and South Australia with no current effort on NWS (Patterson et al. 2018).

Source: Apache (2008); Australian Fisheries Management Authority (2011); Department of Fisheries (2013), Stakeholder consultation.

[1]Sources for catch data: Patterson et al., 2018; Gaughan and Santoro, 2018; DPIRD 2018.

15. References

15.1 Physical Environment

Asia Development Bank (ADB) 2014. State of the Coral Triangle: Indonesia. Mandaluyong City, Philippines 2014.

BHPB 2005. Pyrenees Development. Draft EIS. BHP Billiton Petroleum. Perth

Blaber SJM and Young JW and Dunning, MC 1985. Community structure and zoogeographic affinities of the coastal fishes of the Dampier region of north-western Australia. *Australian Journal of Marine and Freshwater Research* 36(2): 247–266

BOM (Bureau of Meteorology) 2013. Climatology of Tropical Cyclones in Western Australia. Bureau of Meteorology, Canberra, ACT. Available at http://www.bom.gov.au/cyclone/climatology/wa.shtml [Accessed 31 July 2013]

Condie, S, Andrewartha, J, Mansbridge, J and Waring, J 2006. Modelling circulation and connectivity on Australia's North West Shelf. North West Shelf Joint Environmental Management Study: Technical Report No. 6. CSIRO Marine and Atmospheric Research, Hobart, Tasmania

Dames and Moore 1995. Geotechnical investigation. Stag Development, North West Shelf, Western Australia. A report for Apache Energy Limited. 23 November 1995

DEC 2013. Ngari Capes Marine Park management plan 2013 Shelf, Western Australian Department of Environment and Conservation, Perth

DEWHA 2008. The North-west Marine Bioregional Plan: Bioregional profile: A Description of the Ecosystems, Conservation Values and Uses of the North-West Marine Region. Department of the Environment Water, Heritage and the Arts, Canberra, ACT

DEWHA 2008a. The South-west Marine Bioregional Plan: Bioregional profile: A Description of the Ecosystems, Conservation Values and Uses of the Sorth-West Marine Region. Department of the Environment Water, Heritage and the Arts, Canberra, ACT

Heyward, A, Revill, A and Sherwood, C 2006. Review of research and data relevant to marine environmental management of Australia's North West Shelf North West Shelf Joint Environmental Management Study: Technical Report No. 1. CSIRO Marine and Atmospheric Research, Hobart, Tasmania

Holloway, PE 1983. Tides on the Australian north west shelf. *Australian Journal of Marine and Freshwater Research*, 34(1): 213–230

Holloway, PE and Nye, HC 1985 Leeuwin current and wind distributions on the southern part of the Australian North West Shelf between January 1982 and July 1983. *Australian Journal of Marine and Freshwater Research* 36(2): 123–137

McKinnon, AD, Meekan, MG, Carleton, JH, Furnas, MJ, Duggan, S and Skiring, W 2003 Rapid changes in shelf water and pelagic communities on the southern Northwest Shelf, Australia, following a tropical cyclone. *Continental Shelf Research* 23: 93–111

McLoughlin, RJ and Young, PC. 1985. Sedimentary provinces of the fishing grounds of the North-West Shelf of Australia: Grain-Size frequency analysis of surficial sediments. *Australian Journal of Marine and Freshwater Research* 36: 671–81

NSR 1995. Wandoo full field development. Public Environmental Report for Ampolex Ltd, NSR Environmental Consultants Pty Ltd. November 1995

RACAL 1994. Analogue site survey report for Apache Energy Ltd. Stag- 8 Report A2267G. December 1994.
Richardson, WJ, Greene, CR, Maime, CL and Thomson, DH, 1995. Marine Mammals and Noise. Academic Press, San Diego, California

SSE 1991. Normal and extreme environmental design criteria. Campbell and Sinbad locations, and Varanus Island to Mainland Pipeline. Volume 1. Prepared for Hadson Energy Limited by Steedman Science and Engineering. Report E486. March 1991

SSE 1993. Review of oceanography of North West Shelf and Timor Sea regions pertaining to the environmental impact of the offshore oil and gas industry. Vol I prepared for Woodside Offshore Petroleum and the APPEA Review Project of Environmental Consequences of Development Related to the Petroleum Production in the Marine Environment: Review of Scientific Research, Report E1379, October 1993

WNI 1995. Preliminary report on ambient and non-cyclonic design criteria for the Stag location. WNI Science & Engineering. December 1995

WNI 1996. Metocean Conditions on the North West Shelf of Australia, Cape Lambert to the North West Cape Relating to Jack-up Drilling Operation. (DR-50-ED-001). July 1996

Woodside 2005. The Vincent Development. Draft EIS. EPBC Referral 2005/2110. Woodside Energy, Perth

15.2 Benthic & Pelagic Habitats

AIMS 2011. Reef monitoring. Available at http://www.aims.gov.au/documents/30301/908847/Discovering+Scott+Reef+-+Reef+Monitoring.pdf/36e662c2-3378-420c-8d17-66ee800902f3 [Accessed June 2014]

AIMS 2014. Benthic habitat characterisation of Montgomery Reef, Kimberley region, Western Australia. Available at http://data.aims.gov.au/metadataviewer/uuid/b4175af1-e213-4ac7-a7e8-baa121f709b2 [Accessed April 2014]

Amalfi C 2006. Flowers of the Ocean: WA's Expansive Seagrass Meadows; Western Fisheries Nov 2006, pg. 6-9

Australian Ocean Data Network 2017, Australian Phytoplankton Database, Intergrated Marine Observing System. Avaliable from: https://portal.aodn.org.au/ [Accessed: 20/11/2017]

Bancroft KP & JA Davidson 2000. Bibliography of marine scientific research relevant to the conservation of Ningaloo Marine Park and adjacent waters. Marine Conservation Branch, Department of Conservation and Land Management, Perth, Western Australia

Berry PF 1986. Faunal surveys of the Rowley Shoals, Scott Reef and Seringapatam Reef, northwesten Australia. Records of the Western Australian Museum, Supplement No.25, 1986. 106pp

BHPBIO 2011. Proposed Outer Harbour Development, Port Hedland Public Environmental Review/Draft Environmental Impact Statement. BHP Billiton Iron Ore, Perth, Western Australia

Blakeway D & Radford BTM 2004. Scleractinian corals of the Dampier Port and inner Mermaid Sound: species list, community composition and distributional data. Corals of the Dampier Harbour: Their survival and reproduction during the dredging programs of 2004, 1–8

Blondeau-Patissier D, Dekker AG, Schroeder T, Brando VE, Thompson P. Phytoplankton dynamics in shelf waters around Australia 2002–2010. Report prepared for the Australian Government Department of Sustainability, Environment, Water, Population and Communities on behalf of the 2011 State of the Environment Committee. Canberra: DSEWPaC, 2011.

Brooke BP 1997. Geomorphology of the islands and reefs of the central western Kimberley coast In: Marine Biological Survey of the Central Kimberley Coast, Western Australia, Ed DI Walker, University of Western Australia, Western Australia

Brewer DT, Lyne V, Skewes TD and Rothlisberg P 2007. Trophic Systems of the North West Marine Region Prepared for the Department of the Environment, Water, Heritage and the Arts by CSIRO Marine and Atmospheric Research, Cleveland, Queensland

Brown K & Skewes T 2005. A preliminary assessment of the ecology of seagrasses at Ashmore Reef. In: Understanding the Cultural and Natural Heritage Values and Management Challenges of the Ashmore Region,

Santos

Proceedings of a Symposium organised by the Australian Marine Sciences Association and the Museum and Art Gallery of the Northern Territory, Darwin, 4-6 April 2001. Edited *by* B Russell, H Larson, CJ Glasby, RC Willan, and J Martin. Museum and Art Galleries of the Northern Territory & Australian Marine Sciences Association, Darwin, Northern Territory. pp. 143–152

CALM, NPNCA 1996. Shark Bay Marine Reserves Management Plan 1996–2006. Management Plan No. 34. Department of Conservation and Land Management and National Parks and Nature Conservation Authority, Perth, Western Australia

CALM, MPRA 2005a. Management Plan for the Ningaloo Marine Park and Muiron Islands Marine Management Area 2005–2015. Management Plan No. 52. Department of Conservation and Land Management and Marine Parks and Reserves Authority, Perth, Western Australia

CALM, MPRA 2005b. Indicative Management Plan for the Proposed Dampier Archipelago Marine Park and Cape Preston Marine Management Area. Department of Conservation and Land Management and Marine Parks and Reserves Authority, Perth, Western Australia

CALM 2012. Proposed horzion Marine Management Area. Department of Conservation and Land Management, Perth, Western Australia. Available at http://www.dec.wa.gov.au [Accessed April 2014]

Ceccarelli DM, Richards ZT, Pratchett MS, and Cvitanovic C (2011) Rapid increase in coral cover on an isolated coral reef, the Ashmore Reef National Nature Reserve, north-western Australia. Marine and Freshwater Research 62(10): 1214

Chevron 2010. Draft Environmental Impact Statement/Environmental Review and Management Programme for the Proposed Wheatstone Project Volume 1 (Chapters 1 to 6), 6.0 Overview of Existing Environment. Chevron Australia Pty Ltd, Perth, Western Australia

DEC 2008. Preliminary reconnaissance survey of benthic habitats in the Anjo Peninsula area, Kimberley Bioregion, Western Australia. Prepared for Northern Development Taskforce, Department of Industry and Resources by Department of Environment and Conservation, Perth, Western Australia, October 2008

DEC 2013. Ngari Capes Marine Park management plan 2013 and Resourceshe Anjo Peninsular Department of Environment and Conservation, Perth

DEC, MPRA 2007a. Management Plan for the Montebello/Barrow Islands Marine Conservation Reserves 2007–2017. Management Plan No. 55. Department of Environment and Conservation and Marine Parks and Reserves Authority, Perth, Western Australia

DEC, MPRA 2007b. Rowley Shoals Marine Park Management Plan 2007–2017. Management Plan No. 56. Department of Environment and Conservation and Marine Parks and Reserves Authority, Perth, Western Australia

DEH 2002. Ashmore Reef National Nature Reserve and Cartier Island Marine Reserve (Commonwealth Waters) Management Plans. Environment Australia, Department of Environment and Heritage, Canberra, Australian Capital Territory

DEWHA 2008. The North-west Marine Bioregional Plan Bioregional Profile – A Description of the Ecosystems, Conservation Values and Uses of the North-west Marine Region. Department of the Environment, Water, Heritage and the Arts, Canberra, Australian Capital Territory. Available at www.environment.gov.au/coasts/mbp/north-west [Accessed April 2014]

DeVantier, L., Turak, E., Allen, G. 2008. Lesser Sunda Ecoregional Planning Coral Reef Stratification: Reef- and Seascapes of the Lesser Sunda Ecoregion. Report to the Nature Conservancy. Bali, Indonesia. 72 pp.

Director of National Parks 2012. Christmas Island National Park – Draft management Plan 2012-2022 Department of Sustainability, Environment, Water, Population and Communities, Canberra, Australian Capital Territory

DoF 2004. Draft Plan of Management for the Kalbarri Blue Holes Fish Habitat Protection Area. Department of Fisheries, Fisheries Management Paper No. 178, Perth, Western Australia

DoF (2012) Exploring the Houtman Abrolhos Islands. Published by Department of Fisheries, Perth, Western Australia. Publication No. 105, June 2012.

Done TJ Williams D Mc B, Speare P, Turak E, Davidson J, DeVantier LM, Newman SJ & Hutchins JB 1994. Surveys of Coral and Fish Communities at Scott Reef and Rowley Shoals. Australian Institute of Marine Science, Townsville, Queensland

DPAW 2009. Shark Bay World Heritage Area. Department of Parks and Wildlife, Perth, Western Australia. Available at http://www.sharkbay.org/Stromatolitesfactsheet.aspx [Accessed April 2014]

DPAW 2013. Lalang-garram/ Camden Sound Marine Park Management Plan 73 2013–2023. Department of Parks and Wildlife, Perth, Western Australia

EA 2000. Mermaid Reef Marine National Nature Reserve Plan of Management 2000-2007. Environment Australia, Canberra, Australian Capital Territory

Evans K, Bax NJ & Smith DC 2016, Marine environment: State and trends of indicators of marine ecosystem health: Physical, biogeochemical and biological processes. In: Australia state of the environement 2016, Austrealian Government Department of the Environment and Energy, Canberra.

Fry G, Heyward A, Wassenberg T, Taranto T, Stiegliz T and Colquhoun J 2008. Benthic habitat surveys of potential LNG hub locations in the Kimberley region. A CSIRO and AIMS Joint Preliminary Report for the Western Australian Marine Science Institution, Perth, Western Australia, 18 July 2008

Gage JD, Tyler PK 1992. Deep-sea Biology: A Natural History of Organisms at the Deep Sea Floor. Cambridge University Press, Cambridge, UK

Griffith JK 1997. The Corals Collected During September/October at Ashmore Reef, Timor Sea. Parks Australia

Griffith JK 2004. Scleractinian corals collected during 1998 from the Dampier Archipelago, Western Australia. Records of the Western Australian Museum Supplement No. 66: 101–120

Hale J, Butcher R 2013. Ashmore Reef Commonwealth Marine Reserve Ramsar Site Ecological Character Description. A report to the Department of the Environment, Canberra, Australian Capital Territory

Hanson C.E. & McKinnon A.D 2009, Pelagic ecology of the Ningaloo region, Western Australia: influence of the Leeuwin Current, Journal of the Royal Society of Western Australia, vol. 92, pp. 129-137.

Heywood A, Revill A & Sherwood C 2006. Review of research and data relevant to marine environmental management of Australia's North West Shelf. North West Shelf joint environmental management study. Technical Report No. 1 June 2006

Heyward, A.J., Pincerato, E.J., and Smith, L. (eds). 1997. Big Bank Shoals of the Timor Sea: An Environmental Resource Atlas. BHP Petroleum, Melbourne, Victoria

Heyward, A., Radford, B., Burns, K., Colquhoun, J., Moore, C., 2010. Montara Surveys: Final report on Benthic Surveys at Ashmore, Cartier and Seringapatam Reefs. Australian Institute of Marine Science, Crawley

Heyward, A., Jones, R., Travers, M., Burns, K., Suosaari, G., Colquhoun, J., Case, M., Redford, B., Meekan, M., Markey, K., Schenk, T., O'Leary, R.A., Brooks, K., Tinkler, P., Cooper, T., Emslie, M., 2012. Montara: 2011 shallow reef surveys at Ashmore, Cartier and Seringapatam reefs (Monitoring Study No. S6B Coral Reefs). Australian Institute of Marine Science, Townsville.

Hooper J, Ekins M 2004. Collation and Validation of Museum Collection Databases related to the Distribution of Marine Sponges in Northern Australia. (Contract National Oceans Office C2004/020), Unpublished Report to the National Oceans Office, Brisbane: Queensland Museum

Huisman J 2004. Marine benthic flora of the Dampier Archipelago, Western Australia. pages 61–68 In: D.S. Jones (ed.) Marine Biodiversity of the Dampier Archipelago, Western Australia 1998–2002, Report of the Western Australian Museum, 2004, 401 pp., Western Australian Museum, Perth

Huisman JM, Leliaert F, Verbruggen H, Townsend RA 2009. Marine Benthic Plants of Western Australia's Shelf Edge Atolls. Records of the Western Australian Museum Supplement No. 77: 50–87

Hutumo M and Moosa MK 2005. Indonesian marine and coastal biodiversity: present status. Indian Journal of Marine Sciences. 34: 88-97

INPEX 2008. Presentation at the Northern Development Taskforce Site Evaluation Workshop. Broome, WA, 24 July 2008

IRCE 2002. Victoria, Little Sandy and Pedrika wells environmental monitoring programme. Prepared for Apache Energy Ltd by IRC Environment, Perth, Western Australia

IRCE (2003) Environmental monitoring of drilling discharges in shallow water habitats. Prepared for Apache Energy Ltd by IRC Environment, Perth, Western Australia

IRCE (2004) Biannual Coral Monitoring Survey 2004. Prepared for Apache Energy Ltd by IRC Environment, Perth, Western Australia

IRCE (2006) Biannual Macroalgae Monitoring Survey 2005. Prepared for Apache Energy Ltd by IRC Environment, Perth, Western Australia

IRCE 2007. Annual Marine Monitoring 2007: Lowendal and Montebello Islands Macroalgal Survey. Prepared for Apache Energy Ltd by IRC Environment, Perth, Western Australia

Jackson WJ, Argent RM, Bax NJ, Clark GF, Coleman S, Cresswell ID, Emmerson KM, Evans K, Hibberd MF, Johnston EL, Keywood MD, Klekociuk A, Mackay R, Metcalfe D, Murphy H, Rankin A, Smith DC & Wienecke B (2017). Australia state of the environment 2016: overview, independent report to the Australian Government Minister for the Environment and Energy, Australian Government Department of the Environment and Energy, Canberra.

Keesing JK, Irvine TR, Alderslade P, Clapin G, Fromont J, Hosie AM, Huisman JM, Philips JC, Naughton KM, Marsh LM, Slack-Smith SM, Thomson DP, Watson JE (2011). Marine benthic flora and fauna of Gourdon Bay and the Dampier Peninsula in the Kimberley region of north-western Australia. Journal of the Royal Society of Western Australia 94, no. 2 (2011): 285-301

Kendrick GA, Huisman JM and Walker DI (1990). Benthic Macroalgae of Shark Bay, Western Australia. Botanica Marina 33: 47–54

Lanyon JM & Marsh H 1995. Temporal changes in the abundance of some tropical intertidal seagrasses in North Queensland. Aquatic Botany 49:217–237

Last P, Lyne V, Yearsley G, Gledhill D, Gomon M, Rees T & White W, (2005) Validation of National Demersal Fish Datasets for the Regionalisation of the Australian Continental Slope and Outer Shelf (>40 m depth), Department of Environment and Heritage and CSIRO Marine

LEC, Astron 1993. Griffin Gas Pipeline Development Consultative Environmental Review. Prepared for BHP Petroleum and Doral Resources by LeProvost Environmental Consultants and Astron Engineering, Perth, Western Australia

Marsh LM 1990. Hermatypic corals of Shark Bay, Western Australia. In: Research in Shark Bay – Report of the France-Australe Bicentenary Expedition Committee, eds PF Berry, SD Bradshaw, BR Wilson, Western Australian Museum, Perth, pp 115–128

Masini R, Sim C, Simpson C 2009. Protecting the Kimberley: a synthesis of scientific knowledge to support conservation management in the Kimberley region of Western Australia, Part A. Department of Environment and Conservation, Perth, Western Australia

McCook L J, Klumpp DW, McKinnon AD 1995. Seagrass communities in Exmouth Gulf, Western Australia. A preliminary survey. Journal of the Royal Society of Western Australia 78: 81–87

McKenzie L 2007. Seagrass-Watch: Proceedings of a workshop for monitoring seagrass habitats in the Kimberley Region, Western Australia. Broome, WA, September 2007

NASA 2017, Global Patterns and Cycles, Earth Observatory. Avaliable from: https://earthobservatory.nasa.gov/Features/Phytoplankton/page4.php [Accessed 24/11/2017].

Orr M, Zimmer M, Jelinski DE, & Mews M 2005. Wrack deposition on different beach types: spatial and temporal variation in the pattern of subsidy. Ecology 86(6), 2005, pp. 1496–1507

Pattiaratchi C. 2007, Understanding areas of high productivity within the South-West Marine Region, Prepared for the Department of the Environment, Water, Heritage and the Arts.

Pike G & Leach GJ 1997. Handbook of Vascular Plants of Ashmore and Cartier Islands. Parks and Wildlife Commission of the Northern Territory and Parks Australia, Canberra, Australian Capital Territory

Pratchett MS, Munday P, Wilson SK, Graham NA, Cinner JE, Bellwood DR, Jones GP, Polunin & McClanahan TR 2008. Effects of climate-induced coral bleaching on coral-reef fishes. Ecological and economic consequences. Oceanography and Marine Biology: Annual Review 46: 251-296

Prince RIT 1986. Dugong in northern waters of Western Australia 1984. Technical Report No7, Department of Conservation and Land Management, WA

Rees M, Heyward A, Cappo M, Speare P, Smith L 2004. Ningaloo Marine Park – Initial Survey of Seabed Biodiversity in Intermediate and Deeper Waters. Prepared for Australian Government Department of the Environment and Heritage by Australian Institute of Marine Science, Townsville, Queensland

Richards ZT, Bryce M, Bryce C (2013) New records of atypical coral reef habitat in the Kimberley, Australia. Journal of Marine Biology 2013, 363894

RPS Environmental 2008. INPEX environmental impact assessment studies – Technical appendix: Marine Ecology. Prepared for INPEX Browse LTD by RPS Environmental, Perth, Western Australia

RPS BBG 2005. Gorgon Development of Barrow Island Technical Report Marine Benthic Habitats. Report No. R03207. Prepared for ChevronTexaco Australia Pty Ltd by RPS Bowman Bishaw Gorham, Perth, Western Australia, April 2005

Russell BC, Hanley JR 1993. History and Development. In: Survey of the Marine Biological and Heritage Resources of Cartier and Hibernia Reefs, Timor Sea. Northern Territory Museum of Arts and Sciences, Darwin

Seagrass-Watch 2013. Kimberleys. Available at http://www.seagrasswatch.org/WA.html [Accessed June 2014]

Skewes, T., Dennis, D., Jacobs, D., Gordon, S., Taranto, T., Haywood, M., Pitcher, C., Smith, G., Milton, D., Poiner, I., 1999a. Survey and Stock Size Estimates of the Shallow Reef (0-15 M Deep) and Shoal Area (15-50 M Deep) Marine Resources and Habitat Mapping Within the Timor Sea MOU74 Box. Volume 1: Stock Estimates and Stock Status. CSIRO Marine Research, Hobart

Skewes, T., Gordon, S., McLeod, I., Taranto, T., Dennis, D., Jacobs, D., Pitcher, C., Haywood, M., Smith, G., Poiner, I., Milton, D., Griffin, D., Hunter, C., 1999b. Survey and Stock Size Estimates of the Shallow Reef (0-15 m Deep) and Shoal Area (15-50 m Deep) Marine Resources and Habitat Mapping within the Timor Sea MOU74 Box. Volume 2: Habitat Mapping and Coral Dieback. CSIRO Marine Research, Hobart.

Smith, L., Humphrey, C., Hortle, R., Heyward, A., Wilson, D., 1997. Biological Environment, in: Heyward, A., Pinceratto, E., Smith, L. (Eds.), Big Bank Shoals of the Timor Sea: An Environmental Resources Atlas. BHP Petroleum & Australian Institute of Marine Science, Melbourne, pp. 15–94

SKM 2009b. Browse Kimberley LNG DFS#10 – Intertidal Survey. Prepared for Woodside Energy Limited by Sinclair Knight Merz Pty Ltd, Perth, Western Australia

The Ecology Lab 1997. Macroalgal Habitats of the Lowendal/Montebello Island Region. Prepared for Apache Energy Ltd by The Ecology Lab, September 1997

URS 2006. Report on Environmental Surveys Undertaken at Scott Reef in February 2006. Prepared for Woodside Energy Limited by URS Australia Pty Ltd, Perth, Western Australia

URS 2009. Report Annual Marine Monitoring – Macroalgae. Prepared for Apache Energy Ltd by URS Australia Pty Ltd, Perth, Western Australia, August 2009

URS 2010a. Ichthys Gas Field Development Project Studies of the Offshore Marine Environment. Prepared for INPEX Browse Ltd, Perth Western Australia, INPEX Document No. C036-AH-REP-0023

URS 2010b. Benthic Primary Producer (Seagrass and Macroalgae) Habitats of the Wheatstone Project Area. Report R1442. Prepared for Chevron Australia Pty Ltd by URS Australia Pty Ltd, Perth, Western Australia

van Keulen M, Langdon MW 2011. Ningaloo Collaboration Cluster: Biodiversity and ecology of the Ningaloo Reef lagoon. Ningaloo Collaboration Cluster Final Report No. 1c

Veron JEN 1986. Reef building corals. In: Berry, P.F. (ed.). Faunal surveys of the Rowley Shoals, Scott Reef and Seringapatam Reef, north-western Australia. Records of the Western Australian Museum, Supplement No. 25:25–35

Veron JEN 1993. Hermatypic corals of Ashmore Reef and Cartier Island. In: Marine Faunal Surveys of Ashmore Reef and Cartier Island, North-western Australia, ed. P.F. Berry. Western Australian Museum, Perth

Veron JEN, Marsh LM 1988. Hermatypic corals of Western Australia; Records and Annotated Species List. Records of the Western Australian Museum, Supplement No. 29. Western Australian Museum, Perth, Western Australia

Walker DI 1989. Seagrass in Shark Bay – the foundations of an ecosystem. In: Seagrasses: A Treatise on the Biology of Seagrass with Special Reference to the Australian Region, eds A W D Larkum, A J McComb, S A Shepherd, Elsevier, Amsterdam, pp.182-210

Walker DI 1995. Seagrasses and macroalgae. In FE Wells, R Hanley and DI Walker (Eds) Marine Biological Survey of the Southern Kimberley, Western Australia. Western Australian Museum, Perth, Western Australia

Walker DI 1997. Marine Biological survey of the central Kimberley coast, Western Australia. University of Western Australia, Perth, Western Australia

Walker DI, Wells FE & Hanley R 1996. Survey of the marine biota of the eastern Kimberley, Western Australia. University of Western Australia, Western Australian Museum and the Museum and Art Gallery of the Northern Territory

Walker DI & Prince RIT 1987. Distribution and biogeography of seagrass species on the northwest coast of Australia. Aquatic Botany 29:19–32

Waples K & Hollander E 2008. Ningaloo Research Progress Report: Discovering Ningaloo – latest findings andtheir implications for management. Ningaloo Research Coordinating Committee, Department of Environment and Conservation, WA

Western Australian Museum (WAM). 2009. A Marine Biological Survey of Mermaid Reef (Rowley Shoals), Scott and Seringapatam Reefs, Western Australia 2006. Edited by C Bryce. Records of the Western Australian Museum Supplement 77.

Wells FE, Hanley R & Walker DI 1995. Marine Biological survey of the southern Kimberley, Western Australia. Western Australian Museum, Perth, W.A. 1995

Wells FE, Walker DI & Jones DS (eds) 2003. The marine flora and fauna of Dampier, Western Australia. Western Australian Museum, Perth, Western Australia

Whiting S 1999. Use of the remote Sahul Banks, northwestern Australia, by dugongs, including breeding females. Marine Mammal Science 15: 609–615

Williams A, Dunstan P, Althaus F, Barker B, McEnnulty F, Gowlett-Holmes K & Keith G (2010) Characterising the seabed biodiversity and habitats of the deep continental shelf and upper slope off the Kimberley coast, NW Australia. Report produced for Woodside Energy Ltd. CSIRO, pp. 95

Wilson J, Darmawan A, Subijanto J, Green Aand Sheppard S. 2011. Scientific Design of a Resilient Network of Marine Protected Areas. Lesser Sunda Ecoregion, Coral Triangle. The Nature Conservancy. Asia Pacific Marine Program Report No. 2/11. March 2011

Wilson B 2013. The Biogeography of the Australain north West Shelf: Environmental Change and Life’s Response. Elsevier. Western Australian Museum, Perth, Western Australia

Woodside 2011. Browse LNG Development Draft Upstream Environmental Impact Statement. EPBC Referral 2008/4111. Woodside Energy Ltd, Perth, Western Australia, November 2011

Woodside Energy Limited, Australian Institute of Marine Science, Western Australian Museum 2010. Scott Reef Status Report 2010

15.3 Shoreline Habitats

Mangroves

Alongi DM 2002. Present state and future of the world's mangrove forests. Environmental Conservation 29, 331–349. doi:10.1017/S0376892902000231

Alongi DM (2009). The Energetics of Mangrove Forests. Springer.

Ayukai T (1998) Introduction:carbon fixation and storage in mangroves and their relevance to the global climate change – a case study in Hinchinbrook Channel in northeastern Australia. Mangroves and Salt Marshes V2 No 4, Kluwer Academic Publishers.

Astron (2014) Apache OSMP - Desktop Mangrove Assessment. Prepared for Apache Energy Ltd by Astron Environmental Services, Perth, Western Australia, November 2013. Report reference 564-13-1MSR-1Rev0-140225

Astron (2016) Quadrant Environmental Monitoring Program Varanus Island Mangrove Monitoring Annual Report 2016. Prepared for Quadrant Energy Australia Ltd by Astron Environmental Services, Perth, Western Australia, February 2016. Report reference EA-60-RI-10155

CALM (2005) Management Plan for the Ningaloo Marine Park and Muiron Islands Marine Management Area 2005–2015 Management Plan No. 52. Department of Conservation and Land Management, Western Australia.

CALM, MPRA (2005) Indicative Management Plan for the Proposed Dampier Archipelago Marine Park and Cape Preston Marine Management Area

Cresswell I, Semeniuk V, (2011) Mangroves of the Kimberley coast: ecological patterns in a tropical ria coast setting. Journal of the Royal Society of Western Australia 94, 213–237.

DEC (2007) Management Plan for the Montebello/Barrow Islands Marine Conservation Reserves 2007-2017. Management Plan Number 55. Department of Conservation and Land Management, Western Australia.

DEC (2013) Ngari Capes Marine Park management plan 2013– 2023, Management plan number 74. Department of Environment and Conservation, Perth.

DoF (2012) Exploring the Houtman Abrolhos Islands. Published by Department of Fisheries, Perth, Western Australia. Publication No. 105, June 2012.

Duke N, Wood A, Hunnam K, Mackenzie J, Haller A, Christiansen N, Zahmel K, Green T (2010) Shoreline ecological assessment aerial and ground surveys 7-19 November 2009.

Duke NC, Ball MC, Ellison JC (1998) Factors influencing biodiversity and distributional gradients in mangroves. Global Ecology and Biogeography Letters 7, 27–47.

EPA (2009) Environmental Assessment Guidelines No 3. Protection of Benthic Primary Producer Habitat (BPPH) in Western Australia's Marine Environment.

EPA (2001) Guidance Statement for Protection of Tropical Arid Zone Mangroves Along the Pilbara Coastline. Guidance Statement No. 1. Environmental Protection Authority Western Australia Perth

Garnet S.T. and Crowley, G.M. (2000) The action plan for Australian birds 2000. Environment Australia, Canberra.

Gueho, R (2007) Rhythms of the Kimberley: a seasonal journey through Australia's north. Fremantle Press, Australia.

Johnstone R (1984) Intergradation between Lemon-breasted Flycatcher *Microeca flavigaster* Gould and Brown-tailed Flycatcher *Microeca tormenti* Mathews in Cambridge Gulf, Western Australia. Records of the Western Australian Museum 11, 291–295.

Kangas M, McCrea J, Fletcher W, Sporer E and Weir V (2006) Exmouth Gulf Prawn Fishery ESD Report Series No.1 Department of Fisheries Western Australia.

Kathiresan, K., Bingham, B.L., 2001. Biology of mangroves and mangrove ecosystems. Advances in marine biology 40, 81–251.

Kenyon R, Loneragan N, Manson F, Vance D, Venables W (2004). Allopatric distribution of juvenile red-legged banana prawns (*Penaeus indicus* H. Milne Edwards, 1837) and juvenile white banana prawns (*Penaeus merguiensis* De Man, 1888), and inferred extensive migration, in the Joseph Bonaparte Gulf, northwest Australia. Journal of Experimental Marine Biology and Ecology 309, 79–108.

Mangrove Watch Australia (2014) Pilbara Mangroves, MangroveWatch, Australia. Available at http://www.mangrovewatch.org.au/index.php?option=com_content&view=category&layout=blog&id=84&Itemid=300201

Nagelkerken I, van der Velde G, Gorissen MW, Meijer GJ, Van't Hof T, den Hartog C, 2000. Importance of Mangroves, Seagrass Beds and the Shallow Coral Reef as a Nursery for Important Coral Reef Fishes, Using a Visual Census Technique. Estuarine, Coastal and Shelf Science 51, 31–44. doi:10.1006/ecss.2000.0617

NOAA (2010) Oil Spills in Mangroves, Planning and Response. National Oceanic and Atmospheric Administration. US Department of Commerce, Office of Response and Restoration.

Pendretti YM, Paling EI (2001) WA Mangrove Assessment Project 1999-2000. Marine and Freshwater Research Laboratory, Murdoch University, Perth, Western Australia.

Rule M, Kendrick A, Huisman J (2012) Mangroves of the Shark Bay Marine Park. Information Sheet 46/2012 Science Division. Department of Environment and Conservation.

Semeniuk V (1983) Regional and local mangrove distribution in Northwestern Australia in relationship to freshwater seepage. Vegetation 53, 11–31.

Semeniuk V (1993) The mangrove systems of Western Australia: 1993 Presidential Address. Journal of the Royal Society of Western Australia 76:99-122.

Waples K (2007) Kimberley Biodiversity Review. WAMSI. Western Australia.

Wilson B, 1994. A representative Marine Reserve System for Western Australia.

Wilson B (2013) The Biogeography of the Australian North West Shelf: Environmental Change and Life's Response. Elsevier.

Zell L (2007) Kimberley Coast. Wild Discovery.

15.4 Intertidal Habitats

Barter M (2002) Shorebirds of the Yellow Sea: importance, threats and conservation status. Australian Government Publishing Service, Canberra, Australia.

Bennelongia Pty Ltd (2010) Analysis of possible change in ecological character of the Roebuck Bay and Eighty Mile Beach Ramsar sites.

BirdLife International (2018) Important Bird Areas Data Zone [Online]. Available from: http://www.birdlife.org [Accessed December 2018]

CALM (1996) Shark Bay Marine Reserves. Management Plan. 1996-2006. Marine Conservation Branch, Management Plan No. 34. Department of Conservation and Land Management, Western Australia.

DEC (2012) Indicative Management Plan for the Proposed Eight Mile Beach Marine Park. Department of Environment and Conservation, Western Australia.

DoE (2014) Subtropical and Temperate Coastal Saltmarsh in Community and Species Profile and Threats Database, Department of the Environment, Canberra. Available from:http://www.environment.gov.au/sprat. Accessed 2014-05-01T13:46:55EST.

DPaW (2013) Lalang-garram / Camden Sound Marine Park management plan no. 73 2013–2023, Department of Parks and Wildlife, Perth, Western Australia.

DSEWPaC 2013. Shark Bay, Western Australia, Work Heritage Values. [Online, retrieved 17 July 2013] Available at: http://www.environment.gov.au/heritage/places/world/shark-bay/values.html

Garnet ST and Crowley GM (2000) The action plan for Australian birds 2000. Environment Australia Canberra.

Gibson, L., Wellbelove, A (2010). Protecting critical marine habitats: The key to conserving our threatened marine species: a Humane Society International and WWF-Australia Report.

Hanley JR and Morrison PF (2012) A Guide to the intertidal flora and fauna of the Point Samson Fish Reserve. Sinclair Knight Merz and RioTinto Australia Pty Ltd.

Jones DS (2004) Marine biodiversity of the Dampier Archipelago Western Australia 1998-2002.

Masini R, Sim C, Simpson C (2009) Protecting the Kimberley: A synthesis of scientific knowledge to support conservation management in the Kimberley region of Western Australia.

Sinclair Knight Merz (2009) Baseline Intertidal Report. Cape Lambert Port B Development. RioTinto Australia Pty Ltd.

Sinclair Knight Merz (2010) Browse Kimberley LNG DFS10 – Intertidal Survey. James Price Point Intertidal Survey.

Sinclair Knight Merz (2011) Port Hedland Outer Harbour Development. Marine Coastal Intertidal Benthic Habitats Impact Assessment. Prepared for BHPBIO Pty Ltd.

Robertson, A.I., 1988. Decomposition of mangrove leaf litter in tropical Australia. Journal of Experimental Marine Biology and Ecology 116, 235–247. doi:10.1016/0022-0981(88)90029-9

Robson BJ, Burford M, Gehrke P, Revill A, Webster I, Palmer D (2008) Response of the lower Ord River and estuary to changes in flow and sediment and nutrient loads (Water for a Healthy Country Flagship Report). CSIRO.

Wade S, Hickey R, (2008). Mapping Migratory Wading Bird Feeding Habitats using Satellite Imagery and Field Data, Eighty-Mile Beach, Western Australia. Journal of Coastal Research 243, 759–770. doi:10.2112/05-0453.1

Wildsmith MD, Potter IC, Valesini FJ, Platell ME (2005) Do the assemblages of benthic Macroinvertebrates in nearshore waters of Western Australia vary among habitat types, zones and seasons? Journal of Marine Biology 85: 217-232.

15.5 Fish and Sharks

BBG (1994) Dampier Port Authority, Environmental Management Plan. Report prepared by Bowman Bishaw Gorham Perth, for the Dampier Port Authority, Dampier.

Borrell A, Aguilar A, Gazo M, Kumarran RP, Cardona L 2011. Stable isotope profiles in whale shark (Rhincodon typus) suggest segregation and dissimilarities in the diet depending on sex and size. Environmental Biology of Fishes, 92: 559-567.

Bulman C (2006) Trophic Webs and Modelling of Australia's North West Shelf. North West Shelf Joint Environmental Management Study: Technical Report No. 9. CSIRO Marine and Atmospheric Research, Hobart, Tasmania, CSIRO Marine and Atmospheric Research.

Bradshaw CJA, Mollet HF, Meekan MG (2007) Inferring population trends for the world's largest fish from mark-recapture estimates of survival. Journal of Animal Ecology 76: 480-489

Brewer DT, Lyne V, Skewes TD and Rothlisberg P 2007. Trophic Systems of the North West Marine Region. Prepared for the Department of the Environment, Water, Heritage and the Arts by CSIRO Marine and Atmospheric Research, Cleveland, Australia.Cailliet, G.M. 1996. An Evaluation of Methodologies to Study the Population Biology of White Sharks. In: Klimley, A.P. & D.G. Ainley, (eds.) Great White Sharks The biology of *Carcharodon carcharias*. Page(s) 415-416. United States of America: Academic Press Limited.

CALM (1996) Shark Bay Marine Reserves. Management Plan. 1996-2006. Marine Conservation Branch, Management Plan No. 34. Department of Conservation and Land Management.

CALM (2005) Management Plan for the Ningaloo Marine Park and Muiron Islands Marine Management Area 2005 – 2015 Management Plan No. 52. Department of Conservation and Land Management, Perth, Western Australia.

Chen C-T, Liu K-M, Joung S-J (1997) Preliminary report on Taiwan's whale shark fishery. Traffic Bulletin, 17: 53-57.

Chidlow J, Gaughan D and McAuley RB (2006) Identification of Western Australian Grey Nurse Shark aggregation sites. Final report to the Australian Government, Department of the Environment and Heritage. Fisheries research report No. 155. Department of Fisheries, Western Australia, 48p.

Compagno, LJV & Last, PR 1999. Order Pristiformes. Pristidae: sawfishes, in KE Carpenter & VH Niem (eds), FAO species identification guide for fishery purposes – the living marine resources of the western central Pacific, vol. 3, Batoid fishes, chimaeras and bony fishes, part 1 (*Elopidae* to *Linophyroidae*), FAO, Rome, pp. 1410–1417.

Compagno, L J (2001) Sharks of the World: An Annotated and Illustrated Catalogue of Shark Species Known to Date. Vol. 2, Bullhead, Mackeral and Carpet Sharks (Heterodontiformes, Lamniformes and Orectolobiformes) (Vol. 2, No. 1). Food & Agriculture Org.

de Lestang P & Jankowski A (2017). A Guide to the Common Marine Fishes of Barrow Island. Chervon. Available from: https://www.chevronaustralia.com/docs/default-source/publications/gorgon/fish-nature-booklet.pdf?sfvrsn=0 [Accessed 15/12/17].

DEC (2007a) Management Plan for the Montebello/Barrow Islands Marine Conservation Reserves 2007–2017: Management Plan No. 55. Department of Environment and Conservation, Perth, Western Australia.

DEC (2007b) Management Plan for the Rowley Shoals Marine Park 2007–2017: Management Plan No. 56. Department of Environment and Conservation, Perth, Western Australia

DEC (2013) Ngari Capes Marine Park management plan 2013– 2023, Management plan number 74. Department of Environment and Conservation, Perth.

DEH (2006) A Guide to the Integrated Marine and Coastal Regionalisation of Australia Version 4.0. Department of the Environment and Heritage, Canberra, Australia.

DEWHA (2008) The north-west marine region bioregional profile: a description of the ecosystems, conservation values and uses of the north-west marine region, Australian Government Department of the Environment, Water, Heritage and the Arts (DEWHA), Canberra.

DEWHA (2009) DEWHA Fact Sheet – Three sharks listed as migratory species under the EPBC Act. Department of the Environment, Water, Heritage and the Arts, Canberra, Australia.

DEWHA (2012a) Species group report card – bony fishes. Supporting the marine bioregional plan for the North-west Marine Region. Australian Government Department of the Environment, Water, Heritage and the Arts (DEWHA), Canberra.

DEWHA (2012b) Species group report card – sharks and saw fishes. Supporting the marine bioregional plan for the North-west Marine Region. Australian Government Department of the Environment, Water, Heritage and the Arts (DEWHA), Canberra.

DoE (2014a) *Ophisternon candidum* in Species Profile and Threats Database, Department of the Environment, Canberra. Available from:http://www.environment.gov.au/sprat. Accessed Friday, 21 Mar 2014 15:18:30 +1100

DoE (2014b)*Pristis clavata* in Species Profile and Threats Database, Department of the Environment, Canberra. Available from:http://www.environment.gov.au/sprat. Accessed Tue, 18 Mar 2014 14:07:14 +1100

DoE (2014c) *Pristis pristis* in Species Profile and Threats Database, Department of the Environment, Canberra. Available from:http://www.environment.gov.au/sprat. Accessed Tue, 25 Mar 2014 13:18:05 +1100

DoE (2014c) *Pristis zijsron* in Species Profile and Threats Database, Department of the Environment, Canberra. Available from:http://www.environment.gov.au/sprat. Accessed Tue, 25 Mar 2014 13:20:35 +1100

DoEE (2016a). *Nannatherina balstoni* in Species Profile and Threats Database, Department of the Environment, Canberra. Available from: http://www.environment.gov.au/sprat. Accessed Tue, 2 Aug 2016 13:26:01 +1000.

DoEE (2017). *Carcharias Taurus.* in Species Profile and Threats Database, Department of the Environment, Canberra. Available from: http://www.environment.gov.au/sprat. Accessed Tue, 18 Dec 2017 13:27:01 +1000.

DoF (2012) Exploring the Houtman Abrolhos Islands. Published by Department of Fisheries, Perth, Western Australia. Publication No. 105, June 2012.

Fox, NJ and Beckley, LE (2005). Priority areas for conservation of Western Australian coastal fishes: A comparison of hotspot, biogeographical and complementarity approaches. Biological Conservation, 125: 399-410.

Fletcher WJ and Santoro K (2012) Status Reports of the Fisheries and Aquatic Resources of Western Australia 2011/12(eds): The State of the Fisheries. Department of Fisheries, Western Australia.

Fletcher, WJ. and Santoro, K. (2013). Status Reports of the Fisheries and Aquatic Resources of Western Australia 2012/13(eds). The State of the Fisheries. Department of Fisheries, Western Australia.

Gelsleichter J, Musick JA & Nichols S (1999). Food habits of the smooth dogfish, *Mustelus canis*, dusky shark, *Carcharhinus obscurus*, Atlantic sharpnose shark, *Rhizoprionodon terraenovae*, and the sand tiger, *Carcharias taurus*, from the northwest Atlantic Ocean, Environmental Biology of Fishes, vol. 54, pp. 205–217.

Heyward A, Revill A and Sherwood C 2006. Review of research and data relevant to marine environmental management of Australia's North West Shelf. Technical report No 1. CSIRO. Marine and Atmospheric Research. North West Shelf Joint Environmental Management Study

Humphreys WF (1999) The distribution of Australian cave fishes. Records of the Western Australian Museum. 19:469-472.

Humphreys WF & MN Feinberg (1995) Food of the blind cave fishes of northwestern Australia. *Records of the Western Australian Museum*. 17:29-33.

Humphreys B & J Blyth (1994) Subterranean Secrets. Landscope - W.A's Conservation, Forests and Wildlife Magazine. 9, No. 3:22-27.

Hutchins JB (2003). Checklist of marine fishes of the Dampier Archipelago, Western Australia. Pp. 453-478. In: Wells, F.E., Walker D.I. & Jones D.S. (eds). *The Marine Flora and Fauna of Dampier, Western Australia*. Western Australian Museum, Perth.

Hutchins JB (2004) Fishes of the Dampier Archipelago, Western Australia pp. 343-398. In: Jones D.S. (ed). Report on the results of the Western Australia Museum/Woodside Energy Ltd. Partnership to explore the Marine Biodiversity of the Dampier Archipelago. Western Australia 1998-2002. Records of the Western Australian Museum Supplement No. 66: 343-398.

Jarman SN, Wilson SG (2004) DNA-based species identification of krill consumed by whale sharks. *Journal of Fish Biology*, 65: 586-591

Government of WA. Wildlife Conservation (Specially Protected Fauna) Notice 2018. Published in the WA Government Gazette Perth, Tuesday 11 September 2018 No.135.

Kemps, H (2010) Ningaloo: Australia's Untamed Reef. Quinns Rocks: MIRG Australia

Last PR & Stevens JD (2009) Sharks and rays of Australia, 2nd edn, CSIRO Publishing, Collingwood.

Last P, Lyne V, Yearsley G, Gledhill D, Gomon M, Rees T and White, W (2005) Validation of national demersal fish datasets for the regionalisation of the Australian continental slope and outer shelf (>40 m depth). Department of Environment and Heritage and CSIRO Marine Research, Australia. 99pp

McAuley, R. 2004. Western Australian Grey Nurse Shark Pop Up Archival Tag Project. Final Report to Department of Environment and Heritage. Page(s) 55.

Mackie M, Nardi A, Lewis P and Newman S (2007) Small Pelagic Fishes of the North-west Marine Region, Prepared for the Department of the Environment and Water Resources by Department of Fisheries, Perth, Western Australia.

Meekan MG, Bradshaw CJA, Press M, McLean C, Richards A, Quasnichka S, Taylor JA (2006) Population size and structure of whale sharks (*Rhincodon typus*) at Ningaloo Reef, Western Australia. Marine Ecology Progress Series 319: 275-285

Meekan MG, Jarman SN, McLean C, Schultz MB (2009) DNA evidence of whale sharks (*Rhincodon typus*) feeding on red crab (*Gecarcoidea natalis*) larvae at Christmas Island, Australia. Marine and Freshwater Research 60: 607-609

Norman, B (2005) Rhincodon typus. In: IUCN 2012. IUCN Red List of Threatened Species. Version 2012.2. <www.iucnredlist.org>. Downloaded on 31 May 2013.

Norman, B.M. and Stevens, JD (2007) Size and maturity status of the whale shakr (Rhincodon typus) at Ningaloo Reef in Western Australia. Fisheries Research, 84: 81-86.

Otway NM, & PC Parker (2000) The Biology, Ecology, Distribution, Abundance and Identification of Marine Protected Areas for the Conservation of Threatened Grey Nurse Sharks in South-east Australian Waters. NSW Fisheries Office of Conservation.

Peverell SC (2005) Distribution of sawfishes (Pristidae) in the Queensland Gulf of Carpentaria, Australia, with notes on sawfish ecology, Environmental Biology of Fishes, vol. 73, pp. 391–402.

Pogonoski JJ, DA Pollard & JR Paxton (2002) Conservation Overview and Action Plan for Australian Threatened and Potentially Threatened Marine and Estuarine Fishes. [Online]. Canberra, ACT: Environment Australia. Available from: http://www.environment.gov.au/coasts/publications/marine-fish-action/pubs/marine-fish.pdf.

Pollard, DA MP Lincoln-Smith & A.K. Smith (1996) The biology and conservation of the grey nurse shark (*Carcharias taurus* Rafinesque 1810) in New South Wales, Australia. Aquatic Conservation: Marine and Freshwater Ecosystems. 6.

Sainsbury KJ, Campbell RA and Whitlaw AW (1992) Effects of trawling on the marine habitat on the North West Shelf of Australia and implications for sustainable fisheries management. In: Hancock D. A. (Editor). *Sustainable Fisheries through Sustaining Fish Habitat*. Canberra Australia. Australian Government Publishing Service, 1993, 137–145. Aust Soc. for Fish. Biol. Workshop, Victor Harbour, SA, 12–13 August 1992.

Smale MJ (2005) The diet of the ragged-tooth shark *Carcharias taurus* Rafinesque 1810 in the Eastern Cape, South Africa, African Journal of Marine Science, vol. 27, pp. 331–335.

Stevens JD, Pillans, RD and Salini J (2005) Conservation Assessment of Glyphis sp. A (Speartooth Shark), Glyphis sp. C (Northern River Shark), Pristis microdon (Freshwater Sawfish) and Pristis zijsron (Green Sawfish). [Online]. Hobart, Tasmania: CSIRO Marine Research. Available from: http://www.environment.gov.au/coasts/publications/pubs/assessment-glyphis.pdf.

Stevens JD, McAuley RB, Simpfendorfer CA & Pillans RD (2008) Spatial distribution and habitat utilisation of sawfish (Pristis spp) in relation to fishing in northern Australia, report to the Australian Government Department of Environment and Heritage, Canberra.

Stevens JD, Last PR, White WT, McAuley RB & Meekan MG (2009) Diversity, abundance and habitat utilisation of sharks and rays. CSIRO Marine Research. Available from: http://www.wamsi.org.au/sites/wamsi.org.au/files/Node%203.2.1%20Diversity,%20abundance%20and%20habitat%20utilisation%20of%20sharks%20and%20rays.pdf.

Thorburn DC, DL Morgan, AJ Rowland & HS Gill (2007) Freshwater sawfish *Pristis microdon* Latham, 1794 (Chondrichthyes: Pristidae) in the Kimberley region of Western Australia. *Zootaxa*. 1471:27-41.

Thorburn, DC, Morgan, DL, Rowland, AJ, Gill, HS & Paling, E (2008) Life history notes of the critically endangered dwarf sawfish, *Pristis clavata*, Garman 1906 from the Kimberley region of Western Australia', Environmental Biology of Fishes, vol. 83, pp. 139–145

Thorburn, DC, Morgan, DL, Rowland, AJ & Gill HS (2004) The northern river shark (Glyphis sp.C) in Westenr Australia, Report to the National Trust

Whisson, G & Hoshke, A (2013). *In situ* video monitoring of finfish diversity at Ningaloo Reef, Western Australia. Galaxea, Journal of Coral Reef Studies. The Japanese Coral Reef Society. Vol. 15, pp 72-28

Wilson, S Polovina, J Stewart, B & Meekan, M (2006) Movements of whale sharks (*Rhincodon typus*) tagged at Ningaloo Reef. Marine Biology, vol. 147, pp. 1157-1166.

15.6 Marine Reptiles

Astron Environmental Services (2013a) Exmouth Islands Turtle Monitoring Program – Desktop

Review and Gap Analysis. Rev B, 26 September 2013, unpublished report for Apache Energy Ltd, Perth.

Astron Environmental Services (2014) Exmouth Islands Turtle Monitoring Program – January 2014 Field Survey. Rev A, 11 February 2014, unpublished report for Apache Energy Ltd, Perth.

Astron (2017) Quadrant Environmental Monitoring Program Varanus and Airlie Islands Turtle Monitoring Annual Report 2016/17, Prepared for Quadrant Energy Australia Ltd by Astron Environmental Services, Perth, Western Australia, June 2017. Report reference EA-60-RI-10173

BHPB (2005) Pyrenees Development: Draft Environmental Impact Statement. BHP Billiton, Perth, Western Australia.

Baldwin R, Hughes GR and Prince RIT (2003) Loggerhead turtles in the Indian Ocean. In: AB Bolten and BE Witherington (eds) Loggerhead Sea Turtles, Smithsonian Books, Washington.

CALM (2005a) Management Plan for the Ningaloo Marine Park and Muiron Islands Marine Management Area 2005 – 2015 Management Plan No. 52. Department of Conservation and Land Management, Perth, Western Australia.

Chaloupka M and Prince RIT (2012) Estimating demographic parameters for a critically endangered marine species with frequent reproductive omission: Hawksbill turtles nesting at Varanus Island, Western Australia. Marine Biology 159(2): 355-363.

Chevron (2005) Environmental Impact Statement/Environmental Review and Management Programme for the proposed Gorgon Development. Chevron Australia Pty Ltd, Perth, Western Australia.

Chevron (2008) Gorgon Gas Development Revised and Expanded Proposal Public Environmental Review Operated by Chevron Australia in joint venture with Gorgon Project. EPBC Referral 2008/4178Assessment No. 1727. Chevron Australia Pty Ltd, Perth, Western Australia, September 2008.

Commonwealth of Australia (2017), Recovery Plan for Marine Turtles in Australia 2017 – 2027.

Dethmers KM, Broderick D, Moritz C, Fitzsimmons N, Limpus C, Lavery S, Whiting S, Guinea M, Prince RIT and Kennett R (2006) The genetic structure of Australasian Green Turtles (*Chelonia mydas*): exploring the geographical scale of genetic exchange. Molecular Ecology 15:3931-3946.

DEWHA (2008a) The North-west Marine Bioregional Plan: Bioregional profile: A Description of the Ecosystems, Conservation Values and Uses of the North-West Marine Region. Department of the Environment Water, Heritage and the Arts, Canberra, ACT.

DSEWPaC (2012a) *Eretmochelys imbricata* – Hawksbill Turtle. Available from: http://www.environment.gov.au/cgibin/sprat/public/publicspecies.pl?taxon_id=1766. Department of Sustainability, Environment, Water, Population and Communities.

DSEWPaC (2012b) Marine bioregional plans. Department of Sustainability, Environment, Water, Population and Communities, Canberra, ACT. Available at http://www.environment.gov.au/coasts/marineplans/about.html

DSEWPaC (2012c) *Natator depressus* – Flatback Turtle. Available from: http://www.environment.gov.au/cgibin/sprat/public/publicspecies.pl?taxon_id=59257. Department of Sustainability, Environment, Water, Population and Communities.

DSEWPaC (2012d) Species Group Report Card – Reptiles. Supporting the draft marine bioregional plan for the North-west Marine Region. Department of Sustainability, Environment, Water, Populations and Communities, Canberra, Australia.

DoE (2014) Aipysurus foliosquama in Species Profile and Threats Database, Department of the Environment, Canberra. Available from:http://www.environment.gov.au/sprat. Accessed Wed, 23 Jul 2014

DoEE (2017) Species Profile and Threats Database [Online] Department of Environment and Energy Canberra, Commonwealth of Australia Available from: http://www.environment.gov.au/cgi-bin/sprat/public/sprat.pl

Environment Australia (2003) Recovery Plan for Marine Turtles in Australia. Prepared by the Marine Species Section, Approvals and Wildlife Division, Environment Australia, Canberra, ACT

Government of WA. Wildlife Conservation (Specially Protected Fauna) Notice 2018. Published in the WA Government Gazette Perth, Tuesday 11 September 2018 No.135.Kendall WL and Bjorkland R (2001) Using open robust design models to estimate temporary emigration from capture - recapture data. Biometrics: 57,1113 – 1122.

Limpus CJ (2007) A biological review of Australian marine turtle species. 5. Flatback turtle, *Natator depressus* (Garman). The State of Queensland. Environmental Protection Agency, Brisbane, Queensland.

Limpus CJ (2008a) A biological review of Australian marine turtle species. 2. Green turtle, *Chelonia mydas* (Linneaus). The State of Queensland. Environmental Protection Agency, Brisbane, Queensland.

Limpus CJ (2008b) A biological review of Australian marine turtle species. 1. Loggerhead turtle, *Caretta caretta* (Linneaus). The State of Queensland. Environmental Protection Agency, Brisbane, Queensland.

Limpus CJ (2009) *A Biological Review of Australian Marine Turtles*, Queensland Environmental Protection Agency, Queensland.

Limpus CJ 2009a. A biological review of Australian marine turtle species.3. Hawksbill turtle, *Eretmochelys imbricata* (Linneaus). The State of Queensland. Environmental Protection Agency, Brisbane, Queensland.

Limpus CJ (2009b) A biological review of Australian marine turtle species. 6. Leatherback turtle, *(Dermochelys coriacea*). The State of Queensland. Environmental Protection Agency, Brisbane, Queensland.

Limpus C.J and McLachlin N (1994) The conservation status of the Leatherback Turtle, Dermochelys coriacea, in Australia. In: James R (ed.) Proceedings of the Australian Marine Turtle Conservation Workshop, Gold Coast 14-17 November 1990. pp. 63-67. Queensland Department of Environment and Heritage. Canberra: ANCA.

Marquez R (1990) Sea Turtles of the World: An annotated and illustrated catalogue of the sea turtle species known to date. FAO Species Catalogue. Vol. 11, pp. 81. Rome: Food and Agriculture Organisation of United Nations.

Minton SA & Heatwole H (1975) Sea snakes from three reefs of the Sahul Shelf. In: Dunson, W. A., ed. The Biology of Sea Snakes. Page(s) 141-144. Baltimore: University Park Press.

Morris K (2004) Regional significance of marine turtle rookeries on the Lowendal Islands. Unpublished information provided to Apache Energy Ltd.

Oliver GA (1990) Interim Guidelines for Operations – Serrurier Island Nature Reserve. Department of Conservation and Land Management, Perth, Western Australia.

Pendoley KL (2005) Sea Turtles and the Environmental Management of Industrial Activities in North West Western Australia, PhD Thesis, Murdoch University, Australia. 310pp.

Pendoley Environmental (2009) Marine Turtle Beach Survey: Forty Mile Beach Area, North Eat and South West Regnard Island. Report to Apache Energy Ltd.

Pendoley Environmental (2011) Varanus Island Marine Turtle Tagging Programme 2009 - 2010. Report to Apache Energy Ltd.

Pendoley Environmental (2013) Varanus Island Marine Turtle Tagging Program 2012 – 2013 Season. Report to Apache Energy Ltd.

Pendoley, KL, Schofield, G., Whittock, P. A., Ierodiaconou, D., & Hays, G. C. (2014). Protected species use of a coastal marine migratory corridor connecting marine protected areas. Marine Biology, 1-12.

Prince RIT (1994) Status of the Western Australian Marine Turtle Populations: The Western Australian Marine Turtle Project 1986–1990. Report prepared for the Queensland Department of Environment and Heritage and Australian Nature Conservation Agency.

Waayers D (2010) A Holistic Approach to Planning for Wildlife Tourism: A Case Study of Marine

Turtle Tourism and Conservation in the Ningaloo Region, Western Australia. PhD Thesis, Murdoch University, Perth.

Woodside (2002) WA-271-P Field Development: Environmental Impact Statement. Woodside Energy Ltd., Perth.

Woodside (2005) The Vincent Development. Draft EIS. EPBC Referral 2005/2110. Woodside Energy. Perth.

Sea snakes

Cogger HG (2000) Reptiles and Amphibians of Australia - 6th edition. Sydney, NSW: Reed New Holland

Heatwole H and Cogger HG (1993). Family Hydrophiidae, in: Glasby CG, Ross GJB and Beesley PL (eds) Fauna of Australia Volume 2A: Amphibia and Reptilia. AGPS Canberra. 439pp

Guinea ML & SD Whiting (2005) Insights into the distribution and abundance of sea snakes at Ashmore Reef. The Beagle (Supplement 1). Page(s) 199-206

McCosker JE (1975). Feeding behaviour of Indo-Australian Hydrophiidae. In: Dunson W A (eds.) The Biology of Sea Snakes. Page(s) 217-232. Baltimore: University Park Press

Minton S and H Heatwole (1975) Sea snakes from three reefs of the Sahul Shelf. Chapter 5 (pp. 141-144) In: Dunson W A (eds.) The Biology of Sea Snakes, University Park Press, Baltimore, 530 pp.

Storr GM, Smith LA and Johnstone RE (1986) Snakes of Western Australia. First edition. Perth: Western Australian Museum.

15.7 Marine Mammals

Bannister, J.L., C.M. Kemper & R.M. Warneke (1996). *The Action Plan for Australian Cetaceans*. Canberra: Australian Nature Conservation Agency. Available from: http://www.environment.gov.au/resource/action-plan-australian-cetaceans.

Branch TA, Stafford KM, Palacios DM, Allison C, Bannister JL, Burton CLK, Cabrera E, Carlson CA, Galletti vernazzani B, Gill PC, Hucke-gaete R, Jenner KC, Jenner M-N, Matsuoka K, Mikhalev YA, Miyashita MG, Morrice S, Nishiwaki VJ, Sturrock D, Tormosov RC, Anderson AN, Baker PB, Best P, Borsa T, Brownell Jr. RL, Childerhouse SK, Findlay P, Gerrodette, T, Ilangakoon, AD, Joergensen, M, Kahn, B, Ljungblad, DK, Maughan, B, Mccauley, RD, Mckay, S, Norris, TF, Oman whale and Dolphin research group, Rankin, S, Samaran, F, Thiele, D, Van Waerebeek K & Warneke RM (2007) Past and present distribution, densities and movements of blue whales *Balaenoptera musculus* in the Southern Hemisphere and Northern Indian Ocean. Mammal Rev. 37(2):116–175

Campbell R (2005) Historical distribution and abundance of the Australian sea lion (*Neophoca cinerea*) on the west coast of Western Australia. Fisheries Research Report no. 148. Department of Fisheries, Perth, Western Australia

DEH (Department of the Environment and Heritage) (2005a) Blue, Fin and Sei Whale Recovery Plan 2005 - 2010. [Online] Department of the Environment and Heritage Canberra, Commonwealth of Australia Available from: http://www.environment.gov.au/biodiversity/threatened/publications/recovery/balaenoptera-sp/index.html

DEH (2005b) Humpback Whale Recovery Plan 2005 - 2010. [Online] Department of the Environment and Heritage Canberra, Commonwealth of Australia Available from: http://www.environment.gov.au/topics/biodiversity/threatened-species-ecological-communities/recovery-plans

DEWHA (Department of the Environment, Water, Heritage and the Arts) (2008) The South-West Marine Bioregional Plan: Bioregional Profile: A Description of the Ecosystems, Conservation Values and Uses of the South-West Marine Region. [Online] Canberra: DEWHA Available from: http://www.environment.gov.au/coasts/mbp/publications/south-west/pubs/sw-profile-full.pdf

DEWR (Department of Environment and Water Resources) (2007) Whales and dolphins identification guide. Department of Environment and Water Resources, Canberra

DoEE (2016a). *Sousa sahulensis*— Indo-Pacific Humpback Dolphin. Species Profile and Threats Database. Available at: http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=50 [Accessed on 3 August 2016]

DoEE (2016b). *Tursiops aduncus* — Indian Ocean Bottlenose Dolphin, Spotted Bottlenose Dolphin. Species Profile and Threats Database. Available at: http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=68418 [Accessed on 3 August 2016]

DoEE (2016c) *Orcaella heinsohni* — Australian Snubfin Dolphin. Species Profile and Threats Database. Available at: http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=81322 [Accessed on 3 August 2016]

DoEE (2017a) Species Profile and Threats Database [Online] Department of Environment and Energy Canberra, Commonwealth of Australia Available from: http://www.environment.gov.au/cgi-bin/sprat/public/sprat.pl

DoEE (2017b) National Conservation Values Atlas [Online] Department of Environment and Energy Canberra, Commonwealth of Australia Available from: http://www.environment.gov.au/webgis-framework/apps/ncva/ncva.jsf

DoEE (2017c). *Balaenoptera edeni* in Species Profile and Threats Database, Department of the Environment, Canberra. Available from: http://www.environment.gov.au/sprat. [Accessed 21 Nov 2017]

Department of State Development (DSD) 2010. Browse Liquified Natural Gas Precinct – Strategic Assessment Report. Part 3 – Environmental Assessment - Marine Impacts. December 2010

Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC) 2012, Marine Bioregional plan for the North-west Marine Region. Commonwealth of Australia, Canberra.

Double MC, Andrews-Goff V, Jenner KCS, Jenner M-N, Laverick SM, Branch TA & Gales N (2014) Migratory movements of pygmy blue whales (Balaenoptera musculus brevicauda) between Australia and Indonesia as revealed by satellite telemetry. PLOS one, April 2014 9(4)

Double MC, Gales N, Jenner KCS & Jenner M-N (2010) Satellite tracking of south-bound female humpback whales in the Kimberley region of Western Australia. Final report to the Australian Marine Mammal Centre, Tasmania, September 2010

Double MC, Jenner KCS, Jenner M-N, Ball I, Laverick S, Gales N (2012) Satellite tracking of pygmy blue whales (*Balaenoptera musculus brevicauda*) off Western Australia. Final report to the Australian Marine Mammal Centre, Tasmania, May 2012

DSEWPaC (Department of Sustainability, Environment, Water, Population and Communities) (2012) Conservation Management Plan for the Southern Right Whale. [Online] Department of Sustainability, Environment, Water, Population and Communities Canberra, Commonwealth of Australia Available from: http://www.environment.gov.au/topics/biodiversity/threatened-species-ecological-communities/recovery-plans

DSEWPaC (2013) Recovery Plan for the Australian Sea Lion (Neophoca cinerea). [Online] Department of Sustainability, Environment, Water, Population and Communities Canberra, Commonwealth of Australia Available from: http://www.environment.gov.au/topics/biodiversity/threatened-species-ecological-communities/recovery-plans

Gales N, Double MC, Robinson S, Jenner C, Jenner M, King E, Gedamke J, Childerhouse S & Paton D (2010) Satellite tracking of Australian humpback (Megaptera novaeangliae) and pygmy blue whales (Balaenoptera musculus brevicauda). Report number SC/62/SH21 presented to the Scientific Committee of the International Whaling Commission, June 2010, Morocco

Gedamke J, Gales N, Hildebrand J & Wiggins S (2007) Seasonal occurrence of low frequency whale vocalisations across eastern Antarctic and southern Australian waters, February 2004 to February 2007. IWC SC/59/SH5

Gill, P.C., G.J.B. Ross, W.H. Dawbin & H. Wapstra (2000). Confirmed sightings of dusky dolphins *(Lagenorhynchus obscurus)* in southern Australian waters. *Marine Mammal Science*. 16:452-459

Gill PC (2002) A blue whale (*Balaenoptera musculus*) feeding ground in a southern Australian coastal upwelling zone. J. Cetacean Res. Manage. 4(2):179—184

Government of WA. Wildlife Conservation (Specially Protected Fauna) Notice 2018. Published in the WA Government Gazette Perth, Tuesday 11 September 2018 No.135.

Hale, P.T., Barreto, A.S., Ross, G.J.B. (2000) Comparative morphology and distribution of the aduncus and truncatus forms of bottlenose dolphin Tursiops in the Indian and Western Pacific Oceans. Aquatic Mammals 26, 101–110.

Hamer, DJ, Ward, TM, Shaughnessy, PD & Clark, SR 2001 Assessing the effectiveness of the Great Australian Bight Marine Park in protecting the endangered Australian sea lion Neophoca cinerea from bycatch mortality in shark gillnets. End. Species Res. 14: 203—216

Hedley, SL, Bannister, JL & Dunlop, RA 2011 Abundance estimates of Southern Hemisphere Breeding Stock 'D' Humpback Whales from aerial and land-based surveys off Shark Bay, Western Australia, 2008. J. Cetacean Res. Manage. (special issue 3): 209—221

Jenner, KCS, Jenner, M-N & McCabe, KA, 2001 Geographical and temporal movements of humpback whales in Western Australian waters. APPEA Journal Vol 41(2001), pp 749—765

Kato, H. (2002). Bryde's Whales *Balaenoptera edeni* and *B. brydei*. **In:** Perrin W.F., B. Wrsig & H.G.M. Thewissen, eds. *Encyclopedia of Marine Mammals*. Page(s) 171-177. Academic Press.

Kemper, C.A. (2002). Distribution of the pygmy right whale, *Caperea marginata*, in the Australasian region. *Marine Mammal Science*. 18(1):99-111.

Marsh, H, Eros, C, Penrose, H & Hugues, J 2002, Dugong - Status Report and Action Plans for countries and territories, UNEP Early Warning and Assessment Report Series 1.

McCauley RD & Jenner C (2010) Migratory patterns and estimated population size of pygmy blue whales (Balaenoptera musculus brevicauda) traversing the Western Australian coast based on passive acoustics. SC/62/SH26 [Online] Available from: http://www.iwcoffice.co.uk/_documents/sci_com/SC62docs/SC-62-SH26.pdf

McCauley, RD, Jenner, C, Bannister, JL, Burton, CLK, Cato, DH and Duncan, A 2001 Blue whale calling in the Rottnest Trench – 2000, Western Australia. Report R2001-6 Unpublished report for the Centre for Marine Science and Technology, Curtin University, Perth, Western Australia

Perrin, W.F. & R.L. Brownell, Jr (2002). Minke Whales *Balaenoptera acutorostrata* and *B. bonaerensis*. **In:** Perrin W.F., Würsig B. & H.G.M. Thewissen, eds. *Encyclopedia of Marine Mammals*. Page(s) 750-754. Academic Press.

RPS 2010a. Technical Appendix – Marine Mammals. Wheatstone Project EIS/ERMP. Unpublished report for Chevron Australia Pty Ltd, March 2010

RPS. 2010b. Marine Megafauna Report Browse MMFS 2009. Prepared for Woodside Energy Ltd.

Salgado Kent, C, Jenner, C, Jenner, M, Bouchet, P & Rexstad, E 2012 Southern Hemisphere Breeding Stock D humpback whale population estimates from North West Cape, Western Australia. J. Cetacean Res. Manage. 12(1): 29—38

Woodside (2012) Rosebud 3D Marine Seismic Survey Environment Plan Summary. Available online at: http://www.dmp.wa.gov.au/documents/36688_Woodside_Rosebud_3D_Marine_Seismic_Survey_EP_Summary.pdf

15.8 Birds

Astron (2017a), Quadrant Environmental Monitoring Program Varanus and Airlie Islands Shearwater Monitoring Annual Report 2016/17, Prepared for Quadrant Energy Australia Ltd by Astron Environmental Services, Perth, Western Australia, June 2017. Report reference EA-60-RI-10174

Astron (2017b), Quadrant Environmental Monitoring Program Varanus and Airlie Islands Seabird Monitoring Annual Report 2016/17, Prepared for Quadrant Energy Australia Ltd by Astron Environmental Services, Perth, Western Australia, September 2017. Report reference EA-60-RI-10184

Bamford M, Watkins D, Bancroft W, Tischler G & Wahl J (2008) Migratory Shorebirds of the East Asian - Australasian Flyway; Population Estimates and Internationally Important Sites. Wetlands International – Oceania, Canberra, Australia

Bennelongia (2008) Report on shorebird numbers and shorebird values at Cape Preston. Prepared for Citic Pacific Mining by Bennelongia Environmental Consultants, Report 2008/52

Bennelongia (2011) Port Hedland Migratory shorebird survey report and impact assessment. Prepared for BHP Billiton Iron Ore by Bennelongia Environmental Consultants, Report 2011/124

Birdlife Australia (2017) Australasian Bittern [Online]. Available from: http://birdlife.org.au/bird-profile/australasian-bittern. [Accessed November 2017].

Brothers NP (1984) Breeding, distribution and status of burrow-nesting petrels at Macquarie Island. *Australian Wildlife Research* **11**, 113–131.

Burbidge AA, Blyth JD, Fuller PJ, Kendrick PG, Stanley FJ & Smith LA (2000) The Terrestrial Vertebrate Fauna of the Montebello Islands, Western Australia. CALMScience 3: 95-107

CALM & MPRA (2005a) Management Plan for the Ningaloo Marine Park and Muiron Islands Marine Management Area 2005–2015. Management Plan No. 52. Department of Conservation and Land Management and Marine Parks and Reserves Authority. Perth, WA

CALM & MPRA (2005b) Indicative Management Plan for the Proposed Dampier Archipelago Marine Park and Cape Preston Marine Management Area. Department of Conservation and Land Management and Marine Parks and Reserves Authority. Perth, WA

DEH (Department of the Environment and Heritage) (2005) National Recovery Plan for Ten Species of Seabirds 2005-2010. Commonwealth of Australia, 2005

DEWHA (Department of the Environment, Water, Heritage and the Arts) (2008) The North-West Marine Bioregional Plan: Bioregional Profile: A Description of the Ecosystems, Conservation Values and Uses of the South-West Marine Region. [Online]. Canberra: DEWHA. Available from: http://www.environment.gov.au/coasts/mbp/publications/south-west/pubs/sw-profile-full.pdf

DEWHA (2009) Significant impact guidelines for 36 migratory shorebird species EPBC Act policy statement 3.21. Commonwealth of Australia, 2009

Dinara Pty Ltd. (1991) Report on results of shearwater monitoring on Varanus Island, Western Australia for the inclusion in the Hadson Energy Triennial report 1991.

DoE (2014c).*Aipysurus foliosquama* in Species Profile and Threats Database, Department of the Environment, Canberra. Available from:http://www.environment.gov.au/sprat. Accessed Wed, 23 Jul 2014

DoE (2014d) *Fregata andrewsi* in Species Profile and Threats Database, Department of the Environment, Canberra. Available from:http://www.environment.gov.au/sprat. Accessed Wed, 23 Jul 2014

DoE (2014e) *Macronectes halli* in Species Profile and Threats Database, Department of the Environment, Canberra. Available from:http://www.environment.gov.au/sprat. Accessed Wed, 23 Jul 2014

DoE (2014f) *Halobaena caerulea* in Species Profile and Threats Database, Department of the Environment, Canberra. Available from:http://www.environment.gov.au/sprat. Accessed Wed, 23 Jul 2014

DoE (2014g).*Papasula abbotti* in Species Profile and Threats Database, Department of the Environment, Canberra. Available from:http://www.environment.gov.au/sprat. Accessed Wed, 23 Jul 2014

DoE (2014h).*Rostratula australis* in Species Profile and Threats Database, Department of the Environment, Canberra. Available from:http://www.environment.gov.au/sprat. Accessed Wed, 23 Jul 2014

DoEE (2017a) Species Profile and Threats Database [Online]. Department of Environment & Energy. Canberra, Commonwealth of Australia. Available from: http://www.environment.gov.au/cgi-bin/sprat/public/sprat.pl

DoEE (Department of Environment) (2017b) National Conservation Values Atlas [Online]. Department of Environment and Energy. Canberra, Commonwealth of Australia. Available from: http://www.environment.gov.au/webgis-framework/apps/ncva/ncva.jsf

DSEWPaC (Department of Sustainability, Environment, Water, Population and Communities) (2012a) Species group report card- seabirds. Supporting the marine bioregional plan for the North-west Marine Region. Commonwealth of Australia, 2012

DSEWPaC (2012b) Species group report card- seabirds. Supporting the marine bioregional plan for the South-west Marine Region. Commonwealth of Australia, 2012

DSEWPaC (2011) National recovery plan for threatened albatrosses and giant petrels 2011-2016. Commonwealth of Australia, Hobart

Garnett, S.T. & G.M. Crowley (2000). The Action Plan for Australian Birds 2000. Canberra, ACT: Environment Australia and Birds Australia. Available from: http://www.environment.gov.au/biodiversity/threatened/publications/action/birds2000/index.html.[Accessed 21/11/2017]

Garnet ST, Szabo JK, Dutson G (2011) The Action Plan for Australian Birds 2010. CSIRO Publishing, Melbourne

Government of WA. Wildlife Conservation (Specially Protected Fauna) Notice 2018. Published in the WA Government Gazette Perth, Tuesday 11 September 2018 No.135.

Heather B D, & Robertson HA (1997) The field guide to the birds of New Zealand. Oxford University Press, Oxford, UK

Higgins PJ & Davies SJJF eds (1996) Handbook of Australian, New Zealand and Antarctic Birds. Volume Three - Snipe to Pigeons. Melbourne, Victoria: Oxford University Press

Hill R, Bamford M, Rounsevell D & Vincent J (1988) Little Terns and Fairy Terns in Australia - an RAOU Conservation Statement. RAOU Report Series. 53:1-12

HSCT (The Huttons Shearwater Charitable Trust) (2014) A seabird at the top of the mountains – DOC education pack [Online]. Available from: http://www.huttonsshearwater.org.nz/category/resources/education/ [Accessed April 2014]

Lindsey TR (1986) The Seabirds of Australia. North Ryde, NSW: Angus and Robertson

Marchant S & Higgins PJ eds. (1990) Handbook of Australian, New Zealand and Antarctic Birds. Volume One - Ratites to Ducks. Melbourne, Victoria: Oxford University Press

Marchant S & Higgins PJ (Eds) (1993) Handbook of Australian, New Zealand and Antarctic Birds. Volume Two - Raptors to Lapwings. Oxford University Press, Melbourne

May RF, Lenanton RCJ & Berry PF (1983) Ningaloo Marine Park. Report and recommendations by the Marine Parks and Reserves Selection Working Group. National Parks Authority, Perth, Western Australia

Perth Zoo (2014) Radjah shelduck species fact sheet [Online]. Available from: http://www.perthzoo.wa.gov.au/wp-content/uploads/2013/04/Radjah-Shleduck-Fact-Sheet.pdf [Accessed April 2014]

Rogers, D. 1999. What determines shorebird feeding distribution in Roebuck Bay? Chapter 9, 145-174. In Pepping, M., Piersma, T., Pearson, G. and Lavaleye, M. (eds) 1999. Intertidal sediments and benthic animals of Roebuck Bay, Western Australia. Netherlands Institute for Sea Research Report 3, Texel, Netherlands, 1-214

Stokes, T. 1988. A review of the birds of Christmas Island, Indian Ocean. Australian National Parks & Wildlife Service Occasional Paper 16.

Stokes T & Hinchey M (1990) Which small Noddies breed at Ashmore Reef in Eastern Indian Ocean? Emu. 90:269-271

Storr GM, Johnstone RE & Griffin P (1986). Birds of the Houtman Abrolhos, Western Australia. Records of the Western Australian Museum Supplement. 24

Surman CA (2003) Second Field Survey of the Avifauna of the Barrow Island-Double Island Area, December 2003. Prepared for Apache Energy Ltd

Surman CA (2013) Scientific monitoring program 07 seabirds and shorebirds. Unpublished report to Apache Energy Ltd

Surman CA & Nicholson LW (2006) 'Seabirds,' in S McClatchie, J Middleton, C Pattiaratchi, D Currie & G Kendrick (eds), The South-west Marine Region: ecosystems and key species groups, Australian Government Department of the Environment and Water Resources, Hobart

Surman CA & Nicholson LW (2012) Monitoring of annual variation in seabird breeding colonies throughout the Lowendal Group of islands: 2012 Annual Report. Unpublished report prepared for Apache Energy Ltd. by Halfmoon Biosciences. 42pp.

Surman CA & Nicholson LW (2013) Monitoring of annual variation in seabird breeding colonies throughout the Lowendal Group of islands: 2013 Annual Report. Lowendal Island Seabird Monitoring Program (LISMP). Unpublished report prepared for Apache Energy Ltd. by Halfmoon Biosciences. 59pp.

15.9 Protected Areas

Adams M & Humphreys WH (1993) Patterns of genetic diversity within selected subterranean fauna of the Cape Range peninsula Western Australia: systematic and biogeographic implications. Records of the Western Australian Museum, Supplement 45: 145-164

Allen GR & Russell BC (1986) Fishes. Part VII. In "Faunal surveys of the Rowley Shoals, Scott Reef and Seringapatam Reef, north-western Australia" by P.F. Berry (ed.), Records of the Western Australian Museum Supplement No. 25. Western Australian Museum, Perth. pp 75-103

Asia Development Bank (ADB) 2014. State of the Coral Triangle: Indonesia. Mandaluyong City, Philippines 2014.

Bennelongia Oty Ltd (2009) Ecological Character Description for Roebuck Bay. Report prepared for the Department of Environment and Conservation, Perth, Western Australia. Available at < http://www.dec.wa.gov.au/management-and-protection/wetlands/internationally-recognised-wetlands-ramsar/was-ramsar-sites.html> [Accessed April 2014]

Berry PF & Morgan GJ (1986) Decapod Crustacea of Scott and Seringapatam Reefs. Part V. In "Faunal surveys of the Rowley Shoals, Scott Reef and Seringapatam Reef, north-western Australia" by P.F. Berry (ed.), Records of the Western Australian Museum Supplement No. 25. Western Australian Museum, Perth. pp 59-62

Burbidge AA, Hopper SD & van Leeuwen S (1990) Nature Conservation, Landscape and Recreation values of the Lesueur area. A report to the Environment Protection Authority. EPA, Perth, Western Australia, Bulletin 424, January 1990

Butcher R & Hale J (2010) Ecological Character Description for The Dales Ramsar Site. Report to the Department of Sustainability, Environment, Water, Population and Communities, Canberra.

Butcher R & Hale J (2010a) Ecological Character Description for Hosnies Spring Ramsar Site. Report to the Department of Sustainability, Environment, Water, Population and Communities, Canberra

CALM (Department of Conservation and Land Management) (1990) Dampier Archipelago Nature Reserves Management Plan. https://www.dpaw.wa.gov.au/images/documents/parks/management-plans/decarchive/dampier_archipelago.pdf [Accessed Jan 2019]

CALM (WA Department of Conservation and Land Management)(1998). Yalgorup National Park Management Plan.

CALM (WA Department of Conservation and Land Management)(1998). Leschenault Peninsula Management Plan. Available at: https://www.dpaw.wa.gov.au/images/documents/parks/management-plans/decarchive/leschenault.pdf. [Accessed Jan 2019]

CALM (WA Department of Conservation and Land Management) (1998). Namburg National Park Management Plan. Available at: https://www.dpaw.wa.gov.au/images/documents/parks/management-plans/decarchive/nambung.pdf. [Accessed Jan 2019]

CALM (WA Department of Conservation and Land Management)(1999). Jarabi and Bundegi Coastal Parks and Muiron Islands Management Plan. Available at: https://www.dpaw.wa.gov.au/images/documents/parks/management-plans/decarchive/jurabi.pdf [Accessed Jan 2019]

CALM (WA Department of Conservation and Land Management) (2002). Shoalwater Islands Management Plan. Available at: https://www.dpaw.wa.gov.au/images/documents/parks/management-plans/decarchive/shoalwater_islands.pdf. [Accessed Jan 2019]

CALM (WA Department of Conservation and Land Management) (2003). Carnac Island Nature Reserve Management Plan (2003). Available at: https://www.dpaw.wa.gov.au/images/documents/parks/management-plans/decarchive/2003240-carnac_plan.pdf. [Accessed Jan 2019]

CALM (WA Department of Conservation and Land Management) (2004). Turquoise Coast Nature Reserve Management Plan. Available at: https://www.dpaw.wa.gov.au/images/documents/parks/management-plans/decarchive/turquoise_coast_final.pdf [Accessed Jan 2019]

Commonwealth of Australia, 2002. Ashmore Reef National Nature Reserve and Cartier Island Marine Reserve Management Plans. Environment Australia.

Commonwealth of Australia (2007) Commonwealth of Australia Gazette No. S127, 3 July 2007, Inclusion of a Place in the National Heritage List, Dampier Archipelago (including Burrup Peninsula). Published by the Commonwealth of Australia

DBCA (WA Department of Biodiversity, Conservation, and Attractions) (2018). List of Threatened Ecological Communities Endorsed by the Western-Austalia Minister for Environment 28 June 2018.

DBCA (WA Department of Biodiversity, Conservation, and Attractions) (2019). Pilbara Inshore Islands. Frequently Asked Questions.

Department of Defence Environmental Consortium (1998) Lancelin Defence Training Area Environmental Management Plan. Regional Estate Centre, WA, Unpublished Report prepared for Department of Defence

DEC (Department of Environment and Conservation) 2002. A Biodiversity Audit of Western Australia's 53 Biogeographic Subregions.

DEC (2010) A Biodiversity and Cultural Conservation Strategy for the Great Western Woodlands, November, available online at http://www.dec.wa.gov.au/content/view/6115/2183/

DEC (WA Department of Environment and Conservation) (2010). Rockingham Lakes Regional Park. Available at: https://www.dpaw.wa.gov.au/images/documents/parks/management-plans/decarchive/rockingham_lakes_regional_park_management_plan__cover.pdf. [Accessed Jan 2019]

DEC (WA Department of Environment and Conservation) (2010). Woodman Park Regional Park Management Plan. Available at: https://www.dpaw.wa.gov.au/images/documents/parks/management-plans/decarchive/woodman_pt_mgmt_plan_-_draft_9_web_feb_10.pdf. [Accessed Jan 2019]

DEC (WA Department of Environment and Conservation) (2013). Murujuga National Park management plan

DEC (WA Department of Environment and Conservation) (2010). Cape Range National Park Management Plan

DEC (Department of Environment and Conservation) (2011) Interim Recovery Plan 2011-2016 for Sedgelands in Holocene dune swales, Interim Recovery Plan No. 314

DEC (Department of Environment and Conservation) (2012) World Heritage Areas. Available at http://www.dec.wa.gov.au/parks-and-recreation/key-attractions/world-heritage-areas.html) [Accessed June 2013]

DEWHA (2008) Shark bay World Heritage Property Strategic Plan 2008-2020. Department of the Environment, Water, Heritage and the Arts, Canberra, Australia

DEWHA (2010) Ningaloo Coast World Heritage Nomination. Department of the Environment, Water, Heritage and the Arts, Canberra, Australia. Available at < http://www.environment.gov.au/node/19787> [Accessed April 2014]

DoE (Department of Environment) 2012. Interim Biogeographic Regionalisation for Australia, Version 7. Available at: http://www.environment.gov.au/system/files/pages/5b3d2d31-2355-4b60-820c-e370572b2520/files/bioregions-new.pdf [Accessed January 2019]DoE (Department of Environment) (2014a) World Heritage Places - The Ningaloo Coast Western Australia. Available at http://www.environment.gov.au/node/19787 [Accessed April 2014]

DoE (2014b) Shark Bay, Western Australia, Work Heritage Values. Available at: http://www.environment.gov.au/heritage/places/world/shark-bay/values.html [Accessed April 2014]

DoE (2014c) Australian Ramsar Wetlands Database: Roebuck Bay. Available at http://www.environment.gov.au/cgi-bin/wetlands/ramsardetails.pl?refcode=33 [Accessed July 2013]

DoE (2014d) Australian Heritage Database. Available at http://www.environment.gov.au/cgi-bin/ahdb/search.pl [Accessed April 2014]

DoE (2014e) Australian Heritage Database. Available at http://www.environment.gov.au/cgi-bin/ahdb/search.pl?mode=place_detail;place_id=105967 [Accessed December 2014]

DoE (2014f) Australian Heritage Database. Available at http://www.environment.gov.au/cgi-bin/ahdb/search.pl?mode=place_detail;place_id=105578 [Accessed December 2014]

DoE (2014g) Australian Heritage Database. Available at http://www.environment.gov.au/cgi-bin/ahdb/search.pl?mode=place_detail;place_id=105551 [Accessed December 2014]

DoE (2014h) Claypans of the Swan Coastal Plain in Community and Species Profile and Threats Database. Available at: http://www.environment.gov.au/cgi-bin/sprat/public/publicshowcommunity.pl?id=121 [Accessed December 2014]

DoE (2014i) Aquatic Root Mat Community in Caves of the Swan Coastal Plain in Community Species Profile and Threats Database. Available at: http://www.environment.gov.au/cgi-bin/sprat/public/publicshowcommunity.pl?id=12 [Accessed December 2014]

DoE (2014j) Sedgelands in Holocene dune swales of the southern Swan Coastal Plain in Community and Species Profile and Threats Database. Available at:

http://www.environment.gov.au/cgi-bin/sprat/public/publicshowcommunity.pl?id=19 [Accessed December 2014]

DoE (2014k) Subtropical and Temperate Coastal Saltmarsh in Community and Species Profile and Threats Database. Available at:

http://www.environment.gov.au/cgi-bin/sprat/public/publicshowcommunity.pl?id=118 [Accessed December 2014]

DoE (2014l) Australian Wetlands Database, Ramsar wetlands, Becher Point. Available at: http://www.environment.gov.au/cgi-bin/wetlands/ramsardetails.pl?refcode=54 [Accessed December 2014]

DoE (2014m) Australian Wetlands Database, Ramsar wetlands, Peel-Yalgorup System. Available at: http://www.environment.gov.au/cgi-bin/wetlands/ramsardetails.pl?refcode=36 [Accessed December 2014]

DoE (2014n) Australian Wetlands Database, Ramsar wetlands, Vasse-Wonnerup System. Available at: http://www.environment.gov.au/cgi-bin/wetlands/ramsardetails.pl?refcode=38 [Accessed December 2014]

DoE (2015a) Australian Heritage Database. Available at: http://www.environment.gov.au/cgi-bin/ahdb/search.pl?mode=place_detail;place_id=106003 [Accessed January 2015]

DoE (2015b) Proteaceae Dominated Kwongkan Shrublands of the Southeast Coastal Floristic Province of Western Australia in Community and Species Profile and Threats Database, Department of the Environment, Canberra. Available at: http://www.environment.gov.au/cgi-bin/sprat/public/publicshowcommunity.pl?id=126&status=Endangered [Accessed January 2015]

DoEE (2016a) Yampi Defence Area, Koolan Island, WA, Australia. Available at http://www.environment.gov.au/cgi-bin/ahdb/search.pl?mode=place_detail;place_id=105418 [Accessed 2 August 2016]

DoE (2014b) *Pristis clavata* in Species Profile and Threats Database, Department of the Environment, Canberra. Available from:http://www.environment.gov.au/sprat. Accessed Tue, 18 Mar 2014 14:07:14 +1100

DoEE (2016b) Garden Island, Garden Island, WA, Australia. Available at http://www.environment.gov.au/cgi-bin/ahdb/search.pl?mode=place_detail;place_id=105274 [Accessed 2 August 2016]

DPAW (WA Department of Parks and Wildlife) (2012). Shark Bay Terrestrial Reserves and Proposed Reserve Additions Management Plan . Available at: https://www.dpaw.wa.gov.au/images/documents/parks/management-plans/decarchive/sharkbay_managementplanno75_2012.pdf [Accessed Jan 2019]

DPAW (WA Department of Parks and Wildlife) (2015). Kalbarri National Park Management Plan

DPAW (WA Department of Parks and Wildlife) (2015). Barrow Island Group Nature Reserves Management Plan. https://www.dpaw.wa.gov.au/images/documents/parks/management-plans/decarchive/barrow_group_nature_reserves_management_plan_finalweb.pdf [Accessed Jan 2012]

DPAW (WA Department of Parks and Wildlife) (2015). Leeuwin-Naturaliste Capes Area Parks and Reserves Management Plan. Available at: https://www.dpaw.wa.gov.au/images/documents/parks/management-plans/decarchive/Leeuwin-Naturaliste_management_plan_2015_WEB.pdf. [Accessed Jan 2019]

DPAW (WA Department of Parks and Wildlife) (2016). Parks and reserves of the south-west Kimberley and north-west Pilbara Draft Management Plan (2016). Available at: https://www.dpaw.wa.gov.au/images/documents/parks/management-plans/20160400_swest_kimberley_draft_mp_v7.pdf

DPAW (WA Department of Parks and Wildlife) (2016). Yawaru Birragun Conservation Park Management Plan. Available at https://www.dpaw.wa.gov.au/images/documents/parks/management-plans/ybcp_mangement_plan_web.pdf [Accessed Jan 2019]

Ecoscape (Australia) Pty Ltd & HLA Environsciences Pty Ltd (2002). Lancelin Defence Training Area Extension Proposal: Public Environmental Review/Report. Fremantle, WA

English V, Blyth J, Jasinska E, Mutter L, Bastian L, Holmes P, Martin M, Miotti J, Stratico S, Hillman R, Knott B, Kite J, Sanders C, Briggs A & Sands A (2000) Interim Recovery Plan Aquatic Root Mat Community of Caves of the Swan Coastal Plain 2000-2003, Department of Conservation and Land Management Environment Australia

Hale J (2008) Ecological Character Description of the Ord River Floodplain Ramsar Site. Report to the Department of Environment and Conservation, Perth, Western Australia. Available at < http://www.dec.wa.gov.au/management-and-protection/wetlands/internationally-recognised-wetlands-ramsar/was-ramsar-sites.html> [Accessed April 2014]

Hale J & Butcher R (2009) Ecological Character Description of the Eighty Mile Beach Ramsar Site. Report to the Department of Environment and Conservation, Perth, Western Australia. Available at http://www.dec.wa.gov.au/management-and-protection/wetlands/internationally-recognised-wetlands-ramsar/was-ramsar-sites.html [Accessed April 2014]

Hale, J., Butcher, R., 2013. Ashmore Reef Commonwealth Marine Reserve Ramsar Site ecological character description (A report to the Department of the Environment). Department of the Environment, Canberra.

Hatcher BG (1988) Australia, Western. In "Coral Reefs of the World. Volume 2: Indian Ocean, Red Sea and Gulf" by S.M. Wells (ed.) UNEP, Nairobi, Kenya and IUCN, Gland, Switzerland. pp 1-26

Humphreys WF (1993). The significance of the subterranean fauna in biogeographical reconstruction: examples from Cape Range peninsula Western Australia. Records of the Western Australian Museum, Supplement 45: 165-192

Humphreys WF, Poole A, Eberhard SM & Warren D (1999) Effects of research diviing on the physio-chemical profile of Bundera Sinkhole, an anchialine remiped habitat at Cape Range, Western Australia. Journal of the Royal Society of Western Australia 82:99-108

Jasinska EJ (1997). Faunae of aquatic root mats in caves of southwestern Australia: origins and ecology. PhD Thesis, Zoology Department, The University of Western Australia.

Marsh LM (1986) Echinoderms. Part VI. In "Faunal surveys of the Rowley Shoals, Scott Reef and Seringapatam Reef, north-western Australia" by P.F. Berry (ed.), Records of the Western Australian Museum Supplement No. 25. Western Australian Museum, Perth. pp 63-74

Protected Planets (2017) Laut Sawu (Tirosa Batek Marine Area, Sumba Strait Marine Area) in Indonesia. Available from: https://www.protectedplanet.net/laut-sawu-tirosa-batek-marine-area-sumba-strait-marine-area-marine-national-park [Accessed 27/11/2017].

Savu Sea National Marine Conservation Area, Undated. Coral Triangle Atlas – Savu Sea National Marine Conservation Area information requirements for inclusion in CTMPAs Categories 3 or 4. Available at http://ctatlas.reefbase.org/pdf/monitoring/CTMPAS%20SavuSea%20July%202014.pdf [Accessed August 2016]

Semeniuk Research Group, V & C (1994) Ecological Assessment and Evaluation of Wetlands in the System 5 Region. Unpublished report for the Australian Heritage Commission, Canberra.

TSSC (Threatened Species Scientific Community) (2012) Commonwealth Listing Advice on Claypans of the Swan Coastal Plain. Available at: http://www.environment.gov.au/biodiversity/threatened/communities/pubs/121-listing-advice.pdf [Accessed December 2014]

TSSC (Threatened Species Scientific Community) (2013) Commonwealth Conservation Advice for Subtropical and Temperate Coastal Saltmarsh. Available at: http://www.environment.gov.au/biodiversity/threatened/communities/pubs/118-listing-advice.pdf [Accessed December 2014] UNESCO (2014) Shark Bay, Western Australia. United Nations Educational, Scientific, and Cultural Organization. Available at < http://whc.unesco.org/en/list/578> [Accessed April 2014]

Veron JEN (1986) Reef-building corals. Part II. In "Faunal surveys of the Rowley Shoals, Scott Reef and Seringapatam Reef, north-western Australia" by P.F. Berry (ed.), Records of the Western Australian Museum Supplement No. 25. Western Australian Museum, Perth. pp 27-35

Watson A, Judd S, Watson J, Lam A & Mackenzie D (2008) The Extraordinary Nature of the Great Western Woodlands, The Wilderness Society of WA, available online at http://www.wilderness.org.au/files/the-great-western-woodlands-report.pdf

Wells FE and Slack-Smith SM (1986) Molluscs. Part IV. In "Faunal surveys of the Rowley Shoals, Scott Reef and Seringapatam Reef, north-western Australia" by P.F. Berry (ed.), Records of the Western Australian Museum Supplement No. 25. Western Australian Museum, Perth. pp 41-57

15.10 Key Ecological Features

Baker C, Potter A, Tran M, Heap AD (2008) Geomorphology and sedimentology of the North-west Marine Region of Australia. Record 2008/07, Geoscience Australia, Canberra

Bannister, JL, Josephson, EA, Reeves, RR & Smith, TD, (2007). There she blew! Yankee sperm whaling grounds, 1760-1920. DJ Starkey, P Holm & M Barnard, (Eds). Oceans past: management insights from the history of marine animal populations, Earthscan Research Editions, Oxford.

Blaber SJM, Dichmont CM, Buckworth RC, Badrudin, Sumiono B, Nurhakim, Iskandar B, Fegan B, Ramm DC & Salini JP (2005) Shared stocks of snappers (Lutjanidae) in Australia and Indonesia: integrating biology, population dynamics and socio-economics to examine management scenarios, Reviews in Fish Biology and Fisheries, vol. 15, pp. 111-127

Blaber SJM, Dichmont CM, White W, Buckworth R, Sadiyah L, Iskandar B, Nurhakim S, Pillans R, Andamari R, Dharmadi & Fahmi (2009) Elasmobranchs in southern Indonesian fisheries: the fisheries, the status of the stocks and management options, Reviews in Fish Biology and Fisheries, vol. 19, pp. 367-391

Brewer DT, Lyne V, Skewes TD, Rothlisberg, P (2007) Trophic systems of the North West Marine Region. Report to the Australian Government Department of the Environment and Water Resources, CSIRO, Cleveland

DEH (Australian Government Department of the Environment and Heritage), (2006). A Guide to the Integrated Marine and Coastal Regionalisation of Australia Version 4.0., Department of the Environment and Heritage, Canberra, Australia.

DEWHA (Department of the Environment, Water, Heritage and the Arts) (2008a). The South-West Marine Bioregional Plan: Bioregional Profile: A Description of the Ecosystems, Conservation Values and Uses of the South-West Marine Region. Canberra: DWHA.

DEWHA (2008b) A characterisation of the marine environment of the North-west Marine Region: Perth workshop report. A summary of an expert workshop convened in Perth, Western Australia. 5-6 September 2007, DEWHA, Hobart

DEWHA (2008c) The North-west Marine bioregional plan: bioregional profile. A description of the ecosystems, conservation values and uses of the North-west Marine Bioregion. DEWHA, Canberra

DEWHA, (2010). Recovery Plan for the Australian Sea Lion (Neophoca cinerea), Technical Issues Paper., Australian Government, Canberra.

DoEE (2016a) Thrombolite (microbialite) Community of a Coastal Brackish Lake (Lake Clifton) in Community and Species Profile and Threats Database, Department of the Environment, Canberra. Available from: http://www.environment.gov.au/sprat. [Accessed 2016-08-02T13:56:21AEST]

DoEE (2016b) Monsoon vine thickets on the coastal sand dunes of Dampier Peninsula in Community and Species Profile and Threats Database, Department of the Environment, Canberra. Available from: http://www.environment.gov.au/sprat. Accessed 2016-08-02T14:04:23AEST

DoEE (2017a) Species Profile and Threats Database: Perth Canyon and adjacent shelf break, and other west-coast canyons. Available from: https://www.environment.gov.au/sprat-public/action/kef/view/21 [Accessed 18/12/17].

DoEE (2017b) Species Profile and Threats Database: demersal slope and associated fish communities of the Central Western Province. Available from: https://www.environment.gov.au/sprat-public/action/kef/view/17 [Accessed 18/12/17].

DoEE (2017c) Species Profile and Threats Database: Naturaliste Plateau. Available from: https://www.environment.gov.au/sprat-public/action/kef/view/28 [Accessed 18/12/17].

DoEE (2017d) Species Profile and Threats Database: Ancient Coastline. Available from: https://www.environment.gov.au/sprat-public/action/kef/view/28 [Accessed 18/12/17].

DoEE (2017e) Species Profile and Threats Database: Continental slope demersal fish communities. Available from: https://www.environment.gov.au/sprat-public/action/kef/view/79;jsessionid=01AD87551D0DE1B0248C8722BE137004 [Accessed 20/12/17].

Done TJ, Williams DMcB, Speare PJ, Davidson J, DeVantier LM, Newman SJ, Hutchins JB (1994) Surveys of coral and fish communities at Scott Reef and Rowley Shoals. Australian Institute of Marine Science, Townsville

Donovan A, Brewer D, van der Velde T, Skewes T (2008) Scientific descriptions of four selected key ecological features in the North-west Bioregion: final report. Report to the Australian Government Department of Environment, Water, Heritage and the Arts, CSIRO Marine and Atmospheric Research, Cleveland

DSEWPaC (Department of Sustainability, Environment, Water, Population and Communities) (2012) Commonwealth marine environment report card. Commonwealth of Australia

DSEWPaC (Department of Sustainability, Environment, Water, Population and Communities) (2012b) Marine bioregional plan for the South-west Marine Region

DSEWPaC (Department of Sustainability, Environment, Water, Population and Communities) (2012c) Commonwealth marine environment report card: supporting the marine bioregional plan for the South-west Marine Region

DSEWPaC (Department of Sustainability, Environment, Water, Population and Communities) (2012d) Commonwealth marine environment report card. Commonwealth of Australia

EA (Environment Australia) (2002) Ashmore Reef National Nature Reserve and Cartier Island Marine Reserve (Commonwealth waters) management plans. EA, Canberra

Falkner I, Whiteway T, Przeslawski R, Heap AD (2009) Review of ten key ecological features in the Northwest Marine Region. Record 2009/13, Geoscience Australia, Canberra

Fletcher WJ, Santoro K (eds) (2009) State of the fisheries report 2008/09. Department of Fisheries, Western Australia, Perth

Gilmour, J, Cheal, A, Smith, L, Underwood, J, Meekan, M, Fitzgibbon, B & Rees, M, (2007). Data compilation and analysis for Rowley Shoals: Mermaid, Imperieuse and Clerke reefs., Report to the Department of Environment and Water Resources, Australian Institute of Marine Science, Perth.

Government of Western Australia (2010). Browse Liquified Natural Gas Plant Strategic Assessment Report. Part 4 Environmental Assessment – Terrestrial Impacts. December 2010.

Heap AD, Harris PT (2008) Geomorphology of the Australian margin and adjacent seafloor. Australian Journal of Earth Sciences 55:555–585

Heyward A, Pinceratto E, Smith L (1997) Big bank shoals of the Timor Sea: an environmental resource atlas. Australian Institute of Marine Science, Melbourne

Hooper JNA, Ekins M (2004) ‘Collation and validation of museum collection databases related to the distribution of marine sponges in Northern Australia. Unpublished report to the National Oceans Office, Hobart

Jenner C, Jenner M, Pirzl R (2008) A study of cetacean distribution and oceanography in the Scott Reef/Browse Basin development areas during the austral winter of 2008. Centre for Whale Research (WA), Perth

Kemps, H (2010) Ningaloo: Australia’s Untamed Reef. Quinns Rocks: MIRG Australia.

Last P, Lyne V, Yearsley G, Gledhill D, Gomon M, Rees T, White, W (2005) Validation of national demersal fish datasets for the regionalisation of the Australian continental slope and outer shelf (>40 m depth). Australian Government Department of the Environment and Heritage & CSIRO Marine and Atmospheric Research, Hobart

Limpus C (2008) A biological review of Australian marine turtles 2. Green turtle Chelonis mydas (Linnaeus). Environment Protection Agency, Queensland

Lyne V, Fuller M, Last P, Butler A, Martin M, Scott R (2006) Ecosystem characterisation of Australia's North West Shelf. North West Shelf Joint Environmental Management Study Technical Report 12, CSIRO Marine and Atmospheric Research, Hobart

McCauley, R.D., J. Fewtrell, A.J. Duncan, C. Jenner, N. Jenner M-, J.D. Penrose, R.I.T. Prince, A. Adhitya, J. Murdoch & K. McCabe, (2000). Marine seismic surveys: analysis and propagation of air-gun signals; and effects of exposure on humpback whales, sea turtles, fishes and squid., Prepared for the Australian Petroleum Production & Exploration Association (APPEA) by the Centre for Marine Science and Technology, Curtin University of Technology, R99-15.

McLoughlin RJ, Young PC (1985) Sedimentary provinces of the fishing grounds of the North West Shelf of Australia: grain-size frequency analysis of surficial sediments. Australian Journal of Marine and Freshwater Research 36: 671–81

Milton DA (2005) Birds of Ashmore Reef National Nature Reserve: an assessment of its importance for seabirds and waders. The Beagle, Records of the Museums and Art Gallery of the Northern Territory, suppl. 1: 133–141

Pattiaratchi, C, (2007). Understanding areas of high productivity within the South-west Marine Region., Report to the Department of the Environment, Water, Heritage and the Arts, Canberra.

Richardson, L, Mathews, E & Heap, A, (2005). Geomorphology and sedimentology of the south western planning area of Australia: review and synthesis of relevant literature in support of regional marine planning., Record 2005/17, Geoscience Australia, Canberra.

Salini JP, Ovenden JR, Street R, Pendrey R, Haryanti & Ngurah (2006) Genetic population structure of red snappers (*Lutjanus malabaricus* Bloch & Schneider, 1801 and *Lutjanus erythropterus* Bloch, 1790) in central and eastern Indonesia and Australia, Journal of Fish Biology, vol. 68 (supplement B), pp. 217-234

Sleeman JC, Meekan MG, Wilson SG, Jenner CKS, Jenner MN, Boggs GS, Steinberg CC, Bradshaw CJA (2007) 'Biophysical correlates of relative abundances of marine megafauna at Ningaloo Reef, Western Australia', Marine and Freshwater Research, vol. 58, pp. 608–623

Stambler N (2011) Zooxanthellae: the yellow symbionts inside animals, in Dubinsky Z, Stambler N (eds), Coral reefs: an ecosystem in transition. Springer, London

Underwood JN (2009) Genetic diversity and divergence among coastal and offshore reefs in a hard coral depend on geographic discontinuity and oceanic currents. Evolutionary Applications 2: 1–11

Underwood JN, Smith LD, van Oppen MJH, Gilmour J (2009) Ecologically relevant dispersal of a brooding and a broadcast spawning coral at isolated reefs: implications for managing community resilience. Ecological Applications 19: 18–29

Veron JEN (1993) A biogeographic database of hermatypic corals. Australian Institute of Marine Sciences, Townsville

Whiting S (1999) Use of the remote Sahul Banks, northwestern Australia, by dugongs, including breeding females. Marine Mammal Science 15: 609–615

15.11 State Marine Parks

AHC (2006) Cape Range National Park and Surrounds, Exmouth, WA. A WWW publication accessed December 2006 at http://www.deh.gov.au. Australian Heritage Commission, Canberra.

CALM (1996) Shark Bay Marine Reserves. Management Plan. 1996-2006. Marine Conservation Branch, Management Plan No. 34. Department of Conservation and Land Management.

CALM (1999) Swan Estuary Marine Park and Adjacent Nature Reserves Management Plan 1999-2009. Management Plan No. 41. Department of Conservation and Land Management.

CALM (2002) Management Plan for Marmion Marine Park 1992-2002: Management Plan No.23. Department of Conservation and Land Management

CALM (2004) Indicative Management Plan for the Proposed Montebello/Barrow Islands Marine conservation Reserves, 2004.Marine Conservation Branch, Department of Conservation and Land Management.

CALM (2005) Management Plan for the Ningaloo Marine Park and Muiron Islands Marine Management Area 2005 – 2015 Management Plan No. 52. Department of Conservation and Land Management, Perth, Western Australia.

Department of Biodiversity, Conservation and Attractions, DBCA (2017). Parks and Wildlife Services: Approved Management Plans. Accessible from: https://www.dpaw.wa.gov.au/parks/management-plans/approved-management-plans. [20 Dec 2017]

DEC (2005) Jurien Bay Marine Park Management Plan 2005– 2015, Management plan number 49. Department of Environment and Conservation, Perth, Western Australia

DEC (2007a) Management Plan for the Montebello/Barrow Islands Marine Conservation Reserves 2007–2017: Management Plan No. 55. Department of Environment and Conservation, Perth, Western Australia.

DEC (2007b) Management Plan for the Rowley Shoals Marine Park 2007–2017: Management Plan No. 56. Department of Environment and Conservation, Perth, Western Australia.

DEC (2007c). Management Plan for the Shoalwater Islands Marine Park 2007-2017: Management Plan No. 58. Department of Environment and Conservation, Perth, Western Australia.

DEC (2009) Walpole and Nornalup Inlets Marine Park Management Plan 2009-2019. Management Plan No. 62. Department of Environment and Conservation, Perth, Western Australia.

DEC (2010). Shark Bay Marine Park and Hamelin Pool Marine Nature Reserve Recreational Guide. Available at:http://parks.dpaw.wa.gov.au/sites/default/files/downloads/parks/shark_bay_marine_park_and_hamelin_pool_marine_nature_reserve_0.pdf [Accessed January 2015]

DEC (2013) Ngari Capes Marine Park management plan 2013– 2023, Management plan number 74. Department of Environment and Conservation, Perth.

DEWHA (2008) The North-west Marine Bioregional Plan: Bioregional profile: A Description of the Ecosystems, Conservation Values and Uses of the North-West Marine Region. Department of the Environment Water, Heritage and the Arts, Canberra, ACT.

DPaW 2016, Lalang-garram/ Horizontal Falls and North Lalang-garram marine parks joint management plan 2016. Management Plan 88. Department of Parks and Wildlife, Perth.

DoEE 2017, Australia's National Heritage List. Available from: http://www.environment.gov.au/heritage/places/national-heritage-list [Accessed 28 Nov. 17].

DPaW (2013) Lalang-garram / Camden Sound Marine Park management plan no. 73 2013–2023, Department of Parks and Wildlife, Perth, Western Australia.

DPaW (2013a) New and proposed marine parks and reserves. Online, retrieved 23rd April 2014. Available at: http://www.dpaw.wa.gov.au/management/marine/marine-parks-and-reserves/69-new-and-proposed-marine-parks-and-reserves.

DPaW (2014) Eighty Mile Beach Marine Park Management Plan 2014-2024. Management Plan No. 80. Department of Parks and Wildlife, Perth, Western Australia.

Department of Parks and Wildlife (2016a). North Kimberley Marine Park Joint management plan 2016 Uunguu, Balanggarra, Miriuwung Gajerrong, and Wilinggin management areas, Number Plan 89 Department of Parks and Wildlife, Perth.

Department of Parks and Wildlife, DPaW (2016b). Yawuru Nagulagun/Roebuck Bay Marine Park: Joint management plan 2016.

DSEWPaC (2013a) Shark Bay, Western Australia, Work Heritage Values. [Online, retrieved 17 July 2013] Available at: http://www.environment.gov.au/heritage/places/world/shark-bay/values.html

Yawuru Organisation (2017). Environmental Services for Yawuru Protected Areas. Accessible from: http://www.yawuru.com/our-organisation/land-sea/. [20 Dec 2017]

Parks and Wildlife Services, PaWS (2017). Explore Parks WA: Yawuru Nagulagun/Roebuck Bay Marine Park. Accessible from: https://parks.dpaw.wa.gov.au/park/yawuru-nagulagun-roebuck-bay. [20 Dec 2017]

15.12 Australian Marine Parks

Department of the Environment and Energy (DoEE) (2017), Australian Marine Parks. Available at http://www.environment.gov.au/topics/marine/marine-reserves [Accessed 14 November 2017]

DSEWPaC (2012) Marine bioregional plan for the North-west Marine Region. Department of Sustainability, Environment, Water, Population and Communities, Canberra, ACT. 269 pp.

Director of National Parks (2012a) Concerning the Proposed Proclamation of 40 Commonwealth marine reserves (and the related revocation of seven existing Commonwealth reserves and the revocation of the Coral Sea Conservation Zone); and The amendment of the names of four existing Commonwealth marine reserves. Report to the Director of National Parks under the Environment Protection and Biodiversity Conservation Act 1999 Section 351.

Director of National Parks (2014). Christmas Island National Park. Management Plan 2014 – 2024. Australian Government Director of National Parks. Canberra 2014

Director of National Parks (2018a), South-west Marine Parks Network Management Plan 2018, Director of National Parks, Canberra.

Director of National Parks (2018b), North-west Marine Parks Network Management Plan 2018, Director of National Parks, Canberra.

Director of National Parks (2018c), North Marine Parks Network Management Plan 2018, Director of National Parks, Canberra.

15.13 Conservation Management Plans

Hill, R. and Dunn A. (2004), National Recovery Plan for the Christmas Island Frigatebird Fregata andrewsi. Commonwealth of Australia, Canberra.

Department of Sustainability, Environment, Water, Population and Communities (2011), National recovery plan for threatened albatrosses and giant petrels 2011-2016, Commonwealth of Australia, Hobart

Commonwealth of Australia (2015), Conservation Management Plan for the Blue Whale—A Recovery Plan under the Environment Protection and Biodiversity Conservation Act 1999, Commonwealth of Australia, 2015.

Commonwealth of Australia (2012), Conservation Management Plan for the Southern Right Whale - A Recovery Plan under the Environment Protection and Biodiversity Conservation Act 1999 2011 - 2021, Commonwealth of Australia, 2012.

Commonwealth of Australia (2013), Recovery Plan for the Australian Sea Lion (Neophoca cinerea) 2013.

Commonwealth of Australia (2017), Recovery Plan for Marine Turtles in Australia 2017 – 2027.

Commonwealth of Australia (2014), Recovery Plan for the Grey Nurse Shark (Carcharias taurus) 2014.

Commonwealth of Australia (2013), Recovery Plan for the White Shark (Carcharodon carcharias) 2013.

Commonwealth of Australia (2015), Sawfish and River Sharks - Multispecies Recovery Plan 2015.

Threatened Species Scientific Committee (2015). Conservation Advice Anous tenuirostris melanops Australian lesser noddy, Canberra: Department of the Environment. Available from: http://www.environment.gov.au/biodiversity/threatened/species/pubs/26000-conservation-advice-01102015.pdf. In effect under the EPBC Act from 01-Oct-2015.

Department of Sustainability, Environment, Water, Population and Communities (2011), Approved Conservation Advice for Botaurus poiciloptilus (Australasian Bittern). Canberra, ACT: Department of Sustainability, Environment, Water, Population and Communities. Available from: http://www.environment.gov.au/biodiversity/threatened/species/pubs/1001-conservation-advice.pdf. In effect under the EPBC Act from 03-Mar-2011.

Threatened Species Scientific Committee (2016). Conservation Advice Calidris canutus Red knot. Canberra: Department of the Environment. Available from: http://www.environment.gov.au/biodiversity/threatened/species/pubs/855-conservation-advice-05052016.pdf. In effect under the EPBC Act from 05-May-2016.

Department of the Environment (2015). Conservation Advice Calidris ferruginea curlew sandpiper. Canberra: Department of the Environment. Available from: http://www.environment.gov.au/biodiversity/threatened/species/pubs/856-conservation-advice.pdf. In effect under the EPBC Act from 26-May-2015.

Threatened Species Scientific Committee (2016). Conservation Advice Calidris tenuirostriss Great knot. Canberra: Department of the Environment. Available from: http://www.environment.gov.au/biodiversity/threatened/species/pubs/862-conservation-advice-05052016.pdf. In effect under the EPBC Act from 05-May-2016.

Threatened Species Scientific Committee (2016). Conservation Advice Charadrius leschenaultii Greater sand plover. Canberra: Department of the Environment. Available from: http://www.environment.gov.au/biodiversity/threatened/species/pubs/877-conservation-advice-05052016.pdf. In effect under the EPBC Act from 05-May-2016.

Threatened Species Scientific Committee (2016). Conservation Advice Charadrius mongolus Lesser sand plover. Canberra: Department of the Environment. Available from: http://www.environment.gov.au/biodiversity/threatened/species/pubs/879-conservation-advice-05052016.pdf. In effect under the EPBC Act from 05-May-2016.

Threatened Species Scientific Committee (2015). Conservation Advice Halobaena caerulea blue petrel. Canberra: Department of the Environment. Available from: http://www.environment.gov.au/biodiversity/threatened/species/pubs/1059-conservation-advice-01102015.pdf. In effect under the EPBC Act from 01-Oct-2015.

Threatened Species Scientific Committee (2016). Conservation Advice Limosa lapponica baueri Bar-tailed godwit (western Alaskan). Canberra: Department of the Environment. Available from: http://www.environment.gov.au/biodiversity/threatened/species/pubs/86380-conservation-advice-05052016.pdf. In effect under the EPBC Act from 05-May-2016.

Threatened Species Scientific Committee (2016). Conservation Advice Limosa lapponica menzbieri Bar-tailed godwit (northern Siberian). Canberra: Department of the Environment. Available from: http://www.environment.gov.au/biodiversity/threatened/species/pubs/86432-conservation-advice-05052016.pdf. In effect under the EPBC Act from 05-May-2016.

Department of the Environment (2015). Conservation Advice Numenius madagascariensis eastern curlew. Canberra: Department of the Environment. Available from: http://www.environment.gov.au/biodiversity/threatened/species/pubs/847-conservation-advice.pdf. In effect under the EPBC Act from 26-May-2015.

Threatened Species Scientific Committee (2015). Conservation Advice Pachyptila turtur subantarctica fairy prion (southern). Canberra: Department of the Environment. Available from: http://www.environment.gov.au/biodiversity/threatened/species/pubs/64445-conservation-advice-01102015.pdf. In effect under the EPBC Act from 01-Oct-2015.

Threatened Species Scientific Committee (2015). Conservation Advice Papasula abbotti Abbott's booby. Canberra: Department of the Environment. Available from: http://www.environment.gov.au/biodiversity/threatened/species/pubs/59297-conservation-advice-01102015.pdf. In effect under the EPBC Act from 01-Oct-2015.

Department of the Environment (2014). Conservation Advice Phaethon lepturus fulvus white-tailed tropicbird (Christmas Island). Canberra: Department of the Environment. Available from: http://www.environment.gov.au/biodiversity/threatened/species/pubs/26021-conservation-advice.pdf. In effect under the EPBC Act from 06-Nov-2014.

Threatened Species Scientific Committee (2015). Conservation Advice Pterodroma Mollis soft-plumaged petrel. Canberra: Department of the Environment. Available from: http://www.environment.gov.au/biodiversity/threatened/species/pubs/1036-conservation-advice-01102015.pdf. In effect under the EPBC Act from 01-Oct-2015.

Department of Sustainability, Environment, Water, Population and Communities (2013). Approved Conservation Advice for Rostratula australis (Australian painted snipe). Canberra: Department of Sustainability, Environment, Water, Population and Communities. Available from: http://www.environment.gov.au/biodiversity/threatened/species/pubs/77037-conservation-advice.pdf. In effect under the EPBC Act from 15-May-2013.

Department of Sustainability, Environment, Water, Population and Communities (2011). Approved Conservation Advice for Sternula nereis nereis (Fairy Tern). Canberra, ACT: Department of Sustainability, Environment, Water, Population and Communities. Available from: http://www.environment.gov.au/biodiversity/threatened/species/pubs/82950-conservation-advice.pdf. In effect under the EPBC Act from 03-Mar-2011.

Threatened Species Scientific Committee (2015). Conservation Advice Balaenoptera borealis sei whale. Canberra: Department of the Environment. Available from: http://www.environment.gov.au/biodiversity/threatened/species/pubs/34-conservation-advice-01102015.pdf. In effect under the EPBC Act from 01-Oct-2015.

Threatened Species Scientific Committee (2015). Conservation Advice Balaenoptera physalus fin whale. Canberra: Department of the Environment. Available from: http://www.environment.gov.au/biodiversity/threatened/species/pubs/37-conservation-advice-01102015.pdf. In effect under the EPBC Act from 01-Oct-2015.

Threatened Species Scientific Committee (2015). Conservation Advice Megaptera novaeangliae humpback whale. Canberra: Department of the Environment. Available from: http://www.environment.gov.au/biodiversity/threatened/species/pubs/38-conservation-advice-10102015.pdf. In effect under the EPBC Act from 01-Oct-2015.

Department of Sustainability, Environment, Water, Population and Communities (2011). Approved Conservation Advice for Aipysurus apraefrontalis (Short-nosed Sea Snake). Canberra, ACT: Department of Sustainability, Environment, Water, Population and Communities. Available from: http://www.environment.gov.au/biodiversity/threatened/species/pubs/1115-conservation-advice.pdf. In effect under the EPBC Act from 15-Feb-2011.

Department of Sustainability, Environment, Water, Population and Communities (2011). Approved Conservation Advice for Aipysurus foliosquama (Leaf-scaled Sea Snake). Canberra, ACT: Department of Sustainability, Environment, Water, Population and Communities. Available from: http://www.environment.gov.au/biodiversity/threatened/species/pubs/1118-conservation-advice.pdf. In effect under the EPBC Act from 15-Feb-2011.

Department of the Environment, Water, Heritage and the Arts (2008). Approved Conservation Advice for Dermochelys coriacea (Leatherback Turtle). Canberra: Department of the Environment, Water, Heritage and the Arts. Available from: http://www.environment.gov.au/biodiversity/threatened/species/pubs/1768-conservation-advice.pdf. In effect under the EPBC Act from 08-Jan-2009.

Department of the Environment (2014). Approved Conservation Advice for Glyphis garricki (northern river shark). Canberra: Department of the Environment. Available from: http://www.environment.gov.au/biodiversity/threatened/species/pubs/82454-conservation-advice.pdf. In effect under the EPBC Act from 11-Apr-2014.

Department of the Environment, Water, Heritage and the Arts (2009). Approved Conservation Advice for Pristis clavata (Dwarf Sawfish). Canberra, ACT: Department of the Environment, Water, Heritage and the Arts. Available from: http://www.environment.gov.au/biodiversity/threatened/species/pubs/68447-conservation-advice.pdf. In effect under the EPBC Act from 20-Oct-2009.

Department of the Environment (2014). Approved Conservation Advice for Pristis pristis (largetooth sawfish). Canberra: Department of the Environment. Available from: http://www.environment.gov.au/biodiversity/threatened/species/pubs/60756-conservation-advice.pdf. In effect under the EPBC Act from 11-Apr-2014.

Department of the Environment, Water, Heritage and the Arts (2008). Approved Conservation Advice for Green Sawfish. Canberra: Department of the Environment, Water, Heritage and the Arts. Available from: http://www.environment.gov.au/biodiversity/threatened/species/pubs/68442-conservation-advice.pdf. In effect under the EPBC Act from 07-Mar-2008.

Threatened Species Scientific Committee (2015). Conservation Advice Rhincodon typus whale shark. Canberra: Department of the Environment. Available from: http://www.environment.gov.au/biodiversity/threatened/species/pubs/66680-conservation-advice-01102015.pdf. In effect under the EPBC Act from 01-Oct-2015.

15.14 Commercial and Recreational Fisheries

AFMA (2011) Annual Report 10/11. Australian Fisheries Management Authority (Australian Government, Canberra, Australia

Apache (2008) Van Gogh Oil Development Draft Public Environmental Report (EPBC Referral 2007/3213). Apache Energy Ltd, Perth, Western Australia, February 2008.

Caputi, N., Jackson, G. and Pearce, A. (2014). The marine heat wave off Western Australia during the summer of 2010/11 – 2 years on. Fisheries Research Report No. 250. Department of Fisheries, Western Australia. 40pp.

DEWHA 2008. North-West Marine Bioregional Plan: Bioregional Profile: A Description of the Ecosystems, Conservation Values and Uses of the North-West Marine Region. Department of Environment Water Heritage and the Arts, Canberra, Australian Capital Territory.

DPIRD (2018) Departmen of Primary Industries and Regional Development. Annual Report 2018. Government of Western Australia.

DSEWPaC (2012) Marine Bioregional Plan for the North-west Marine Region. Prepared under the Environment Protection and Biodiversity Conservation Act 1999. Department of Sustainability, Environment, Water, Population and Communities, Canberra, Australian Capital Territory

Environmental Resources Management (ERM) 2008, Indonesian Fishers SIA Report (Phase 1) 2007. Report produced for Woodside Energy Limited. 170 pp.

Environmental Resources Management (ERM) 2009, Browse LNG Development: Social Study on Indonesian Fishers (Phase 2) 2008. Report produced for Woodside Energy Limited. 93 pp

Fletcher, W J and Santoro, K. (2013) Status Reports of the Fisheries and Aquatic Resources of Western Australia 2012/13 (eds).: The State of the Fisheries. Department of Fisheries, Western Australia.

Fletcher, W.J. and Santoro, K. (eds). (2015). Status Reports of the Fisheries and Aquatic Resources of Western Australia 2014/15: The State of the Fisheries. Department of Fisheries, Western Australia.

Fletcher W.J., Mumme M.D and Webster F.J. (eds) (2017) Status Reports of the Fisheries and Aquatic Resources of Western Australia 2015/2016: The State of the Fisheries. Department of Fisheries, Western Australia.

Gaughan, D.J. and Santoro, K. (eds). 2018. *Status Reports of the Fisheries and Aquatic Resources of Western Australia 2016/17: The State of the Fisheries*. Department of Primary Industries andRegional Development, Western Australia

Patterson, H, Larcombe, J, Nicol, S and Curtotti, R (2018) Fishery status reports 2018, Australian Bureau of Agricultural and Resource Economics and Sciences, Canberra. CC BY 4.0.

Phillips M, Henriksson PJG, Tran N, Chan CY, Mohan CV, Rodriguez U-P, Suri S, Hall S and Koeshendrajana S. 2015. Exploring Indonesian aquaculture futures. Penang, Malaysia: WorldFish.Program Report: 2015-39.

Valderrama, D., Cai, J., Hishamunda, N. & Ridler, N., eds. 2013. Social and economic dimensions of carrageenan seaweed farming. Fisheries and Aquaculture Technical Paper No. 580. Rome, FAO. 204 pp.

WAFIC undated. Western Australia Fishing Industry Council Incorporated. Available at: http://www.wafic.org.au/region/west-coast/ [Accessed August 2016]

Woodside Energy Limited (Woodside) (2011) Browse LNG Development, Draft Upstream Environmental Impact Statement, EPBC Referral 2008/4111, November 2011.

15.15 Social, Economic and Cultural Features

Global Business Guide (2014). http://www.gbgindonesia.com/en/agriculture/article/2014/indonesia_s_aquaculture_and_fisheries_sector.php

AMSA (Australian Marine Safety Authority) (2012) Marine Notice 15/2012, Shipping Fairways off the north-west coast of Australia. Australian Maritime Safety Authority, Australian Government

AMSA (2013) North West Shipping Management. Available at http://www.amsa.gov.au/navigation/shipping-management/nwsm/ [Accessed April 2014]

DEWHA (Department of the Environment, Water, Heritage and the Arts) (2008) The North-West Marine Bioregional Plan: Bioregional Profile: A Description of the Ecosystems, Conservation Values and Uses of the South-West Marine Region. [Online]. Canberra: DEWHA. Available from: http://www.environment.gov.au/coasts/mbp/publications/south-west/pubs/sw-profile-full.pdf

DoE (Department of Environment) (2014) Australian Heritage Database. Available at http://www.environment.gov.au/cgi-bin/ahdb/search.pl [Accessed April 2014]

DMP (Department of Mines and Petroleum) (2014) Petroleum in Western Australia. East Perth, Western Australia, April 2014.

Shire of Exmouth (2014) HEH Naval Communication Station. Available at http://www.exmouth.wa.gov.au/HEH-Naval-Communication-Station.aspx [Accessed April 2014]

Royal Australian Air Force (RAAF) (2014) Bases Western Australia. Available at http://www.airforce.gov.au/RAAFBases/Western-Australia/?RAAF-XhA6h8hubJMckf8rNnzxCVJKmekjdh/S [Accessed April 2014]

Tourism Western Australia (2014) Visitor Fact Sheets – Tourism Regional Level. Available at http://www.tourism.wa.gov.au/Research_and_Reports/Regional_Fact_Sheets/Pages/Regional_Fact_Sheets.aspx [Accessed April 2014]

Appendix A: EPBC Act Protected Matters Report

Australian Government
Department of the Environment and Energy

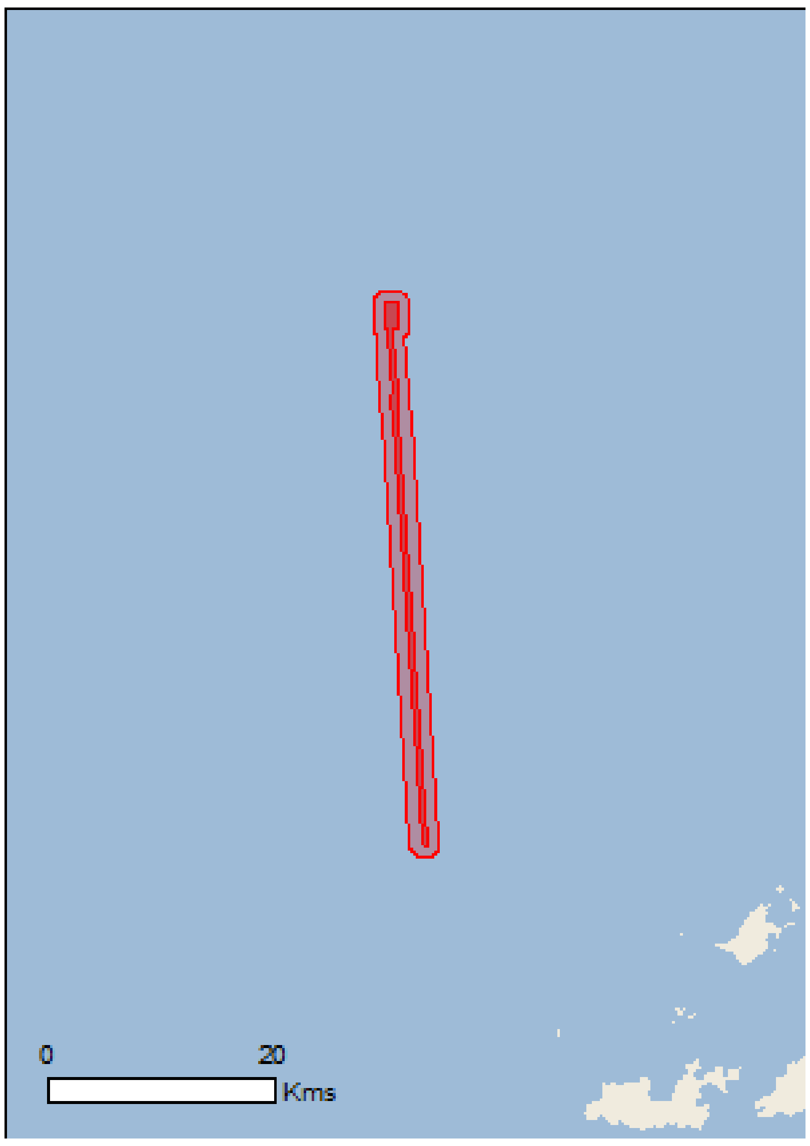
EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected.

Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

Information is available about Environment Assessments and the EPBC Act including significance guidelines, forms and application process details.

Report created: 08/04/19 10:20:52



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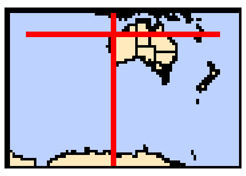

Summary

Matters of National Environmental Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Importance:	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	1
Listed Threatened Ecological Communities:	None
Listed Threatened Species:	20
Listed Migratory Species:	35

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at http://www.environment.gov.au/heritage

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Land:	None
Commonwealth Heritage Places:	None
Listed Marine Species:	69
Whales and Other Cetaceans:	15
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	None

Extra Information

This part of the report provides information that may also be relevant to the area you have nominated.

State and Territory Reserves:	None
Regional Forest Agreements:	None
Invasive Species:	None
Nationally Important Wetlands:	None
Key Ecological Features (Marine)	None

Details

Matters of National Environmental Significance

Commonwealth Marine Area [Resource Information]

Approval is required for a proposed activity that is located within the Commonwealth Marine Area which has, will have, or is likely to have a significant impact on the environment. Approval may be required for a proposed action taken outside the Commonwealth Marine Area but which has, may have or is likely to have a significant impact on the environment in the Commonwealth Marine Area. Generally the Commonwealth Marine Area stretches from three nautical miles to two hundred nautical miles from the coast.

Name
EEZ and Territorial Sea

Marine Regions [Resource Information]

If you are planning to undertake action in an area in or close to the Commonwealth Marine Area, and a marine bioregional plan has been prepared for the Commonwealth Marine Area in that area, the marine bioregional plan may inform your decision as to whether to refer your proposed action under the EPBC Act.

Name
North-west

Listed Threatened Species [Resource Information]

Name	Status	Type of Presence
Birds		
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Sternula nereis nereis Australian Fairy Tern [82950]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Mammals		
Balaenoptera borealis Sei Whale [34]	Vulnerable	Species or species habitat may occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Species or species habitat likely to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Species or species habitat may occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Species or species

Name	Status	Type of Presence
		habitat known to occur within area
Reptiles		
Aipysurus apraefrontalis Short-nosed Seasnake [1115]	Critically Endangered	Species or species habitat may occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Species or species habitat known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Species or species habitat known to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat likely to occur within area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Species or species habitat known to occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Congregation or aggregation known to occur within area
Sharks		
Carcharias taurus (west coast population) Grey Nurse Shark (west coast population) [68752]	Vulnerable	Species or species habitat likely to occur within area
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat may occur within area
Pristis clavata Dwarf Sawfish, Queensland Sawfish [68447]	Vulnerable	Species or species habitat known to occur within area
Pristis zijsron Green Sawfish, Dindagubba, Narrowsnout Sawfish [68442]	Vulnerable	Species or species habitat known to occur within area
Rhincodon typus Whale Shark [66680]	Vulnerable	Foraging, feeding or related behaviour known to occur within area

Listed Migratory Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Migratory Marine Birds		
Anous stolidus Common Noddy [825]		Species or species habitat may occur within area
Calonectris leucomelas Streaked Shearwater [1077]		Species or species habitat likely to occur within area
Fregata ariel Lesser Frigatebird, Least Frigatebird [1012]		Species or species habitat likely to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Sterna dougallii Roseate Tern [817]		Foraging, feeding or related behaviour likely to occur within area

Name	Threatened	Type of Presence
Migratory Marine Species		
Anoxypristis cuspidata Narrow Sawfish, Knifetooth Sawfish [68448]		Species or species habitat likely to occur within area
Balaenoptera borealis Sei Whale [34]	Vulnerable	Species or species habitat may occur within area
Balaenoptera edeni Bryde's Whale [35]		Species or species habitat may occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Species or species habitat likely to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Species or species habitat may occur within area
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat may occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Species or species habitat known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Species or species habitat known to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat likely to occur within area
Dugong dugon Dugong [28]		Species or species habitat likely to occur within area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Species or species habitat known to occur within area
Isurus oxyrinchus Shortfin Mako, Mako Shark [79073]		Species or species habitat likely to occur within area
Isurus paucus Longfin Mako [82947]		Species or species habitat likely to occur within area
Manta alfredi Reef Manta Ray, Coastal Manta Ray, Inshore Manta Ray, Prince Alfred's Ray, Resident Manta Ray [84994]		Species or species habitat known to occur within area
Manta birostris Giant Manta Ray, Chevron Manta Ray, Pacific Manta Ray, Pelagic Manta Ray, Oceanic Manta Ray [84995]		Species or species habitat likely to occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Species or species habitat known to occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Congregation or aggregation known to occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
Pristis clavata Dwarf Sawfish, Queensland Sawfish [68447]	Vulnerable	Species or species habitat known to occur within area
Pristis zijsron Green Sawfish, Dindagubba, Narrowsnout Sawfish [68442]	Vulnerable	Species or species habitat known to occur within area
Rhincodon typus Whale Shark [66680]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Sousa chinensis Indo-Pacific Humpback Dolphin [50]		Species or species habitat may occur within area
Tursiops aduncus (Arafura/Timor Sea populations) Spotted Bottlenose Dolphin (Arafura/Timor Sea populations) [78900]		Species or species habitat likely to occur within area
Migratory Wetlands Species		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat may occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat may occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Pandion haliaetus Osprey [952]		Species or species habitat may occur within area

Other Matters Protected by the EPBC Act

Listed Marine Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Birds		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat may occur within area
Anous stolidus Common Noddy [825]		Species or species habitat may occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area
Calonectris leucomelas Streaked Shearwater [1077]		Species or species habitat likely to occur within area
Fregata ariel Lesser Frigatebird, Least Frigatebird [1012]		Species or species habitat likely to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Pandion haliaetus Osprey [952]		Species or species habitat may occur within area
Sterna dougallii Roseate Tern [817]		Foraging, feeding or related behaviour likely to occur within area
Fish		
Acentronura larsonae Helen's Pygmy Pipehorse [66186]		Species or species habitat may occur within area
Bulbonaricus brauni Braun's Pughead Pipefish, Pug-headed Pipefish [66189]		Species or species habitat may occur within area
Campichthys tricarinatus Three-keel Pipefish [66192]		Species or species habitat may occur within area
Choeroichthys brachysoma Pacific Short-bodied Pipefish, Short-bodied Pipefish [66194]		Species or species habitat may occur within area
Choeroichthys latispinosus Muiron Island Pipefish [66196]		Species or species habitat may occur within area
Choeroichthys suillus Pig-snouted Pipefish [66198]		Species or species habitat may occur within area
Corythoichthys flavofasciatus Reticulate Pipefish, Yellow-banded Pipefish, Network Pipefish [66200]		Species or species habitat may occur within area
Cosmocampus banneri Roughridge Pipefish [66206]		Species or species habitat may occur within area
Doryrhamphus dactyliophorus Banded Pipefish, Ringed Pipefish [66210]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
Doryrhamphus excisus Bluestripe Pipefish, Indian Blue-stripe Pipefish, Pacific Blue-stripe Pipefish [66211]		Species or species habitat may occur within area
Doryrhamphus janssi Cleaner Pipefish, Janss' Pipefish [66212]		Species or species habitat may occur within area
Doryrhamphus multiannulatus Many-banded Pipefish [66717]		Species or species habitat may occur within area
Doryrhamphus negrosensis Flagtail Pipefish, Masthead Island Pipefish [66213]		Species or species habitat may occur within area
Festucalex scalaris Ladder Pipefish [66216]		Species or species habitat may occur within area
Filicampus tigris Tiger Pipefish [66217]		Species or species habitat may occur within area
Halicampus brocki Brock's Pipefish [66219]		Species or species habitat may occur within area
Halicampus grayi Mud Pipefish, Gray's Pipefish [66221]		Species or species habitat may occur within area
Halicampus nitidus Glittering Pipefish [66224]		Species or species habitat may occur within area
Halicampus spinirostris Spiny-snout Pipefish [66225]		Species or species habitat may occur within area
Haliichthys taeniophorus Ribboned Pipehorse, Ribboned Seadragon [66226]		Species or species habitat may occur within area
Hippichthys penicillus Beady Pipefish, Steep-nosed Pipefish [66231]		Species or species habitat may occur within area
Hippocampus angustus Western Spiny Seahorse, Narrow-bellied Seahorse [66234]		Species or species habitat may occur within area
Hippocampus histrix Spiny Seahorse, Thorny Seahorse [66236]		Species or species habitat may occur within area
Hippocampus kuda Spotted Seahorse, Yellow Seahorse [66237]		Species or species habitat may occur within area
Hippocampus planifrons Flat-face Seahorse [66238]		Species or species habitat may occur within area
Hippocampus spinosissimus Hedgehog Seahorse [66239]		Species or species habitat may occur within area
Hippocampus trimaculatus Three-spot Seahorse, Low-crowned Seahorse, Flat-faced Seahorse [66720]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
Micrognathus micronotopterus Tidepool Pipefish [66255]		Species or species habitat may occur within area
Phoxocampus belcheri Black Rock Pipefish [66719]		Species or species habitat may occur within area
Solegnathus hardwickii Pallid Pipehorse, Hardwick's Pipehorse [66272]		Species or species habitat may occur within area
Solegnathus lettiensis Gunther's Pipehorse, Indonesian Pipefish [66273]		Species or species habitat may occur within area
Solenostomus cyanopterus Robust Ghostpipefish, Blue-finned Ghost Pipefish, [66183]		Species or species habitat may occur within area
Syngnathoides biaculeatus Double-end Pipehorse, Double-ended Pipehorse, Alligator Pipefish [66279]		Species or species habitat may occur within area
Trachyrhamphus bicoarctatus Bentstick Pipefish, Bend Stick Pipefish, Short-tailed Pipefish [66280]		Species or species habitat may occur within area
Trachyrhamphus longirostris Straightstick Pipefish, Long-nosed Pipefish, Straight Stick Pipefish [66281]		Species or species habitat may occur within area
Mammals		
Dugong dugon Dugong [28]		Species or species habitat likely to occur within area
Reptiles		
Acalyptophis peronii Horned Seasnake [1114]		Species or species habitat may occur within area
Aipysurus apraefrontalis Short-nosed Seasnake [1115]	Critically Endangered	Species or species habitat may occur within area
Aipysurus duboisii Dubois' Seasnake [1116]		Species or species habitat may occur within area
Aipysurus eydouxii Spine-tailed Seasnake [1117]		Species or species habitat may occur within area
Aipysurus laevis Olive Seasnake [1120]		Species or species habitat may occur within area
Aipysurus tenuis Brown-lined Seasnake [1121]		Species or species habitat may occur within area
Astrotia stokesii Stokes' Seasnake [1122]		Species or species habitat may occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Species or species habitat known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Species or species habitat known to occur

Name	Threatened	Type of Presence
		within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat likely to occur within area
Disteira kingii Spectacled Seasnake [1123]		Species or species habitat may occur within area
Disteira major Olive-headed Seasnake [1124]		Species or species habitat may occur within area
Ephalophis greyi North-western Mangrove Seasnake [1127]		Species or species habitat may occur within area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Species or species habitat known to occur within area
Hydrelaps darwiniensis Black-ringed Seasnake [1100]		Species or species habitat may occur within area
Hydrophis czeblukovi Fine-spined Seasnake [59233]		Species or species habitat may occur within area
Hydrophis elegans Elegant Seasnake [1104]		Species or species habitat may occur within area
Hydrophis mcdowelli null [25926]		Species or species habitat may occur within area
Hydrophis ornatus Spotted Seasnake, Ornate Reef Seasnake [1111]		Species or species habitat may occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Congregation or aggregation known to occur within area
Pelamis platurus Yellow-bellied Seasnake [1091]		Species or species habitat may occur within area

Whales and other Cetaceans [Resource Information]

Name	Status	Type of Presence
Mammals		
Balaenoptera acutorostrata Minke Whale [33]		Species or species habitat may occur within area
Balaenoptera borealis Sei Whale [34]	Vulnerable	Species or species habitat may occur within area
Balaenoptera edeni Bryde's Whale [35]		Species or species habitat may occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Species or species habitat likely to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Species or species habitat may occur within area

Name	Status	Type of Presence
Delphinus delphis Common Dophin, Short-beaked Common Dolphin [60]		Species or species habitat may occur within area
Grampus griseus Risso's Dolphin, Grampus [64]		Species or species habitat may occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Species or species habitat known to occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat may occur within area
Pseudorca crassidens False Killer Whale [48]		Species or species habitat likely to occur within area
Sousa chinensis Indo-Pacific Humpback Dolphin [50]		Species or species habitat may occur within area
Stenella attenuata Spotted Dolphin, Pantropical Spotted Dolphin [51]		Species or species habitat may occur within area
Tursiops aduncus Indian Ocean Bottlenose Dolphin, Spotted Bottlenose Dolphin [68418]		Species or species habitat may occur within area
Tursiops aduncus (Arafura/Timor Sea populations) Spotted Bottlenose Dolphin (Arafura/Timor Sea populations) [78900]		Species or species habitat likely to occur within area
Tursiops truncatus s. str. Bottlenose Dolphin [68417]		Species or species habitat may occur within area

Extra Information

Caveat
The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the Environment Protection and Biodiversity Conservation Act 1999. It holds mapped locations of World and National Heritage properties, Wetlands of International and National Importance, Commonwealth and State/Territory reserves, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various resolutions.

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the qualifications below and may need to seek and consider other information sources.

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Threatened, migratory and marine species distributions have been derived through a variety of methods. Where distributions are well known and if time permits, maps are derived using either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc) together with point locations and described habitat; or environmental modelling (MAXENT or BIOCLIM habitat modelling) using point locations and environmental data layers.

Where very little information is available for species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc). In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More reliable distribution mapping methods are used to update these distributions as time permits.

Only selected species covered by the following provisions of the EPBC Act have been mapped:

- migratory and
- marine

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:

- threatened species listed as extinct or considered as vagrants
- some species and ecological communities that have only recently been listed
- some terrestrial species that overfly the Commonwealth marine area
- migratory species that are very widespread, vagrant, or only occur in small numbers

The following groups have been mapped, but may not cover the complete distribution of the species:

- non-threatened seabirds which have only been mapped for recorded breeding sites
- seals which have only been mapped for breeding sites near the Australian continent

Such breeding sites may be important for the protection of the Commonwealth Marine environment.

Coordinates
-20.00925655 116.3144895,-20.02862638 116.314491,-20.02861356 116.3111468,-20.0333615 116.3111393,-20.03736591 116.3112554,-20.04642121 116.3130387,-20.04762971 116.3131642,-20.05867286 116.3129334,-20.07097756 116.3148735,-20.08332405 116.3146299,-20.09270323 116.3160902,-20.41109694 116.3381233,-20.41077335 116.3332962,-20.0931682 116.3113332,-20.0836928 116.3098633,-20.07164595 116.3101222,-20.05919881 116.3081801,-20.04758562 116.3083741,-20.03810018 116.3065309,-20.03035036 116.306289,-20.02859511 116.30636,-20.02858957 116.3049301,-20.0092193 116.3049299,-20.00925655 116.3144895

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

- -Office of Environment and Heritage, New South Wales
- -Department of Environment and Primary Industries, Victoria
- -Department of Primary Industries, Parks, Water and Environment, Tasmania
- -Department of Environment, Water and Natural Resources, South Australia
- -Department of Land and Resource Management, Northern Territory
- -Department of Environmental and Heritage Protection, Queensland
- -Department of Parks and Wildlife, Western Australia
- -Environment and Planning Directorate, ACT
- -Birdlife Australia
- -Australian Bird and Bat Banding Scheme
- -Australian National Wildlife Collection
- -Natural history museums of Australia
- -Museum Victoria
- -Australian Museum
- -South Australian Museum
- -Queensland Museum
- -Online Zoological Collections of Australian Museums
- -Queensland Herbarium
- -National Herbarium of NSW
- -Royal Botanic Gardens and National Herbarium of Victoria
- -Tasmanian Herbarium
- -State Herbarium of South Australia
- -Northern Territory Herbarium
- -Western Australian Herbarium
- -Australian National Herbarium, Canberra
- -University of New England
- -Ocean Biogeographic Information System
- -Australian Government, Department of Defence
- Forestry Corporation, NSW
- -Geoscience Australia
- -CSIRO
- -Australian Tropical Herbarium, Cairns
- -eBird Australia
- -Australian Government – Australian Antarctic Data Centre
- -Museum and Art Gallery of the Northern Territory
- -Australian Government National Environmental Science Program
- -Australian Institute of Marine Science
- -Reef Life Survey Australia
- -American Museum of Natural History
- -Queen Victoria Museum and Art Gallery, Inveresk, Tasmania
- -Tasmanian Museum and Art Gallery, Hobart, Tasmania
- -Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the Contact Us page.

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Australian Government
Department of the Environment and Energy

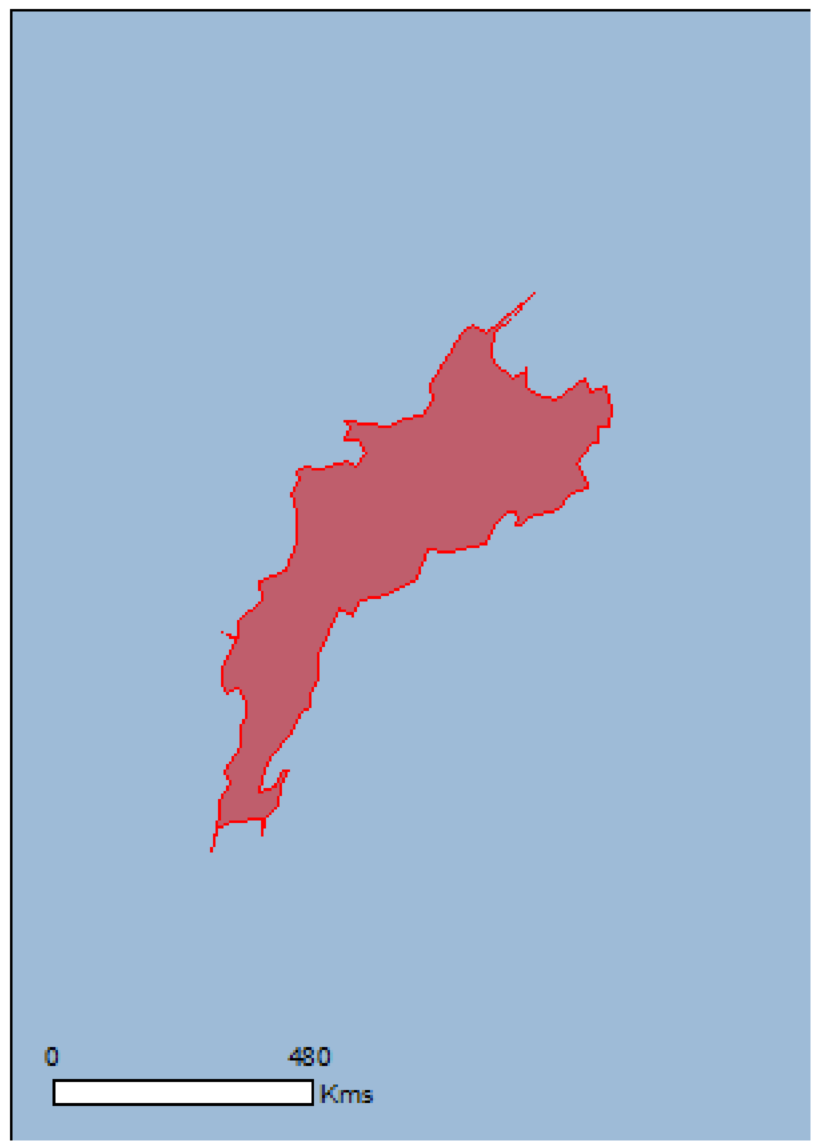
EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected.

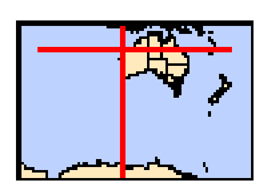
Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

Information is available about Environment Assessments and the EPBC Act including significance guidelines, forms and application process details.

Report created: 12/04/19 21:31:58



Coordinates
Buffer: 1.0Km



Summary

Matters of National Environmental Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

World Heritage Properties:	1
National Heritage Places:	2
Wetlands of International Importance:	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	1
Listed Threatened Ecological Communities:	None
Listed Threatened Species:	50
Listed Migratory Species:	60

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at http://www.environment.gov.au/heritage

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Land:	3
Commonwealth Heritage Places:	1
Listed Marine Species:	110
Whales and Other Cetaceans:	31
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	10

Extra Information

This part of the report provides information that may also be relevant to the area you have nominated.

State and Territory Reserves:	19
Regional Forest Agreements:	None
Invasive Species:	15
Nationally Important Wetlands:	1
Key Ecological Features (Marine)	6

Details

Matters of National Environmental Significance

World Heritage Properties [Resource Information]

Name	State	Status
The Ningaloo Coast	WA	Declared property

National Heritage Properties [Resource Information]

Name	State	Status
Natural		
The Ningaloo Coast	WA	Listed place
Indigenous		
Dampier Archipelago (including Burrup Peninsula)	WA	Listed place

Commonwealth Marine Area [Resource Information]

Approval is required for a proposed activity that is located within the Commonwealth Marine Area which has, will have, or is likely to have a significant impact on the environment. Approval may be required for a proposed action taken outside the Commonwealth Marine Area but which has, may have or is likely to have a significant impact on the environment in the Commonwealth Marine Area. Generally the Commonwealth Marine Area stretches from three nautical miles to two hundred nautical miles from the coast.

Name
EEZ and Territorial Sea

Marine Regions [Resource Information]

If you are planning to undertake action in an area in or close to the Commonwealth Marine Area, and a marine bioregional plan has been prepared for the Commonwealth Marine Area in that area, the marine bioregional plan may inform your decision as to whether to refer your proposed action under the EPBC Act.

Name
North-west

Listed Threatened Species [Resource Information]

Name	Status	Type of Presence
Birds		
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat known to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Limosa lapponica baueri Bar-tailed Godwit (baueri), Western Alaskan Bar-tailed Godwit [86380]	Vulnerable	Species or species habitat likely to occur within area
Limosa lapponica menzbieri Northern Siberian Bar-tailed Godwit, Bar-tailed Godwit (menzbieri) [86432]	Critically Endangered	Species or species habitat may occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Malurus leucopterus edouardi White-winged Fairy-wren (Barrow Island), Barrow Island Black-and-white Fairy-wren [26194]	Vulnerable	Species or species habitat likely to occur

Name	Status	Type of Presence
		within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area
Papasula abbotti Abbott's Booby [59297]	Endangered	Species or species habitat may occur within area
Pezoporus occidentalis Night Parrot [59350]	Endangered	Species or species habitat may occur within area
Pterodroma mollis Soft-plumaged Petrel [1036]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Rostratula australis Australian Painted-snipe, Australian Painted Snipe [77037]	Endangered	Species or species habitat may occur within area
Sternula nereis nereis Australian Fairy Tern [82950]	Vulnerable	Breeding known to occur within area
Thalassarche carteri Indian Yellow-nosed Albatross [64464]	Vulnerable	Foraging, feeding or related behaviour may occur within area
Thalassarche cauta cauta Shy Albatross, Tasmanian Shy Albatross [82345]	Vulnerable	Species or species habitat may occur within area
Thalassarche cauta steadi White-capped Albatross [82344]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Species or species habitat may occur within area
Fish		
Milyeringa veritas Blind Gudgeon [66676]	Vulnerable	Species or species habitat known to occur within area
Ophisternon candidum Blind Cave Eel [66678]	Vulnerable	Species or species habitat known to occur within area
Mammals		
Balaenoptera borealis Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Migration route known to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Bettongia lesueur Barrow and Boodie Islands subspecies Boodie, Burrowing Bettong (Barrow and Boodie Islands) [88021]	Vulnerable	Species or species habitat known to occur within area
Dasyurus hallucatus Northern Quoll, Digul [Gogo-Yimidir], Wijingadda [Dambimangari], Wiminji [Martu] [331]	Endangered	Species or species habitat likely to occur within area

Name	Status	Type of Presence
Eubalaena australis Southern Right Whale [40]	Endangered	Species or species habitat likely to occur within area
Isoodon auratus barrowensis Golden Bandicoot (Barrow Island) [66666]	Vulnerable	Species or species habitat known to occur within area
Lagorchestes conspicillatus conspicillatus Spectacled Hare-wallaby (Barrow Island) [66661]	Vulnerable	Species or species habitat known to occur within area
Lagorchestes hirsutus Central Australian subspecies Mala, Rufous Hare-Wallaby (Central Australia) [88019]	Endangered	Translocated population known to occur within area
Macroderma gigas Ghost Bat [174]	Vulnerable	Species or species habitat likely to occur within area
Macrotis lagotis Greater Bilby [282]	Vulnerable	Species or species habitat likely to occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Congregation or aggregation known to occur within area
Osphranter robustus isabellinus Barrow Island Wallaroo, Barrow Island Euro [89262]	Vulnerable	Species or species habitat likely to occur within area
Petrogale lateralis lateralis Black-flanked Rock-wallaby, Moororong, Black-footed Rock Wallaby [66647]	Endangered	Species or species habitat known to occur within area
Rhinonicteris aurantia (Pilbara form) Pilbara Leaf-nosed Bat [82790]	Vulnerable	Species or species habitat known to occur within area
Reptiles		
Aipysurus apraefrontalis Short-nosed Seasnake [1115]	Critically Endangered	Species or species habitat known to occur within area
Aprasia rostrata rostrata Monte Bello Worm-lizard, Hermite Island Worm-lizard [64481]	Vulnerable	Species or species habitat known to occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Breeding known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Breeding known to occur within area
Ctenotus angusticeps Northwestern Coastal Ctenotus, Airlie Island Ctenotus [25937]	Vulnerable	Species or species habitat known to occur within area
Ctenotus zastictus Hamelin Ctenotus [25570]	Vulnerable	Species or species habitat known to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Foraging, feeding or related behaviour known to occur within area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Breeding known to occur within area
Liasis olivaceus barroni Olive Python (Pilbara subspecies) [66699]	Vulnerable	Species or species habitat likely to occur

Name	Status	Type of Presence
		within area
[Natator depressus](#) Flatback Turtle [59257]	Vulnerable	Breeding known to occur within area
Sharks		
[Carcharias taurus (west coast population)](#) Grey Nurse Shark (west coast population) [68752]	Vulnerable	Species or species habitat known to occur within area
[Carcharodon carcharias](#) White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat known to occur within area
[Pristis clavata](#) Dwarf Sawfish, Queensland Sawfish [68447]	Vulnerable	Species or species habitat known to occur within area
[Pristis zijsron](#) Green Sawfish, Dindagubba, Narrowsnout Sawfish [68442]	Vulnerable	Species or species habitat known to occur within area
[Rhincodon typus](#) Whale Shark [66680]	Vulnerable	Foraging, feeding or related behaviour known to occur within area

Listed Migratory Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Migratory Marine Birds		
[Anous stolidus](#) Common Noddy [825]		Species or species habitat likely to occur within area
[Apus pacificus](#) Fork-tailed Swift [678]		Species or species habitat likely to occur within area
[Ardenna carneipes](#) Flesh-footed Shearwater, Fleshy-footed Shearwater [82404]		Species or species habitat likely to occur within area
[Ardenna pacifica](#) Wedge-tailed Shearwater [84292]		Breeding known to occur within area
[Calonectris leucomelas](#) Streaked Shearwater [1077]		Species or species habitat likely to occur within area
[Fregata ariel](#) Lesser Frigatebird, Least Frigatebird [1012]		Species or species habitat known to occur within area
[Fregata minor](#) Great Frigatebird, Greater Frigatebird [1013]		Species or species habitat may occur within area
[Hydroprogne caspia](#) Caspian Tern [808]		Breeding known to occur within area
[Macronectes giganteus](#) Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
[Macronectes halli](#) Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
[Onychoprion anaethetus](#) Bridled Tern [82845]		Breeding known to occur within area

Name	Threatened	Type of Presence
Phaethon lepturus White-tailed Tropicbird [1014]		Foraging, feeding or related behaviour likely to occur within area
Sterna dougallii Roseate Tern [817]		Breeding known to occur within area
Thalassarche carteri Indian Yellow-nosed Albatross [64464]	Vulnerable	Foraging, feeding or related behaviour may occur within area
Thalassarche cauta Tasmanian Shy Albatross [89224]	Vulnerable*	Species or species habitat may occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Species or species habitat may occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable*	Foraging, feeding or related behaviour likely to occur within area
Migratory Marine Species		
Anoxypristis cuspidata Narrow Sawfish, Knifetooth Sawfish [68448]		Species or species habitat known to occur within area
Balaena glacialis australis Southern Right Whale [75529]	Endangered*	Species or species habitat likely to occur within area
Balaenoptera bonaerensis Antarctic Minke Whale, Dark-shoulder Minke Whale [67812]		Species or species habitat likely to occur within area
Balaenoptera borealis Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Balaenoptera edeni Bryde's Whale [35]		Species or species habitat likely to occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Migration route known to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat known to occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Breeding known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Breeding known to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Foraging, feeding or related behaviour known to occur within area
Dugong dugon Dugong [28]		Breeding known to occur within area

Name	Threatened	Type of Presence
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Breeding known to occur within area
Isurus oxyrinchus Shortfin Mako, Mako Shark [79073]		Species or species habitat likely to occur within area
Isurus paucus Longfin Mako [82947]		Species or species habitat likely to occur within area
Lamna nasus Porbeagle, Mackerel Shark [83288]		Species or species habitat may occur within area
Manta alfredi Reef Manta Ray, Coastal Manta Ray, Inshore Manta Ray, Prince Alfred's Ray, Resident Manta Ray [84994]		Species or species habitat known to occur within area
Manta birostris Giant Manta Ray, Chevron Manta Ray, Pacific Manta Ray, Pelagic Manta Ray, Oceanic Manta Ray [84995]		Species or species habitat known to occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Congregation or aggregation known to occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Breeding known to occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat may occur within area
Physeter macrocephalus Sperm Whale [59]		Species or species habitat may occur within area
Pristis clavata Dwarf Sawfish, Queensland Sawfish [68447]	Vulnerable	Species or species habitat known to occur within area
Pristis zijsron Green Sawfish, Dindagubba, Narrowsnout Sawfish [68442]	Vulnerable	Species or species habitat known to occur within area
Rhincodon typus Whale Shark [66680]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Sousa chinensis Indo-Pacific Humpback Dolphin [50]		Species or species habitat known to occur within area
Tursiops aduncus (Arafura/Timor Sea populations) Spotted Bottlenose Dolphin (Arafura/Timor Sea populations) [78900]		Species or species habitat known to occur within area
Migratory Terrestrial Species		
Hirundo rustica Barn Swallow [662]		Species or species habitat may occur within area
Motacilla cinerea Grey Wagtail [642]		Species or species habitat may occur within area
Motacilla flava Yellow Wagtail [644]		Species or species habitat may occur within area
Migratory Wetlands Species		

Name	Threatened	Type of Presence
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat known to occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat known to occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat known to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area
Charadrius veredus Oriental Plover, Oriental Dotterel [882]		Species or species habitat may occur within area
Glareola maldivarum Oriental Pratincole [840]		Species or species habitat may occur within area
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat known to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area
Pandion haliaetus Osprey [952]		Breeding known to occur within area
Thalasseus bergii Crested Tern [83000]		Breeding known to occur within area
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat likely to occur within area

Other Matters Protected by the EPBC Act

Commonwealth Land [Resource Information]

The Commonwealth area listed below may indicate the presence of Commonwealth land in this vicinity. Due to the unreliability of the data source, all proposals should be checked as to whether it impacts on a Commonwealth area, before making a definitive decision. Contact the State or Territory government land department for further information.

Name
Defence - EXMOUTH ADMIN & HF TRANSMITTING
Defence - EXMOUTH VLF TRANSMITTER STATION
Defence - LEARMONTH RADAR SITE - VLAMING HEAD EXMOUTH

Commonwealth Heritage Places [Resource Information]

Name	State	Status
Natural		
Ningaloo Marine Area - Commonwealth Waters	WA	Listed place

Listed Marine Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Birds		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat known to occur

Name	Threatened	Type of Presence
		within area
Anous stolidus Common Noddy [825]		Species or species habitat likely to occur within area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardea alba Great Egret, White Egret [59541]		Species or species habitat known to occur within area
Ardea ibis Cattle Egret [59542]		Species or species habitat may occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat known to occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat known to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area
Calonectris leucomelas Streaked Shearwater [1077]		Species or species habitat likely to occur within area
Charadrius veredus Oriental Plover, Oriental Dotterel [882]		Species or species habitat may occur within area
Chrysococcyx osculans Black-eared Cuckoo [705]		Species or species habitat known to occur within area
Fregata ariel Lesser Frigatebird, Least Frigatebird [1012]		Species or species habitat known to occur within area
Fregata minor Great Frigatebird, Greater Frigatebird [1013]		Species or species habitat may occur within area
Glareola maldivarum Oriental Pratincole [840]		Species or species habitat may occur within area
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat known to occur within area
Hirundo rustica Barn Swallow [662]		Species or species habitat may occur within area
Larus novaehollandiae Silver Gull [810]		Breeding known to occur within area
Larus pacificus Pacific Gull [811]		Foraging, feeding or related behaviour known to occur within area

Name	Threatened	Type of Presence
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat known to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area
Motacilla cinerea Grey Wagtail [642]		Species or species habitat may occur within area
Motacilla flava Yellow Wagtail [644]		Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area
Pandion haliaetus Osprey [952]		Breeding known to occur within area
Papasula abbotti Abbott's Booby [59297]	Endangered	Species or species habitat may occur within area
Phaethon lepturus White-tailed Tropicbird [1014]		Foraging, feeding or related behaviour likely to occur within area
Pterodroma mollis Soft-plumaged Petrel [1036]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Puffinus carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [1043]		Species or species habitat likely to occur within area
Puffinus pacificus Wedge-tailed Shearwater [1027]		Breeding known to occur within area
Rostratula benghalensis (sensu lato) Painted Snipe [889]	Endangered*	Species or species habitat may occur within area
Sterna anaethetus Bridled Tern [814]		Breeding known to occur within area
Sterna bengalensis Lesser Crested Tern [815]		Breeding known to occur within area
Sterna bergii Crested Tern [816]		Breeding known to occur within area
Sterna caspia Caspian Tern [59467]		Breeding known to occur within area
Sterna dougallii Roseate Tern [817]		Breeding known to occur within area
Sterna fuscata Sooty Tern [794]		Breeding known to occur within area

Name	Threatened	Type of Presence
Sterna nereis Fairy Tern [796]		Breeding known to occur within area
Thalassarche carteri Indian Yellow-nosed Albatross [64464]	Vulnerable	Foraging, feeding or related behaviour may occur within area
Thalassarche cauta Tasmanian Shy Albatross [89224]	Vulnerable*	Species or species habitat may occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Species or species habitat may occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable*	Foraging, feeding or related behaviour likely to occur within area
Thinornis rubricollis Hooded Plover [59510]		Species or species habitat known to occur within area
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat likely to occur within area
Fish		
Acentronura larsonae Helen's Pygmy Pipehorse [66186]		Species or species habitat may occur within area
Bulbonaricus brauni Braun's Pughead Pipefish, Pug-headed Pipefish [66189]		Species or species habitat may occur within area
Campichthys galei Gale's Pipefish [66191]		Species or species habitat may occur within area
Campichthys tricarinatus Three-keel Pipefish [66192]		Species or species habitat may occur within area
Choeroichthys brachysoma Pacific Short-bodied Pipefish, Short-bodied Pipefish [66194]		Species or species habitat may occur within area
Choeroichthys latispinosus Muiron Island Pipefish [66196]		Species or species habitat may occur within area
Choeroichthys suillus Pig-snouted Pipefish [66198]		Species or species habitat may occur within area
Corythoichthys flavofasciatus Reticulate Pipefish, Yellow-banded Pipefish, Network Pipefish [66200]		Species or species habitat may occur within area
Cosmocampus banneri Roughridge Pipefish [66206]		Species or species habitat may occur within area
Doryrhamphus dactyliophorus Banded Pipefish, Ringed Pipefish [66210]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
Doryrhamphus excisus Bluestripe Pipefish, Indian Blue-stripe Pipefish, Pacific Blue-stripe Pipefish [66211]		Species or species habitat may occur within area
Doryrhamphus janssi Cleaner Pipefish, Janss' Pipefish [66212]		Species or species habitat may occur within area
Doryrhamphus multiannulatus Many-banded Pipefish [66717]		Species or species habitat may occur within area
Doryrhamphus negrosensis Flagtail Pipefish, Masthead Island Pipefish [66213]		Species or species habitat may occur within area
Festucalex scalaris Ladder Pipefish [66216]		Species or species habitat may occur within area
Filicampus tigris Tiger Pipefish [66217]		Species or species habitat may occur within area
Halicampus brocki Brock's Pipefish [66219]		Species or species habitat may occur within area
Halicampus grayi Mud Pipefish, Gray's Pipefish [66221]		Species or species habitat may occur within area
Halicampus nitidus Glittering Pipefish [66224]		Species or species habitat may occur within area
Halicampus spinirostris Spiny-snout Pipefish [66225]		Species or species habitat may occur within area
Haliichthys taeniophorus Ribboned Pipehorse, Ribboned Seadragon [66226]		Species or species habitat may occur within area
Hippichthys penicillus Beady Pipefish, Steep-nosed Pipefish [66231]		Species or species habitat may occur within area
Hippocampus angustus Western Spiny Seahorse, Narrow-bellied Seahorse [66234]		Species or species habitat may occur within area
Hippocampus histrix Spiny Seahorse, Thorny Seahorse [66236]		Species or species habitat may occur within area
Hippocampus kuda Spotted Seahorse, Yellow Seahorse [66237]		Species or species habitat may occur within area
Hippocampus planifrons Flat-face Seahorse [66238]		Species or species habitat may occur within area
Hippocampus spinosissimus Hedgehog Seahorse [66239]		Species or species habitat may occur within area
Hippocampus trimaculatus Three-spot Seahorse, Low-crowned Seahorse, Flat-faced Seahorse [66720]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
Lissocampus fatiloquus Prophet's Pipefish [66250]		Species or species habitat may occur within area
Micrognathus micronotopterus Tidepool Pipefish [66255]		Species or species habitat may occur within area
Nannocampus subosseus Bonyhead Pipefish, Bony-headed Pipefish [66264]		Species or species habitat may occur within area
Phoxocampus belcheri Black Rock Pipefish [66719]		Species or species habitat may occur within area
Solegnathus hardwickii Pallid Pipehorse, Hardwick's Pipehorse [66272]		Species or species habitat may occur within area
Solegnathus lettiensis Gunther's Pipehorse, Indonesian Pipefish [66273]		Species or species habitat may occur within area
Solenostomus cyanopterus Robust Ghostpipefish, Blue-finned Ghost Pipefish, [66183]		Species or species habitat may occur within area
Stigmatopora argus Spotted Pipefish, Gulf Pipefish, Peacock Pipefish [66276]		Species or species habitat may occur within area
Syngnathoides biaculeatus Double-end Pipehorse, Double-ended Pipehorse, Alligator Pipefish [66279]		Species or species habitat may occur within area
Trachyrhamphus bicoarctatus Bentstick Pipefish, Bend Stick Pipefish, Short-tailed Pipefish [66280]		Species or species habitat may occur within area
Trachyrhamphus longirostris Straightstick Pipefish, Long-nosed Pipefish, Straight Stick Pipefish [66281]		Species or species habitat may occur within area
Mammals		
Dugong dugon Dugong [28]		Breeding known to occur within area
Reptiles		
Acalyptophis peronii Horned Seasnake [1114]		Species or species habitat may occur within area
Aipysurus apraefrontalis Short-nosed Seasnake [1115]	Critically Endangered	Species or species habitat known to occur within area
Aipysurus duboisii Dubois' Seasnake [1116]		Species or species habitat may occur within area
Aipysurus eydouxii Spine-tailed Seasnake [1117]		Species or species habitat may occur within area
Aipysurus laevis Olive Seasnake [1120]		Species or species habitat may occur within area
Aipysurus pooleorum Shark Bay Seasnake [66061]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
Aipysurus tenuis Brown-lined Seasnake [1121]		Species or species habitat may occur within area
Astrotia stokesii Stokes' Seasnake [1122]		Species or species habitat may occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Breeding known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Breeding known to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Foraging, feeding or related behaviour known to occur within area
Disteira kingii Spectacled Seasnake [1123]		Species or species habitat may occur within area
Disteira major Olive-headed Seasnake [1124]		Species or species habitat may occur within area
Emydocephalus annulatus Turtle-headed Seasnake [1125]		Species or species habitat may occur within area
Ephalophis greyi North-western Mangrove Seasnake [1127]		Species or species habitat may occur within area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Breeding known to occur within area
Hydrelaps darwiniensis Black-ringed Seasnake [1100]		Species or species habitat may occur within area
Hydrophis czeblukovi Fine-spined Seasnake [59233]		Species or species habitat may occur within area
Hydrophis elegans Elegant Seasnake [1104]		Species or species habitat may occur within area
Hydrophis mcdowelli null [25926]		Species or species habitat may occur within area
Hydrophis ornatus Spotted Seasnake, Ornate Reef Seasnake [1111]		Species or species habitat may occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Breeding known to occur within area
Pelamis platurus Yellow-bellied Seasnake [1091]		Species or species habitat may occur within area

Whales and other Cetaceans [Resource Information]

Name	Status	Type of Presence
Mammals		
Balaenoptera acutorostrata Minke Whale [33]		Species or species habitat may occur within area

Name	Status	Type of Presence
Balaenoptera bonaerensis Antarctic Minke Whale, Dark-shoulder Minke Whale [67812]		Species or species habitat likely to occur within area
Balaenoptera borealis Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Balaenoptera edeni Bryde's Whale [35]		Species or species habitat likely to occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Migration route known to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Delphinus delphis Common Dophin, Short-beaked Common Dolphin [60]		Species or species habitat may occur within area
Eubalaena australis Southern Right Whale [40]	Endangered	Species or species habitat likely to occur within area
Feresa attenuata Pygmy Killer Whale [61]		Species or species habitat may occur within area
Globicephala macrorhynchus Short-finned Pilot Whale [62]		Species or species habitat may occur within area
Grampus griseus Risso's Dolphin, Grampus [64]		Species or species habitat may occur within area
Indopacetus pacificus Longman's Beaked Whale [72]		Species or species habitat may occur within area
Kogia breviceps Pygmy Sperm Whale [57]		Species or species habitat may occur within area
Kogia simus Dwarf Sperm Whale [58]		Species or species habitat may occur within area
Lagenodelphis hosei Fraser's Dolphin, Sarawak Dolphin [41]		Species or species habitat may occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Congregation or aggregation known to occur within area
Mesoplodon densirostris Blainville's Beaked Whale, Dense-beaked Whale [74]		Species or species habitat may occur within area
Mesoplodon ginkgodens Gingko-toothed Beaked Whale, Gingko-toothed Whale, Gingko Beaked Whale [59564]		Species or species habitat may occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat may occur within area
Peponocephala electra Melon-headed Whale [47]		Species or species

Name	Status	Type of Presence
		habitat may occur within area
Physeter macrocephalus Sperm Whale [59]		Species or species habitat may occur within area
Pseudorca crassidens False Killer Whale [48]		Species or species habitat likely to occur within area
Sousa chinensis Indo-Pacific Humpback Dolphin [50]		Species or species habitat known to occur within area
Stenella attenuata Spotted Dolphin, Pantropical Spotted Dolphin [51]		Species or species habitat may occur within area
Stenella coeruleoalba Striped Dolphin, Euphrosyne Dolphin [52]		Species or species habitat may occur within area
Stenella longirostris Long-snouted Spinner Dolphin [29]		Species or species habitat may occur within area
Steno bredanensis Rough-toothed Dolphin [30]		Species or species habitat may occur within area
Tursiops aduncus Indian Ocean Bottlenose Dolphin, Spotted Bottlenose Dolphin [68418]		Species or species habitat likely to occur within area
Tursiops aduncus (Arafura/Timor Sea populations) Spotted Bottlenose Dolphin (Arafura/Timor Sea populations) [78900]		Species or species habitat known to occur within area
Tursiops truncatus s. str. Bottlenose Dolphin [68417]		Species or species habitat may occur within area
Ziphius cavirostris Cuvier's Beaked Whale, Goose-beaked Whale [56]		Species or species habitat may occur within area

Australian Marine Parks [Resource Information]

Name	Label
Argo-Rowley Terrace	Multiple Use Zone (IUCN VI)
Dampier	Habitat Protection Zone (IUCN IV)
Dampier	Multiple Use Zone (IUCN VI)
Dampier	National Park Zone (IUCN II)
Gascoyne	Habitat Protection Zone (IUCN IV)
Gascoyne	Multiple Use Zone (IUCN VI)
Montebello	Multiple Use Zone (IUCN VI)
Ningaloo	National Park Zone (IUCN II)
Ningaloo	Recreational Use Zone (IUCN IV)
Shark Bay	Multiple Use Zone (IUCN VI)

Extra Information

State and Territory Reserves [Resource Information]

Name	State
Airlie Island	WA
Barrow Island	WA
Bessieres Island	WA
Boodie, Double Middle Islands	WA
Bundegi Coastal Park	WA
Cape Range	WA
Jurabi Coastal Park	WA

Name	State
Lowendal Islands	WA
Montebello Islands	WA
Muiron Islands	WA
Round Island	WA
Serrurier Island	WA
Unnamed WA36913	WA
Unnamed WA36915	WA
Unnamed WA40322	WA
Unnamed WA40828	WA
Unnamed WA40877	WA
Unnamed WA41080	WA
Unnamed WA44665	WA

Invasive Species [Resource Information]

Weeds reported here are the 20 species of national significance (WoNS), along with other introduced plants that are considered by the States and Territories to pose a particularly significant threat to biodiversity. The following feral animals are reported: Goat, Red Fox, Cat, Rabbit, Pig, Water Buffalo and Cane Toad. Maps from Landscape Health Project, National Land and Water Resouces Audit, 2001.

Name	Status	Type of Presence
Birds		
Columba livia		
Rock Pigeon, Rock Dove, Domestic Pigeon [803]		Species or species habitat likely to occur within area
Mammals		
Canis lupus familiaris		
Domestic Dog [82654]		Species or species habitat likely to occur within area
Capra hircus		
Goat [2]		Species or species habitat likely to occur within area
Equus caballus		
Horse [5]		Species or species habitat likely to occur within area
Felis catus		
Cat, House Cat, Domestic Cat [19]		Species or species habitat likely to occur within area
Mus musculus		
House Mouse [120]		Species or species habitat likely to occur within area
Oryctolagus cuniculus		
Rabbit, European Rabbit [128]		Species or species habitat likely to occur within area
Rattus rattus		
Black Rat, Ship Rat [84]		Species or species habitat likely to occur within area
Vulpes vulpes		
Red Fox, Fox [18]		Species or species habitat likely to occur within area
Plants		
Cenchrus ciliaris		
Buffel-grass, Black Buffel-grass [20213]		Species or species habitat likely to occur within area
Jatropha gossypifolia		
Cotton-leaved Physic-Nut, Bellyache Bush, Cotton-leaf Physic Nut, Cotton-leaf Jatropha, Black Physic Nut [7507]		Species or species habitat likely to occur within area
Parkinsonia aculeata		
Parkinsonia, Jerusalem Thorn, Jelly Bean Tree,		Species or species

Name	Status	Type of Presence
Horse Bean [12301]		habitat likely to occur within area
Prosopis spp.		
Mesquite, Algaroba [68407]		Species or species habitat likely to occur within area
Reptiles		
Hemidactylus frenatus		
Asian House Gecko [1708]		Species or species habitat likely to occur within area
Ramphotyphlops braminus		
Flowerpot Blind Snake, Brahminy Blind Snake, Cacing Besi [1258]		Species or species habitat likely to occur within area

Nationally Important Wetlands [Resource Information]

Name	State
Cape Range Subterranean Waterways	WA

Key Ecological Features (Marine) [Resource Information]

Key Ecological Features are the parts of the marine ecosystem that are considered to be important for the biodiversity or ecosystem functioning and integrity of the Commonwealth Marine Area.

Name	Region
Ancient coastline at 125 m depth contour	North-west
Canyons linking the Cuvier Abyssal Plain and the	North-west
Commonwealth waters adjacent to Ningaloo Reef	North-west
Continental Slope Demersal Fish Communities	North-west
Exmouth Plateau	North-west
Glomar Shoals	North-west

Caveat

The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the Environment Protection and Biodiversity Conservation Act 1999. It holds mapped locations of World and National Heritage properties, Wetlands of International and National Importance, Commonwealth and State/Territory reserves, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various resolutions.

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the qualifications below and may need to seek and consider other information sources.

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Threatened, migratory and marine species distributions have been derived through a variety of methods. Where distributions are well known and if time permits, maps are derived using either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc) together with point locations and described habitat; or environmental modelling (MAXENT or BIOCLIM habitat modelling) using point locations and environmental data layers.

Where very little information is available for species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc). In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More reliable distribution mapping methods are used to update these distributions as time permits.

Only selected species covered by the following provisions of the EPBC Act have been mapped:

- migratory and
- marine

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:

- threatened species listed as extinct or considered as vagrants
- some species and ecological communities that have only recently been listed
- some terrestrial species that overfly the Commonwealth marine area
- migratory species that are very widespread, vagrant, or only occur in small numbers

The following groups have been mapped, but may not cover the complete distribution of the species:

- non-threatened seabirds which have only been mapped for recorded breeding sites
- seals which have only been mapped for breeding sites near the Australian continent

Such breeding sites may be important for the protection of the Commonwealth Marine environment.

Coordinates

-18.0842970706 117.1426514622,-18.3735488396 117.1243829057,-18.5000004495 117.291598729,-18.5722585117 117.5878096148,-18.2651617453 118.1085674631,-18.4458069028 118.1850089818,-18.3825810978 118.4429991078,-18.7393552818 118.5385510068,-19.0012907589 118.4907750573,-19.0193552744 118.33789202,-19.2451617203 118.3187816397,-19.2722584941 118.2232297416,-19.6064520334 117.9747948043,-19.8791912308 118.1390294739,-19.9710153158 118.1197911542,-20.043034207 117.8850836504,-20.3167059914 117.6542238114,-20.431936216 117.1655704849,-20.561570219 117.0155115895,-20.5399645518 116.9481774692,-20.4283874966 116.9858326535,-20.3606455625 116.9285015142,-20.3312907251 116.8186168302,-20.505161688 116.63945702,-20.8361422401 116.4460573185,-20.9504722289 115.8381264081,-20.9070971613 115.4808902487,-21.3677423114 115.2897864507,-21.6296777884 114.8120269575,-21.6929035933 114.3868210082,-21.9367745548 114.2387155653,-21.8464519761 114.0237237934,-22.5780648605 113.6462937936,-22.9574196901 113.6558489833,-23.1651616195 113.5316315152,-23.345806777 113.5220763255,-23.4270970975 113.3978588564,-23.7612906368 113.2354206294,-24.0683874032 112.891433794,-24.2941938491 112.7576611353,-24.6238712602 112.7098851858,-24.5696777126 112.9726529071,-24.2987099782 113.0682048061,-24.3122583646 113.1971998696,-24.5606454552 113.0538720211,-24.8451615769 112.9965408819,-25.0303228626 112.7863267053,-25.3148389843 112.7289955661,-25.0438712491 112.7146627811,-25.0800002802 112.2321256925,-25.1974196318 111.9932459459,-25.5767744614 111.8929164525,-24.9580647995 112.0362443001,-24.7774196429 112.0171339207,-24.5154841659 112.1891273384,-24.3167744937 112.1222410094,-23.9374196642 112.3706759457,-23.6303228987 112.3706759457,-23.5129035462 112.4662278447,-23.2645164565 112.4757830345,-23.0658067835 112.332455186,-23.1290325884 112.170016958,-22.984516463 112.0744650599,-22.7632261462 112.0840202496,-22.334193899 112.3133448065,-22.2560208176 112.1600491108,-22.2935487388 112.3420103757,-22.0496777773 112.332455186,-21.7109681089 112.7242179708,-21.4354842454 112.685997211,-21.2367745724 113.1159807556,-20.7851616806 113.297529363,-20.3245165314 113.3070845527,-20.0716133126 113.2401982238,-19.8593552531 113.3357501228,-19.7193552568 113.3166397424,-19.6200004208 113.4599675909,-19.6832262257 113.6940697431,-19.5567746159 114.1622740466,-19.6290326781 114.2769363251,-19.430323006 114.4632625268,-19.2180649474 114.3390450587,-19.2090326892 114.1192756915,-18.9922585015 114.1957172111,-18.9245165675 114.1192756915,-19.0238714035 114.859802907,-18.8703230208 115.0652394891,-18.8251617314 115.4092263244,-18.6038714146 115.5621093627,-18.3283875502 115.5429989823,-17.5516133774 116.0494240456,-17.4070972519 116.230972653,-17.5245166036 116.4602972098,-16.9735488757 117.181714045,-17.5561295056 116.598847463,-17.8270972408 116.5415163238,-18.0212907838 116.6084026528,-18.2470972298 116.9141687292,-18.1070972335 117.1291605011,-18.0842970706 117.1426514622

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

- -Office of Environment and Heritage, New South Wales
- -Department of Environment and Primary Industries, Victoria
- -Department of Primary Industries, Parks, Water and Environment, Tasmania
- -Department of Environment, Water and Natural Resources, South Australia
- -Department of Land and Resource Management, Northern Territory
- -Department of Environmental and Heritage Protection, Queensland
- -Department of Parks and Wildlife, Western Australia
- -Environment and Planning Directorate, ACT
- -Birdlife Australia
- -Australian Bird and Bat Banding Scheme
- -Australian National Wildlife Collection
- -Natural history museums of Australia
- -Museum Victoria
- -Australian Museum
- -South Australian Museum
- -Queensland Museum
- -Online Zoological Collections of Australian Museums
- -Queensland Herbarium
- -National Herbarium of NSW
- -Royal Botanic Gardens and National Herbarium of Victoria
- -Tasmanian Herbarium
- -State Herbarium of South Australia
- -Northern Territory Herbarium
- -Western Australian Herbarium
- -Australian National Herbarium, Canberra
- -University of New England
- -Ocean Biogeographic Information System
- -Australian Government, Department of Defence
- Forestry Corporation, NSW
- -Geoscience Australia
- -CSIRO
- -Australian Tropical Herbarium, Cairns
- -eBird Australia
- -Australian Government – Australian Antarctic Data Centre
- -Museum and Art Gallery of the Northern Territory
- -Australian Government National Environmental Science Program
- -Australian Institute of Marine Science
- -Reef Life Survey Australia
- -American Museum of Natural History
- -Queen Victoria Museum and Art Gallery, Inveresk, Tasmania
- -Tasmanian Museum and Art Gallery, Hobart, Tasmania
- -Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the Contact Us page.

Department of the Environment
GPO Box 787
Canberra ACT 2601 Australia
+61 2 6274 1111

Appendix D: Evidence of Environment Plan Consultation

Stakeholder Consultation

Copy of Notification Advice

From: Consultation, Quadrant
Bcc: [redacted]
Subject: Santos | Reindeer Wellhead Platform and Pipeline Environment Plans
Date: Thursday, 23 May 2019 5:13:00 PM
Attachments: Santos Reindeer DC EP Revision Consultation Package.pdf
image001.jpg
image002.jpg
image003.jpg
image004.jpg

Dear stakeholders,

Please be advised Santos Limited (Santos) is preparing to revise the Reindeer Wellhead Platform and Offshore Gas Supply Pipeline Operations EP (Commonwealth waters) and the Devil Creek Gas Supply Pipeline and Sales Gas Pipeline Operations EP (Onshore and State Waters).

As outlined in attached consultation material, Santos is required to revise operational EP's every five years. Primarily, these EPs will be remaining consistent with the previous revisions accepted by the relevant regulators.

In relation to the Reindeer Wellhead Platform and Offshore Gas Supply Pipeline Operations EP, please be aware recent amendments to the Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009 (the Environment Regulations) require NOPSEMA to publish a copy of a proponent's EP upon submission and again upon acceptance.

As a relevant stakeholder you are invited to provide comments on this EP. All correspondence relating to the Reindeer Wellhead Platform and Offshore Gas Supply Pipeline Operations EP will be contained in the consultation report that is provided to NOPSEMA by Santos, as required by the Environment Regulations. Santos will not use or disclose your personal information in this report.

If you do not wish for your comments to be published in this EP, or wish to provide your comments anonymously, you should make this known to Santos when you respond to this document.

If you wish to discuss this consultation material further please provide comment by June 24, 2019.

Kind regards

[redacted]

h[redacted]/

From: [redacted]
[redacted]
Subject: Santos | Reindeer Wellhead Platform and Pipeline Environment Plans
Date: Thursday, 23 May 2019 6:05:00 PM
Attachments: Santos Reindeer DC EP Revision Consultation Package.pdf
image001.jpg
image005.jpg
image006.jpg
image007.jpg

Dear stakeholders,

Please be advised Santos Limited (Santos) is preparing to revise the Reindeer Wellhead Platform and Offshore Gas Supply Pipeline Operations EP (Commonwealth waters) and the Devil Creek Gas Supply Pipeline and Sales Gas Pipeline Operations EP (Onshore and State Waters).

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Kind regards

[redacted]

h[redacted]/

From: [redacted]
[redacted] [redacted]
Subject: Santos | Reindeer Wellhead Platform and Pipeline Environment Plans
Date: Thursday, 30 May 2019 3:50:00 PM
Attachments: Santos Reindeer DC EP Revision Consultation Package.pdf
image001.jpg
image014.jpg
image015.jpg
image016.jpg
image017.jpg
image018.jpg
image019.jpg

Hi [redacted]

Further to our phone conversation earlier this week, please find attached the Consultation Package for Reindeer Wellhead Platform and Pipeline Environment Plans.

I will ensure you are included in all future correspondence.

Kind regards

[redacted]

[redacted]

From: [redacted]
Sent: Thursday, 23 May 2019 6:05 PM
Subject: Santos | Reindeer Wellhead Platform and Pipeline Environment Plans

Dear stakeholders,

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If you wish to discuss this consultation material further please provide comment by June 24, 2019.

Kind regards

[redacted]

[redacted]

From: [redacted]
To: [redacted]
[redacted] [redacted]
Subject: FW: Santos | Reindeer Wellhead Platform and Pipeline Environment Plans
Date: Wednesday, 12 June 2019 4:13:00 PM
Attachments: Santos Reindeer DC EP Revision Consultation Package.pdf
image001.jpg
2019 Jun 12 - Santos Limited Quarterly Consultation Update - WAFIC FEEDBACK.msg
image014.jpg
image015.jpg
image016.jpg
image017.jpg
image018.jpg
image019.jpg

Hi [redacted]

Thank you for your email (attached) in response to the June Quarterly Consultation Update. I must sincerely apologise. The consultation package for the Reindeer DC EP revision was sent on 23 May 2019 and a check of the recipients confirms that I entered your email address incorrectly, hence you did not receive it.

I have now corrected the address I have for you, and again, sincere apologies.

If you have any questions on the attached, please don't hesitate to call.

Kind regards

[redacted]

[redacted]

[redacted]

From: [redacted]
Sent: Thursday, 23 May 2019 5:14 PM
Subject: Santos | Reindeer Wellhead Platform and Pipeline Environment Plans

Dear stakeholders,

Please be advised Santos Limited (Santos) is preparing to revise the Reindeer Wellhead Platform and Offshore Gas Supply Pipeline Operations EP (Commonwealth waters) and the Devil Creek Gas Supply Pipeline and Sales Gas Pipeline Operations EP (Onshore and State Waters).

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If you wish to discuss this consultation material further please provide comment by June 24, 2019.

Kind regards

[redacted]

[redacted]

From: [redacted]
[redacted] [redacted]
Subject: Santos | Reindeer Wellhead Platform and Pipeline Environment Plans
Date: Thursday, 4 July 2019 8:10:00 AM
Attachments: Santos Reindeer DC EP Revision Consultation Package.pdf
image001.jpg
image005.jpg
image006.jpg
image007.jpg

Dear stakeholders,

Please be advised Santos Limited (Santos) is preparing to revise the Reindeer Wellhead Platform and Offshore Gas Supply Pipeline Operations EP (Commonwealth waters) and the Devil Creek Gas Supply Pipeline and Sales Gas Pipeline Operations EP (Onshore and State Waters).

As outlined in attached consultation material, Santos is required to revise operational EP's every five years. Primarily, these EPs will be remaining consistent with the previous revisions accepted by the relevant regulators.

In relation to the Reindeer Wellhead Platform and Offshore Gas Supply Pipeline Operations EP, please be aware recent amendments to the Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009 (the Environment Regulations) require NOPSEMA to publish a copy of a proponent's EP upon submission and again upon acceptance.

As a relevant stakeholder you are invited to provide comments on this EP. All correspondence relating to the Reindeer Wellhead Platform and Offshore Gas Supply Pipeline Operations EP will be contained in the consultation report that is provided to NOPSEMA by Santos, as required by the Environment Regulations. Santos will not use or disclose your personal information in this report.

If you do not wish for your comments to be published in this EP, or wish to provide your comments anonymously, you should make this known to Santos when you respond to this document.

We welcome any comments you may wish to make on this consultation material.

Kind regards

[redacted]

[redacted]

Stakeholder Consultation

Copy of Consultation Pack

Santos

Reindeer Wellhead Platform and Pipeline Environment Plans for Commonwealth and State Waters

Santos Limited (Santos) is the operator of the Reindeer Wellhead Platform (WHP) and associated wells within permit area WA-41-L, and the associated offshore gas supply pipeline (WA-18-PL) located approximately 80 km offshore north-west of Dampier.

Santos is also the operator of the:

+ Devil Creek Gas Plant (DCGP), located approximately 45 km south west of Karratha, WA, that ties into the offshore Reindeer gas field;
+ Reindeer offshore gas supply pipeline in State waters within permit area TPL20;
+ Onshore portion of the gas supply pipeline (underground) in permit PL81; and
+ Onshore Devil Creek sales gas export pipeline (underground) in permit PL86 from the DCGP to the Dampier to Bunbury Natural Gas Pipeline.

Background

This Consultation Package relates to the five-yearly regulatory revision of the two Environment Plans (EPs) which govern activities at the Reindeer Wellhead platform and the offshore and onshore pipeline:

+ Devil Creek Gas Supply Pipeline and Sales Gas Pipeline Operations EP for Onshore and State waters which was previously approved by the Department of Mines, Industry Regulation and Safety in August 2014; and
+ Reindeer Wellhead Platform and Offshore Gas Supply Pipeline Operations EP which was previously accepted by the National Offshore Petroleum Safety and Environment Management Authority in July 2014.

Facility	Water Depth	Latitude	Longitude	Exclusion zone
Reindeer Wellhead Platform	58.7 m	20°01'26.738"	116°18'35.021"	500 m plus 2.5 nm cautionary zone

Activity overview

Reindeer Wellhead platform

The Reindeer field has three production wells which are tied back to the WHP. There is a charted 500m exclusion zone around the Reindeer WHP.

There is another well, Reindeer-1, which is temporarily abandoned and not connected to the WHP. This is marked on charts but does not have an exclusion zone.

The Reindeer WHP is a normally unmanned facility and visits to the WHP are generally conducted via helicopter utilising the helideck, or may be conducted via vessels.

Offshore pipeline

The offshore pipeline is marked on nautical charts and runs from the Reindeer WHP to a shoreline crossing point. Approximately 48km of the pipeline is within State waters, and approximately 43km length is in Commonwealth waters.

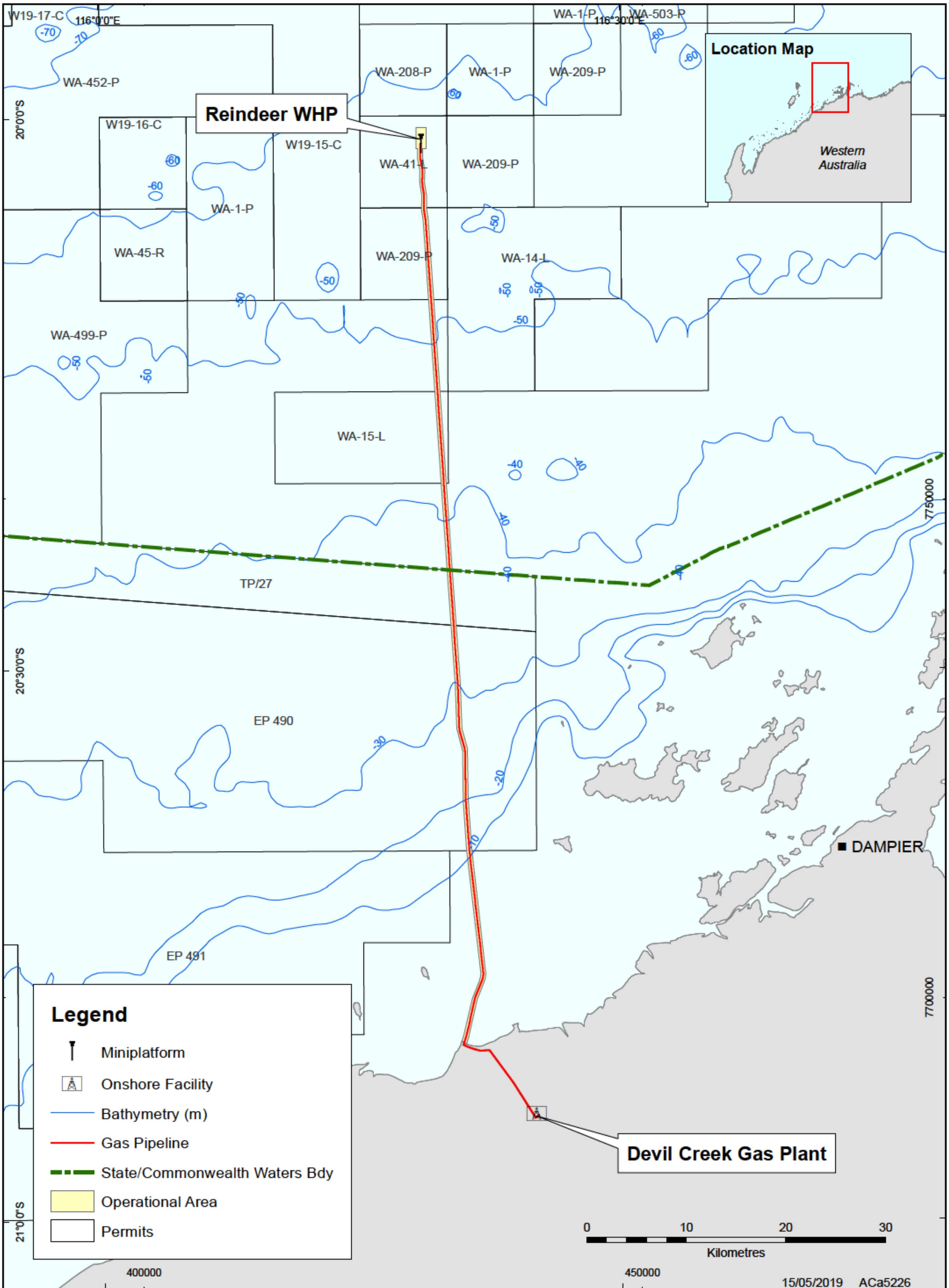
Onshore pipeline

The onshore pipeline is 11.1 km in length from the mean low water mark buried within the Forty Mile Beach Road Reserve adjacent to Mardie Station and Karratha Station pastoral leases to the DCGP.

Inspection, repair and maintenance

To support Santos' ongoing safe and reliable operations, inspection, maintenance and repair activities are regularly conducted to ensure safe and reliable operations.

These activities may require additional vessels in the field. If activities have the potential to result in significant change to the facility or to environmental or social impacts, additional stakeholder engagement or environmental approvals may be required.



Santos

REINDEER & DEVIL CREEK FACILITIES
LOCATION MAP

Environmental management

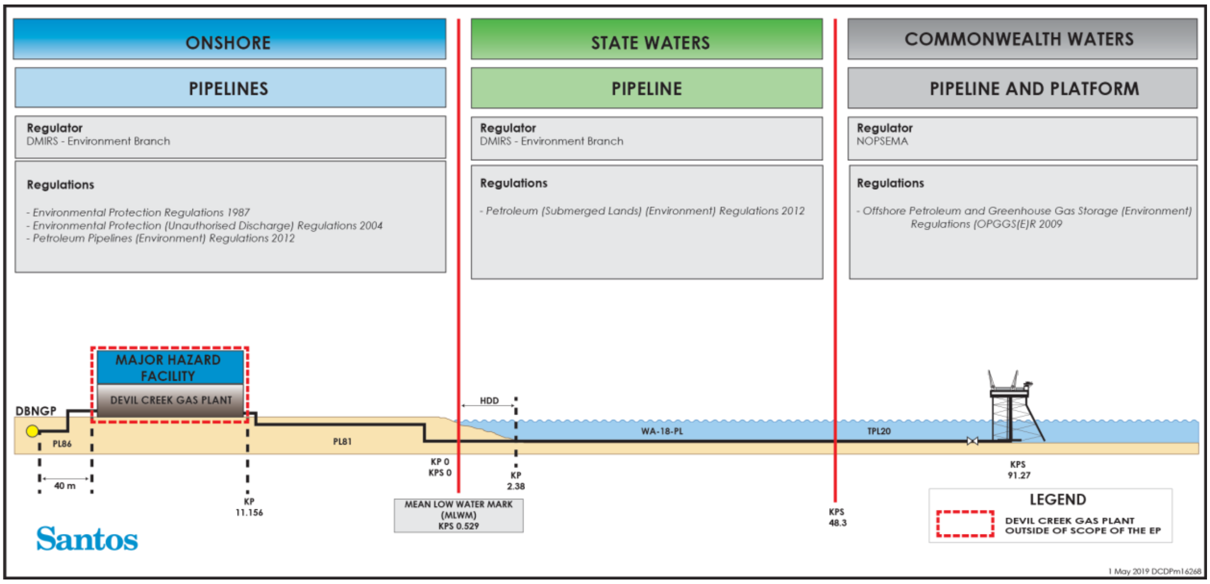
Santos understands retaining a broad licence to operate depends on the development and maintenance of positive and constructive relationships with a comprehensive set of stakeholders. To allow an informed assessment by stakeholders of the potential impact of Santos' activities, this consultation material includes information on planned and unplanned events. In addition this table includes a high level overview of measures in place to manage or mitigate the associated impacts and risks.

Potential risks and/or impacts	Management measures
Light emissions	+ Lighting is minimised to that required for safety and navigational purposes. + There is no lighting along the onshore pipeline.
Underwater noise impacts	+ Santos has measures in place for interacting with protected marine fauna as per the EPBC Regulations (Part 8).
Atmospheric emissions	+ All vessels must follow relevant operating and maintenance procedures to minimised process upsets. + MARPOL requirements will be implemented as per vessel class.
Interactions with other marine users	+ Quadrant's existing infrastructure is marked on nautical charts. + A 500 m petroleum safety zone is in place around the Reindeer wellhead platform.
Disturbance to seabed	+ All offshore activities will be managed in accordance with Santos' lifting and transfer procedure and anchoring restrictions.
Planned discharges to the marine environment	+ Routine discharges from facilities and vessels will meet legal requirements. + Chemical use will be managed in accordance with Santos' Chemical Selection Procedure + All visitors to Reindeer Wellhead platform will undergo relevant inductions and training.
Invasive marine species	+ Vessels and equipment will be assessed and managed to reduce the risk of invasive marine species. + Santos contracted vessels comply with Australian ballast water requirements.
Marine fauna interaction	+ Santos has measures in place for interacting with protected marine fauna as per the EPBC Regulations (Part 8).
Unplanned releases including hydrocarbons	+ Santos Waste Management Plan allows for the safe and environmentally responsible manner that prevents accidental loss to the environment. + All offshore activities will be managed in accordance with Santos' lifting and transfer procedure. + All personnel undertaking activities will undergo relevant inductions and training. + Santos has procedures for equipment maintenance, inspections and bunding. + Appropriate spill response plans, equipment and materials will be in place and maintained.
Terrestrial impacts due to onshore pipeline maintenance and inspection	+ The risk of the introduction of terrestrial non-indigenous species as a result of Santos operations is managed in accordance with Santos' Quarantine Procedure. + Permit to work system in place + Impacts from vehicle access is limited as the pipeline is adjacent to forty mile beach road (public access road)

Regulators

The section of offshore gas supply pipeline and onshore pipeline covered within the State EP reside within the WA State jurisdictional boundary and therefore are subject to State legislation.

The Reindeer WHP and section of offshore gas supply pipeline covered within the Commonwealth EP reside within the Commonwealth jurisdictional boundary and therefore are subject to Commonwealth legislation.



Providing feedback

Santos commits to providing all stakeholder feedback to both State and Commonwealth regulators within relevant EPs.

Please be aware recent amendments to the Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009 (the Environment Regulations) require NOPSEMA to publish a copy of a proponent’s EP upon submission and again upon acceptance.

As a relevant stakeholder you are invited to provide comments on this EP. All correspondence relating to the Reindeer Wellhead Platform and Offshore Gas Supply Pipeline Operations EP will be contained in the consultation report that is provided to NOPSEMA by Santos, as required by the Environment Regulations. Santos will not use or disclose your personal information in this report.

If you do not wish for your comments to be published in this EP, or wish to provide your comments anonymously, you should make this known to Santos when you respond to this document.

If you wish to discuss this consultation material further please provide comment by June 24, 2019.

Consultation Adviser
Santos Limited
[redacted]

Stakeholder Consultation

Copy of Quarterly Consultation Update

Quarterly Consultation Update

Santos

June 2019

This update outlines planned activities by Santos Limited (Santos) in Western Australia through Q3 2019 to Q4 2019. It is intended to provide advanced notification to enable stakeholders to identify activities that may impact them, or for which more information is sought.

This document is provided in accordance with State and Commonwealth regulatory consultation guidelines, and can be supplemented with detailed project information packages or briefing sessions from Santos by request to the contact details provided below.

Please note that scheduling of the activities described in this update is subject to vessel and equipment availability and receipt of all necessary approvals, therefore the timing indicated may be subject to change. If there are any significant changes made to the scheduling indicated, stakeholders will be advised.

A summary of Santos' current operating facilities is also provided.

The spatial locations of activities described throughout this document can be found in the tables within, and in figures at the end of this update.

Potential impact to stakeholder interests

When reviewing Santos' activities within this document, please consider how they may impact your area of interest as an individual stakeholder.

Impacts to stakeholders may include exclusion zones for short and long term projects. For example, the gazetted exclusion zone around a drilling rig is 500 metres (m), while the exclusion zone around a slow-moving vessel, towing seismic streamers, can be larger.

This may impact access by mariners to an area during a proposed activity. Santos recommends stakeholders assess all information provided and seek additional information if required.

Operational activities relate to operating facilities at Varanus Island, Burrup Pipeline, Devil Creek and the *Ningaloo Vision* FPSO. These facilities have an existing exclusion zone which has been in place for an extended period of time.

Thank you for taking the time to review this update. Stakeholder feedback is valuable before, during and after activities, so if you have any concerns or queries relating to the activities described in this document, please feel free to contact us at the email below.

Contact Us

[redacted]

Proposed Western Australia offshore activities

This table gives key information on upcoming activities that are proposed to occur from Q3 2019

Activity Name	Type of Activity	Permit	Latitude	Longitude	Water Depth (approx.)	Start date estimate	Duration estimate	Exclusion zone details
Bedout Basin (Commonwealth waters)	Roc South-1 Drilling	WA-437-P	18° 58’ 04.44” S	118° 50’ 51.51” E	94 m	Q3 – 4 2019	80 days	500 m around MODU
	Dorado 3 Drilling	WA-437-P	19° 01’ 42.01” S	118° 44’ 08.23” E	90 m	Q3 – 4 2019	125 days	500 m around MODU

Current offshore activities

Santos provides an update on ongoing activities in Q3 2019.

Activity Name	Type of Activity	Permit Number	Latitude	Longitude	Water Depth	Cessation date	Exclusion zone
Keraudren (Commonwealth waters)	Seismic Survey	WA-435-P WA-436-P WA-437-P WA-438-P	Coordinates available upon request		50 - 135 m	Must be completed prior to July 31, 2019	3 nautical miles around vessel
Bedout Basin (Commonwealth waters)	Dorado 2 Drilling	WA-437-P	19° 01’ 19.56” S	118° 45’ 04.05” E	91 m	Anticipated mid-late June 2019	500 m around MODU

Completed offshore activities

Santos provides an update on activities previously consulted and now completed.

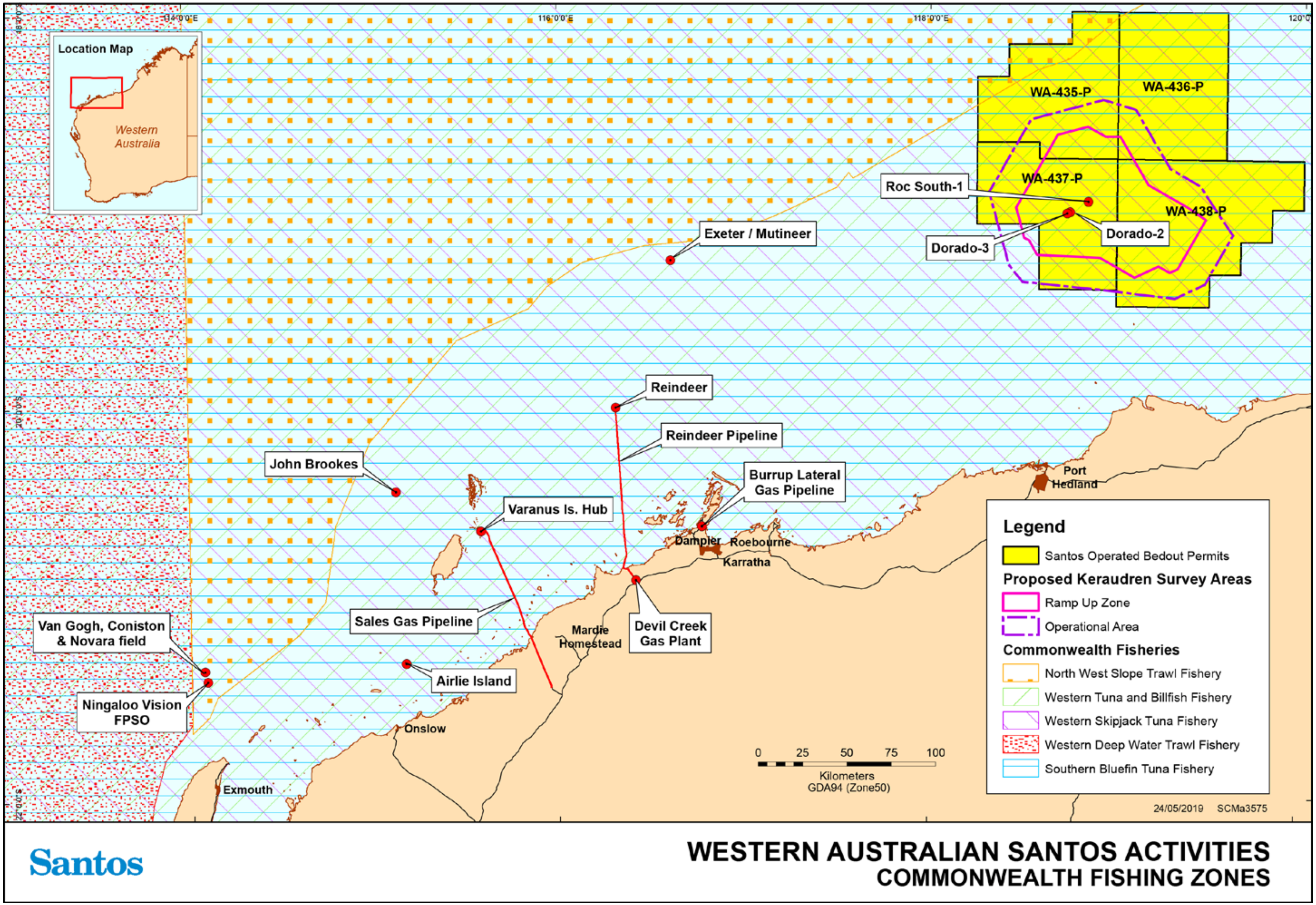
Activity Name	Type of Activity	Permit Number	Water Depth	Latitude	Longitude
Corvus-2 (Commonwealth waters	Exploration Drilling	WA-45-R	63 m	20° 07' 04.91" S	116° 03' 38.66" E
Bedout Basin (Commonwealth waters)	Site Surveys	WA-437-P	90 - 95 m	Coordinates available on request	
Bedout Basin (Commonwealth waters)	Metocean Buoys in situ	WA-435-P WA-437-P	40 – 140 m	Various locations and types of buoys, coordinates available on request	

Santos

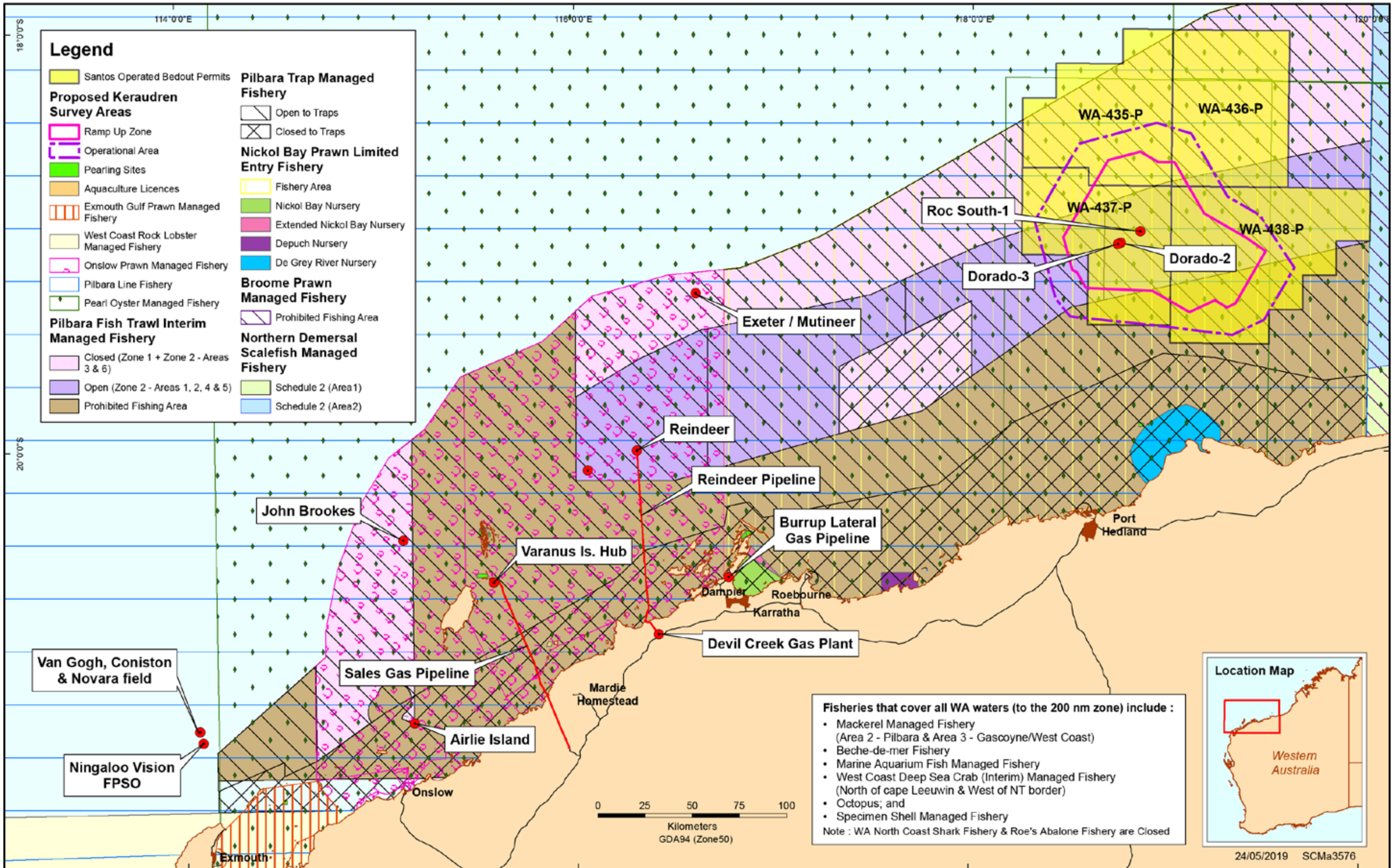
Santos' West Australian operations

Santos provides an overview of existing operations on the North West Shelf.

Operational Activity Name	Type of Activity	Water depth	Exclusion zone	Update
Devil Creek Gas Plant (Reindeer facility, pipeline and gas plant)	Gas Production	Reindeer platform at 61 m	500 m around Reindeer Platform	Ongoing operations The five yearly regulatory revision of the two Environment Plans (EPs) which govern activities for the Reindeer Wellhead Platform and associated infrastructure are currently underway and due for submission in Q3 2019.
Varanus Island Hub (State and Commonwealth waters)	Oil & Gas Production	Various offshore platforms from	500 m around all offshore platforms (coordinates available on request)	Ongoing operations Maintenance activities ongoing in Q3 2019 at Varanus Island Environmental monitoring program ongoing at Varanus Island The five yearly regulatory revision of the two Environment Plans (EPs) which govern activities at the Varanus Island Hub are currently underway and due for submission in Q3 2019.
Mutineer-Exeter Field	Ceased production	130 – 160 m	None	Production from the field has ceased and subsea infrastructure is currently preserved.
Burrup Lateral Gas	Gas Supply	Onshore	Onshore	Ongoing operations
***Ningaloo Vision* FPSO**	Oil Production	340 m	500 m around FPSO	Ongoing operations The five yearly regulatory revision of the *Ningaloo Vision* Operations Environment Plan (EP) is currently underway and due for submission Q2 2020.


Location Map
Western Australia
114°0'0"E
116°0'0"E
118°0'0"E
120°0'
WA-435-P
WA-436-P
WA-437-P
WA-438-P
Roc South-1
Dorado-2
Dorado-3
Exeter / Mutineer
Reindeer
Reindeer Pipeline
John Brookes
Burrup Lateral Gas Pipeline
Port Hedland
Varanus Is. Hub
Dampier
Roebourne
Karratha
Sales Gas Pipeline
Devil Creek Gas Plant
Mardie Homestead
Van Gogh, Coniston & Novara field
Ningaloo Vision FPSO
Airlie Island
Onslow
Exmouth
Legend
Santos Operated Bedout Permits
Proposed Keraudren Survey Areas
Ramp Up Zone
Operational Area
Commonwealth Fisheries
North West Slope Trawl Fishery
Western Tuna and Billfish Fishery
Western Skipjack Tuna Fishery
Western Deep Water Trawl Fishery
Southern Bluefin Tuna Fishery
0 25 50 75 100
Kilometers
GDA94 (Zone50)
24/05/2019 SCMa3575
Santos
WESTERN AUSTRALIAN SANTOS ACTIVITIES
COMMONWEALTH FISHING ZONES

Santos



Santos

WESTERN AUSTRALIAN SANTOS ACTIVITIES
STATE FISHING ZONES

Stakeholder Consultation

Copy of Responses

From: [redacted]
To: [redacted]
Subject: Santos | Reindeer Wellhead Platform and Pipeline Environment Plans [SEC=UNCLASSIFIED]
Date: Thursday, 4 July 2019 3:27:00 PM
Attachments: Santos Reindeer Wellhead Platform and Pipeline Environment Plans SECUNCLASSIFIED.msg

Dear [redacted]

Thank you for your emails of 25 June 2019 (below) and 28 May 2019 (attached) in which you provided guidance on the department's biosecurity requirements for offshore installation operations.

We are working through this information and would welcome the opportunity to meet with you when you are in Perth in mid-August.

In the interim, we will continue to prepare our Environment Plans for submission and acknowledge that we are in ongoing discussions with you to close out our obligations for biosecurity arrangements.

I trust this is suitable and please let me know when you are available to meet in Perth so that I can make the appropriate arrangements.

Kind regards

Santos

[redacted]

h[redacted]

From: [redacted]
Sent: Tuesday, 25 June 2019 1:23 PM
To: [redacted]t Plans
[SEC=UNCLASSIFIED]

Hello [redacted]

Thank you for the comments. We are working through them now and will get back to you if any questions.

Kind regards

[redacted]

[redacted]

From: [redacted]]
Sent: Tuesday, 25 June 2019 11:39 AM
To: [redacted]
Subject: FW: Santos | Reindeer Wellhead Platform and Pipeline Environment Plans [SEC=UNCLASSIFIED]

Dear [redacted]

Thank you for providing the Commonwealth Department of Agriculture (the department) with information regarding the proposed Reindeer Wellhead Platform and Pipeline Environment Plans.

The department safeguards Australia's animal and plant health status to maintain overseas markets and protect the economy and environment from the impact of exotic pests and diseases, through risk assessment inspection and certification and the implementation of emergency response arrangements for Australian agricultural, food and fibre industries. International vessels, aircraft, persons and goods arriving at installations operating within or outside Australian territory present possible pathways for exotic pests and diseases to enter Australia. I have attached a link to the offshore petroleum installations biosecurity guide for your reference.

The Department of Agriculture manages the regulation of ballast water in Australia and has released a Biofouling Consultation Regulation Impact Statement relating to Australia's proposed mandatory biofouling regulations under the Biosecurity Act 2015, with an anticipated implementation in 2020.

The Department considers the implementation of an effective biofouling management plan and biofouling record book in line with the International Maritime Organization's 2011 Biofouling guidelines as integral to any vessel proactively minimising biosecurity risk associated with biofouling. An effective plan would address all activities that a vessel would implement to manage its biofouling during normal operation and set out contingency measures used to mitigate risk where the vessel deviates from its usual operational profile (e.g. extended lay-ups).

Further information on biofouling management and biosecurity requirements can be found at http://www.marinepests.gov.au/commercial/offshore-infrastructure.

We note the Reindeer Wellhead Operations intend to comply with Australia's ballast water regulations, in order to do so all vessels using ballast water must meet the requirements detailed in the Australian Ballast Water Management Requirements.

If you require additional information on requirements under the *Biosecurity Act 2015* for biosecurity risk which includes animals, goods, crew health, hitchhiking pests, biofouling and ballast water management, please do not hesitate to contact us.

Additionally, as I know that this information is a bit overwhelming, I intend to visit Perth in mid-August to talk to a number of offshore installation operations regarding biosecurity. If you would like me to visit you at your office, or if you have any further queries, please let me know.

Thank you,

[redacted]

[redacted]

[redacted]

[redacted]

Australian Government Department of Agriculture
18 Marcus Clarke Street, Canberra ACT 2601 Australia
GPO Box 858 Canberra ACT 2601 Australia

From: [redacted]
Sent: Thursday, 23 May 2019 7:14 PM
Subject: Santos | Reindeer Wellhead Platform and Pipeline Environment Plans [SEC=UNCLASSIFIED]

Dear stakeholders,

Please be advised Santos Limited (Santos) is preparing to revise the Reindeer Wellhead Platform and Offshore Gas Supply Pipeline Operations EP (Commonwealth waters) and the Devil Creek Gas Supply Pipeline and Sales Gas Pipeline Operations EP (Onshore and State Waters).

As outlined in attached consultation material, Santos is required to revise operational EP's every five years. Primarily, these EPs will be remaining consistent with the previous revisions accepted by the relevant regulators.

In relation to the Reindeer Wellhead Platform and Offshore Gas Supply Pipeline Operations EP, please be aware recent amendments to the Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009 (the Environment Regulations) require NOPSEMA to publish a copy of a proponent's EP upon submission and again upon acceptance.

As a relevant stakeholder you are invited to provide comments on this EP. All correspondence relating to the Reindeer Wellhead Platform and Offshore Gas Supply Pipeline Operations EP will be contained in the consultation report that is provided to NOPSEMA by Santos, as required by the Environment Regulations. Santos will not use or disclose your personal information in this report.

If you do not wish for your comments to be published in this EP, or wish to provide your comments anonymously, you should make this known to Santos when you respond to this document.

If you wish to discuss this consultation material further please provide comment by June 24, 2019.

Kind regards

Santos

[redacted]

[redacted]

From: [redacted]
[redacted]
Subject: Santos | Reindeer Wellhead Platform and Pipeline Environment Plans [SEC=UNCLASSIFIED]
Date: Tuesday, 28 May 2019 8:51:35 AM
Attachments: offshore-installations-guide.doc

Hell[redacted]

The Department of Agriculture and Water Resources regulatory framework that affects offshore installations and exposed conveyances may have changed since the last revision of your plans for the Reindeer Wellhead Platform and Ningaloo Vision operations.

Under the Biosecurity Act 2015, installations operating outside of Australian territory will not be subject to provisions of the Act. However, any conveyance which is not subject to biosecurity control when it leaves Australian territory, but which is exposed to an installation once outside Australian territory, will become an exposed conveyance (i.e your support helicopters and vessels). When the exposed conveyance returns to Australian territory, it will become subject to biosecurity control and must do pre-arrival reporting and notification if it intends to unload goods.

To avoid this pre-arrival reporting every time support conveyances to the installation return to Australian waters, there are three options for you to consider. I have attached the department's offshore installation biosecurity guide for your information.
We can discuss what option is best for your operations or you may already have low risk status for the installations and these campaigns.

My contact numbers are below, please contact me at your convenience to discuss how I can help you.
Regards,

[redacted]

Australian Government Department of Agriculture and Water Resources
18 Marcus Clarke Street, Canberra ACT 2601 Australia
GPO Box 858 Canberra ACT 2601 Australia

From: [redacted]
[redacted]
Subject: Santos | Reindeer Wellhead Platform and Pipeline Environment Plans
Date: Thursday, 4 July 2019 11:55:00 AM
Attachments: image002.png

Good morning [redacted]

Thank you for responding on Santos' Reindeer Wellhead Platform and Pipeline Environment Plans.

Please note that Santos will also shortly be submitting its Oil Pollution Emergency Plans to NOPSEMA for the Reindeer Wellhead Platform and Pipeline Environment Plans, as well as the Varanus Island Hub Operations and the Ningaloo Vision Operations, as part of NOPSEMA's 5 year revision requirements. This will also include the Scientific Monitoring Arrangements Santos would be implementing to monitor impacts from a spill.

Can you please let me know if DBCA would like to receive a copy of these plans for information or comment, or discuss further with Santos?

It would also be helpful from our perspective if you could clarify DBCA's expectation for ongoing consultation with Santos in regards to oil spill contingency and scientific plans.

I look forward to your advice and I am more than happy to discuss these matters further if required.

Kind regards

Santos

[redacted]

[redacted]

From: [redacted]
Sent: Thursday, 27 June 2019 3:11 PM
[redacted]
Subject: RE: Santos | Reindeer Wellhead Platform and Pipeline Environment Plans

H [redacted]

Apologies, I had thought I'd responded. Thank you for providing the department with the opportunity to comment on the Reindeer Wellhead Platform and Pipeline Environment Plans. The department has no comments to make at this stage of the plan revisions pursuant to its roles and responsibilities under the *Conservation and Land Management Act 1984* or the *Biodiversity Conservation Act 2016*.

Regards

[redacted]

Parks and Wildlife Service
Department of Biodiversity, Conservation and Attractions
[redacted]

From: [redacted]
Sent: Thursday, 30 May 2019 3:50 PM
To: [redacted]
Subject: Santos | Reindeer Wellhead Platform and Pipeline Environment Plans

H[redacted]

Further to our phone conversation earlier this week, please find attached the Consultation Package for Reindeer Wellhead Platform and Pipeline Environment Plans.

I will ensure you are included in all future correspondence.

Kind regards

Santos

[redacted]

[redacted]

From: [redacted]
Sent: Thursday, 23 May 2019 6:05 PM
Subject: Santos | Reindeer Wellhead Platform and Pipeline Environment Plans

Dear stakeholders,

Please be advised Santos Limited (Santos) is preparing to revise the Reindeer Wellhead Platform and Offshore Gas Supply Pipeline Operations EP (Commonwealth waters) and the Devil Creek Gas Supply Pipeline and Sales Gas Pipeline Operations EP (Onshore and State Waters).

As outlined in attached consultation material, Santos is required to revise operational EP's every five years. Primarily, these EPs will be remaining consistent with the previous revisions accepted by the relevant regulators.

In relation to the Reindeer Wellhead Platform and Offshore Gas Supply Pipeline Operations EP, please be aware recent amendments to the Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009 (the Environment Regulations) require NOPSEMA to publish a copy of a proponent's EP upon submission and again upon acceptance.

As a relevant stakeholder you are invited to provide comments on this EP. All correspondence relating to the Reindeer Wellhead Platform and Offshore Gas Supply Pipeline Operations EP will be contained in the consultation report that is provided to NOPSEMA by Santos, as required by the Environment Regulations. Santos will not use or disclose your personal information in this report.

If you do not wish for your comments to be published in this EP, or wish to provide your comments anonymously, you should make this known to Santos when you respond to this document.

If you wish to discuss this consultation material further please provide comment by June 24, 2019.

Kind regards

Santos

[redacted]

[redacted]

From: [redacted]t
To: [redacted]
Subject: RE: Santos Limited | Quarterly Consultation Update
Date: Thursday, 4 July 2019 11:45:00 AM
Attachments: image013.png
image005.png

H[redacted]

Thanks for your feedback, much appreciated.

Kind regards

Santos

[redacted]

[redacted]

From: [redacted]
Sent: Thursday, 27 June 2019 4:11 PM
To: [redacted]
Subject: RE: Santos Limited | Quarterly Consultation Update

Hi [redacted]

Thanks for keeping DMIRS informed on Santos' activities in State and Commonwealth waters, and apologies for the delay in my response.

The Quarterly Consultation Update has been reviewed and no further information is required at this stage. DMIRS notes Santos plan to submit five year revisions of the *Varanus Island Hub Operations Environment Plan* and the *Devil Creek Gas Supply Pipeline and Sales Gas Pipeline Operations Environment Plan (Onshore & State Waters)* in Q3 2019.

DMIRS has also reviewed the following updates provided by Santos:

- Reindeer Wellhead Platform and Pipeline Environment Plans update provided on 23 May 2019.
- Ningaloo Vision Operations EP Revision update provided on 27 May 2019.
- Noble Tom Prosser - Notice of Arrival provided on 30 May 2019.
- Noble Tom Prosser – Notice of Completion Dorado-2 drilling provided on 14 June 2019.

No further information is required in relation to the above.

If you would like to discuss, feel free to get in contact.

Regards

[redacted]

Department of Mines, Industry Regulation and Safety
[redacted]

We acknowledge Aboriginal and Torres Strait Islander people as the Traditional Custodians of this land on which we deliver our services. We pay our respects to elders and leaders past, present and emerging.

From: [redacted]
Sent: Wednesday, 12 June 2019 2:49 PM
Subject: Santos Limited | Quarterly Consultation Update

Good afternoon,

Please find attached Santos' *Quarterly Consultation Update*, a document providing details of activities Santos plans to undertake from Q3 to Q4 2019.

This document is intended to provide **advanced notification to allow stakeholders to identify activities that may impact them or for which more information is sought**. Information of interest to other marine users (such as commercial fishers), including water depth and exclusion zones, are provided within and a map is provided at the rear of the document.

If you have questions regarding any projects included in this document, please be in touch ASAP. If you would like to arrange to meet with Santos staff for a briefing session regarding the upcoming projects program, please do not hesitate to contact us and that meeting will be arranged.

I thank you for your time and continued support, your acknowledgment of receipt of this email is appreciated.

Thank you

Kind regards

[redacted]

[redacted]

[redacted]

From: [redacted]
[redacted]
Subject: RE: Santos | Reindeer Wellhead Platform and Pipeline Environment Plans
Date: Monday, 8 July 2019 1:51:00 PM

Hello Jade

Much appreciated and thank you for clarifying.

Kind regards

Santos | [redacted]

From: [redacted]
Sent: Friday, 5 July 2019 3:25 PM
To: [redacted]
Subject: [EXT]: RE: Santos | Reindeer Wellhead Platform and Pipeline Environment Plans

Hi Aileen,

If you can please ensure that the OPEP aligns with the requirements of the Department of Transport Offshore Petroleum Industry Guidance Note – Marine Oil Pollution: Response and Consultation Arrangements (September 2018), we are happy with that approach.

Kind Regards,

[redacted]

» CLEAR DIRECTION » FRESH THINKING » EXCELLENT SERVICE » GREAT PEOPLE

From: [redacted]
Sent: Thursday, 4 July 2019 11:23 AM
To [redacted]
Subject: Santos | Reindeer Wellhead Platform and Pipeline Environment Plans

Good morning [redacted]

Thank you for your response on the planned revisions of the Reindeer Wellhead Platform and Offshore Gas Supply Pipeline Operations EP and the Devil Creek Gas Supply Pipeline and Sales Gas Pipeline Operations EP.

The Devil Creek Pipeline and Reindeer Well Head Platform OPEP was last revised and accepted by DMIRS on 7 June 2017 as per their 2.5 year revision requirements. The current revision will be submitted to NOPSEMA by 17 July 2019 as per their 5 year revision requirements. Within the current review for NOPSEMA, we do not believe there are any significant changes to the spill response strategies and spill risks since the last revision provided to DoT. However, a copy of the revised OPEP will be provided to DOT prior to submission to NOPSEMA and we are happy to receive any comments from DOT.

Can you please confirm you are happy with this approach.

Kind regards

Santos

[redacted]

[redacted]

From: [redacted]
Sent: Wednesday, 5 June 2019 9:36 AM
[redacted]
Subject: RE: Santos | Reindeer Wellhead Platform and Pipeline Environment Plans

Hi [redacted]

Thank you for your response on the planned revisions of the Reindeer Wellhead Platform and Offshore Gas Supply Pipeline Operations EP and the Devil Creek Gas Supply Pipeline and Sales Gas Pipeline Operations EP. Your comments will be taken into account in the revision of these plans.

Kind regards

Santos

[redacted]

[redacted]

From: [redacted]
Sent: Tuesday, 4 June 2019 2:58 PM
To: [redacted]
Cc: [redacted]
Subject: RE: Santos | Reindeer Wellhead Platform and Pipeline Environment Plans

Hi [redacted]

Thank you for the notification in regards to the planned revisions of the Reindeer Wellhead Platform and Offshore Gas Supply Pipeline Operations EP and the Devil Creek Gas Supply Pipeline and Sales Gas Pipeline Operations EP. If there are any changes to the corresponding Oil Spill Contingency Plans/Oil Pollution Emergency Plans, or change to spill risk, please ensure that the Department of Transport is consulted in accordance with the requirements outlined in the Department of Transport Offshore Petroleum Industry Guidance Note – Marine Oil Pollution: Response and Consultation Arrangements (September 2018) which can be accessed here
-https://www.transport.wa.gov.au/mediaFiles/marine/MAC_P_Westplan_MOP_OffshorePetroleumIndGuidance.pdf

Kind Regards,

[redacted]

Department of Transport

» CLEAR DIRECTION » FRESH THINKING » EXCELLENT SERVICE » GREAT PEOPLE

From: [redacted]
Sent: Thursday, 23 May 2019 5:14 PM
Subject: Santos | Reindeer Wellhead Platform and Pipeline Environment Plans

Dear stakeholders,

Please be advised Santos Limited (Santos) is preparing to revise the Reindeer Wellhead Platform and Offshore Gas Supply Pipeline Operations EP (Commonwealth waters) and the Devil Creek Gas Supply Pipeline and Sales Gas Pipeline Operations EP (Onshore and State Waters).

As outlined in attached consultation material, Santos is required to revise operational EP's every five years. Primarily, these EPs will be remaining consistent with the previous revisions accepted by the relevant regulators.

In relation to the Reindeer Wellhead Platform and Offshore Gas Supply Pipeline Operations EP, please be aware recent amendments to the Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009 (the Environment Regulations) require NOPSEMA to publish a copy of a proponent's EP upon submission and again upon acceptance.

As a relevant stakeholder you are invited to provide comments on this EP. All correspondence relating to the Reindeer Wellhead Platform and Offshore Gas Supply Pipeline Operations EP will be contained in the consultation report that is provided to NOPSEMA by Santos, as required by the Environment Regulations. Santos will not use or disclose your personal information in this report.

If you do not wish for your comments to be published in this EP, or wish to provide your comments anonymously, you should make this known to Santos when you respond to this document.

If you wish to discuss this consultation material further please provide comment by June 24, 2019.

Kind regards

Santos

[redacted]

[redacted]/

This email and any attachments are confidential and may contain legally privileged and/or copyright material. You should not read, copy, use or disclose any of the information contained in this email without authorisation. If you have received it in error please contact us at once by return email and then delete both emails. There is no warranty that this email is error or virus free.

From: [redacted]
To: [redacted]
Subject: Santos | Reindeer Wellhead Platform and Pipeline Environment Plans and Ningaloo Vision Operations
Date: Thursday, 4 July 2019 11:38:00 AM

Good morning [redacted]

Thank you for your comments on the Reindeer Wellhead Platform and Offshore Gas Supply Pipeline Operations EP and the Ningaloo Vision Operations EP Revision received on 20 June 2019.

In the revision of these EPs, Santos has consulted with the relevant peak fishery bodies, charter operators and Traditional Owner groups, and commits to ongoing consultation with these groups as well as individual commercial fishers and charter operators who fish in the affected areas. Santos is currently in the process of reviewing and updating its FishCube data to verify individual commercial fishers who fish in the affected areas, and commits to ongoing consultation with these fishers as required.

With respect to the corresponding Oil Pollution Emergency Plans (OPEPs) for these EPs we can advise that we have included notification details of the DPIRD spill response officer in these plans as per your correspondence.

The OPEPs developed for these activities contain spill response strategies that have been developed to mitigate impacts to key environmental sensitivities which include marine and coastal habitats, fauna and socio-economic activities. The OPEPs detail the net environmental benefit analysis process that would be followed to verify that strategies and tactics are selected that provide the greatest net benefit to the environment, this considers the spatial and temporal sensitivity of resources at risk, which would include fish habitats, fisheries and fishing activities, where relevant.

The OPEPs detail Santos' oil spill scientific monitoring arrangements that would be implemented in the event of a spill. The scientific monitoring plans provides details of monitoring that would be implemented across all key environmental receptors including arrangements for monitoring fish, fisheries and aquaculture. Santos has identified relevant baseline data for its scientific monitoring plans and outlines the process for collecting further data for impact assessment.

Specifically for the Ningaloo Vision Operations, Santos has considered and incorporated the recommendations published by NOPSEMA on Produced Formation Water in the draft revision of the Ningaloo Vision Operations EP.

Santos would be happy to provide further information on its EPs, OPEPs or Oil Spill Scientific Monitoring Plan and welcomes any comments whether it be specific to the Reindeer Wellhead Platform and Offshore Gas Supply Pipeline Operations EP and the Ningaloo Vision Operations EP or more general in nature.

Kind regards

[redacted]

Santos

[redacted]

[redacted]/

From: [redacted]
Sent: Tuesday, 25 June 2019 1:13 PM
To: [redacted]>
Subject: RE: Santos | Reindeer Wellhead Platform and Pipeline Environment Plans and Ningaloo Vision Operations

Hello [redacted]

Thank you for the comments. Working through them now and will get back to you if any questions.

Kind regards

Santos

[redacted]

[redacted]

From: [redacted]
Sent: Thursday, 20 June 2019 3:18 PM
To: [redacted]
Subject: RE: Santos | Reindeer Wellhead Platform and Pipeline Environment Plans and Ningaloo Vision Operations

Hi [redacted]

Thank you for the information you sent on the 23 May 2019 regarding the Reindeer Wellhead Platform and Offshore Gas Supply Pipeline Operations EP and the Ningaloo Vision Operations EP Revision on the 27 May 2019.

The Department of Primary Industries and Regional Development (Department) requests that Santos consults the following representative bodies as appropriate to the proposed activities:

- Western Australian Fishing Industry Council (WAFIC);
- Pearl Producers Association of WA;
- Recfishwest; and
- Relevant Traditional Owner groups.

The Department also requests that individual commercial fishers and charter operators who fish in the affected area are consulted. Individual commercial fisher and charter operator contact details can be obtained through the Department's public register - Application for a copy of an entry in, or extract from the register http://www.fish.wa.gov.au/Documents/commercial_fishing/r-1_application.pdf.

To determine the relevant fisheries and understand the fish stock in the proposed area, the Departments spatial boundaries are available on at data.wa.gov.au which is central portal for WA government data, fisheries boundaries are available at https://catalogue.data.wa.gov.au/dataset?q=fisheries+guide. This list can then be further analysed by obtaining Fishcube data, which will verify the fisheries and species present in the area of operation. In addition, significant volumes of published literature is available through our Departments website http://www.fish.wa.gov.au/About-Us/Publications/Pages/default.aspx and through scientist staff profiles http://www.fish.wa.gov.au/Sustainability-and-Environment/Fisheries-Science/Pages/Staff-Profiles.aspx.

When requesting data you will need to provide some parameters, these may include: Please note only non-confidential fishing data will be released.

- Time period – financial or calendar years, number of years of data
- Catch – species type, estimated total weight
- Effort – number of active boats
- Fishery – e.g. Pilbara Line, Trap, Trawl
- Block locations – 60 x 60nm or 10nm x 10nm – these blocks are available via our online spatial catalogue (as above)

Pollution Plans

In the event of an oil spill or discharge of any other pollutant into the environment, the Department requests that its spill response officer is contacted by phone (0439 258 575) or by email ([redacted] within 24 hours of Santos reporting the incident to the appropriate authority.

When developing the Oil Pollution Emergency Plan (OPEP), the Department requests that Santos collects and maintains marine baseline data to compare against any post-spill monitoring to determine the nature and extent of any impacts. This data should be made available to the Department upon request.

The Department expects that Santos in its EP has considered and incorporated the recommendations published by NOPSEMA on Produced Formation Water regarding the Ningaloo Vision Operations https://www.nopsema.gov.au/environmental-management/environment-resources/produced-formation-water-oil-in-water/

Spawning grounds and nursery areas for key fish species are particularly vulnerable to the impacts of spills or sudden changes to the marine environment such as water quality, temperature. The Department therefore requests that specific strategies are developed in the EP and/or OPEP to mitigate these risks.

Updated finfish spawning information is attached, this is based on the most current science from relevant scientists, please note that this table was also sent to WAFIC and relevant fishers.

Please contact me if you require any additional information.

Kind regards

[redacted]

[redacted]

From: [redacted]
Sent: Thursday, 23 May 2019 5:14 PM
Subject: Santos | Reindeer Wellhead Platform and Pipeline Environment Plans

Dear stakeholders,

Please be advised Santos Limited (Santos) is preparing to revise the Reindeer Wellhead Platform and Offshore Gas Supply Pipeline Operations EP (Commonwealth waters) and the Devil Creek Gas Supply Pipeline and Sales Gas Pipeline Operations EP (Onshore and State Waters).

As outlined in attached consultation material, Santos is required to revise operational EP's every five years. Primarily, these EPs will be remaining consistent with the previous revisions accepted by the relevant regulators.

In relation to the Reindeer Wellhead Platform and Offshore Gas Supply Pipeline Operations EP, please be aware recent amendments to the Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009 (the Environment Regulations) require NOPSEMA to publish a copy of a proponent's EP upon submission and again upon acceptance.

As a relevant stakeholder you are invited to provide comments on this EP. All correspondence relating to the Reindeer Wellhead Platform and Offshore Gas Supply Pipeline Operations EP will be contained in the consultation report that is provided to NOPSEMA by Santos, as required by the Environment Regulations. Santos will not use or disclose your personal information in this report.

If you do not wish for your comments to be published in this EP, or wish to provide your comments anonymously, you should make this known to Santos when you respond to this document.

If you wish to discuss this consultation material further please provide comment by June 24, 2019.

Kind regards

Santos

[redacted]

[redacted]

Species	Stock status	Spatial extent of stock	Depth Range	Reproductive mode	Spawning season	Key spawning ground	Demersal v pelagic
Goldband snapper	Sustainable	Restricted Indo-Pacific	50-200m	Gonochoristic	Gascoyne: Dec-June (extended peak spawning period) Pilbara: Oct-May (extended peak spawning period) Kimberley: Nov-May (extended peak spawning period)	Spawns throughout their range (rather than aggregating at specific locations)	Demersal
Red emperor	Sustainable	Indo-West Pacific	10-180m	Gonochoristic	Sept-June (with bimodal peaks from Sept-Nov and Jan-Mar)	Spawns throughout their range (rather than aggregating at specific locations)	Demersal
Rankin cod	Sustainable	Indian Ocean	10-150m	Protogynous	June-Dec and Mar (peak spawning period Aug-Oct)	Spawns throughout their range (rather than aggregating at specific locations)	Demersal
Bluespotted emperor	Sustainable	Endemic Australia - Exmouth to Darwin	5-110m	Functional gonochorist	Jul-Mar (extended peak spawning period)	Spawns throughout their range (rather than aggregating at specific locations)	Demersal
Giant ruby snapper	Sustainable	Indo-West Pacific	150-480m	Gonochoristic	Dec-Apr (peak spawning period Jan-Mar)	Spawns throughout their range (rather than aggregating at specific locations)	Demersal
Other demersal species	Sustainable	Variable	Variable	Variable	Most likely to exhibit a peak spawning period from Oct-May	Spawns throughout their range (rather than aggregating at specific locations)	Demersal

Spanish mackerel	Sustainable	Indo-West Pacific	1 m to at least 50m	Gonochoristic	Pilbara: Sept-Dec (peak spawning period) Kimberley: Sept-Jan (peak spawning period)	Form spawning schools around inshore reefs in north coast bioregion	Pelagic

Other Information

- The Pilbara Demersal Scalefish Fisheries and the Northern Demersal Scalefish Fishery target the entire demersal suite of fish's year round.
- The Mackerel Managed Fishery runs primarily from May to November.

From: [redacted]
To: [redacted]
Subject: RE: 2019 Jul 4 - Santos | Reindeer Wellhead Platform and Pipeline Environment Plans - WAFIC reply
Date: Monday, 8 July 2019 1:42:00 PM
Attachments: image012.png
image011.png
image021.png
image022.png
image023.png

Hello [redacted]

Much appreciated and I will keep you updated on our review of the FishCube data.

Kind regards

[redacted]

Santos | [redacted]

[redacted]

From: [redacted]
Sent: Thursday, 4 July 2019 3:49 PM
To: [redacted]
Subject: [EXT]: 2019 Jul 4 - Santos | Reindeer Wellhead Platform and Pipeline Environment Plans - WAFIC reply

Hello [redacted]

Many thanks for the timely reply in the email trail below addressing points raised by WAFIC.

Thank you for advising that Santos is currently reviewing current FishCube data to identify any individual commercial fishers who fish in the affected areas and that Santos is committed to ongoing consultation with these fishers as required. It would be greatly appreciated if you could please update WAFIC on this process in due course.

Many thanks and best regards

[redacted]

[redacted]

From: [redacted]
Sent: Thursday, 4 July 2019 3:28 PM
To: [redacted]
Subject: FW: Santos | Reindeer Wellhead Platform and Pipeline Environment Plans

Good afternoon [redacted]

Thank you for providing comment on Santos' Reindeer Wellhead Platform and Pipeline Environment Plans, we value your input.

In relation to the matters you have raised, please note the following:

- General feedback on content of Consultation Pack

  Thank you for this feedback, and as discussed on the phone recently, Santos would welcome the opportunity to meet with you to discuss how we can improve the presentation of material in our consultation packs and Quarterly Consultation Updates.

- Fisheries consulted as part of this EP

  In the revision of these EPs, Santos has consulted with the relevant peak fishery bodies, including yourself and Recfishwest. Santos is currently in the process of reviewing and updating its FishCube data to identify any individual commercial fishers who fish in the affected areas, and commit to ongoing consultation with these fishers as required. We would welcome any input you may have on relevant commercial fishers we should include in this ongoing consultation.

- Santos' communications strategy to ensure staff, contractors and sub-contractors are aware of the difference between exclusion zones and cautionary zones, noting the Reindeer WHP is located in a pre-existing 500 metre radius exclusion zone with a 2.5nm cautionary zone;

  A designated platform Person in Charge (PIC) is present on the WHP whenever works are occurring and is responsible for the activity. This dedicated role is staffed by personnel who have a full understanding of rules and regulations regarding access and is clear on the difference between cautionary zones and PSZ.

- Acknowledgment that WAFIC appreciates there is no exclusion zone for Reindeer-1 (which is temporarily abandoned), as this provides a potential fish aggregation site;

  Thank you for the acknowledgement.

- Santos' communication policy with all staff and vessel crew, contractors and sub-contractors regarding interacting and protecting the rights of active commercial fishers on the water;

Santos WA contracts reputable and highly experienced vessel contractors to undertake its offshore vessel based activities. These operators meet all of the relevant maritime legislation requirements and responsibly manage their interactions with other marine users, including commercial fishers, when undertaking activities.

- A request that the Table referring to interactions with other marine users also include reference to commercial fishing activities.

  The Table appearing on page three of the Consultation Pack does not appear in the final EP and is used for consultation purposes only. However we are more than happy to revise this Table in future consultation packs to ensure it also includes reference to commercial fishing activities.

- Santos confirm that the *"No fishing from support/commercial vessels"* policy is abided by all at operator / proponent level and also strictly enforced and communicated with contractors and subcontractors? What is Santos's audit / compliance policy / process regarding recreational fishing on support/commercial vessels?

  There is no change to Santos WA's policy on fishing from support vessels. All vessel contractors are required to acknowledge and sign a statement of conformance which includes the requirement for no fishing from vessels. This is undertaken both pre-mobilisation and post-mobilisation to confirm adherence to Santos requirements.

Please feel free to contact me if you wish to discuss any of the above, and I look forward to catching up with you soon to discuss the materials we present in both our Consultations Packs and Quarterly Consultation Updates.

Kind regards

Santos

[redacted]

[redacted]

From: [redacted]
Sent: Monday, 1 July 2019 7:33 AM
To [redacted]
Subject: RE: 2019 Jun 28 - Santos | Reindeer Wellhead Platform and Pipeline Environment Plans - WAFIC REPLY

Good morning [redacted]

Thank you for your comments on the Reindeer Wellhead Platform and Pipeline Environment Plans. We will respond to your comments shorty.

Kind regards

Santos | [redacted]

[redacted]

From: [redacted]
Sent: Friday, 28 June 2019 12:44 PM
To: [redacted]
Subject: 2019 Jun 28 - Santos | Reindeer Wellhead Platform and Pipeline Environment Plans - WAFIC REPLY

Good afternoon [redacted]

Many thanks for re-sending the Reindeer Wellhead Platform and Pipeline EPs (5 year renewals).

This is a generic consultation package with zero reference to commercial fishing. Noting as per the regulations regarding “relevant potentially affected parties to an activity”, by and large, the commercial fishing sector is the only stakeholder on the water who may be potentially (financially, functionally) impacted by offshore activities, therefore it is our expectation that consultation is bespoke for our industry. To read through a consultation update and the two words “commercial fishing” are not mentioned once is very frustrating.

Please advise which fisheries you liaised with as part of this EP consultation.

In relation to Reindeer Wellhead Platform and Pipeline EPs WAFIC’s comments as under:

This is pre-existing infrastructure and activities, thank you for confirming this is a “business as usual” plan.

In relation to the Santos fact sheet note the following:

- Understand it is located in a pre-existing 500 metre radius exclusion zone with a 2.5nm cautionary zone
    - Commercial fishers have had issues in the north-west re access to cautionary zones. It is essential that access rights of commercial fishers are protected. Is Santos’s staff, contractors and sub-contractors all aware of the difference between exclusion zones and cautionary zones? Fishers understand the zero access criteria for O&G safety / exclusion zones however, for cautionary zones they are permitted to “*anchor, transit and or fish as long as it is safe to do so*”. What is Santos’s communications strategy to ensure this is fully understood by all staff, contractors and subcontractors etc to avoid any on-water misunderstandings and

unnecessary impacts on commercial fishing activities / at sea mobility?

- Reindeer Wellhead Platform
    - Note Reindeer-1 which is temporarily abandoned and not connected to the WHP, is marked on charts but does not have an exclusion zone. THANK YOU, WAFIC would like this acknowledgment to be on the formal record that there is no exclusion zone here, very much appreciated, a potential fish aggregation site. Some other proponents do have exclusion zones on similar sites – this is loss of rights and access to fishable areas.

- Inspection, repair and maintenance
    - It is noted that this may result in additional vessels in the field. This has been an issue for commercial fishers issue in other areas in the north-west. What is the Santos's communication policy with all staff and vessel crew, contractors and sub-contractors regarding interacting and protecting the rights of active commercial fishers on the water? All support vessels must divert around active commercial fishing activity and remain clear of underwater fishing gear (even if not convenient to do so). All support vessels are to avoid any close and or disruptive engagement with any commercial fishing activity. All support vessels in the vicinity of a commercial fishing vessel to do their utmost not to create an ocean disturbance risking disruption to schooling fish, etc.

- Table on page 3 under Interactions with other marine users
    - It would be greatly appreciated if the above point regarding interaction with commercial fishing activities etc is contained within this table acknowledging the need to also protect commercial fisher access, not just the safety zone for the platform.

In addition, it is WAFIC's expectation that there is no recreational fishing from any Santos vessel, contractor's vessels and subcontractors etc vessels. Commercial fishers are not permitted (illegal) to recreationally fish whilst engaged in commercial fishing activity, based on impact on the (fish) resource and safety. It is the commercial fishing industry expectation that there is zero recreational fishing from any support or O&G commercial vessel. Can Santos please confirm that the *"No fishing from support/commercial vessels"* policy is abided by all at operator / proponent level and also strictly enforced and communicated with contractors and subcontractors? What is Santos's audit / compliance policy / process regarding recreational fishing on support/commercial vessels, for example, do you have a contractual arrangement which prohibits bringing any recreational fishing gear on to any vessels (operators, contractors and or subcontract vessels) etc?

Look forward to your update regarding the above.

Best regards

[redacted]

WAFIC FISHING PEARLING AQUACULTURE

[redacted]

WESTERN AUSTRALIAN FISHING INDUSTRY COUNCIL INC

From: [redacted]
Sent: Wednesday, 12 June 2019 4:13 PM
To [redacted]
Subject: FW: Santos | Reindeer Wellhead Platform and Pipeline Environment Plans

H[redacted]

Thank you for your email (attached) in response to the June Quarterly Consultation Update. I must sincerely apologise. The consultation package for the Reindeer DC EP revision was sent on 23 May 2019 and a check of the recipients confirms that I entered your email address incorrectly, hence you did not receive it.

I have now corrected the address I have for you, and again, sincere apologies.

If you have any questions on the attached, please don't hesitate to call.

Kind regards

[redacted]

Santos

[redacted]

From: [redacted]
Sent: Thursday, 23 May 2019 5:14 PM
Subject: Santos | Reindeer Wellhead Platform and Pipeline Environment Plans

Dear stakeholders,

Please be advised Santos Limited (Santos) is preparing to revise the Reindeer Wellhead Platform and Offshore Gas Supply Pipeline Operations EP (Commonwealth waters) and the Devil Creek Gas Supply Pipeline and Sales Gas Pipeline Operations EP (Onshore and State Waters).

As outlined in attached consultation material, Santos is required to revise operational EP's every five years. Primarily, these EPs will be remaining consistent with the previous revisions accepted by the relevant regulators.

In relation to the Reindeer Wellhead Platform and Offshore Gas Supply Pipeline Operations EP, please be aware recent amendments to the Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009 (the Environment Regulations) require NOPSEMA to publish a copy of a proponent's EP upon submission and again upon acceptance.

As a relevant stakeholder you are invited to provide comments on this EP. All correspondence relating to the Reindeer Wellhead Platform and Offshore Gas Supply Pipeline Operations EP will be contained in the consultation report that is provided to NOPSEMA by Santos, as required by the Environment Regulations. Santos will not use or disclose your personal information in this report.

If you do not wish for your comments to be published in this EP, or wish to provide your comments anonymously, you should make this known to Santos when you respond to this document.

If you wish to discuss this consultation material further please provide comment by June 24, 2019.

Kind regards

Santos

[redacted]

[redacted]

From: [redacted]
To: [redacted]t"
Subject: RE: Santos | Reindeer Wellhead Platform and Pipeline Environment Plans [SEC=UNCLASSIFIED] CRM:0077000000472
Date: Tuesday, 9 July 2019 12:43:00 PM

Hi [redacted]

Thank you for your confirmation and advice.

Kind regards

Santos

[redacted]

[redacted]

From: [redacted]
Sent: Tuesday, 9 July 2019 12:08 PM
To [redacted]
Subject: [EXT]: RE: Santos | Reindeer Wellhead Platform and Pipeline Environment Plans [SEC=UNCLASSIFIED] CRM:0077000000472

Good [redacted]

Thank you for your email.

Your proposed approach is appropriate, if there is any deviation from the normal activities then we advise that you follow the steps provided in our original response.

Kind regards,

[redacted]

[redacted]

[redacted]

------------------- Original Message -------------------
From: [redacted]

Received: Thu Jul 04 2019 14:02:12 GMT+1000 (Australian Eastern Standard Time)
To: [redacted]
Subject: RE: Santos | Reindeer Wellhead Platform and Pipeline Environment Plans [SEC=UNCLASSIFIED] CRM:0077000000472

Good afternoon,

Thank you for providing feedback on Santos' Reindeer Wellhead Platform and Pipeline Environment Plans.

As this is an operations EP it pertains to ongoing activities at the wellhead platform within the PSZ and along the pipeline. This infrastructure is already marked on nautical charts and therefore Santos proposes that Notice to Mariners and Radio Navigation Warnings are not required prior to activities commencing. Activities occur on a weekly basis using vessels that adhere to maritime legislation.

Can you please confirm this approach is appropriate?

Kind regards

[redacted]

[redacted]

From: [redacted]
Sent: Thursday, 30 May 2019 10:35 AM
To: [redacted]
Subject: RE: Santos | Reindeer Wellhead Platform and Pipeline Environment Plans [SEC=UNCLASSIFIED] CRM:0077000000472

Good afternoon [redacted]

Thank you for contacting the Australian Maritime Safety Authority.

The Master should notify AMSA's Joint Rescue Coordination Centre (JRCC) by e-mail to [redacted] for promulgation of radio-navigation warnings at least 24-48 hours before operations commence. AMSA's JRCC will require the vessel details (including name, callsign and Maritime Mobile Service Identity (MMSI)), satellite communications details (including INMARSAT-C and satellite telephone numbers), area of operation, requested clearance from other vessels and any other information that may contribute to safety at sea. JRCC will also need to be advised when operations start and end.

Contact the Australian Hydrographic Office at [redacted] no less than four working weeks before operations, with details relevant to the operations. The AHO will promulgate the appropriate Notice to Mariners (NTM), which will ensure other vessels are informed of your activities.

To obtain a vessel traffic plot showing Automatic Identification System (AIS) traffic data for your area of interest, please visit AMSA's spatial data gateway and [redacted] portal to download digital data sets and maps. A form for requesting customised information and data is also available via the portal (fees and charges may apply).

Kind regards,

[redacted]

[redacted]

------------------- Original Message -------------------
From: [redacted]
Received: Fri May 24 2019 12:42:50 GMT+1000 (Australian Eastern Standard Time)
To: [redacted]
Subject: FW: Santos | Reindeer Wellhead Platform and Pipeline Environment Plans [SEC=UNCLASSIFIED]

Dear stakeholders,

Please be advised Santos Limited (Santos) is preparing to revise the Reindeer Wellhead Platform and Offshore Gas Supply Pipeline Operations EP (Commonwealth waters) and the Devil Creek Gas Supply Pipeline and Sales Gas Pipeline Operations EP (Onshore and State Waters).

As outlined in attached consultation material, Santos is required to revise operational EP's every five years. Primarily, these EPs will be remaining consistent with the previous revisions accepted by the relevant regulators.

In relation to the Reindeer Wellhead Platform and Offshore Gas Supply Pipeline Operations EP, please be aware recent amendments to the Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009 (the Environment Regulations) require NOPSEMA to publish a copy of a proponent's EP upon submission and again upon acceptance.

As a relevant stakeholder you are invited to provide comments on this EP. All correspondence relating to the Reindeer Wellhead Platform and Offshore Gas Supply Pipeline Operations EP will be contained in the consultation report that is provided to NOPSEMA by Santos, as required by the Environment Regulations. Santos will not use or disclose your personal information in this report.

If you do not wish for your comments to be published in this EP, or wish to provide your comments anonymously, you should make this known to Santos when you respond to this document.

If you wish to discuss this consultation material further please provide comment by June 24, 2019.

Kind regards

[redacted]

[redacted]

If you have received this transmission in error please note that error does not constitute waiver of any confidentiality, privilege or copyright in respect of information in the E-mail or attachments and any use of this material is prohibited. Please notify the sender by return email and delete all copies of this transmission and attachments.

Appendix E: Environmental Consequence levels used for impact assessment

Consequence level		A – Negligible	B – Minor	C – Moderate	D – Major	E – Critical
Acceptability		Acceptable	Acceptable	Unacceptable	Unacceptable	Unacceptable
Severity		*No impact or negligible impact.* *Environmental impact lasting days up to 1 week*	*Detectable but insignificant change to local population, industry or ecosystem factors. Localised effect* *Environmental impact lasting weeks up to 12 months*	*Significant impact to local population, industry or ecosystem factors.* *Environmental impact lasting 1 to 10 years*	*Major long-term effect on local population, industry or ecosystem factors.* *Environmental impact lasting 10 to 20 years*	*Complete loss of local population, industry or ecosystem factors AND/ OR major wide-spread regional impacts with slow to no full recovery.* *Environmental impact lasting more than 20 years to no recovery*
Environmental Receptors	**Fauna** In particular, EPBC Act listed threatened/migratory fauna or WA Wildlife Conservation Act 1950 specially protected fauna	Short term behavioural impacts only to small proportion of local population and not during critical lifecycle activity; No decrease in local population size; No reduction in area of occupancy of species; No loss/disruption of habitat critical to survival of a species; No disruption to the breeding cycle of any individual; No introduction of disease likely to cause a detectable population decline.	Detectable but insignificant decrease in local population size (excluding protected species); Insignificant reduction in area of occupancy of species; Insignificant loss/disruption of habitat critical to survival of a species; Insignificant disruption to the breeding cycle of local population.	Significant decrease in local population size but no threat to overall population viability; Significant behavioural disruption to local population; Significant disruption to the breeding cycle of a local population; Significant reduction in area of occupancy of species; Significant loss of habitat critical to survival of a species; Modify, destroy, remove, isolate or decrease availability of quality of habitat to the extent that a significant decline in local population is likely; Introduce disease likely to cause a significant population decline.	Long term decrease in local population size and threat to local population viability; Major disruption to the breeding cycle of local population; Major reduction in area of occupancy of species; Fragmentation of existing population; Major loss of habitat critical to survival of a species; Modify, destroy, remove, isolate or decrease availability of quality of habitat to the extent that a long term decline in local population is likely; Introduce disease likely to cause a long term population decline	Complete loss of local population; Complete loss of habitat critical to survival of local population; Wide spread (regional) decline in population size or habitat critical to regional population.
	Physical Environment / Habitat Includes: air quality; water quality; benthic habitat (biotic/abiotic), particularly habitats that are rare or unique; habitat that represents a Key Ecological Feature[4]; habitat within a protected area; habitats that include benthic primary producers[5] and/ or epi-fauna[6]	No or negligible reduction in physical environment / habitat area/function.	Detectable but localised and insignificant loss of area/function of physical environment / habitat. Rapid recovery evident within ~ 1 year (seasonal recovery)	Significant loss of area and/or function of local physical environment / habitat. Recovery over medium term (2–10 years)	Major, large-scale loss of area and/or function of physical environment / local habitat. Slow recovery over decades.	Complete destruction of local physical environment / habitat with no recovery; Long term (decades) and wide spread loss of area or function primary producers on a regional scale
	Threatened ecological communities (EPBC Act listed ecological communities)	No decline in threatened ecological community population size, diversity or function; No reduction in area of threatened ecological community; No introduction of disease likely to cause decline in threatened ecological community population size, diversity or function.	Detectable but insignificant decline in threatened ecological community population size, diversity or function; Insignificant reduction in area of threatened ecological community.	Significant decline in threatened ecological community population size, diversity or function; Significant reduction in area of threatened ecological community; Introduction of disease likely to cause significant decline in threatened ecological community population size, diversity or function.	Major long term decline in threatened ecological community population size, diversity or function Major reduction in area of threatened ecological community Fragmentation of threatened ecological community Introduce disease likely to cause long term decline in threatened ecological community population size, diversity or function	Complete loss of threatened ecological community
	Protected Areas Includes: World Heritage Properties; Ramsar wetlands; Commonwealth/ National Heritage Areas; Land/ Marine Conservation Reserves.	No or negligible impact on protected area values; No decline in species population within protected area; No or negligible alteration, modification, obscuring or diminishing of protected area values.*	Detectable but insignificant impact on one of more of protected area's values. Detectable but insignificant decline in species population within protected area. Detectable but insignificant alteration, modification, obscuring or diminishing of protected area values*	Significant impact on one of more of protected area's values; Significant decrease in population within protected area; Significant alteration, modification, obscuring or diminishing of protected area values.	Major long term effect on one of more of protected area's values Long term decrease in species population contained within protected area and threat to that population's viability Major alteration, modification, obscuring or diminishing of protected area values	Complete loss of one of more of protected area's values; Complete loss of species population contained within protected area.
	Socio-economic receptors Includes: fisheries (commercial and recreational); tourism; oil and gas; defence; commercial shipping.	No or negligible loss of value of the local industry; No or negligible reduction in key natural features or populations supporting the activity.	Detectable but insignificant short-term loss of value of the local industry. Detectable but insignificant reduction in key natural features or population supporting the local activity.	Significant loss of value of the local industry; Significant medium term reduction of key natural features or populations supporting the local activity.	Major long-term loss of value of the local industry and threat to viability. Major reduction of key natural features or populations supporting the local activity.	Shutdown of local industry or widespread major damage to regional industry; Permanent loss of key natural features or populations supporting the local industry.

* Excluding World Heritage Areas

[4] As defined by the Department of Environment (DoE)
[5] Benthic photosynthetic organisms such as seagrass, algae, hard corals and mangroves
[6] Fauna attached to the substrate including sponges, soft corals and crinoids.