Santos

Varanus Island Hub Operations Environment Plan for Commonwealth Waters

PROJECT / FACILITY	Varanus Island Hub
REVIEW INTERVAL (MONTHS)	60 Months
SAFETY CRITICAL DOCUMENT	NO

Rev	Owner	Reviewer/s *Managerial/Technical/Site*	Approver
	Operations Superintendent – Varanus Island	Environmental Approvals and Compliance Team Lead	Production Manager – WA Gas Assets
6		pp:	

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Rev	Rev Date	Author / Editor	Amendment
0	6 Sept 2013	Apache Energy Ltd	Submission to NOPSEMA
1	27 May 2014	Apache Energy Ltd	Revised Submission to NOPSEMA incorporating comments received on Rev 0 from NOPSEMA
1.1	11 Sept 2014	Apache Energy Ltd	Minor Internal Revision as per MoC-58
1.2	16 June 2017	Quadrant Energy	Minor revision to incorporate temporary changes to EP for Greater East Spar Phase 1 Activities in June 2017 as per MOC-173
1.2A	3 May 2019	Santos	Draft issued for internal review
1.2 B	21 June 2019	Santos	Draft issued for internal review
2	31 July 2019	Santos	Submission to NOPSEMA - 5 yearly revision
2A	13 December 2019	CDM Smith	Draft issued for internal review
3	16 December 2019	Santos	Response to NOPSEMA comments – 5 yearly revision
3A	30 March 2020	Santos	Addressed comments from NOPSEMA, issued for Santos review. Note: material deleted text will appear as ~~highlighted strikethrough~~ all new text appears as highlighted text.
4	6 April 2020	Santos	Response to NOPSEMA comments – 5 yearly revision
4A	June 2020	Santos	Addressed comments from NOPSEMA RFFWI dated 5 May 2020, issued for Santos review. Note: material deleted text will appear as ~~highlighted strikethrough~~ all new text appears as highlighted text.
5	July 2020	Santos	Response to NOPSEMA comments – 5 yearly revision
6	January 2022	Santos	Inclusion of Spartan Development infrastructure. Inclusion of updated Santos Risk Matrix and Management System

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Abbreviations

Abbreviation	Description
AFMA	Australian Fisheries Management Authority
ALARP	as low as reasonably practicable
AMOSC	Australian Marine Oil Spill Centre Pty Ltd
AMSA	Australian Marine Safety Authority
APASA	Asia-Pacific Applied Sciences Associates
APPEA	Australian Petroleum Production & Exploration Association
AUV	autonomous underwater vehicle
BIA	biologically important area
BTEX	benzene, toluene, ethylbenzene and xylene
CAMBA	China-Australia Migratory Bird Agreement
CHARM	Chemical Hazard Assessment and Risk Management
CH_4	methane
CMMS	Computerised Maintenance Management System
cP	centipoise (millipascal-second (mPa. s))
CO_2	carbon dioxide
CTD	conductivity, temperature and depth
DBCA	Department of Biodiversity, Conservation and Attractions
DMIRS	Department of Mines, Industry Regulation and Safety
DoE	(Commonwealth) Department of the Environment (now DoEE)
DoEE	Department of the Environment and Energy
DoT	Department of Transport
DPaW	Department of Parks and Wildlife (now DBCA)
DPIRD	Department of Primary Industries and Regional Development
DWER	Department of Water and Environmental Regulation
EHU	electro-hydraulic umbilical
EMBA	environment that may be affected
EP	Environment Plan
EPA	West Australian (WA) Environmental Protection Authority
EPBC Act	Environmental Protection and Biodiversity Conservation Act 1999
EPO	environmental performance outcome
EPS	environmental performance standard
ESD	emergency shutdown
g/m^2	gram per square metre
GES	Greater East Spar
GHG	greenhouse gas

Abbreviation	Description
HEV	high environmental value
HSEMS	Health, Safety and Environment Management System
IMCRA	Integrated Marine and Coastal Regionalisation of Australia
IMMR	inspection, maintenance, monitoring and repair
IMS	invasive marine species
IMT	Incident Management Team
KEF	key ecological feature
kL	kilolitre
L	litre
LEMS	Lifting Equipment Management System
m^3/d	cubic metre per day
MEG	monoethylene glycol
MPNMP	Marine Parks Network Management Plan
NEBA	net environmental benefit analysis
nm	nautical mile
N_2O	nitrogen oxide
NOPSEMA	National Offshore Petroleum Safety and Environmental Management Authority
NOPTA	National Offshore Petroleum Titles Administrator
NO_X	nitrous oxides
NWS	North West Shelf
OCNS	Offshore Chemical Notification Scheme
OPEP	oil pollution emergency plan
OPGGS Act	Offshore Petroleum and Greenhouse Gas Storage Act 2006
OPGGS(E)R 2009	Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009
OSRL	Oil Spill Response Limited
PLEM	pipeline end manifold
PLET	pipeline end termination
ppb	part per billion
ppm	part per million
PMS	Preventative Maintenance System
PTS	permanent threshold shift
ROTV	remotely operated towed vehicle
ROV	remotely operated vehicle
SMPEP	shipboard marine pollution emergency plan
SOPEP	shipboard oil pollution emergency plan

Abbreviation	Description
SO_X	sulphur oxides
SSS	side-scan sonar
TTS	temporary threshold shift
VI	Varanus Island
VI Hub	Varanus Island oil and gas hub
VOC	volatile organic compound
WA	Western Australia
WAFIC	Western Australian Fishing Industry Council
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 (EP) (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.

This Varanus Island Hub Operations Environment Plan for Commonwealth Waters EP summary, has been prepared from material provided in this EP. The summary consists of the following as required by regulation 11(4):

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 **8.4**
The arrangements for ongoing monitoring of the titleholders environmental performance	**Section 8**
Response arrangements in the oil pollution emergency plan	**Section 6.7 and OPEP**
Consultation already undertaken and plans for ongoing consultation	**Section 4**
Details of the titleholders nominated liaison person for the activity	**Section 1.5.2**

1.2 Activity Overview

Santos WA Energy Ltd (Santos) is the operator of the John Brookes, Spartan and Greater East Spar (GES) gas fields in offshore Commonwealth waters on the North West Shelf of Western Australia. Production fluids from these fields are transported by subsea pipelines to the Varanus Island (VI) oil and gas hub (VI Hub) located in State waters (**Figure 2-2**). **Table 1-1** outlines the infrastructure, infrastructure status, production permit and pipeline licence details for each of the facilities covered under this EP.

This EP explicitly excludes offshore drilling and decommissioning activities, which will require separate EPs when or if required.

Table 1-1: Varanus Island Commonwealth Infrastructure Licences and Permits included in the Operational EP

<table>
<tr><th>Infrastructure</th><th>Production Permit</th><th>Pipeline Licence</th><th>Status (As at January 2021)</th></tr>
<tr><td colspan="4">John Brookes field Infrastructure</td></tr>
<tr><td>John Brookes Wellhead Platform (WHP)</td><td rowspan="9">WA-29-L</td><td>N/A</td><td>Active</td></tr>
<tr><td>John Brookes Pipeline</td><td>WA-11-PL</td><td>Active</td></tr>
<tr><td>John Brookes 2 Well</td><td>N/A</td><td>Active production well</td></tr>
<tr><td>John Brookes 3 (ST 1) Well</td><td>N/A</td><td>Active production well</td></tr>
<tr><td>John Brookes 4 Well</td><td>N/A</td><td>Plugged and Abandoned with 2 cement barriers</td></tr>
<tr><td>John Brookes 5 Well</td><td>N/A</td><td>Active production well, shares the same slot on the WHP as the John Brookes 4 well (abandoned).</td></tr>
<tr><td>John Brookes 6 (ST 1) Well</td><td>N/A</td><td>Active production well</td></tr>
<tr><td>Halyard Umbilical</td><td>N/a</td><td>Active</td></tr>
<tr><td>Rosella-1 (ST 2) Well</td><td>N/A</td><td>Plugged and temporarily abandoned with confirmed double barrier in place. Corrosion cap in place.</td></tr>
<tr><td colspan="4">Spartan Infrastructure</td></tr>
<tr><td>Spartan-2 Well</td><td>WA-63-L</td><td>N/A</td><td>Development drilling scheduled for Q2/Q3 2022.
Expected online Q3-Q4 2022</td></tr>
<tr><td>Spartan Umbilical</td><td>WA-63-L, WA 214-P and WA-29-L</td><td>N/A</td><td>Installation scheduled for Q2/Q3 2022.
Expected online Q3/Q4 2022</td></tr>
<tr><td>Spartan Flexible Flowline</td><td>WA-63-L</td><td>WA-30-PL</td><td>Installation scheduled for Q2/Q3 2022.
Expected online Q3/Q4 2022</td></tr>
<tr><td colspan="4">Greater East Spar (GES) field Infrastructure</td></tr>
<tr><td>Spar-2 Well</td><td rowspan="2">WA-45-L</td><td>N/A</td><td>Active production well</td></tr>
<tr><td>Spar-2 Xmas Tree</td><td>N/A</td><td>Active</td></tr>
</table>

Infrastructure	Production Permit	Pipeline Licence	Status (As at January 2021)
Spar-2 Flowline		WA-21-PL	Active
GES Umbilical (and flying leads)		WA-21-PL	Active
GES PLEM (and flying leads)	WA-13-L	WA-21-PL	Active
GES subsea cooling skid (and tie-in spool)		WA-21-PL	Active
Halyard-1 Well		N/A	Active production well
Halyard-1 Xmas Tree		N/A	Active
Halyard Production Flowline		WA-21-PL	Active
East Spar PLEM	WA-13-L	WA-21-PL	Active
East Spar Pipeline		WA-5-PL	Active
East Spar Manifold		WA-5-PL	Active
East Spar tie in spool		WA-5-PL	Active
East Spar-3 well		N/A	Reservoir permanently abandoned. Two verified permanent barriers installed to the reservoir. Well classified as temporarily abandoned due to XT and wellhead remaining in place. HXT protected by HXT debris cap.
East Spar-4A (ST 1) well		N/A	Well temporarily abandoned. Confirmed single barrier - Wellhead corrosion caps and guide base protection frame.
East Spar 6 Well		N/A	Reservoir permanently abandoned. Two verified permanent barriers installed to the reservoir. Well classified as temporarily abandoned due to XT and wellhead remaining in place. HXT protected by HXT debris cap.
East Spar-7 Well		N/A	At same location as original East Spar-1 well. Well temporarily abandoned - Xmas tree remains in place (valves closed). Confirmed double barrier. Protected by wellhead corrosion caps installed and guide-base structure.
East Spar-9 Well		N/A	Well temporarily abandoned. Confirmed single barrier - Protected by wellhead corrosion caps installed and guide-base structure.

1.3 Purpose of this Environment Plan

OPGGS(E)R 2009 Requirements
Regulation 17(5)
A titleholder must submit to the Regulator a proposed revision of the environment plan for an activity before the commencement of any significant modification or new stage of the activity that is not provided for in the environment plan as currently in force.

The operation of the VI Hub in Commonwealth waters has been managed under the Varanus Island Hub Operations Environment Plan for Commonwealth Waters (John Brookes, Greater East Spar and Associated Facilities) (EA-66-RI-10003) accepted by the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) on 11 September 2014. The EP was revised (five yearly revision) in August 2019 in accordance with Regulation 19 of the Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009 (OPGGS(E)R 2009) and accepted by NOPSEMA in July 2020.

This revision is made in accordance with Regulation 17 (5) of the OPGGS (E) Regulations (2009) and incorporates the operations associated with the single well Spartan gas field, that will be tied-back to the John Brookes wellhead platform (WHP) via a single flexible flowline and umbilical. The environmental impacts and risks associated with the development drilling and installation activities associated with the Spartan gas field and demonstration of how these will be reduced to as low as reasonably practicable (ALARP) and to an acceptable level is addressed in the Spartan Development Addendum (EA-60-RI-10003.02) and are not discussed further in this EP.

This EP details the environmental impacts and risks associated with the operation of the VI Hub (Commonwealth waters) (**Section 2**) and demonstrates how these will be reduced to as low as reasonably practicable (ALARP) and to an acceptable level. The EP provides an implementation strategy that will be 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 activities described in the EP complies with the Santos Environmental Management Policy and with all relevant legislation. This EP documents and considers all relevant stakeholder consultation performed during the planning of the activity.

1.4 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 revises this EP in the event a significant change to the activity or level of impact or risk occurs as required under Subregulation 17(10, 17(5), 17(6), 17(7).

Santos may revise the EP, using the MOC Process described in Section 8. Any changes made under this process will not affect the validity of this EP.

1.5 Titleholder

OPGGS(E)R 2009 Requirements
Regulation 15. Details of titleholder and liaison person
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. 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).

1.5.1 Details of Titleholder

Table 1-2 provides the titleholders and their contact details.

Table 1-2: Titleholder Details for All Titles Under this EP

Title	Pipeline Licence	Titleholder (Operators in bold)	ACN	Interest (%)	Address
WA-29-L	WA-11-PL	**Santos WA Northwest Pty Ltd**	009 140 854	55	Business Address: Level 7, 100 St Georges Terrace, Perth, Western Australia, 6000 Telephone number: (08) 6218 7100 Fax number: (08) 6218 7200 Email address: offshore.environment.admin@santos.com
		Santos (BOL) Pty Ltd	000 670 575	45	Business Address: Level 7, 100 St Georges Terrace, Perth, Western Australia, 6000 Telephone number: (08) 6218 7100 Fax number: (08) 6218 7200 Email address: want@santos.com

Title	Pipeline Licence	Titleholder (Operators in bold)	ACN	Interest (%)	Address
WA-45-L WA-13-L	WA-21-PL WA-05-PL	**Santos WA Southwest Pty Ltd**	050 611 688	100	Business Address: Level 7, 100 St Georges Terrace, Perth, Western Australia, 6000 Telephone number: (08) 6218 7100 Fax number: (08) 6218 7200 Email address: offshore.environment.admin@santos.com
WA-63-L	WA-30-PL	**Santos WA Southwest Pty Ltd**	050 611 688	55	Business Address: Level 7, 100 St Georges Terrace, Perth, Western Australia, 6000 Telephone number: (08) 6218 7100 Fax number: (08) 6218 7200 Email address: offshore.environment.admin@santos.com
		Santos (BOL) Pty Ltd	000 670 575	45	Business Address: Level 7, 100 St Georges Terrace, Perth, Western Australia, 6000 Telephone number: (08) 6218 7100 Fax number: (08) 6218 7200 Email address: want@santos.com
WA-214-P		**Santos WA Northwest Pty Ltd**	009 140 854	55	Business Address: Level 7, 100 St Georges Terrace, Perth, Western Australia, 6000 Telephone number: (08) 6218 7100 Fax number: (08) 6218 7200 Email address: offshore.environment.admin@santos.com
		Santos (BOL) Pty Ltd	000 670 575	45	Business Address: Level 7, 100 St Georges Terrace, Perth, Western Australia, 6000 Telephone number: (08) 6218 7100 Fax number: (08) 6218 7200 Email address: want@santos.com

1.5.2 Details for Nominated Liaison Person

Details for Santos's nominated liaison person for the activity are as follows:

Name:	N. Vitanza (Production Manager – WA Gas Assets)
Business address:	Level 7, 100 St Georges Terrace, Perth, WA 6000
Telephone number:	(08) 6218 7100
Email address:	offshore.environment.admin@santos.com

1.5.3 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 will notify NOPSEMA in writing and provide the updated details.

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

1.6 Environmental Management Framework

OPGGS(E)R 2009 Requirements
Regulation 13. Environmental assessment
Description of the activity 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(a). Other information in the environment plan
The environment plan must contain the following: (a) a statement of the titleholder's corporate environmental policy;

1.6.1 Environmental Management Policy

The activities will be conducted in accordance with the Santos Environment, Health and Safety Policy presented in **Appendix A**, 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 Santos Environment, Health and Safety 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.

1.6.2 International Legislation

Australia is a signatory to numerous international conventions and agreements that obligate the Commonwealth government to prevent pollution and protect specified habitats, flora and fauna. Those that are relevant to the operational activities are detailed in **Appendix B.**

1.6.3 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 the EP will comply with legislative requirements established under relevant Commonwealth legislation detailed in **Appendix B**.

1.6.4 State Legislation

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

2 Activity Description

OPGGS(E)R 2009 Requirements
Regulation 13. Environmental assessment.
Description of the activity 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; and (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.

All the facilities described in **Section 2** are part of the VI Hub, a central gathering and processing hub for Santos oil and gas production facilities. The well fluids (gas and condensate) from the John Brookes, Spartan and GES reservoirs are processed in the onshore VI Hub processing plant. The onshore VI Hub also hosts the accommodation, administration and control centre for the production facilities. All facilities that form part of the hub are operated and maintained from VI. Personnel reside at VI and journey to and from the offshore facilities via helicopter or support vessel. Only VI Hub infrastructure located in Commonwealth waters has been described in **Section 2** of this EP. All VI Hub infrastructure located onshore at VI or within the State waters boundary is outside of the scope of this EP.

2.1 Location

The activities will occur in Petroleum Production Licences WA-63-L, WA-29-L, WA-45-L and WA-13-L approximately 127 km northwest of Karratha. The water depth in the operational area ranges between approximately 45 m and 115 m.

The locations of the producing and non-producing infrastructure in the operational area are listed in **Table 2-1** and shown in **Figure 2-1**.

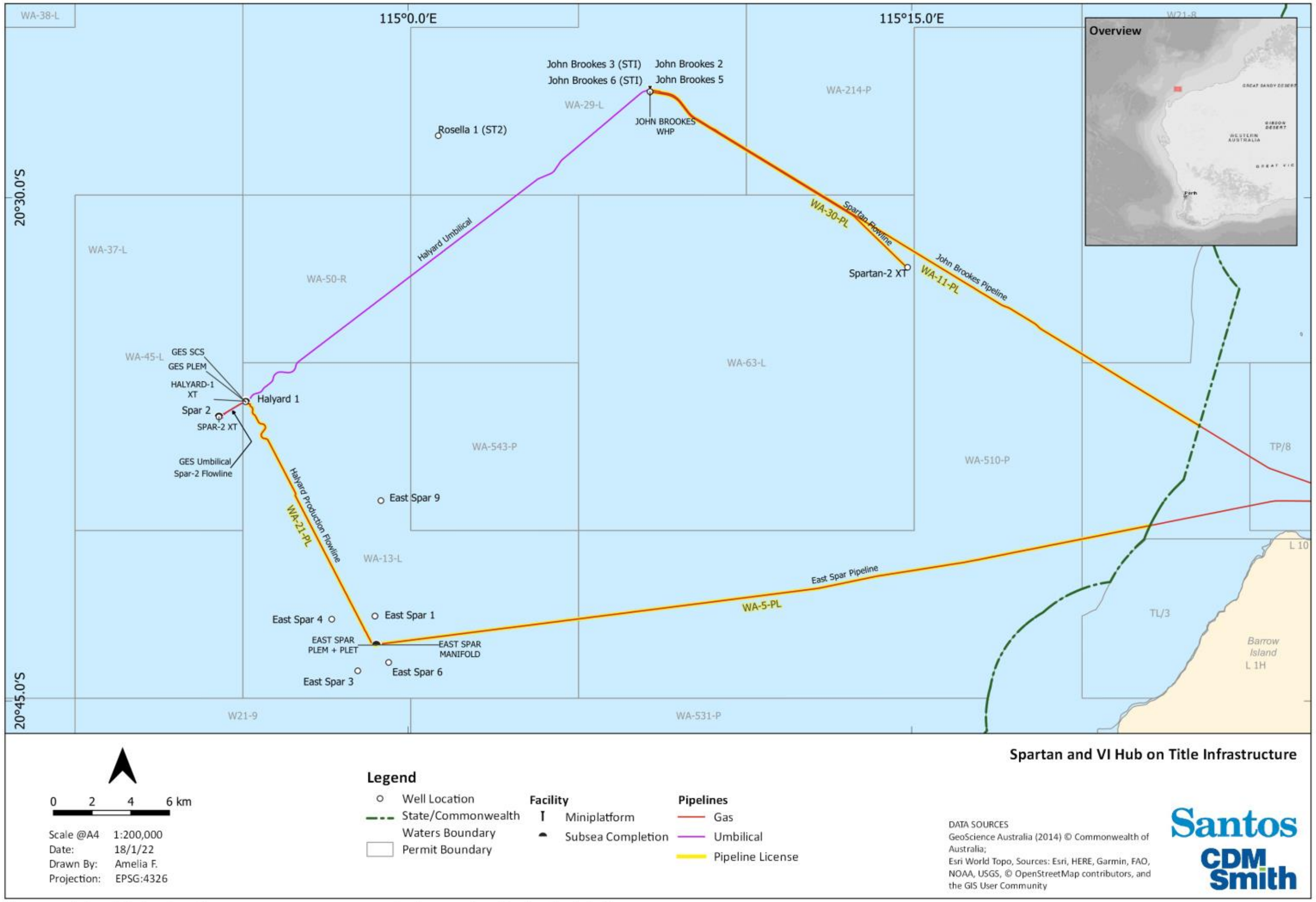

Figure 2-1: Infrastructure Locations

Table 2-1: Surface Locations for John Brookes, Spartan and GES Infrastructure

Infrastructure	Approx. Water Depth (m)	Closest Distance to VI (km)	Coordinates (Datum/Projection: GDA 94 Zone 50)			
			Latitude	Longitude	Easting (m E)	Northing (m N)
John Brookes field Infrastructure						
John Brookes WHP	48	52 km southeast	20°26’50”S	115°07’13”E	303,892.90	7,737,890.25
John Brookes Pipeline	45.8	Intersects State waters boundary	Approximately 45 km between John Brookes WHP and VI			
John Brookes 2 Well	48	52 km northwest	20°26’50.44” S	115°07’12.47” E	303,890.7	7,737,890.2
John Brookes 3 (ST 1) Well	48	52 km northwest	20°26’50.51” S	115°07’12.47” E	303,890.6	7,737,887.8
John Brookes 5 Well	48	52 km northwest	20°26’50.44” S	115°07’12.56” E	303,893.1	7,737,890.2
John Brookes 6 (ST 1) Well	48	52 km northwest	20°26’50.52” S	115°07’12.64” E	303,895.5	7,737,887.8
Halyard umbilical	Variable (approx. 48-105m)	52 km southeast	Approximately 28 km between Halyard-1 well and John Brookes WHP			
Rosella-1 (ST 2) Well*	95	50 km	20°28’08.90” S	115°00’54.10” E	292,952.0	7,735,347.7
Spartan field infrastructure						
Spartan-2 Well	58	35 km southeast	20° 32' 4.47" S	115° 14' 52.90" E	317,339.5	7,728,381.0

Infrastructure	Approx. Water Depth (m)	Closest Distance to VI (km)	Coordinates (Datum/Projection: GDA 94 Zone 50)			
			Latitude	Longitude	Easting (m E)	Northing (m N)
Spartan flexible flowline	48 – 60	35 km southeast	Approximately 17 km between Spartan-2 well and John Brookes WHP			
Spartan umbilical	48 - 60	35 km southeast	Approximately 17 km between Spartan-2 well and John Brookes WHP			
GES field Infrastructure						
Spar-2 Well	112.9	70 km west	20°36'31.981"S	114°54'2.09"E	281,788.82	7,719,733.4
Spar-2 Xmas tree	112.9	70 km west	20°36'31.981"S	114°54'2.09"E	281,788.82	7,719,733.4
Spar-2 Flowline	Variable (approx.112m)	69 km west	Approximately 1.9km long, from Spar-2 well to GES PLEM			
GES Umbilical	Variable (approx.112m)	69 km west	Approximately 1.9km long, from Spar-2 well to GES PLEM			
GES PLEM	110	69 km west	20°36'04.88	114°55'09.71	283156.82	7720584.72
GES Subsea Cooling Skid (and tie-in spool)	110	69 km west	20°36'05.70	114°55'10.18	283170.76	7720559.56
Halyard-1 Well	105	68 km west	20°36'04.06"S	114°55'09.67"E	283,155.40	7,720,610.40

Infrastructure	Approx. Water Depth (m)	Closest Distance to VI (km)	Coordinates (Datum/Projection: GDA 94 Zone 50)			
			Latitude	Longitude	Easting (m E)	Northing (m N)
Halyard-1 Xmas tree (and tie-in spool)	105	68 km west	20°36'04.06"S	114°55'09.67"E	283,155.40	7,720,610.40
Halyard Production Flowline	Variable (from 105-95m)	62 km west	Approximately 16 km long, between Halyard-1 well and East Spar PLEM			
East Spar PLEM and PLET (and tie-in spool)	96	62 km west	20°43'20.25"S	114°9'03.36"E	290,089.71	7,707,279.49
East Spar manifold	95	62 km west	20°43'19.91"S	114°59'04.01"E	290,108.26	7,707,290.32
East Spar pipeline	95	41 km west	Approximately 65 km between East Spar Manifold and intersection with State water boundary			
East Spar-3 Well*	99	62.5 km	20°44'01.227" S	114°58'26.15" E	289,028.628	7,706,005.986
East Spar-4 Well*-xmas tree	101	60 km	20°42'35.04" S	114°57'34.95" E	287,513.1	7,708,630.2
East Spar-6 Well*	96	55 km	20°43'49.310" S	114°59'23.98"E	290,697.29	7,706,393.4
East Spar-7 Well*#	98.6	60 km	20°42'25.334" S	114°58'58.998" E	289,942.2	7,708,967.1

Infrastructure	Approx. Water Depth (m)	Closest Distance to VI (km)	Coordinates (Datum/Projection: GDA 94 Zone 50)			
			Latitude	Longitude	Easting (m E)	Northing (m N)
East Spar-9 Well*	97.1	60 km	20°39’02.150” S	114°59’10.01” E	290,183.77	7,715,220.71
East Spar 6	95	.5 km	20°43'49.307" S	114°59'23.982" E	290697.312	7706393.455

* Not active infrastructure

At same location as original East Spar-1 well

2.2 Operational Area

The operational area is defined as a:

+ 500 m radius around the John Brookes WHP;
+ 250 m buffer either side of all subsea infrastructure; and
+ 500 m radius buffer surrounding the temporarily plugged and abandoned Rosella-1 wellhead.

This is the boundary within which activities described in this EP will occur, as shown on **Figure 2-2**.

The East Spar-1 Well, East Spar-3 Well and East Spar Manifold are protected from third-party vessels through the application of a gazetted petroleum safety zone and a cautionary zone under Part 6.6: "Safety zones and the area to be avoided" of the Offshore Petroleum and Greenhouse Gas Storage Act 2006 (OPGGS Act). Aside from the East Spar infrastructure, no other infrastructure has a gazetted PSZ in place. The John Brookes Platform has a 500 m petroleum safety zone and 2.5 nm cautionary area marked on nautical charts.

Halyard and GES subsea infrastructure is marked on nautical charts; however, it is not subject to a petroleum safety zone around the subsea infrastructure. This is due to the low level of fishing in the area (including no active trawl fisheries) and the unmanned nature of the facility limiting compliance ability. This is in line with standard industry practice.

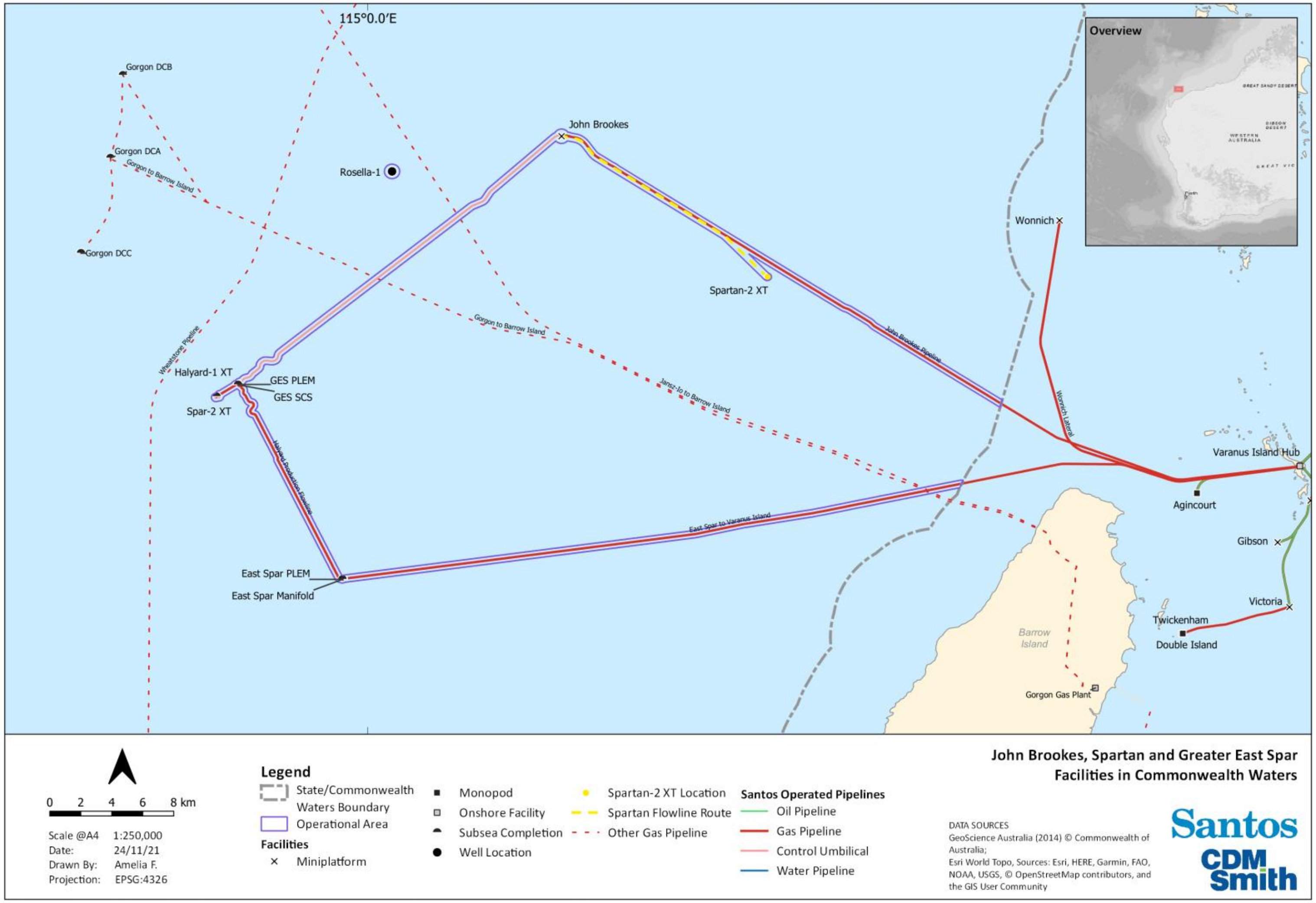

Figure 2-2: John Brookes, Spartan and Greater East Spar (GES) Facilities in Commonwealth Waters

2.3 Timing

The VI Hub Operations Commonwealth Facilities operate 24 hours a day, every day of the year; and routine activities may occur at any time during any season.

Santos uses Asset Reference Plans to assess and identify what stage of the lifecycle an asset has reached in order to inform asset management decisions. For context, the five phases used by Santos are:

+ Phase 1 – Start up;
+ Phase 2 – Plateau/Extension;
+ Phase 3 – Decline/Tail;
+ Phase 4 – Suspension; and
+ Phase 5 – Decommission.

In the 2018 John Brookes Asset Reference Plan (LM-10-RG-10007), the facility was in what Santos defines as the 'plateau' phase. The Halyard, Spar and East Spar Asset Reference Plan (HL-91-RG-10001) also confirms the fields are within what Santos defines as the 'plateau' phase.

2.4 John Brookes Field Infrastructure

The John Brookes facility is located in approximately 45 m of water. Production commenced in 2005, and the facility consists of the following:

+ John Brookes WHP – a normally unmanned wellhead platform designed to accommodate a maximum of six production wells;
+ John Brookes pipeline – a 55-km-long, 450-mm nominal bore (18") subsea gas pipeline, routed to the VI onshore processing facilities; and
+ John Brookes wells – four producing wells at the John Brookes WHP.

The John Brookes facility also provides infrastructure for the control of the Spartan-2, Halyard-1 and Spar-2 wellheads; this control infrastructure consists of the following:

+ Halyard electro-hydraulic umbilical (**Section 2.4.2.6**) – a 28-km-long umbilical supplying electrical power, hydraulic control fluid and chemicals from the John Brookes WHP to control and monitor the Halyard-1 and Spar-2 production wells via the GES PLEM;
+ Spartan electro-hydraulic umbilical (**Section 2.4.2.5**) – a 17 km long umbilical supplying electrical power, hydraulic control fluid and chemicals from the John Brookes WHP to control and monitor the Spartan-2 production well; and
+ A three-level cantilever deck comprising the mezzanine and main decks and the upper valve access platform of the John Brookes WHP, which extends 6 m to the north, beneath the crane pedestal. This k houses a power generation package and topsides control unit for the Spartan, Halyard and Spar subsea infrastructure, including a hydraulic power unit, master control systems and a chemical injection skid and chemical tank. Minor modifications were made to the integrated control system and chemical injection skid to accommodate the Spartan infrastructure.

Production from the Halyard-1 and Spar wells are independent of the John Brookes facility, as Halyard-1 well fluids are exported to VI via the East Spar pipeline. Production from the Spartan-2 well is via the John Brookes WHP and John Brookes pipeline to the VI onshore facilities.

2.4.1 Topsides Infrastructure

The John Brookes WHP has been designed with minimum facilities so as to:

+ Minimise hydrocarbon inventory and hazardous areas;
+ Minimise equipment maintenance;
+ Maximise the reliability of the WHP, with the use of redundancy for the wellhead control panel, telemetry, and instrument gas and power systems; and

- Minimise the requirement for operating and maintenance personnel to attend the WHP.

The platform topsides are illustrated in **Figure 2-3**. The topsides modules have four levels (specifically, highest to lowest):

- Upper deck;
- Mezzanine deck;
- Main deck; and
- Lower deck.

The topsides modules are supported by a four-legged jacket secured to the seabed with grouted piles through pile sleeves at each leg. The main and upper decks are plated, while the mezzanine deck is grated. A list of the equipment available on each deck is presented in Table 2-2. The following items are attached to the substructure of the WHP:

- One John Brookes production riser located in the jacket bracing;
- One Spartan Production J-tube;
- Twin J-tube to host the Spartan umbilical and Spar-Halyard replacement umbilical;
- One Halyard umbilical J-tube; and
- One boat landing with bumpers, ladders and intermediate landings on the northwest corner.

Figure 2-3: John Brookes WHP – Halyard Wing Deck

Table 2-2: Equipment Layout on the John Brookes WHP

Deck	Equipment
Upper deck (Helideck)	+ Helideck crane (northwest corner) to lift equipment, materials and products to or from vessels or around the WHP; and + Laydown area for temporary chemical storage (e.g., monoethylene glycol (MEG) storage (for well start-up)) and corrosion inhibitor.
Mezzanine deck	+ John Brookes chemical injection tanks (three compartmented tanks with approximately 1,600 L each); + Crane hydraulic power pack with bulk chemical containers; + Diesel tank (electrical backup generator skid) and diesel storage; + Instrument gas knock-out drum; + Wellhead control panel; + Regulating panels; + Pig launcher; + Instrument gas shutdown valve; + Navigation lights; and + Two microturbine power generators with associated fuel gas skid and fuel gas preheater for the Halyard subsea wells.
Main deck	+ Four installed wellheads, flowlines and flow meters, with the capacity for six wellheads; + Process piping, valves and instrumentation; + Instrument gas knock-out drum; + Equipment shelter; + Telemetry facilities to enable remote collection of process data and allow process shutdown and emergency shutdown control from VI; + Instrument gas system; + Vent and drain systems and associated pumps; + Fully automatic navigation system; + Safety equipment; + Hydraulic power unit for the Spartan, Halyard and Spar wells subsea control system with associated hydraulic fluids storage vessel; and + Chemical injection equipment (i.e., MEG skid, Spartan, Halyard and Spar injection system).
Lower deck	+ Access to the production emergency shutdown valve; + Toilet; + Atmospheric sump and pumps; and + Closed-drains sump and pumps.

MEG is typically permanently stored in a tank on the WHP and is used for initial field start-up and infrequent well start-ups, with variable injection rates depending on the mode of operation (e.g., predose, injection post-start-up). MEG may also be brought onto the WHP for start-up of the wells as required.

The main deck is completely bunded, and the bunding feeds into the closed drainage system. A drainage system collects any spillage from installed splash and drip trays.

The atmospheric sump tank is equipped with an oil interface switch and is baffled to intercept and hold any oil in it. The design of the sump allows uncontaminated rainwater to drain overboard from the sump, even during heavy periods of rain associated with cyclonic conditions. The interface level controls effectively mean that only rainwater flows overboard while hydrocarbon fluids are pumped into the export pipeline. The sump design prevents rainwater being pumped into the export pipeline, precluding bacterial growth.

The closed-drains sump vessel collects hydrocarbon fluids from:

+ Liquid knock out from the instrument gas drying system and gas-powered pump exhausts;
+ Fuel gas knock-out pot;
+ Drainage of production lines during maintenance; and
+ Drainage of pig launchers.

Fluid collected in the sump is pumped to the production manifold by a gas-driven sump pump controlled by a high/low level controller.

A toilet and small hand washing basin are installed on the John Brookes WHP. The WHP is unmanned, so the toilet and basin is only used intermittently by the maintenance crew, if required, and discharges to the ocean.

Transport of personnel to the WHP is primarily by helicopter and support vessel (during daylight hours under normal operations).

2.4.2 Subsea Infrastructure

The John Brookes subsea infrastructure and status is presented in **Table 1-1.** The maintenance for subsea infrastructure is further described in **Section 2.7**. The well integrity risk assessment and ongoing management of the subsea wells is further detailed in the relevant risk assessment **Sections 7.6** and **7.8**.

2.4.2.1 John Brookes Wells

Four John Brookes production wells were drilled to produce from the gas-bearing Upper Barrow formation. Three of these wells were completed in 2005, and one was completed in 2009. Two slots on the WHP are spare for production from any future wells. Production fluids from the wellheads flow into a manifold and then directly into the John Brookes pipeline.

2.4.2.2 John Brookes Pipeline

The John Brookes pipeline is a single 450 mm-diameter carbon steel wet-gas pipeline that runs approximately 55 km from the WHP to the East Spar Joint Venture Plant on VI. The design life of the pipeline system is 20 years from installation in 2004. The first 500 m of the pipeline was replaced in 2015 with an upgraded section. The pipeline is pigged for inspection and/or operational requirements. The current field life is expected to be until at least 2037.

A hydraulically operated subsea isolation valve is located approximately 100 m from the WHP. The subsea isolation valve is set to fail last position for normal operations. During well intervention operations, the subsea isolation valve is configured to close on emergency shutdown.

The pipeline stabilisation system was designed to DNV-RP-E305, On-bottom Stability Design of Submarine Pipelines. It comprises concrete weight coating and rockbolts for secondary stabilisation. Concrete gravity anchors provide stabilisation of the spool and pipeline at the WHP end.

The pipeline approach to the WHP is optimised to allow for:

+ Constraints of the undulating seabed near the WHP;
+ Mobile offshore drilling unit (MODU) approaches for future drilling; and
+ Lifting operations from the WHP crane or MODU crane.

A passive cathodic protection system is used to protect the riser, tie-in spools, pipeline, protection frames and anchor assemblies. Pipeline cathodic protection is provided by half-shell bracelet anodes bolted to the pipeline. The anodes are designed for a life of 20 years to match the pipeline design life. The current field life is expected to be until at least 2037, therefore infrastructure may be upgraded or replaced as required to meet this.

A pig launcher is provided on the John Brookes WHP that is capable of launching cleaning pigs and can accommodate intelligent pigs. On the upper deck above the pig launcher trapdoor is an access hatch to allow pig loading from the upper deck. A kicker line and pig signaller are also provided.

2.4.2.3 Spartan-2 Well

The Spartan-2 well is expected to be drilled in Q2/Q3 2022 and online in Q3/Q4 2022. The Spartan well targets the Flag Sandstone reservoir and will produce gas and condensate. The Spartan-2 well will be connected to the John Brookes WHP via a 17 km flexible flowline and pre-installed production J-tube. Production fluids form Spartan-2 will then enter the John Brookes pipeline for transportation to the VI onshore facility for processing.

2.4.2.4 Spartan flexible flowline

A 17 km, 8-inch diameter flexible flowline will connect the Spartan-2 well to the John Brookes WHP, via a pre-installed production J-tube. The design life of the flowline is 20 years, with field life of the Spartan field expected to be approximately seven years. Post lay stabilisation and protection of the flowline (on approach to the John Brookes WHP) is provided by concrete mattresses.

2.4.2.5 Spartan umbilical

A 17 km electro-hydraulic umbilical will connect the Spartan-2 xmas tree to the John Brookes WHP, via a pre-installed J-tube. This will provide hydraulic control fluid, low-voltage power and chemical injection services to the Spartan-2 production well via the umbilical's electro-hydraulic flying leads (EFLs) and cobra-head. Control of the well and distribution of the chemicals is via the distributed control system on the John Brookes WHP. The Spartan umbilical will make one crossing of the John Brookes pipeline. Protection and stabilisation at the John Brookes pipeline crossing, and pre-lay and post lay stabilisation of the umbilical is provided by concrete mattresses and grout bags.

2.4.2.6 Halyard umbilical

The 28 km electro-hydraulic umbilical from the John Brookes WHP to the Halyard xmas tree supplies hydraulic control fluid, low-voltage power and chemical injection services to the Halyard-1 production well via the umbilical's end termination subsea distribution unit and electro-hydraulic flying lead. Control of the well and distribution of the chemicals is via the distributed control system on the John Brookes WHP.

2.4.2.7 Halyard replacement umbilical

Due to communication faults in the existing Halyard umbilical a replacement electrical umbilical is being installed adjacent to the Halyard umbilical. The replacement umbilical is also 28km long and is terminated with a UTA.

2.5 Greater East Spar GES Subsea Infrastructure

GES is the name given to facilities consisting of the Halyard, Spar and East Spar fields. There is no topside infrastructure associated with this field. It includes the producing wells (Halyard-1 and Spar-2) and temporarily abandoned wells (as described in **Table 2-1**).

The East Spar field was discovered in 1993. Gas and condensate production commenced in 1996 from the East Spar field via VI and was suspended in 2006 upon exhaustion of the field reserves, and the East Spar wells are temporarily abandoned with permanent barriers. However, the infrastructure remains in place to support production from the Halyard and Spar fields. Production from Halyard commenced in 2011 and from Spar-2 in 2017.

The East Spar pipeline was installed in January 1996. Halyard-1 and Spar-2 production fluids are transported from the East Spar manifold to VI via the 350 mm (14"), 62.5-km-long East Spar pipeline. The pipeline has a total volume of approximately 6,000 kL. The East Spar pipeline is crossed by four pipelines, two flowlines and two umbilicals owned by Chevron. These pipeline and umbilical crossings and their locations (given in eastings and northings) are as follows:

+ Jansz export flowline crossing – 328 755 E, 7 714 025 N;
+ Jansz utility pipeline crossing – 328 352 N, 7 713 935 N;

- Jansz MEG pipeline crossing – 328 355 N, 7 713 936 N;
- Gorgon MEG pipeline crossing – 328 345 E, 7 713 934 N;
- Gorgon utility pipeline crossing – 328 348 E, 7 713 934 N;
- Gorgon production flowline crossing – 328 254 E, 7 713 914 N;
- Gorgon umbilical crossing East Spar – 328 049 E, 7 713 869 N; and
- Jansz umbilical crossing East Spar – 328 053 E, 7 713 870 N.

During the East Spar Intelligent Pigging and Removal Project in the first quarter of 2019, the East Spar pipeline end termination was installed to the East Spar PLEM to allow diverless intelligent pigging of the East Spar pipeline and associated infrastructure. As part of this project all subsea infrastructure between the East Spar manifold and the xmas trees (East Spar-1, East Spar-3 and East Spar-6) was removed but the East Spar manifold remains in place. The removed infrastructure included the flexible flowlines, control umbilicals, rigid spools and subsea heat exchangers.

A pipeline life extension process was completed as per the Pipeline Life Extension Procedure (QE-91-IX-00003) and has concluded that the East Spar pipeline is currently fit for service and can continue to operate until at least 2026. Maintenance of the remaining East Spar infrastructure is covered under this EP, and therefore Santos remains compliant with the OPGGS Act obligations for the titleholder to maintain, remove or have alternative arrangements accepted for infrastructure.

The Halyard-1 well was drilled and completed in March 2008. The Halyard-1 well produces fluids containing gas, condensate and water. The Halyard flexible 10” flowline is connected from the GES PLEM to the East Spar PLEM and East Spar manifold from which the well fluids are transported 65 km via the East Spar pipeline to VI.

The East Spar PLEM is connected to the East Spar manifold via a rigid tie-in spool. To match the East Spar manifold production header and facilitate pigging, the PLEM has a 14” production header.

The Spar-2 well, located 1.7 km west-southwest of the Halyard-1 well, was drilled and completed in December 2010 as a gas production well in approximately 115 m water depth. The Spar-2 well produces raw gas. Production from the Halyard-1 and Spar-2 wells is independent of the John Brookes facility, as the well fluids are exported to VI via the East Spar Pipeline. The Spar-2 well produces through the same 10” Halyard flowline and 14” East Spar pipeline as the Halyard gas field. To enable production from the Spar-2 well, minor modification to the existing Halyard subsea infrastructure took place in 2018, and the modification included installation of:

- The GES PLEM;
- A subsea cooling skid;
- A 1.7-km 8” flowline (connecting the GES PLEM to the Spar-2 xmas tree);
- Two 6” tie-in spools;
- Two electric flying leads; and
- A 1.9-km subsea control umbilical.

The Halyard umbilical and flowline were also re-routed.

The GES PLEM and subsea cooling skid are connected via a rigid tie-in spool. The Spar-2 xmas tree operates with direct flowline and umbilical connections to the GES PLEM, and a second rigid tie-in spool completes the connection of the Halyard-1 xmas tree into the GES PLEM.

The Halyard-1 and Spar-2 wells have been completed with a second-generation subsea control module for hydraulic control of the fail-safe xmas tree valves and production and annulus monitoring.

Reservoir fluids flow from one or more subsea wellheads directly into the flowlines and pipeline to VI. Both the Halyard-1 and Spar-2 wells have an expected service life of approximately 8 years; however, the subsea facilities these wells connect to have been designed for a 20-year operating life.

2.5.1 Subsea Infrastructure

The GES subsea infrastructure and status is presented in **Table 1-1**. The maintenance for subsea infrastructure is further described in **Section 2.7**. The well integrity risk assessment and ongoing management of the subsea wells is further detailed in the relevant risk assessment **Sections 7.6** and **7.8.**

Due to communication faults in the existing umbilical, a replacement 28km umbilical shall be laid next to the Halyard umbilical and terminated in the UTA. The UTA shall be connected to the GES PLEM via 3 EFLs and the existing umbilical EFLS disconnected.

2.6 Operational Activities

The John Brookes, Spartan and GES facilities have been designed to export well fluids from the production wells to the processing facilities on VI. Side streams of gas are taken from the main production manifold and dried for use as utility gas and as fuel gas for the Halyard microturbines.

VI operators provide 24-hour control of the WHP via telemetry and a distributed control system from a central control building on VI. WHP visits are only required for maintenance, with crews travelling via helicopter or support vessel to the WHP to carry out inspection, maintenance, monitoring and repair; to replenish fuel or chemicals; and to carry out operational requirements, such as a restart after a trip.

2.6.1 John Brookes WHP Visits

The John Brookes WHP is a normally unmanned facility; therefore, inspections and maintenance activities are conducted on a scheduled or as-needed basis. Inspections and maintenance of the WHP and the John Brookes and East Spar pipelines and Spartan flowline are managed using the Santos 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**.

2.6.2 Chemical Use and Storage

Storage of chemicals and hydrocarbons is limited to the small amounts of diesel, hydraulic oil, MEG and corrosion inhibitor required to operate the facility. Chemical injection for Halyard-1 production and Spartan-2 takes place from the John Brookes WHP.

Batch injection of MEG is conducted during start-up and restart of the Spartan-2, Halyard-1 and Spar-2 wells. Corrosion Inhibitor is injected continuously to support normal operations from John Brookes, Spartan-2, Halyard-1 and Spar-2 wells.

MEG and corrosion inhibitor are delivered to the WHP in transportable certified tote tanks by support vessels. The transportable tanks are typically lifted onto the upper deck by the WHP crane from where the chemicals are transferred to the fixed storage tanks by hoses fitted with quick connect/disconnect couplings.

2.6.2.1 Chemical Selection

A risk-based approach to select chemical products ranked under the Offshore Chemical Notification Scheme (OCNS) is applied for those chemicals used and discharged to the marine environment. This scheme lists and ranks all chemicals used in the exploration, exploitation, and associated offshore processing of petroleum on the UK Continental Shelf.

Chemicals are ranked according to their calculated Hazard Quotients (HQ) by the CHARM (Chemical Hazard Assessment and Risk Management) mathematical model, which uses aquatic toxicity, biodegradation and bioaccumulation data. The HQ is converted to a colour banding with Gold and Silver colour bands representing the least environmentally hazardous chemicals. Chemicals not amenable to the CHARM model (i.e. inorganic substances, hydraulic fluids or chemicals used only in pipelines) are assigned an OCNS grouping based on the worst-case ecotoxicity data with Group E and D representing the least hazard potential.

The Santos Operations Chemical Selection, Evaluation and Approval Procedure (EA-91-II-10001) and Santos Drilling Fluid and Chemical Selection in Drilling Activities Procedure (EA-91-II-00007) accept CHARM ranked Gold/Silver, or non-CHARM ranked E/D chemicals for use and discharge without a detailed environmental risk assessment. The same applies to chemicals that are OSPAR Pose Little or No Risk to the Environment (PLONOR) List. The PLONOR Listed, agreed upon by the OSPAR Convention (Convention for the Protection of the Marine Environment of the North-East Atlantic), contains a list of substances that will pose little or no risk to the environment in offshore waters. If chemicals are ranked lower than Gold, Silver, E or D (i.e. CHARM ranked purple, orange, blue or white, or non-CHARM A, B or C ranked chemicals) and no alternatives are available, a risk assessment is conducted providing technical justification for their use, and showing that their use and associated risk is acceptable and ALARP.

As described above, investigation of potential alternative chemicals is completed when chemicals are ranked lower than CHARM Gold, Silver, E or D (i.e. CHARM ranked purple, orange, blue or white, or non-CHARM A, B or C ranked chemicals). There is a preference for chemical options that are CHARM ranked Gold/Silver, or non-CHARM ranked E/D chemicals and / or chemical that have a low aquatic toxicity, are readily biodegradable and do not bioaccumulate (discussed below).

Any chemicals that may be discharged to the marine environment and not OCNS CHARM or non-CHARM ranked are risk assessed using the OCNS CHARM or non-CHARM models. The chemical is assigned a pseudo-ranking based on the available aquatic toxicity, biodegradation and bioaccumulation data (discussed below) and assessed for environmental acceptability for discharge.

Ecotoxicity Assessment

Table 2-3 and **Table 2-4** act as guidance in assessing the ecotoxicity of chemicals during the investigation of potential alternatives. **Table 2-3** is used by Cefas to group a chemical based on ecotoxicity results, 'A' representing highest toxicity/risk to environment and 'E' lowest. **Table 2-4** shows classifications/categories of toxicity against aquatic toxicity results.

Table 2-3: Initial OCNS grouping

Initial grouping	A	B	C	D	E
Result for aquatic-toxicity data (ppm)	<1	≥1-10	>10-100	>100-1,000	>1,000
Result for sediment-toxicity data (ppm)	<10	≥10-100	>100-1,000	>1,000-10,000	>10,000

Note: Aquatic toxicity refers to the Skeletonema costatum EC50, Acartia tonsa LC50, and Scophthalmus maximus (juvenile turbot) LC50 toxicity tests. Sediment toxicity refers to the Corophium volutator LC50 test.

Source: Cefas Standard Procedure 2019, OCNS 011 NL Protocol PART 1: Core Elements

Table 2-4: Aquatic Species Toxicity Grouping

Category	Species	LC_{50} and EC_{50} criteria
Category Acute 1 Hazard statement - Very toxic to aquatic life	Fish	LC_{50} (96hr) of ≤1 mg/L
	Crustacea	EC_{50} (48hr) of ≤1 mg/L
	Algae / other aquatic plant species	ErC_{50} (72 or 96hr) of ≤1 mg/L
	Fish	LC_{50} (96hr) of >1 mg/L to ≤10 mg/L
	Crustacea	EC_{50} (48hr) of >1 mg/L to ≤10 mg/L

Category	Species	LC_{50} and EC_{50} criteria
Category Acute 2 – Hazard statement – Toxic to aquatic life	Algae / other aquatic plant species	ErC_{50} (72 or 96hr) of >1 mg/L to ≤10 mg/L
Category Acute 3 – Hazard statement – Harmful to aquatic life	Fish	LC_{50} (96hr) of >10 mg/L to ≤100 mg/L
	Crustacea	EC_{50} (48hr) of >10 mg/L to ≤100 mg/L
	Algae / other aquatic plant species	ErC_{50} (72 or 96hr) of >10 mg/L to ≤100 mg/L

Source: United Nations (2019) Globally Harmonized System of Classification and Labelling of Chemicals (GHS), Eight Revised Edition

Biodegradation Assessment

The biodegradation of chemicals is assessed using the Cefas biodegradation criteria, which aligns with the categorisation outlined in the United Nations GHS Annex 9 Guidance on Hazards to the Aquatic Environment (2019). The below is used as a guide during the investigation of potential chemical alternatives. Preference is to select readily biodegradable chemicals.

Cefas categorises biodegradation into the following groups:

+ Readily biodegradable: results of >X% biodegradation in 28 days to an OSPAR harmonised offshore chemical notification format (HOCNF) accepted ready biodegradation protocol.
+ Moderately biodegradable: results >20% and <X% to an OSPAR HOCNF accepted ready biodegradation protocol.
+ Poorly biodegradable: results from OSPAR HOCNF accepted ready biodegradation protocol

Where X is equal to:

+ 60% in 28 days in OECD 306, Marine BODIS or any other acceptable marine protocols, or in the absence of valid results for such tests.
+ 60% in 28 days (OECD 301B, 301C, 301D, 301F, Freshwater BODIS) OR
+ 70% in 28 days (OECD 301A, 301E).

Bioaccumulation Assessment

The bioaccumulation of chemicals is assessed using the Cefas bioaccumulation criteria, which aligns with the categorisation outlined in the United Nations GHS Annex 9 Guidance on Hazards to the Aquatic Environment (2019). Preference is to select non bioaccumulative chemicals.

The following guidance is used by Cefas:

+ Non-bioaccumulative/non-bioaccumulating: Log Pow <3, or results from a bioaccumulation test (preferably using Mytilus edulis) demonstrates a satisfactory rate of uptake and depuration, and the molecular mass is ≥700.
+ Bioaccumulative/Bioaccumulates: Log Pow ≥3, or results from a bioaccumulation test (preferably using Mytilus edulis) demonstrates an unsatisfactory rate of uptake and depuration, and the molecular mass is <700.

All chemicals will be selected in accordance with the Santos Operations Chemical Selection, Evaluation and Approval Procedure (EA-91-II-10001) and Santos Drilling Fluid and Chemical Selection in Drilling Activities Procedure (EA-91-II-00007), as applicable.

2.6.3 Bird Deterrent Activities

Safety of aircraft and passengers visiting the John Brooks WHP is paramount. Management of birds for the safe landing and take-off of helicopters is critical.

Due to potential bird strikes on helicopters when approaching the WHP to land, a bird-deterrent system has been installed on the WHP (CMC-VI-1207).

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 noise, vibration and light options.

2.7 Maintenance, Inspection, Monitoring and Repair Activities

The John Brookes WHP is normally an unmanned facility, and the Spartan and Greater East Spar facilities are subsea developments, which by their very nature are unmanned facilities. As such, inspection, maintenance, monitoring and repair (IMMR) activities are conducted on a scheduled and as-needed basis, while intervention activities (**Section 2.7.8**) are conducted on an as-needed basis.

Maintenance of the WHP and subsea equipment is managed using the CMMS. This system provides:

+ The ability to analyse equipment for better maintenance regimes, design changes or replacement;
+ Timely preventive maintenance schedules;
+ Improved control over maintenance expenditures;
+ Automatic parts ordering and inventory control;
+ Reduction of inventory costs and improved stores accountability; and
+ Improved utilisation of labour.

Preventive maintenance is incorporated into the VI CMMS and includes:

+ Routine inspections of operational and suspended infrastructure;
+ Assurance activities; and
+ Maintenance carried out on a usage basis, such as machine running hours.

It is through the implementation of this maintenance regime that Santos will meet its obligations under the OPGGS Act (s.572(2)) to ‘maintain in good condition and repair all structures that are, and all equipment and other property that is, in the title area and used in connection with the operations’.

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

Ongoing IMMR may include such activities as:

+ General inspections;
+ Integrity Corrosion control;
+ Plant and subsea infrastructure cleaning, repair and modifications;
+ Subsea pipeline and seafloor imaging surveys;
+ Subsea Equipment and Infrastructure Installation, Cleaning, Repair and Modification;
+ Marine growth removal;
+ Inline inspections of pipelines (pigging);
+ Installation of replacement equipment/parts;
+ Installation of additional secondary stabilisation;
+ Pipeline stabilization;
+ Topsides cleaning of facilities (both maintenance and for suspension);
+ Flexible riser annulus vacuum testing; and
+ Rigless well servicing or intervention.

2.7.1 General Inspections

Topsides and subsea maintenance, inspection or repair activities are expected to be undertaken by Santos using dedicated crew, remotely operated vehicles (ROVs), autonomous underwater vehicles (AUVs) or diving contractors.

ROV inspection activities normally comprise a simple visual survey that does not involve making contact with subsea infrastructure, usually after such events as major storms. Such inspections check for disturbance or damage to the subsea infrastructure that may impact on safe operation.

ROV surveys may include inspection, photography, side-scan sonar survey, cleaning, condition monitoring, anode replacement and general maintenance of structures, riser or pipeline, and intervention activities or valve operations.

All subsea inspections are carried out in accordance with Santos's Underwater Inspection Manual (SO-00-MG-00005).

2.7.2 Abandoned subsea well inspection

Well integrity monitoring for temporarily abandoned subsea wells will be undertaken. The monitoring is defined in the respective WOMPs and includes routine visual inspection around the wellhead to demonstrate no evidence of loss of containment.

All subsea inspections are carried out in accordance with Santos's Underwater Inspection Manual (SO-00-MG-00005).

2.7.3 Integrity and Corrosion Control

Integrity and corrosion control is managed based on inspections and maintenance of the subsea infrastructure are scheduled through the CMMS and carried out in accordance with routine work orders.

Offshore external inspection of all Santos subsea assets is based on asset class, as outlined in the Subsea Inspection Procedure (SO-35-IS-00001). This procedure covers inspection of all subsea infrastructure, including structural, riser, pipelines, conductors, flowlines, Christmas trees, manifold systems, wellheads, hoses.

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

Offshore inspection ancillary work is detailed in Varanus Island Offshore Facilities and Harriet Alpha Performance Standard Assurance Plans: PS-01 Platform Structural Integrity: Jackets, Subsea and Topsides Structures, including Helidecks (SO-00-RG-00213) and PS-03 Hydrocarbon Containment: Risers and Pipelines (SO-00-RG-00215). Procedures referenced in these assurance plans cover subsea infrastructure to assess their integrity. These activities can involve topsides inspections and ROV or AUV inspections or diver-assisted surveys.

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

Diving operations may be periodically required at or near the WHP. Diving operations are carried out using detailed planning and execution procedures. All diving operations are carried out in accordance with the Commonwealth OPGGS (Safety) Regulations 2009. Diving work is undertaken from a dedicated dive support vessel. No diving operations are carried out from the WHP.

A program of ongoing fabric maintenance of the WHP is also undertaken as part of the corrosion control program. Prior to painting, the offshore structures may be cleaned with an ultra-high-pressure water or grit-blasted with garnet (a naturally occurring (inert/nontoxic) product) or other means.

Following an inspection, it may be necessary to disturb the seabed in the vicinity of subsea infrastructure, such as a pipeline, to correct free spans (e.g., by placing grout bags under the free span) or burial (by jetting or airlifting sediments from the top of the pipeline).

Activities associated with mothballing pipelines and facilities may include subsea infrastructure cleaning or flushing to maintain integrity during extended periods of inactivity. Such activities may involve marine vessel or diver-based interventions to flush lines with treated seawater or inert gas. This may involve hot tapping (the process of drilling a hole through a pressure barrier using special equipment and procedures so that the pressure and fluids are safely contained when access is made) pipelines to facilitate this outcome.

2.7.4 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 (SBESs), multibeam echo sonders (MBESs), side scan sonars (SSS)and AUVs to identify:

+ Free spans;
+ 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.

2.7.4.1 Single-beam echo sounders and multi-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 to allow for correction for the motion. MBESs work in the same way but produce a swath of acoustic fan-shaped pulses of sound made up of many single beams.

2.7.4.2 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 or vessel hulls or more commonly operated using an ROTV. The ROTV is towed behind the vessel using a tether at approximately 4 knots.

2.7.4.3 Autonomous Underwater Vehicles

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. The survey speed is often determined by the payload and survey objective but is generally around 4 knots. AUVs are battery powered.

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.

2.7.5 Subsea Equipment and Infrastructure Installation, Cleaning, Repair and Modification

Installation, modification, and cleaning of equipment or infrastructure in the operational area is occasionally required due to changes in recovery rates or other operational modifications and upgrades. Infrastructure and equipment may also need to be replaced as dictated by the inspection and testing regime (**Section 2.7.11**). Such activities can include:

+ Removing pipework and process units;
+ Extensions to the WHP;
+ Upgrading the various components, control systems and equipment on the WHP;
+ Upgrading the various subsea components, control systems and equipment;
+ Flushing, draining and recovering residual liquids from pipes;

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- Flushing residual liquids from subsea infrastructure to VI;
- Piping, process and electrical alterations to accommodate operational changes to the field, such as new wells; and
- Topsides cleaning or abrasive blasting, involving the use of cleaning and corrosion-inhibitor chemicals, with high-pressure or steam cleaning of pressure vessels, piping and equipment.

2.7.6 Marine Growth Removal

Marine growth on the substructures of offshore platforms must be maintained at levels that do not compromise the structural integrity of the platform. The John Brookes 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 typically measured every five years using ROVs and/or divers; and if determined to be beyond the allocated thickness, it is periodically removed. This is carried out on an as-required basis in line with Santos's CMMS requirements.

In addition, as part of ongoing maintenance and to facilitate inspections, marine growth is removed from the WHP substructure, subsea pipelines, wellheads, heat exchangers and manifolds using inspection or working class ROVs and/or divers.

Marine growth is removed using high-pressure water cleaning (water jetting), brushing, vacuuming, grit blasting, or a combination of these:

- Water jetting – typically conducted by ROVs or divers, where water is pressurised to above hydrostatic pressure. Generally, water-jetting activities shall be through small-diameter water jets that act locally on the pipeline or structure;
- Brushing – typically a coarse brush is applied to the pipeline or structure;
- Vacuuming of infrastructure;
- Grit blasting – may be required to expose parent metal on very localised areas only (typically used for spot checks). This activity is conducted via diver intervention. Air and beach sand would be the only components of this type of cleaning technique; and
- Acid wash removal – on occasion as required by the extent of marine or calciferous growth on subsea infrastructure, an acid wash chemical (e.g., citric acid, sulfamic acid, calcium wash) may be used in addition to water jetting, vacuuming or non-aggressive brushing. The acid wash is generally conducted via an acid injection skid mounted on an ROV or lowered to the seabed on a subsea frame.

2.7.7 Pipeline Span Rectification

Pipeline span rectifications may be required to prevent possible damage to the pipelines and flowlines and to maintain their integrity. Where span rectification is required, there are various methods that may be used for span rectification, as outlined below.

2.7.7.1 Grout or sand Bags

Spans can be filled in through the use of a grout bag (a bladder or bag) that is positioned under the pipeline and pumped full of grout or sand until the bag supports the pipeline. This method, using a support vessel, can address scouring issues around support structures, which are checked to confirm that these are stable under storm conditions.

2.7.7.2 Trenching or Jetting

Trenching or water jetting the pipeline into the seabed removes the span and provides additional stability protection to the pipeline.

2.7.8 Well Intervention

There are no current or ongoing well intervention activities planned on John Brookes platform. Well intervention activities may be required in response to well servicing requirements for John Brookes Wells, Spartan-2, Spar-2 or Halyard-1. Well intervention is a collective term for deployment of tools, fluids, and equipment in pressurised or dead completed wells. A range of activities is undertaken through well interventions completed from the John Brookes WHP. These may include but are not limited to:

+ Plug and abandon, kill and cement, or suspend old wells in preparedness for a drill rig to re-enter a well and undertake a side track (MODU 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 xmas tree maintenance and removal (from the John Brookes WHP only) and wireline logging in the well bores; and
+ Commissioning new wellheads.

Different well intervention techniques, all of which can be carried out in either pressurised (live) or dead wells, are summaries in **Table 2-5**.

Table 2-5: Well Intervention Techniques

Intervention Technique	Description
Coil tubing	A coil tubing operation is a technique that is used to deploy various tools (logging tools, drilling tools, packers, etc.) and to circulate or place fluids in the well.
Wireline operation	A wireline operation is a technique that is used to deploy various electrical or mechanical down hole tools (logging tools, plugs, packers, perforating guns, shifting tools, pulling tools etc.) on electrical cables, braided cables or slickline (non-electrical cable).
Hydraulic work over	A hydraulic work over (snubbing) operation is a technique that is used to deploy tools and equipment via jointed pipe and to provide a conduit to circulate or place fluids in the well.
Pumping operation	A pumping operation can be defined as an injection of fluids into a well through tubing and annuli.

All well intervention activities are carried out under an activity-specific, internally approved well services program as per the John Brookes Well Operations Management Plan (WOMP) (DR-91-ZG-10037), the Halyard-1 and Spar-2 WOMP (DR-91-ZG-10052) and the proposed Spartan-2 WOMP. These work programs (one for each well) outline work sequence, method of isolation and tubing or annulus fluid volumes. The WOMP prescribes the well integrity management of individual wells for a given asset and is the primary document in terms of well integrity management for a given Santos well. Well design and well barriers are assessed against the Well Lifecycle Management System Technical Standards. The WOMP is a stand-alone document and defines the well integrity performance standards for the relevant wells.

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

The Rosella-1 well and East Spar wells 3, 4, 6, 7 and 9 are all temporarily abandoned, and inspected in accordance with NOPSEMA-accepted WOMPs. No intervention activities are planned on these open-ocean wells. If well intervention activities are required on these wells at a later date, they will be the subject of a separate approval.

2.7.9 Well Abandonment or Suspension

During the field life, the John Brookes wells, Spartan-2 well, Halyard-1 and Spar-2 wells may be temporarily suspended or plugged and abandoned in accordance with the requirements of the OPGGS Act. Activities involving the use of a MODU, such as the drilling of new wells or the permanent abandonment of wells, are not covered in this EP.

Equipment used for suspension activities will either be lifted aboard and operated on the WHP or operated from a support vessel. Activities are as described in the respective WOMPs and include:

+ Installation of deep-set tubing/tubing hanger plugs to isolate tubing leak; and
+ Installation of tubing/tubing hanger plug(s) to provide barriers to enable XT/WHD removal, remediation and/or repair.

This process usually involves placing cement plugs in the casing of the well at various intervals and flooding the casing with fluids containing corrosion inhibitor and/or biocide.

Depending upon the specific well activity requirements at the time, flushing and/or purging the pipeline and process equipment of any residual hydrocarbons may be required, while leaving the pipeline in situ until a final decommissioning program has been developed. NOPSEMA-accepted WOMPs are in place for all wells within the operational area. The WOMPs describe the well integrity risks and inspection requirements for operational and suspended wells.

2.7.10 Cold venting

There is no flare on the WHP; therefore, any gas emissions are cold-vented. Fugitive emissions can also occur during cold venting. 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 well stream hydrocarbons are mainly methane.

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.

2.7.11 Inline Inspections

The John Brookes pipeline has the ability to be pigged while operational. A pig launcher is provided on the WHP that is capable of launching cleaning pigs and can accommodate intelligent pigs. Pigs travel from the WHP to VI.

Pigging of the East Spar pipeline is done infrequently, as the pig launcher is subsea. Intelligent pigging frequency depends on the findings from the previous inspection.

2.7.12 Life Extension Works

Section 8.8 describes Santos' approach to asset life cycle management and that end-of-field-life (EOFL) is dependent on multiple variables and therefore subject to change. To ensure continued safe operations until EOFL, life extension works may be required on infrastructure in the John Brookes, Spartan and GES fields.

The design life of the John Brookes WHP and pipeline system is until 2024-2025 respectively, however the field life is currently estimated to be until at least 2037. Similarly, the design life of the 14" East Spar pipeline is 2025 and 2030 for Halyard 10" flowline, however the GES field life is currently estimated to be until at least 2032. The design life of the Spartan 8" flowline is 20 years, with field life estimated to be approximately 7 years (2030). Santos is not planning to cease operation of or remove this property within the five-year period of this EP.

Engineering studies will be completed, and potentially rectification works if necessary, to ensure infrastructure integrity and safe operations beyond design life. Any rectification work that may be required will be the types of maintenance and repair activities that have been described in **Section 2.7** above. If additional works are required that are not already described, any proposed changes to the EP will be managed in accordance with Santos's Environment Management of Change Procedure (EA-91-IQ-10001), as described in **Section 8.12.2**.

2.8 Safeguards, Emergency Blowdown and Shutdown Systems

2.8.1 Safeguards Overview

Safeguarding systems are in place and tested to automatically sense any abnormal process or upset condition, to alert the operator or control interface, and to execute actions (such as to isolate process inventories or to initiate shutdown and blowdown equipment as outlined in **Sections 2.8.2** and **Section 2.8.3**.

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

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

The safeguard 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
+ Automated emergency shutdown – to isolate sections of the facility to bring it to a safe condition.

The emergency shutdown and emergency blowdown activities for the John Brookes WHP and Halyard, Spar and East Spar pipelines are as described below.

2.8.2 Emergency Shutdown Activities

When the John Brookes WHP shutdown is activated, the pipeline is also shut in. The Spartan, Halyard and Spar subsea wells are shut in along with shutdown of the Spartan, Halyard and Spar equipment on the WHP. All safety systems on the WHP are designed to fail safe, with the wells and WHP isolated. Automatic shutdown is preceded by a pre-alarm relayed to the onshore VI control room. In addition, if an emergency shutdown at the onshore East Spar Joint Venture gas plant occurs, the John Brookes WHP wells, Spartan, Halyard and Spar subsea wells will also automatically shut in.

2.8.3 Emergency Blowdown Activities

There is no automatic depressurisation for the John Brookes WHP or the Spartan, Halyard, Spar and East Spar subsea system. The production system remains pressurised after shutdown.

2.9 Vessel Operations

Support vessels are used for routine visits to the John Brookes WHP for activities such as chemical replenishment chemicals, diesel fuel and potable water. Support vessels will also be used to backload any equipment, waste and materials that require offloading.

Dedicated equipment-specific vessels that may be used include dive support vessels, ROV support vessels, 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 John Brookes, Spartan or GES 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 is not likely to be required for routine activities. However, there are circumstances where anchoring could be required. Therefore, the impacts 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 impacts and risks associated with sourcing non-local vessels, including appropriate management controls, are included in this EP.

2.10 Decommissioning

A stand-alone environmental approval to undertake decommissioning of the VI Hub Commonwealth Waters 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.

Santos' approach to asset life cycle management, including decommissioning, is described in Section 8.8. Santos does not currently have plans to decommission the VI Hub Commonwealth facilities within the five-year period of the environment plan.

Santos will ensure through monitoring, and maintenance if required, that property can be removed when required, and the ongoing presence of the property is not causing unacceptable environmental impacts or risks.

Monitoring and maintenance activities, as relevant to the point of decommissioning, are described in **Section 2.7.**

3 Description of the Environment

OPGGS(E)R 2009 Requirements
Regulation 13. Environmental assessment.
Description of the environment 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. 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 all infrastructure and activities associated with the John Brookes, Spartan and Greater East Spar facilities in Commonwealth waters; and
+ The area that may be affected (EMBA), shown in **Figure 3-1.**

A detailed and comprehensive description of the environment (required by OPGGS(E)R 2009, Section13(3)) in the operational area and broader EMBA is provided in **Appendix C**.

Copies of the Department of the Environment and Energy (DoEE) Protected Matters Search Tool outputs for the operational area and the EMBA are also available in **Appendix D**. The searches are completed using the exact coordinates that are utilised to produce the figures throughout **Section 3** of the EP, ensuring that the EMBA encompasses the full range of environmental receptors that might be contacted by surface and subsurface hydrocarbons at the low exposure level in the highly unlikely event of a worst case oil spill.

On the first page of the PMST report, is a coarse graphic showing the area over which the search has been conducted. However, the granularity of this can make the output look different to the spatial area represented on figures within the EP.

The co-ordinates are also provided within the PMST report to allow for duplication of the search and verification if required. Santos do not have control over the PMST search tool output, but instead have provided the reports and coordinates to ensure transparency.

The EMBA encompasses the full range of environmental receptors that might be contacted by surface and subsurface hydrocarbons in the highly unlikely event of a worst case oil spill. Most planned and unplanned events associated with the activity may affect the environment up to a few hundred metres from the facilities.

A large unplanned hydrocarbon spill would extend substantially beyond a few hundred metres. **Section 3.1.1** describes how the EMBA is determined.

3.1.1 Determining the Environment that May be Affected

Stochastic hydrocarbon dispersion and fate modelling, applied to all credible spill scenarios identified as relevant to the activity (**Section 7.5.1**), was undertaken to inform the EMBA (RPS, 2019). Stochastic modelling is created by overlaying hundreds of individual hypothetical oil spill simulations from an oil spill into a single map, with each simulation subject to a different set of metocean conditions drawn from historical records. Stochastic modelling is completed to reduce uncertainty in risk assessment and spill response planning.

The modelling considered four key physical or chemical phases of hydrocarbons that pose differing environmental and socioeconomic risks: surface, entrained, dissolved aromatic and shoreline accumulated hydrocarbons. The modelling used defined hydrocarbon exposure values, as relevant, to identifying an area that might be contacted by hydrocarbons, environment risk assessment and oil spill response planning, for the various hydrocarbon phases. Refer to **Table 3-1** for the exposure values used and to **Section 7.5** for further information on the reasons why these exposure values have been selected and how they relate to the risk assessment in **Section 7.6** to **Section 7.9.**

The EMBA is based on stochastic modelling, using the low exposure values (**Table 3-1**). The EMBA encompasses the outer most boundary of the overlaid worst-case spatial extent of the four hydrocarbon phases listed above for all of the credible spill scenarios. The EMBA is illustrated in **Figure 3-1.**

The low exposure values are used as a predictive tool to set the outer boundaries of an EMBA, and may not necessarily result in ecologically significant impacts. To inform the evaluation of potential environmental consequences of a hydrocarbon release (impact assessment), modelling is undertaken using higher exposure values (i.e. the concentrations at which environmental consequences may result). The higher exposure values are known as ‘moderate’ and ‘high’ are described within **Table 3-1** and further explained **Section 7.5.5**. Applying the same method used to determine the EMBA, spatial areas were derived for moderate and high exposure values as illustrated in **Figure 3-3.**.

While the EMBA represents the largest possible spatial extent that could be contacted by any of the worst-case spill events modelled, an actual spill event is more accurately represented by only one of the simulations from the stochastic modelling, resulting in a much smaller spatial footprint from an actual spill event. Modelling of a single simulation, representative of a single spill event is termed deterministic modelling. An example of a deterministic run (single is illustrated in **Figure 3-1** to demonstrate a more realistic spatial extent for the worst-case spill event (i.e. a deterministic EMBA – using low exposure values). The deterministic EMBA for this EP is a single simulation from the worst case scenario described in **Table 7-10**, which is a surface hydrocarbon release from the JB (**Section 7.6**).

The exposure values in **Table 3-1** are displayed on the relevant figures (**Figure 3-3** to **Figure 3-18**).

Table 3-1: EMBA hydrocarbon exposure values

Hydrocarbon phase	Exposure Value		
	Low	Moderate	High
Floating (g/m²)	1	10	25
Shoreline accumulation (g/m²)	10	100	1,000
Dissolved aromatics (ppb)	6	50	400
Entrained (ppb)	10	100	-

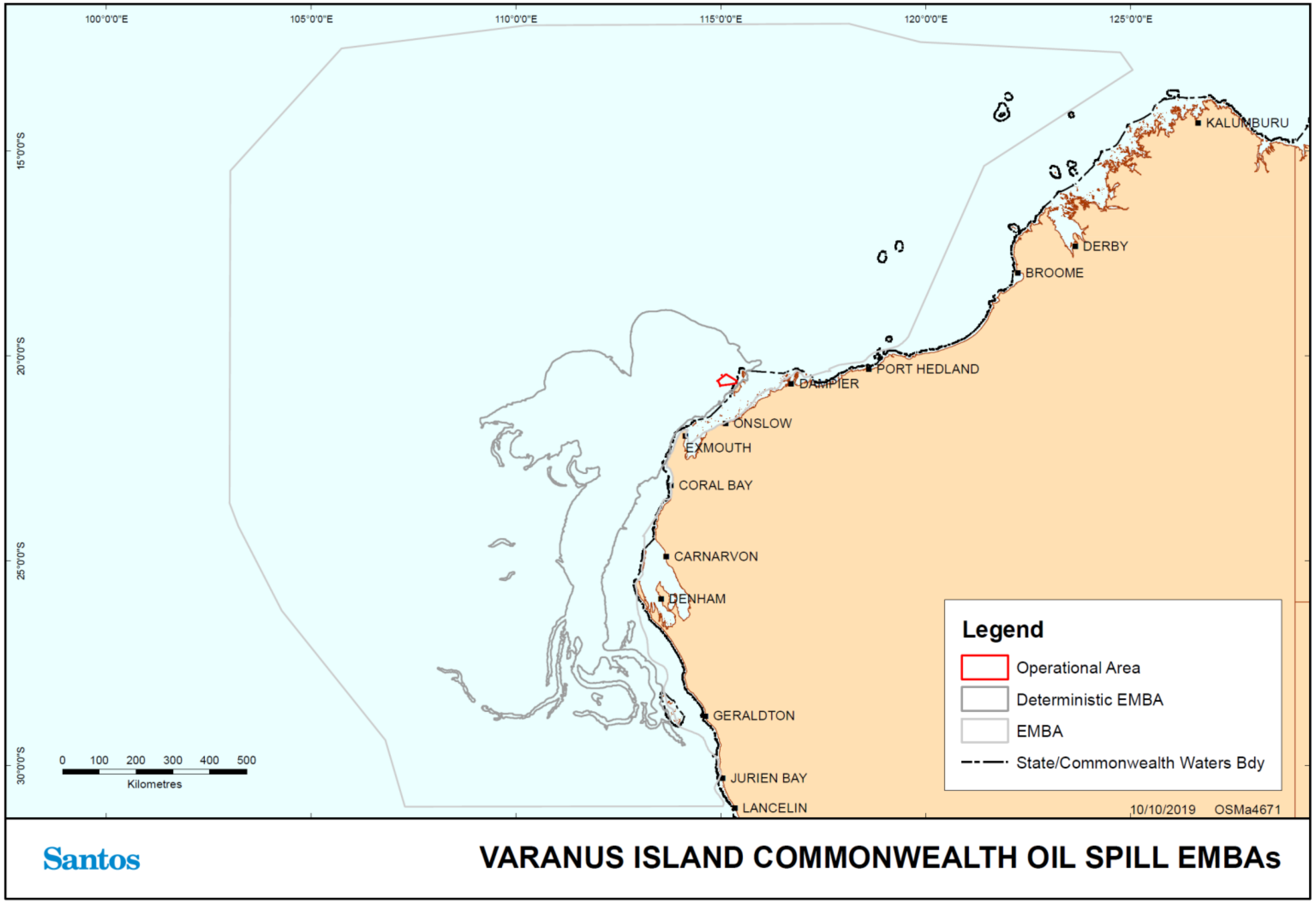

Figure 3-1: Varanus Island Commonwealth Oil Spill EMBAs

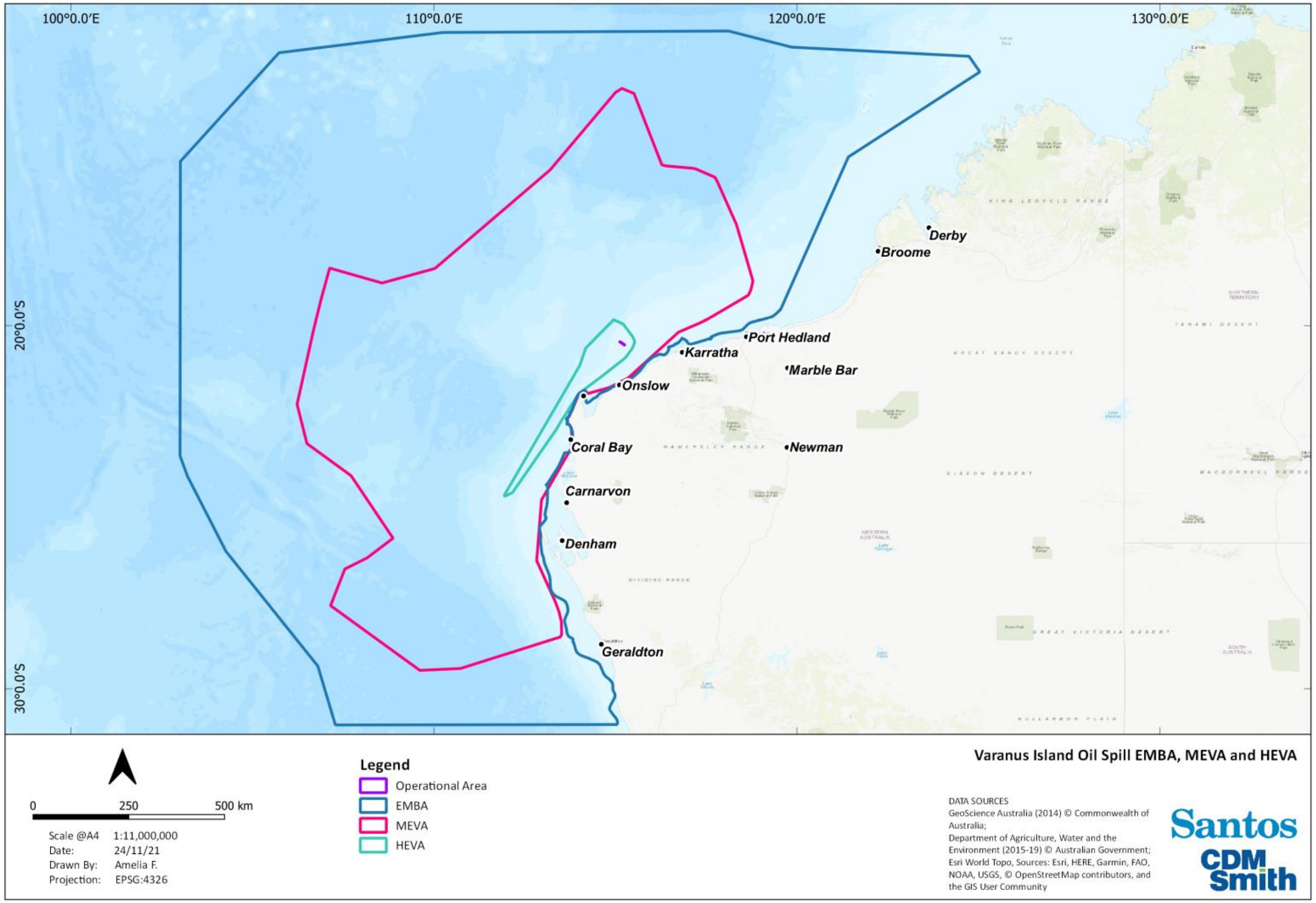

Figure 3-2: Overall EMBA, MEVA and HEVA for the Varanus Island Hub Operations

3.2 Environmental Values and Sensitivities

Desktop searches of the operational area and the EMBA were undertaken using the DoEE Protected Matters Search Tool to identify matters of national environmental significance listed under the EPBC Act. The results of these searches, undertaken on 30 September 2021, are provided in **Appendix D.**

A comprehensive description of the environmental values and sensitivities of the existing environment in the EMBA (required by OPGGS(E)R 2009, Section 13(3)) is provided in **Appendix C.** A summary of the information derived from the Protected Matters Search, bioregional plans and fauna recovery plans relevant to the operational area and the EMBA is provided in this section.

3.2.1 Bioregions

Based on the Integrated Marine and Coastal Regionalisation of Australia (IMCRA), Version 4.0 (DEH, 2006) IMCRA Version 4.0, the operational area overlaps the Northwest Shelf Province and the EMBA overlaps the:

+ Northwest Shelf Province;
+ Northwest Province;
+ Northwest Transition;
+ Timor Province;
+ Central Western Transition;
+ Central Western Shelf Transition;
+ Central Western Shelf Province;
+ Northwest Shelf Transition;
+ Christmas Island Province;
+ Southwest Shelf Transition; and
+ Central Western Province (**Figure 3-3**).

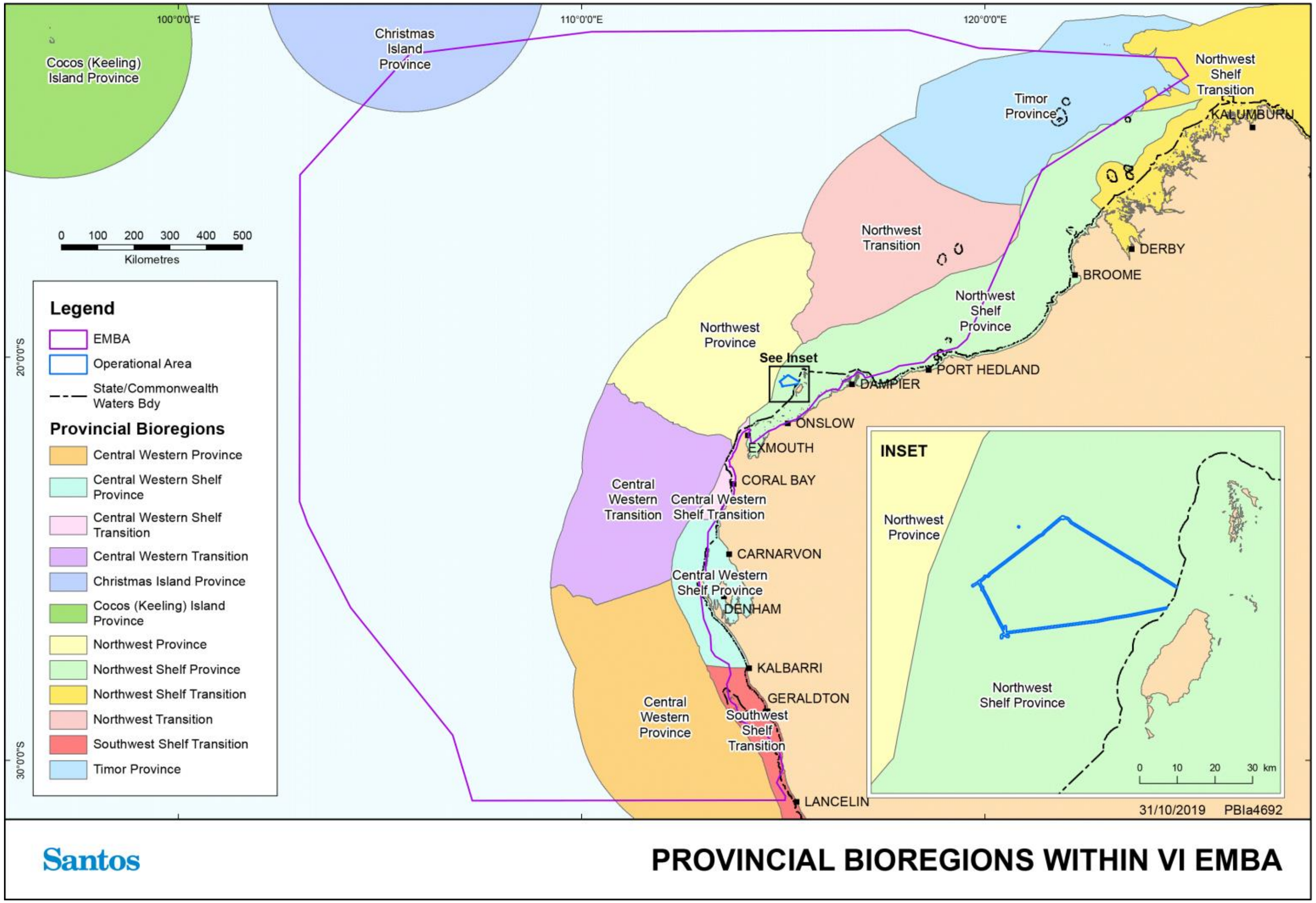

Figure 3-3: IMCRA 4.0 Provincial Bioregions within the Operational Area and EMBA

3.2.2 Benthic Habitats

The presence of marine and coastal habitats in the operational area and the EMBA are summarised in **Table 3-2** and illustrated in **Figure 3-4.**

A detailed description of these habitats with reference to the IMCRA provincial bioregions is provided in **Appendix C.** A summary of key benthic habitats, offshore reefs and islands, and shoals and banks is provided below.

The benthic (at or just below the seabed) habitats in waters in the operational area lie at depths ranging from approximately 45 m to 110 m. The operational area is likely to consist of soft sediment seabeds and sandy and muddy substrates, occasionally interspersed with hard substrates covered with sand veneers (DEWHA, 2008). Non-coral benthic invertebrates are likely to be the dominant community, albeit in low densities. Non-coral benthic invertebrates that occur in the operational area are likely to include sea cucumbers, urchins, crabs and polychaetes on soft substrate. Hard substrates are likely to contain sessile (fixed in one place) invertebrates, such as sponges and gorgonians (DEWHA, 2008).

There are no known offshore reefs or islands in or in close proximity (less than 5 km) to the operational area. However, there are a number of emergent oceanic reefs and islands in the EMBA, including Barrow Island, Montebello Islands, Lowendal Islands, Dampier Archipelago, Thevenard Islands, Muiron Islands and the Abrolhos Islands. A description of the values and sensitivities associated with these reefs and islands is provided in **Appendix C.**

A number of shoals and banks in the open offshore waters of the region have recognised environmental value. The key shoals and banks in the EMBA include the Rowley Shoals, Glomar Shoals, Rankin Bank and the Abrolhos Shoals. The closest bank feature to the operational area is Penguin Bank, located approximately 70 km south of the operational area. Approximately 40 bank features were identified in the wider EMBA (Geoscience Australia, 2019). The nearest key shoals to the operational area are the Glomar Shoals, located approximately 160 km northeast of the operational area. An understanding of these features has been gained from the Big Bank Shoals study (Heyward *et al.*, 1997) and the PTTEP Australasia surveys initiated in response to the Montara incident (Heyward *et al.*, 2010; Heyward *et al.*, 2012).

The shoals and banks in the EMBA contain benthic habitats and associated fauna assemblages that are highly diverse compared to the surrounding relatively deep and bare seabed that constitutes the majority of the outer continental shelf in the region. These shoals and banks may act as important sources of larvae of important taxa such as fish and corals, which may be advected considerable distances (Shell, 2019). The shoals and banks support many of the same species found on emergent reef systems of the Indo-West Pacific region (Heyward *et al.*, 2017a). This indicates a high level of ecological connectivity among the reef systems and between the shoals and banks. This is further supported by an analysis undertaken by the Australian Institute of Marine Science that compared benthic habitat community data from a number of shoals and banks in the Timor Sea and Bonaparte Gulf region. The analysis showed that neighbouring shoals and banks frequently share many attributes in terms of benthic community composition and species (Heyward *et al.*, 2017b).

While the benthic communities on each shoal or bank reveal a degree of connectivity, it is acknowledged that they may vary in the abundance and diversity of dominant benthic species, with subsets of species featuring more prominently on some than others (Heyward *et al.*, 2017b). This variability may reflect different disturbance events (e.g., cyclones, storm damage and coral bleaching) and recruitment histories, as well as potentially different ecosystem trajectories (Heyward *et al.*, 2017b).

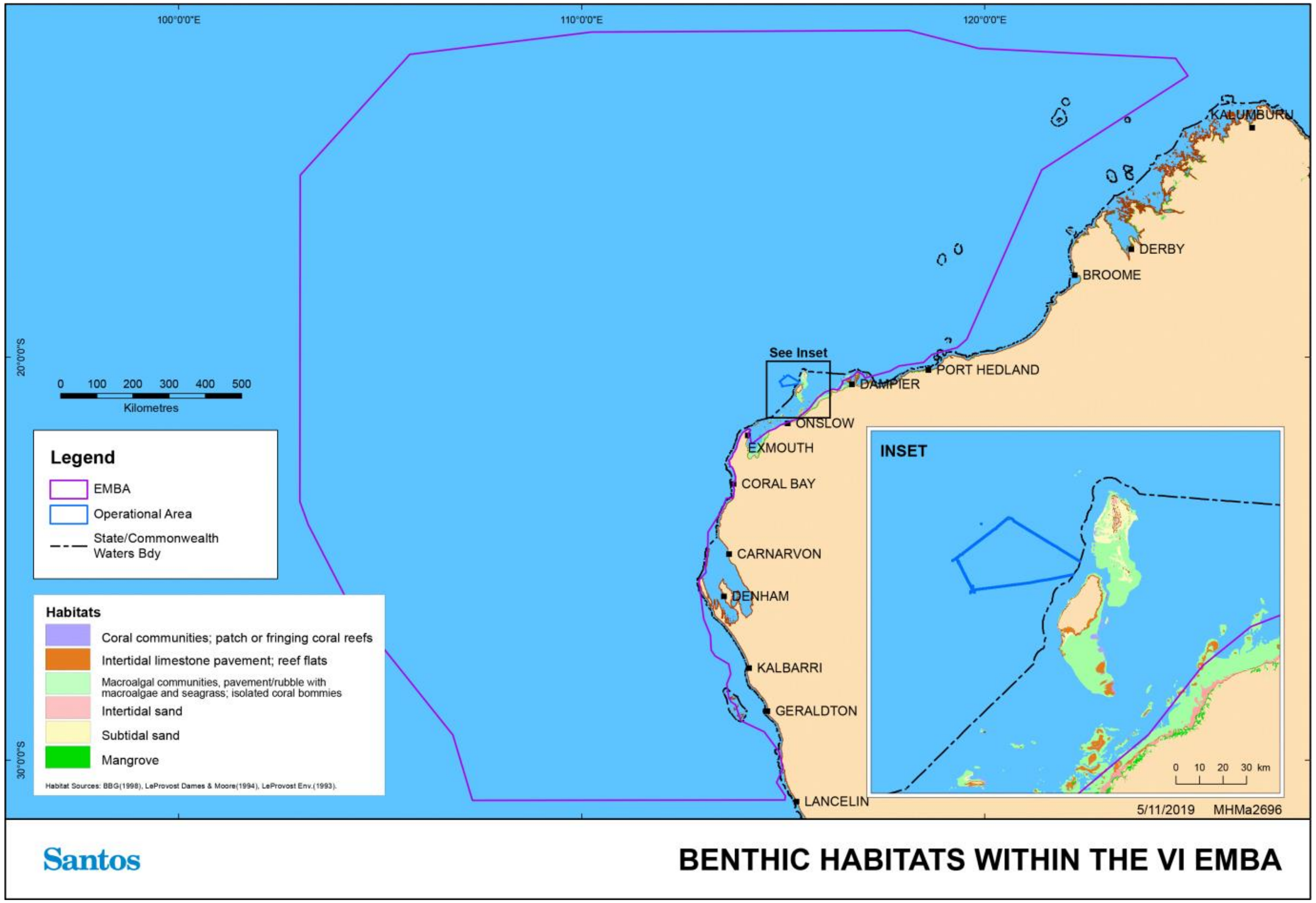

Figure 3-4: Benthic Habitats within the Operational Area and EMBA

Table 3-2: Habitats in the EMBA Listed According to Presence in the Operational Area and IMCRA Provincial Bioregions of Australia

Category	Receptor	Operational Area Presence	EMBA Presence: Northwest Province	Northwest Shelf Province	Northwest Transition	Central Western Transition	Central Western Shelf Transition	Central Western Shelf Province	Central Western Province	Northwest Shelf Transition	Christmas Island Province	Timor Province	Southwest Shelf Transition	Relevant Events that May Impact on the Receptors
Benthic Habitats	Coral reefs			✓	✓		✓	✓				✓	✓	Unplanned Condensate release due to subsea or surface well release. Diesel release from vessel collision.
	Seagrass			✓	✓		✓	✓				✓	✓	
	Macroalgae			✓	✓		✓	✓				✓	✓	
	Non-coral benthic invertebrates	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	Planned Seabed disturbance. Planned operational discharges. Unplanned Condensate release due to subsea or surface well release. Diesel release from vessel collision. Unplanned release of solids.
Shoreline Habitats	Mangroves			✓			✓	✓						Unplanned Condensate release due to subsea or surface well release. Diesel release from vessel collision.
	Intertidal platforms			✓			✓	✓					✓	

Category	Receptor	Operational Area Presence	EMBA Presence											Relevant Events that May Impact on the Receptors
			Northwest Province	Northwest Shelf Province	Northwest Transition	Central Western Transition	Central Western Shelf Transition	Central Western Shelf Province	Central Western Province	Northwest Shelf Transition	Christmas Island Province	Timor Province	Southwest Shelf Transition	
	Sandy beaches			✓			✓	✓					✓	
	Rocky shorelines			✓			✓	✓					✓	

3.2.3 Protected and Significant Areas

Protected and significant areas identified in the operational area and the EMBA are detailed in **Table 3-3**, **Figure 3-5** and **Figure 3-6**. These areas are further discussed in **Appendix C.**

The management zones associated with the Australian marine parks identified in the EMBA and the relevant objectives are detailed in **Table 3-4.**

Table 3-3: Distance from Operational Area Boundary to Protected Areas, Key Ecological Features and Threatened Ecological Communities in the EMBA

Value/Sensitivity	Name	Zone or IUCN Classification	Within Operational Area	Distance to Operational Area
Australian Marine Parks	Montebello Marine Park	Multiple Use Zone (IUCN VI)	Yes	0 km (intersects)
	Gascoyne Marine Park	Habitat Protection Zone (IUCN IV)	No	249 km
		Multiple Use Zone (IUCN VI)		120 km
		National Park Zone (IUCN II)		330 km
	Ningaloo Marine Park	Recreational Use Zone (IUCN IV)	No	129 km
		National Park Zone (IUCN II)		258 km
	Dampier Marine Park	Habitat Protection Zone (IUCN IV) National Park Zone (IUCN II)	No	154 km
	Argo-Rowley Terrace Marine Park	Multiple Use Zone (IUCN VI)	No	327 km
	Eighty Mile Beach	Multiple Use Zone (IUCN VI)	No	381 km
	Shark Bay Marine Park	Multiple Use Zone (IUCN VI)	No	439 km
	Carnarvon Canyon Marine Park	Habitat Protection Zone (IUCN IV)	No	466 km
	Mermaid Reef	Multiple Use Zone (IUCN VI)	No	576 km
	Abrolhos Marine Park	Habitat Protection Zone (IUCN IV)	No	614 km
		Multiple Use Zone (IUCN VI)		765 km
		National Park Zone (IUCN II)		725 km

Value/Sensitivity	Name	Zone or IUCN Classification	Within Operational Area	Distance to Operational Area
		Special Purpose Zone (IUCN VI)		754 km
	Kimberley	Multiple Use Zone (IUCN VI)	No	714 km
	Jurien Marine Park	Special Purpose Zone (IUCN VI)	No	1,046 km
	Cartier Island	Sanctuary Zone (IUCN Ia)	No	1,242 km
State Marine Parks and Marine Management Areas (Coastal marine parks are described in **Appendix C**.)	Barrow Island Marine Management Area	–	Yes	0 km (intersects)
	Barrow Island Marine Park	Sanctuary Zones	No	5.5 km
	Montebello Islands Marine Park	Sanctuary Zones, Recreation Zones, Special Purpose Zones	No	7.5 km, 17.3 km, 18.2 km, 14.0 km
	Muiron Islands Marine Management Area	-	No	111 km
	Ningaloo Marine Park	Sanctuary Zones, Special Purpose Zones, Recreation Zones, General Use Zone	No	142 km, 143 km, 141 km, 129 km
	Rowley Shoals Marine Park	Sanctuary Zones, Recreation Zones, General Use Zone	No	489 km
	Jurien Bay Marine Park	Sanctuary Zones, Special Purpose Zones, Aquaculture Zones, General Use Zone	No	1,034 km
World & National Heritage Areas	The Ningaloo Coast	–	No	111 km
	Dampier Archipelago (including Burrup Peninsula)	–	No	112 km
	Shark Bay	–	No	473 km
	Dirk Hartog Landing Site 1616 – Cape Inscription Area	–	No	565 km

Value/Sensitivity	Name	Zone or IUCN Classification	Within Operational Area	Distance to Operational Area
	HMAS Sydney II and HSK Kormoran Shipwreck Sites	–	No	714 km
Commonwealth Heritage Areas	Ningaloo Marine Area – Commonwealth Waters	–	No	129 km
	HMAS Sydney II and HSK Kormoran Shipwreck Sites	–	No	586 km
	Mermaid Reef – Rowley Shoals	–	No	715 km
	Scott Reef and Surrounds – Commonwealth Area	–	No	988 km
Wetlands of International Importance	None	–	–	–
Wetlands of National Importance	None	–	–	–
Key Ecological Features	Ancient coastline at 125 m depth contour	–	No	2 km
	Continental slope demersal fish communities	–	No	11.8 km
	Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula	–	No	84.5 km
	Exmouth Plateau	–	No	120 km
	Commonwealth waters adjacent to Ningaloo Reef	–	No	129 km
	Glomar Shoals	–	No	159 km
	Commonwealth marine environment within and adjacent to the west coast inshore lagoons	–	No	480 km
	Western demersal slope and associated fish communities	–	No	598 km
	Wallaby Saddle	–	No	628 km
	Western rock lobster	–	No	777 km

Value/Sensitivity	Name	Zone or IUCN Classification	Within Operational Area	Distance to Operational Area
	Ancient coastline between 90 and 120 m depth	–	No	787 km
	Canyons linking the Argo Abyssal Plain with Scott Plateau	–	No	800 km
	Seringapatam Reef and Commonwealth waters in the Scott Reef complex	–	No	817 km
	Commonwealth marine environment surrounding the Houtman Abrolhos Islands (and adjacent shelf break)	–	No	824 km
	Perth Canyon and adjacent shelf break, and other west-coast canyons	–	No	821 km
	Mermaid Reef and Commonwealth waters surrounding Rowley Shoals	–	No	975 km
	Ashmore Reef and Cartier Island and surrounding Commonwealth waters	–	No	1,225 km
Threatened Ecological Communities	None	–	–	–

Table 3-4: Management Zones for the Australian and State Marine Parks Found in 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.
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 for the protection and conservation of 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 in the North-west Marine Parks Network Management Plan (North-west MPNMP) (Director of National Parks, 2018). The Class Approval – Mining Operations and Greenhouse Gas Activities for the North-west MPNMP, which is applicable to petroleum-related activities, came into effect on 1 July 2018. Prescriptions / 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 3-5**.

Table 3-5: Prescriptions/Conditions from the North-West MPNMP 2018 and Associated Class Approval – Mining Operations and Greenhouse 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: (a) an Environment Plan accepted under the Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations (2009);	The OPEP (some proposed response activities in the event of an oil pollution incident may be undertaken within the North-west Marine Park Network).
	(b) the EPBC Act;	**Appendix B** (Legislation)
	(c) the EPBC Regulations;	This EP.
	(d) the North-west Network Management Plan;	This table.
	(e) Any prohibitions, restrictions or determinations made under the EPBC Regulations by the Director of National Parks; and	Not applicable.
	(f) 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 paragraphs a to e)).	**Appendix B** (Legislation), and the OPEP.
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 8.10** (Reporting) and the OPEP.

Prescription/ Condition Number	Prescription / Condition	Relevant Section of EP
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.

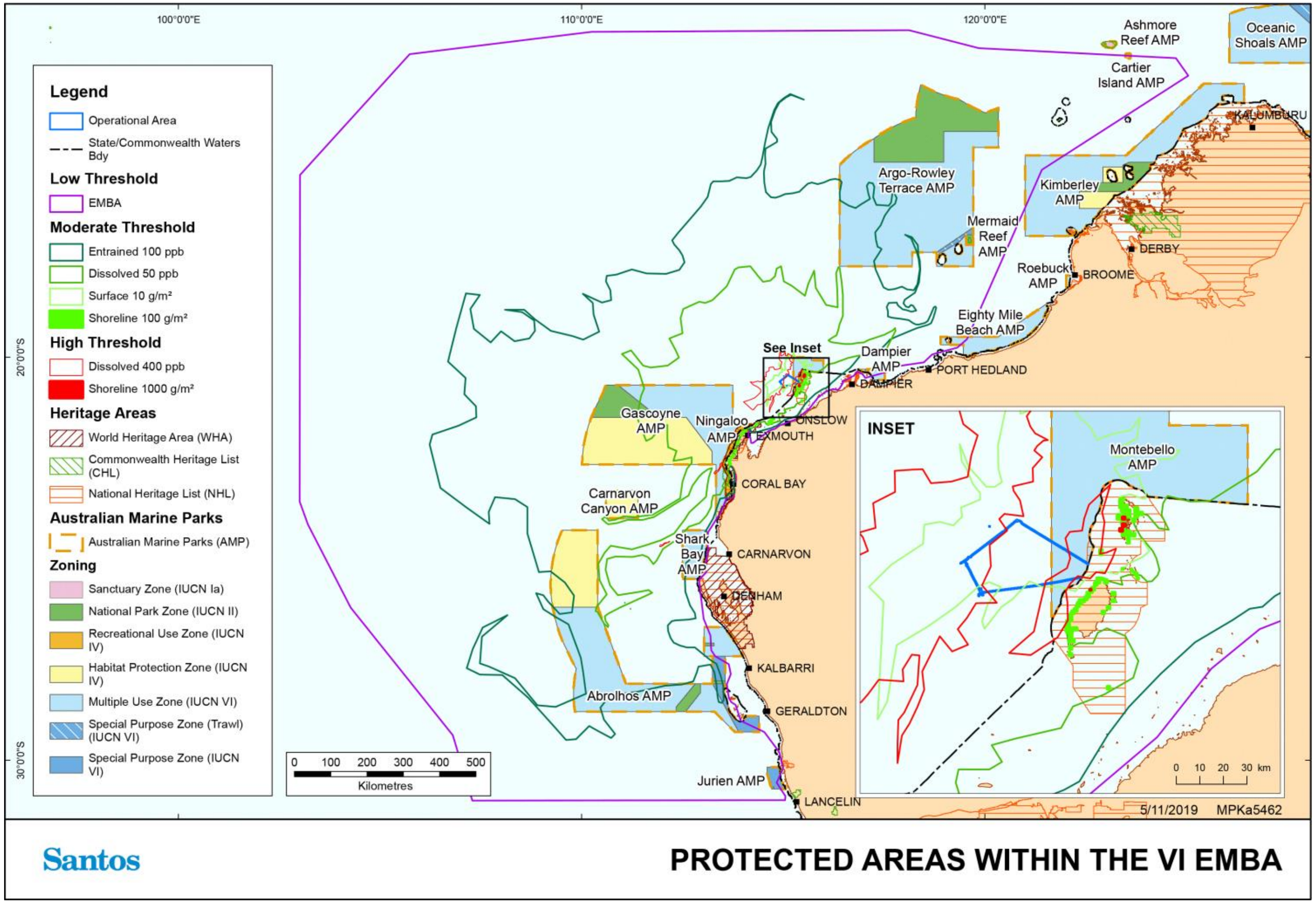

Figure 3-5: Protected Areas in and near the EMBA and Operational Area

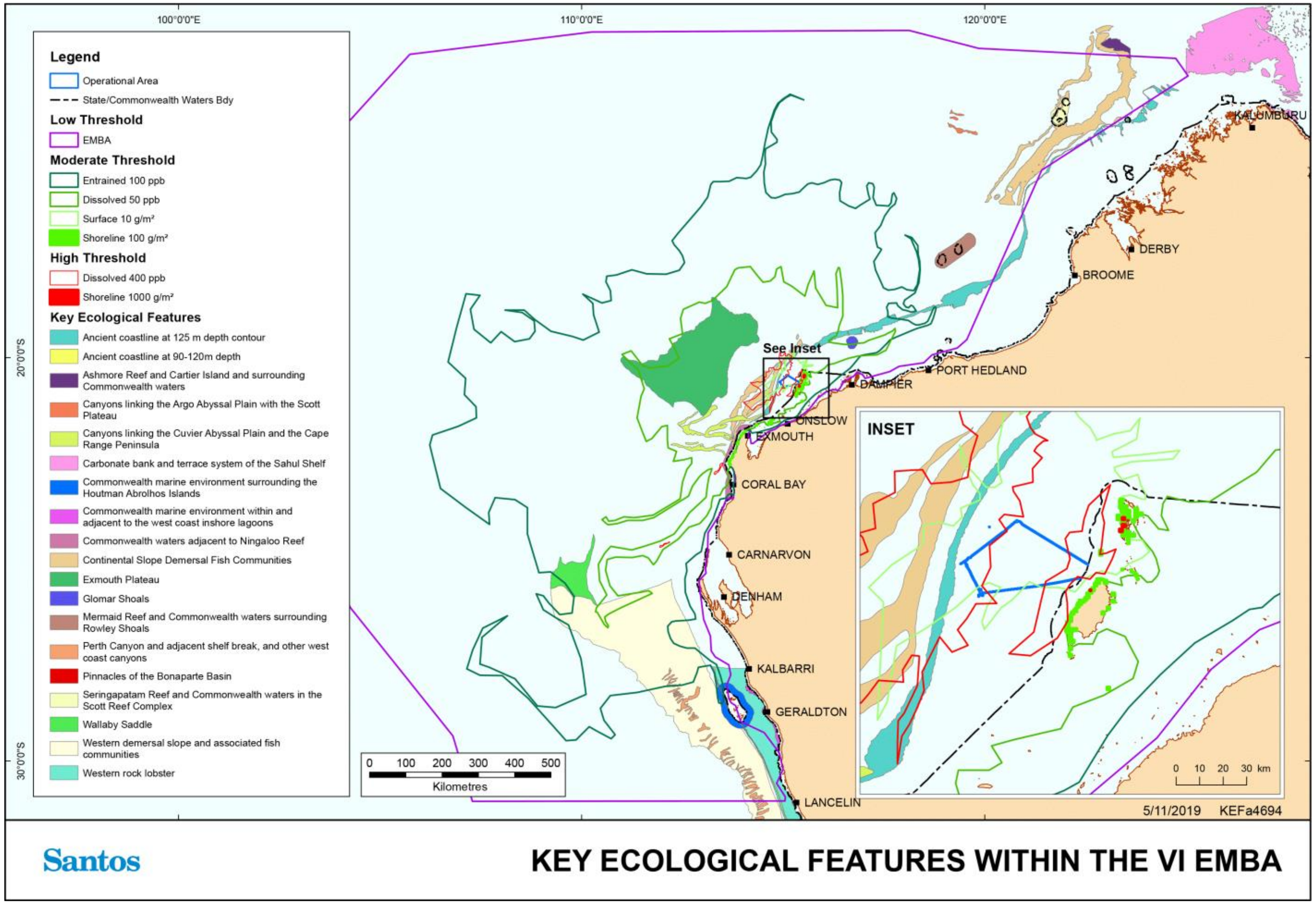

Figure 3-6: Key Ecological Features in and near the EMBA and Operational Area

3.2.4 Threatened and Migratory Fauna

The Protected Matters Search Tool identified 78 listed threatened species and 79 listed migratory species under the EPBC Act 1999 as having the potential to occur in the EMBA. An examination of the species profile and threats database showed that some listed threatened species are not expected to occur in significant numbers in the marine and coastal environments due to their terrestrial distributions. These species will not come into contact with any potential oil spill and therefore are not discussed further.

Those listed as threatened species groups or vulnerable species groups and that have been identified as potentially being present in the operational area or the EMBA and the relevant planned and unplanned events that may impact them are discussed in **Table 3-6**. Threatened and vulnerable species within these species groups are further described in **Appendix C.**

Note, terrestrial species that occur in the EPBC Protected Matters searches of the EMBA have been excluded where not relevant with respect to hydrocarbon concentrations of floating oil, in-water hydrocarbons (entrained and dissolved oil) and shoreline accumulations used to define the EMBA. Species that may occur on shorelines include shorebirds, but terrestrial mammals, reptiles (such as pythons) and bird species that do not have habitats along shorelines have been excluded. It should also be noted that seabirds and shorebirds are classified as marine fauna for the purposes of impact assessment within this EP

Biologically important areas (BIAs), such as aggregation, breeding, resting, nesting or feeding areas or known migratory routes, for whales, dugongs, Australian sea lions, various marine turtles, sharks and seabird species in the operational area and the EMBA are shown in **Figure 3-7** to **Figure 3-15** and are also identified in **Table 3-6** and further described in **Appendix C.**

The relevant BIAs that occur in the operational area are listed below, with examples of the species that use these BIAs:

+ Internesting (loggerhead, green, hawksbill and flatback turtles);
+ Foraging (whale shark, sooty tern);
+ Migration (humpback and blue whales);
+ Distribution (blue whale);
+ Breeding and foraging (lesser frigatebird); and
+ Breeding (wedge-tailed shearwater, Australian fairy tern, lesser crested tern, white-tailed tropicbird and roseate tern).

Critical nesting habitat for green, hawksbill and flatback turtles also occurs in the operational area**. Figure 3-10** to **Figure 3-13** shows the BIA and critical habitat categories for each of these turtle species in the operational area and EMBA.

Table 3-6: Environmental Values and Sensitivities – Threatened and Migratory Marine Fauna

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	Offshore EMBA Presence	Particular Values or Sensitivities Within the 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 BIAs	<u>Planned</u> + Light emissions; + Noise emissions; + Interaction with other marine users; + Planned operational discharges; + Spill response operations. <u>Unplanned</u>
Grey nurse shark (west coast population)	*Carcharias taurus (west coast population)*	V	✓	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	Offshore EMBA Presence	Particular Values or Sensitivities Within the EMBA	Relevant Events
Common Name	Scientific Name						
Great white shark	*Carcharodon carcharias*	V, M	✓	Species or species habitat may occur within area	✓	Foraging, feeding or related behaviour known to occur within area Overlaps with foraging BIA (Abrolhos Islands)	+ Hydrocarbon releases; + Non-hydrocarbon releases; + Marine fauna interaction; and + Introduction of invasive marine species.
Dwarf sawfish	*Pristis clavata*	V, M	✓	Species or species habitat known to occur within area	✓	Species or species habitat known to occur within area	
Green sawfish	*Pristis zijsron*	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	Offshore EMBA Presence	Particular Values or Sensitivities Within the EMBA	Relevant Events
Common Name	Scientific Name						
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	
Oceanic Whitetip Shark	*Carcharhinus longimanus*	M	✓	Species or species habitat likely to occur within area	✓	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	Offshore EMBA Presence	Particular Values or Sensitivities Within the EMBA	Relevant Events
Common Name	Scientific Name						
Reef manta ray	*Manta alfredi*	M	✓	Species or species habitat known to occur within area	✓	Species or species habitat 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	<u>Planned</u> + Planned operational discharges; and + Spill response operations. <u>Unplanned</u> + Hydrocarbon releases;
Blind cave eel	*Ophisternon candidum*	V	X	N/A	✓	Species or species habitat known to occur within area	
Northern river shark	*Glyphis garricki*	E	X	N/A	✓	Species or species habitat may 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	Offshore EMBA Presence	Particular Values or Sensitivities Within the EMBA	Relevant Events
Common Name	Scientific Name						
Largetooth sawfish	*Pristis pristis*	V	X	N/A	✓	Species or species habitat known to occur within area	+ Non-hydrocarbon releases; + Marine fauna interaction; and + Introduction of invasive marine species.
Porbeagle (Mackerel shark)	*Lamna nasus*	M	X	N/A	✓	Species or species habitat may 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 and resting	<u>Planned</u> + Light emissions; + Noise emissions; + Interaction with other marine users; + Planned operational discharges; and + Spill response operations.
Blue whale	*Balaenoptera musculus*	E, M	✓	Species or species habitat likely to occur within area	✓	Migration route known 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**	**Offshore EMBA Presence**	**Particular Values or Sensitivities Within the EMBA**	**Relevant Events**
				Overlap with BIA for foraging		Overlap with BIA for migration and foraging	<u>Unplanned</u> + Hydrocarbon releases; + Non-hydrocarbon releases; + Marine fauna interaction; and + Introduction of invasive marine species.
Sei whale	*Balaenoptera borealis*	V, M	✓	Species or species habitat likely to occur within area	✓	Foraging, feeding or related behaviour likely to occur within area	
Fin whale	*Balaenoptera physalus*	V, M	✓	Species or species habitat likely to 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	

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	Offshore EMBA Presence	Particular Values or Sensitivities Within the EMBA	Relevant Events
Spotted bottlenose dolphin	*Tursiops aduncus (Arafura/Timor Sea populations)*	M	✓	Species or species habitat likely to 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 Overlaps with BIA for foraging and breeding, calving and nursing	
Sperm whale	*Physeter macrocephalus*	M	✓	Species or species habitat may occur within area	✓	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	

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	Offshore EMBA Presence	Particular Values or Sensitivities Within the EMBA	Relevant Events
Common Name	Scientific Name						
Southern right whale	*Eubalaena australis*	E	X	N/A	✓	Species or species habitat likely to occur within area	Planned + Planned operational discharges; and + Spill response operations. Unplanned + Hydrocarbon releases; + Non-hydrocarbon releases; + Marine fauna interaction; and + Introduction of invasive marine species.
Pygmy right whale	*Caperea marginata*	M	X	N/A	✓	Species or species habitat may occur within area	
Australian snubfin dolphin (Irrawaddy dolphin)	*Orcaella brevirostris*	M	X	N/A	✓	Species or species habitat may occur within area	
Australian sea lion	*Neophoca cinerea*	V	X	N/A	✓	Species or species habitat known to occur within area Overlaps with BIA for foraging.	

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	Offshore EMBA Presence	Particular Values or Sensitivities Within the EMBA	Relevant Events
Antarctic minke whale	*Balaenoptera bonaerensis*	M	X	N/A	✓	Species or species habitat likely to occur within area	
Protected Species and Communities: Marine Reptiles							
Short-nosed seasnake	*Aipysurus apraefrontalis*	CE	✓	Species or species habitat likely to occur within area	✓	Species or species habitat known to occur within area	<u>Planned</u> + Light emissions; + Noise emissions; + Interaction with other marine users; + Planned operational discharges; and + Spill response operations. <u>Unplanned</u> + Hydrocarbon releases;
Loggerhead turtle	*Caretta caretta*	E, M	✓	Congregation or aggregation known to occur within area Overlaps with interesting BIA	✓	Breeding known to occur within area Overlaps with BIAs and critical habitats	
Green turtle	*Chelonia mydas*	V, M	✓	Congregation or aggregation	✓	Breeding 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	Offshore EMBA Presence	Particular Values or Sensitivities Within the EMBA	Relevant Events
Common Name	Scientific Name						
				known to occur within area Overlaps with BIAs and critical habitats		Overlaps with BIAs and critical habitats	+ Non-hydrocarbon releases; + Marine fauna interaction; and + Introduction of IMS.
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	
Hawksbill turtle	*Eretmochelys imbricata*	V, M	✓	Congregation or aggregation known to occur within area Overlaps with internesting habitat (60 km off Barrow Island)	✓	Breeding known to occur within area Overlaps with BIAs and critical habitats	

Value/Sensitivity		EPBC Act Status	Operational Area Presence	Particular Values or Sensitivities Within Operational Area	Offshore EMBA Presence	Particular Values or Sensitivities Within the EMBA	Relevant Events
Common Name	**Scientific Name**	**(CE = Critically Endangered E = Endangered V = Vulnerable M = Migratory CD = Conservation Dependent)**					
Flatback turtle	*Natator depressus*	V, M	✓	Congregation or aggregation known to occur within area Overlap with internesting BIA (60 km of Montebello Islands and from Dampier Archipelago)	✓	Breeding known to occur within area Overlaps with BIAs and critical habitats (including mating, aggregation, foraging and internesting).	
Olive Ridley turtle	*Lepidochelys olivacea*	E	X	N/A	✓	Species or species habitat known to occur within area	<u>Planned</u> + Planned operational discharges; and + Spill response operations. <u>Unplanned</u>
Leaf-scaled snake	*Aipysurus foliosquama*	CE	X	N/A	✓	Species or species habitat may 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	Offshore EMBA Presence	Particular Values or Sensitivities Within the EMBA	Relevant Events
Common Name	Scientific Name						
							+ Hydrocarbon releases; + Non-hydrocarbon releases; + Marine fauna interaction; and + Introduction of IMS.
Protected Species and Communities: Marine Birds							
Roseate tern	*Sterna dougallii*	M	✓	Foraging, feeding or related behaviour likely to occur within area Overlaps with breeding BIA	✓	Breeding known to occur within area	Planned + Light emissions; + Noise emissions; + Interaction with other marine users; + Planned operational discharges; and

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	Offshore EMBA Presence	Particular Values or Sensitivities Within the EMBA	Relevant Events
Common Name	Scientific Name						
Curlew sandpiper	*Calidris ferruginea*	CE, M	✓	Species or species habitat may occur within area	✓	Species or species habitat known to occur within area	+ Spill response operations. Unplanned + Hydrocarbon releases; + Non-hydrocarbon releases; + Marine fauna interaction; and + Introduction of IMS.
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 may to occur within area	✓	Species or species habitat may occur within area	
Eastern curlew	*Numenius madagascariensis*	CE, M	✓	Species or species habitat may 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	Offshore EMBA Presence	Particular Values or Sensitivities Within the EMBA	Relevant Events
Common Name	Scientific Name						
Common noddy	*Anous stolidus*	M	✓	Species or species habitat may occur within area	✓	Species or species habitat likely to occur within area Overlaps foraging BIA (provisioning young)	
Streaked shearwater	*Calonectris leucomelas*	M	✓	Species or species habitat likely to occur within area	✓	Species or species habitat likely to occur within area	
Lesser frigatebird	*Fregata ariel*	M	✓	Species or species habitat likely to occur within area	✓	Species or species habitat known to occur within area Overlaps with breeding, foraging BIA	
Common sandpiper	*Actitis hypoleucos*	M	✓	Species or species habitat	✓	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	Offshore EMBA Presence	Particular Values or Sensitivities Within the EMBA	Relevant Events
Common Name	Scientific Name						
				may 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	
Australian fairy tern	*Sternula nereis*	V	✓	Breeding known to occur within area	✓	Breeding 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	Offshore EMBA Presence	Particular Values or Sensitivities Within the EMBA	Relevant Events
Common Name	Scientific Name						
				Overlaps with breeding BIA		Overlaps with breeding and foraging BIAs	
Fork-tailed swift	*Apus pacificus*	M	✓	Species or species habitat likely to occur within area	✓	Species or species habitat likely to occur within area	
Lesser crested tern	*Thalasseus bengalensis*	M	✓	Breeding known to occur within area Overlaps with breeding BIA	✓	Breeding known to occur within area Overlaps with breeding BIA	
Wedge-tailed shearwater	*Ardenna pacifica*	M	✓	Was not identified by the Protected Matter Search Tool; however, this area overlaps	✓	Breeding known to occur within area Overlaps with breeding and foraging BIA	

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	Offshore EMBA Presence	Particular Values or Sensitivities Within the EMBA	Relevant Events
Common Name	Scientific Name						
				with breeding BIA			
Western Alaskan bar-tailed godwit	*Limosa lapponica baueri*	V, M	X	N/A	✓	Species or species habitat may occur within area	<u>Planned</u> + Planned operational discharges; and + Spill response operations. <u>Unplanned</u> + Hydrocarbon releases; + Non-hydrocarbon releases; and + Marine fauna interaction.
Northern Siberian bar-tailed godwit	*Limosa lapponica menzbierii*	CE, M	X	N/A	✓	Species or species habitat may occur within area	
Asian Dowitcher	*Limnodromus semipalmatus*	M	X	N/A	✓	Species or species habitat may occur within area	
Christmas Island White-tailed Tropic Bird	*Phaethon lepturus fulvus*	E, M	X	N/A	✓	Species or species habitat may 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	Offshore EMBA Presence	Particular Values or Sensitivities Within the EMBA	Relevant Events
Common Name	Scientific Name						
White-tailed tropicbird	*Phaethon lepturus*	M	X	N/A	✓	Foraging, feeding or related behaviour likely to occur within area Overlaps breeding BIA	
Little shearwater	*Puffinus assimilis*	Listed Marine Species	X	N/A	✓	Foraging, feeding or related behaviour known to occur within area Overlaps foraging BIA	
Pacific gull	*Larus pacificus*	Listed Marine Species	X	N/A	✓	Breeding known to occur within area Overlaps foraging BIA	
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 (CE = Critically Endangered E = Endangered V = Vulnerable M = Migratory CD = Conservation Dependent)	Operational Area Presence	Particular Values or Sensitivities Within Operational Area	Offshore EMBA Presence	Particular Values or Sensitivities Within the EMBA	Relevant Events
Common Name	Scientific Name						
Little tern	*Sternula albifrons*	M	X	N/A	✓	Congregation or aggregation known to occur within area	
Bridled tern	*Onychoprion anaethetus*	M	X	N/A	✓	Breeding known to occur within area Overlaps foraging BIA	
Oriental plover	*Charadrius veredus*	M	X	N/A	✓	Species or species habitat may occur within area	
Greater Sand Plover	*Charadrius leschenault*	V	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	

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	Offshore EMBA Presence	Particular Values or Sensitivities Within the EMBA	Relevant Events
Common Name	Scientific Name						
Crested tern	*Thalasseus bergii*	M	X	N/A	✓	Breeding known occur within area	
Caspian tern	*Sterna caspia*	M	X	N/A	✓	Breeding known occur within area Overlaps foraging BIA	
Common greenshank	*Tringa nebularia*	M	X	N/A	✓	Species or species habitat likely to occur within area	
White-winged fairy-wren (Barrow Island)	*Malurus leucopterus edouardi*	V	X	N/A	✓	Species or species habitat likely to occur within area	
White-winged fairy-wren (Dirk Hartog Island)	*Malurus leucopterus*	V	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	Offshore EMBA Presence	Particular Values or Sensitivities Within the EMBA	Relevant Events
Common Name	Scientific Name						
Night parrot	*Pezoporus occidentalis*	E	X	N/A	✓	Species or species habitat may occur within area	
Soft-plumaged petrel	*Pterodroma mollis*	V	X	N/A	✓	Foraging, feeding or related behaviour known to occur within area Overlaps with foraging BIA	
Campbell albatross	*Thalassarache impavida*	V	X	N/A	✓	Species or species habitat may occur within area	
Flesh-footed shearwater	*Ardenna carneipes*	V	X	N/A	✓	Foraging, feeding or related behaviour likely to occur within area	
Australian lesser noddy	*Anous tenuirostris melanops*	V	X	N/A	✓	Foraging, feeding or related behaviour 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	Offshore EMBA Presence	Particular Values or Sensitivities Within the EMBA	Relevant Events
Common Name	Scientific Name						
						Overlaps with foraging BIA	
Amsterdam albatross	*Diomedea amsterdamensis*	E	X	N/A	✓	Species or species habitat likely to occur within area	
Southern royal albatross	*Diomedea epomophora*	V	X	N/A	✓	Species or species habitat likely to occur within area	
Wandering albatross	*Diomedea exulans*	V	X	N/A	✓	Species or species habitat likely to occur within area	
Northern royal albatross	*Diomedea sanfordi*	E	X	N/A	✓	Species or species habitat likely to occur within area	
Northern giant petrel	*Macronectes halli*	V	X	N/A	✓	Species or species habitat may 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	Offshore EMBA Presence	Particular Values or Sensitivities Within the EMBA	Relevant Events
Common Name	Scientific Name						
Abbott's booby	*Papasula abbotti*	E	X	N/A	✓	Species or species habitat may occur within area	
Masked booby	*Sula dactylatra*	M	X	N/A	✓	Breeding known to occur within area	
Red-footed booby	*Sula sula*	M	X	N/A	✓	Breeding known to occur within area	
Brown booby	*Sula leucogaster*	M	X	N/A	✓	Breeding known to occur within area	
Black-browed albatross	*Thalassarche melanophris*	V	X	N/A	✓	Species or species habitat may occur within area	
White-capped albatross	*Thalassarche cauta steadi*	V	X	N/A	✓	Foraging, feeding or related behaviour 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	Offshore EMBA Presence	Particular Values or Sensitivities Within the EMBA	Relevant Events
Sooty albatross	*Phoebetria fusca*	V	X	N/A	✓	Species or species habitat may occur within area	
Sooty tern	*Sterna fuscata*	Listed Marine Species	X	N/A	✓	Breeding known to occur within area Overlaps with foraging BIA	
Blue petrel	*Halobaena caerulea*	V	X	N/A	✓	Species or species habitat may occur within area	
Australian painted snipe	*Rostratula australis*	E	X	N/A	✓	Species or species habitat may occur within area	
Shy albatross	*Thalassarche cauta*	E	X	N/A	✓	Species or species habitat may 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	Offshore EMBA Presence	Particular Values or Sensitivities Within the EMBA	Relevant Events
Common Name	Scientific Name						
Indian yellow-nosed albatross	*Thalassarche carteri*	V	X	N/A	✓	Foraging, feeding or related behaviour may occur within area	
Christmas Island frigatebird	*Fregata andrewsi*	E, M	X	N/A	✓	Foraging, feeding or related behaviour may occur within area	
Fairy prion (southern)	*Pachyptila turtur subantarctica*	V	X	N/A	✓	Species or species habitat may occur within area	
Red-tailed tropicbird	*Phaethon rubricauda*	M	X	N/A	✓	Breeding known to occur within area	

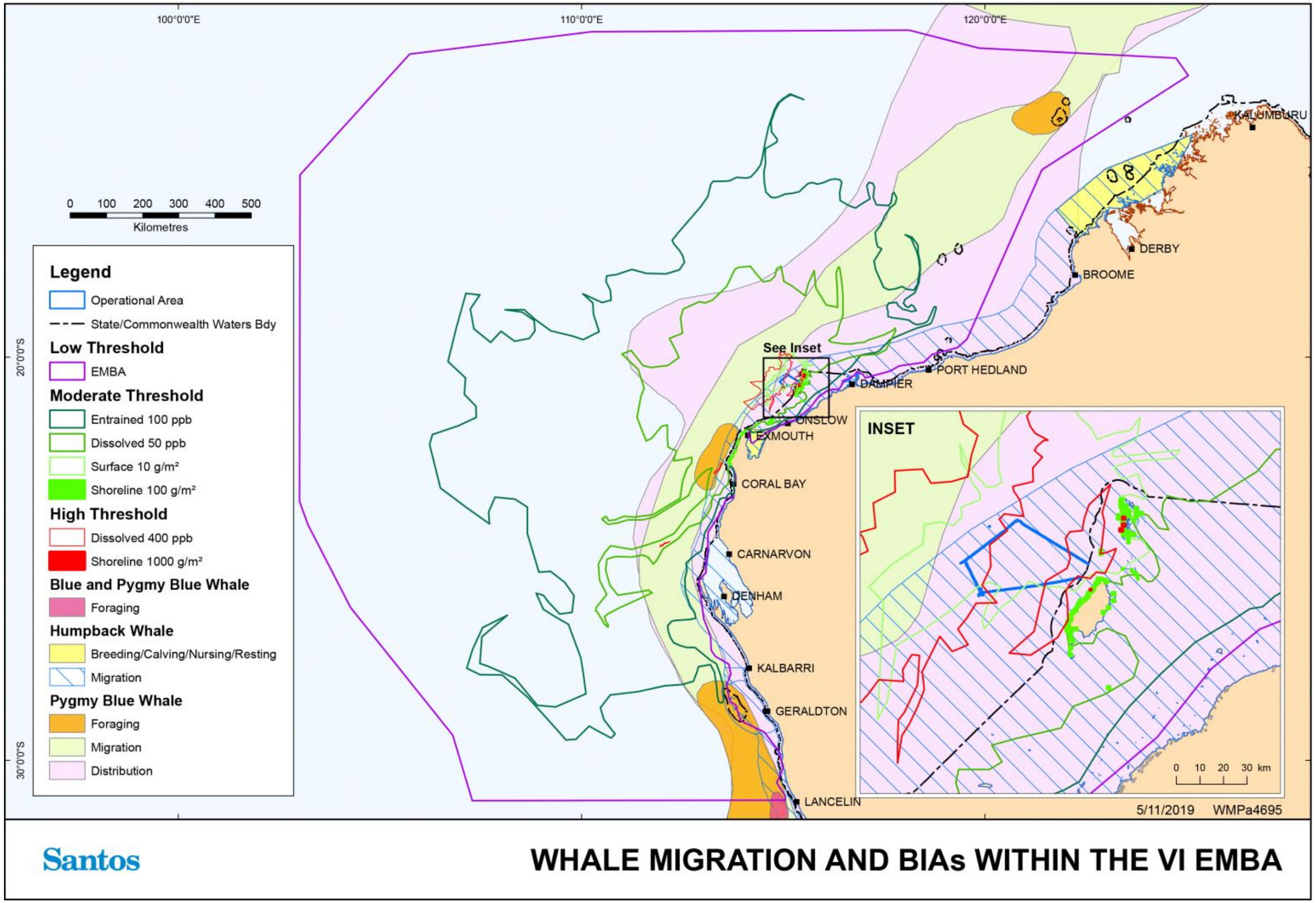

Figure 3-7: Biologically Important Areas for EPBC Protected Whale Species in the Vicinity of the EMBA and Operational Area

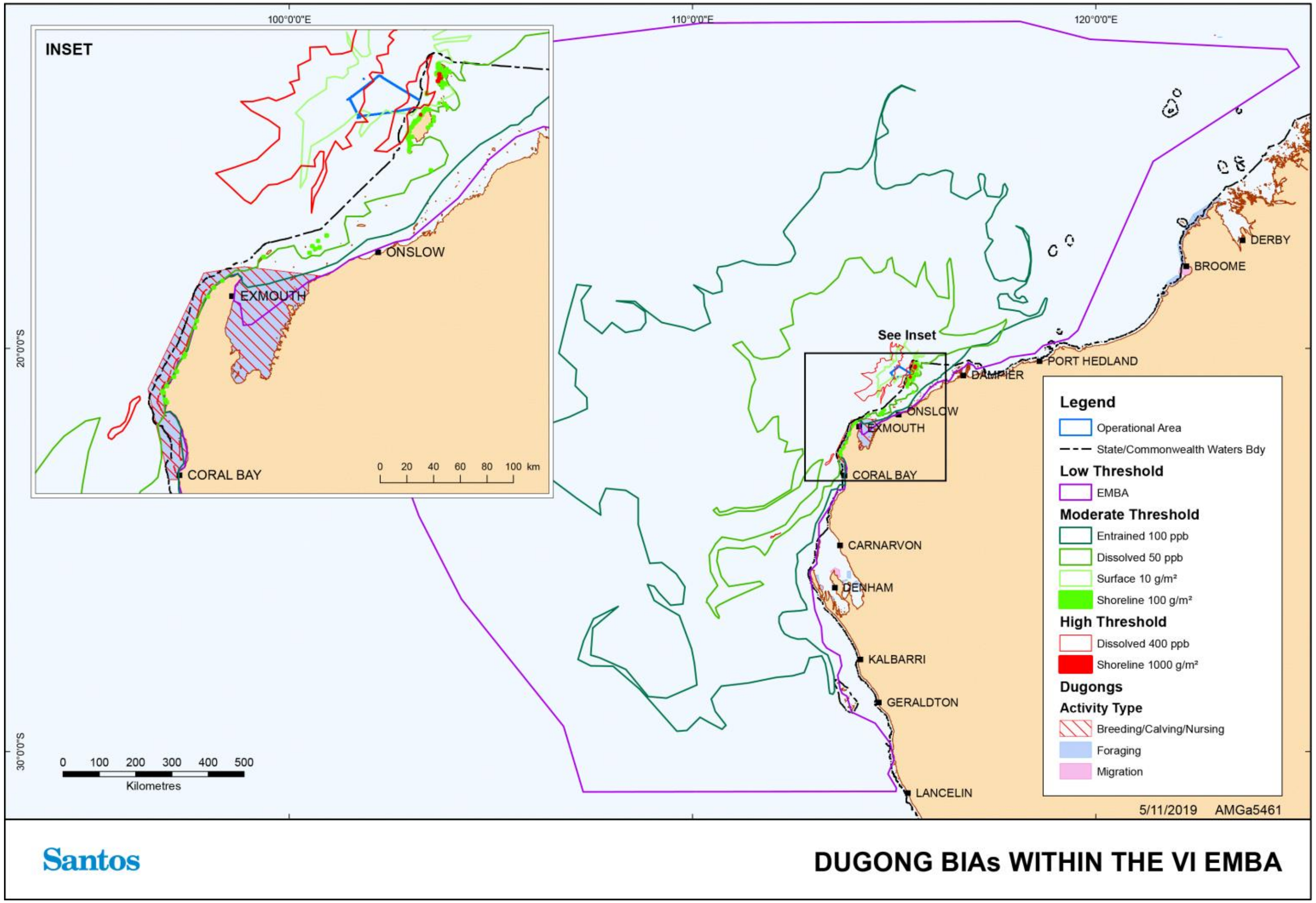

Figure 3-8: Biologically Important Areas for Dugongs in the Vicinity of the EMBA and Operational Area

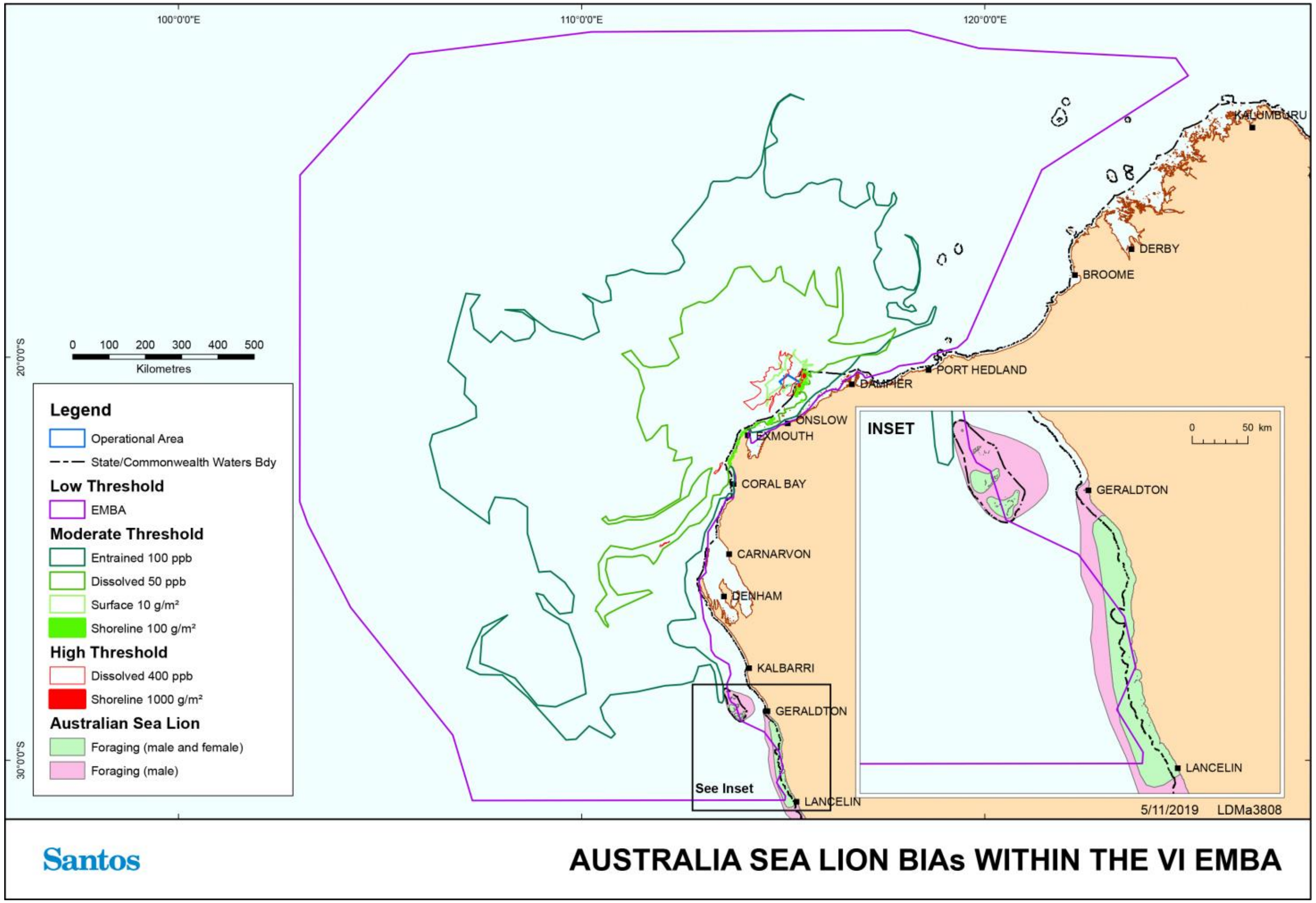

Figure 3-9: Biologically Important Areas for the Australian Sea Lion in the Vicinity of the EMBA and Operational Area

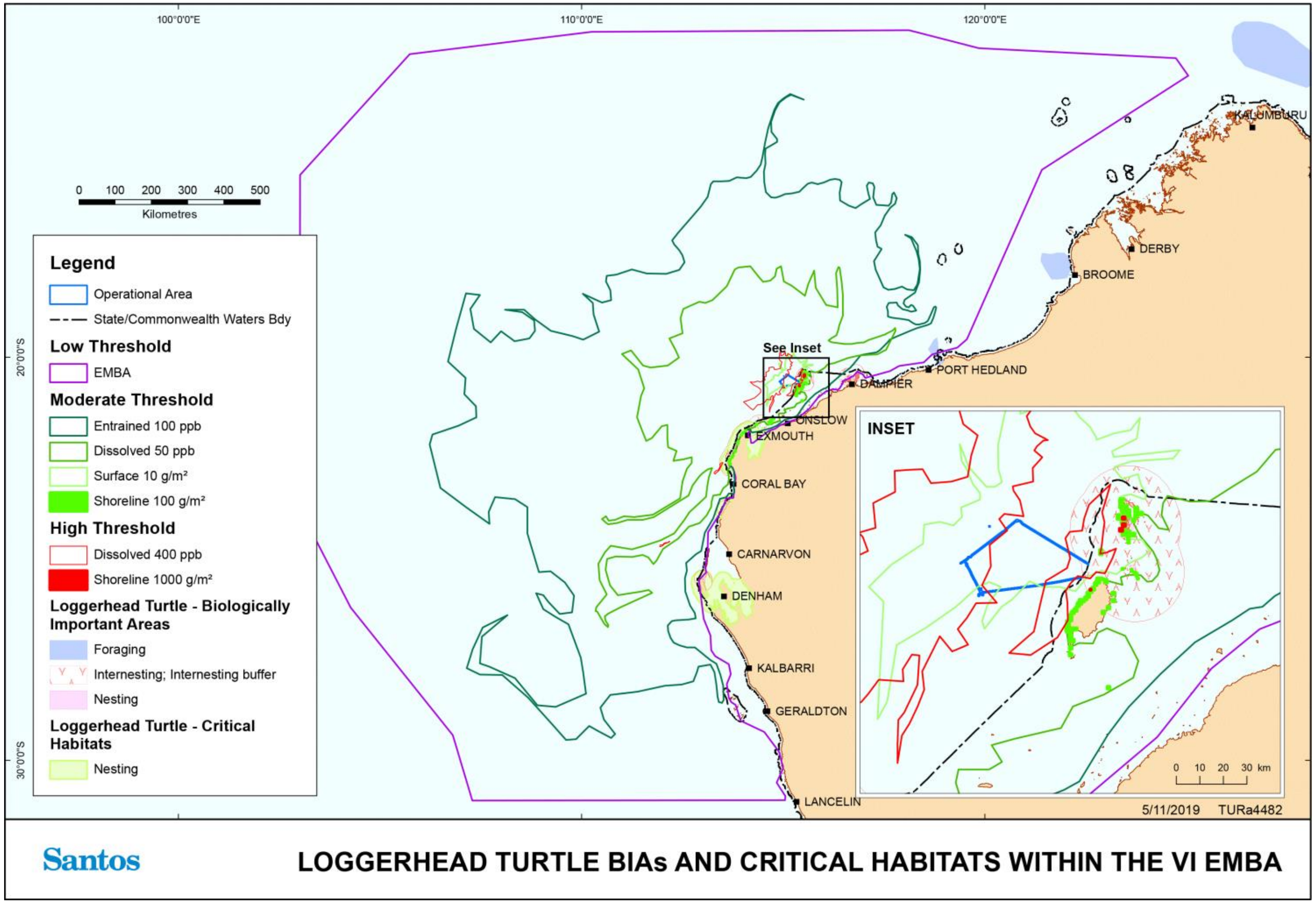

Figure 3-10: Biologically Important Areas and Critical Habitats for the Loggerhead Turtle in the Vicinity of the EMBA and Operational Area

Santos

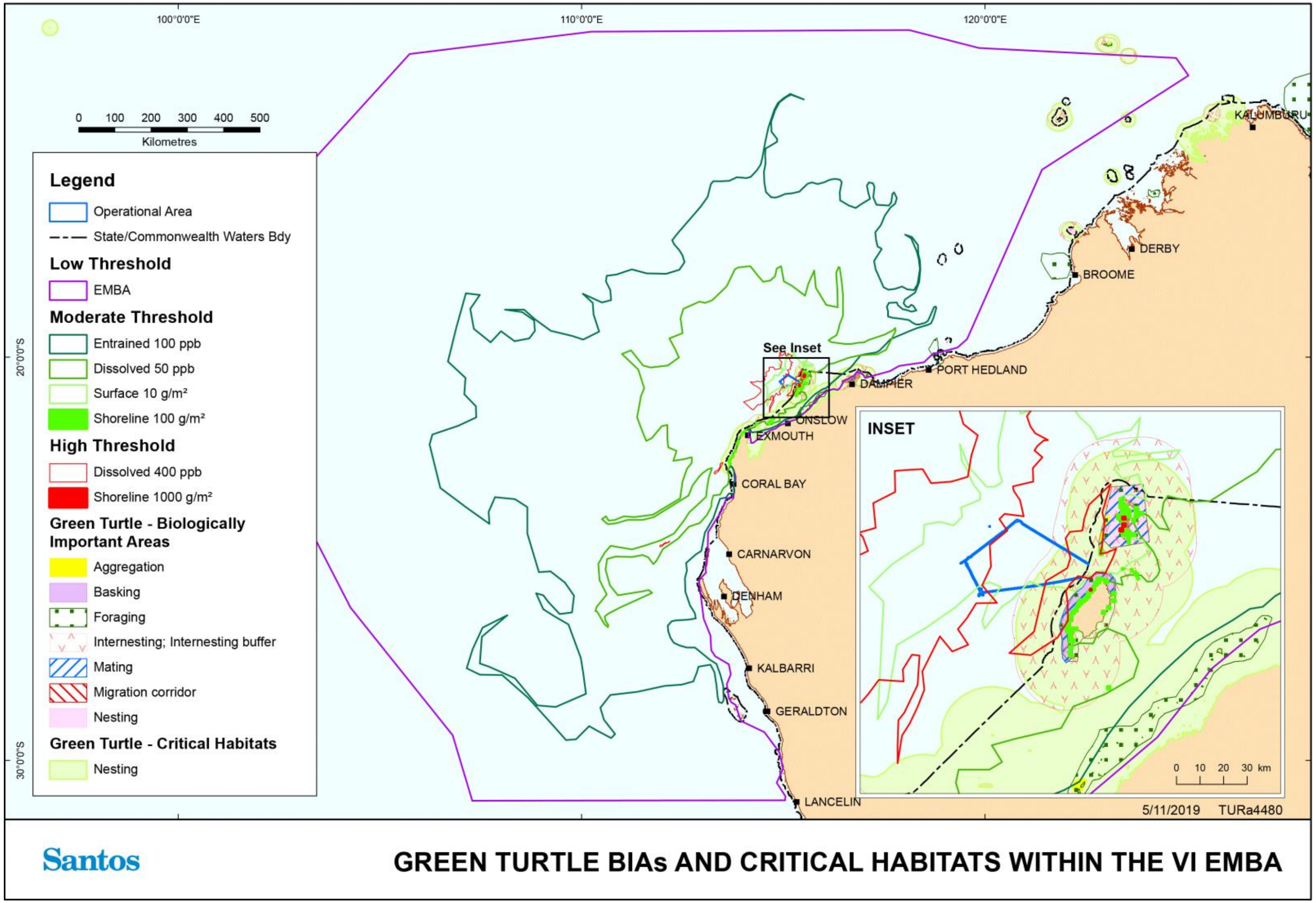

Figure 3-11: Biologically Important Areas and Critical Habitats for the Green Turtle in the Vicinity of the EMBA and Operational Area

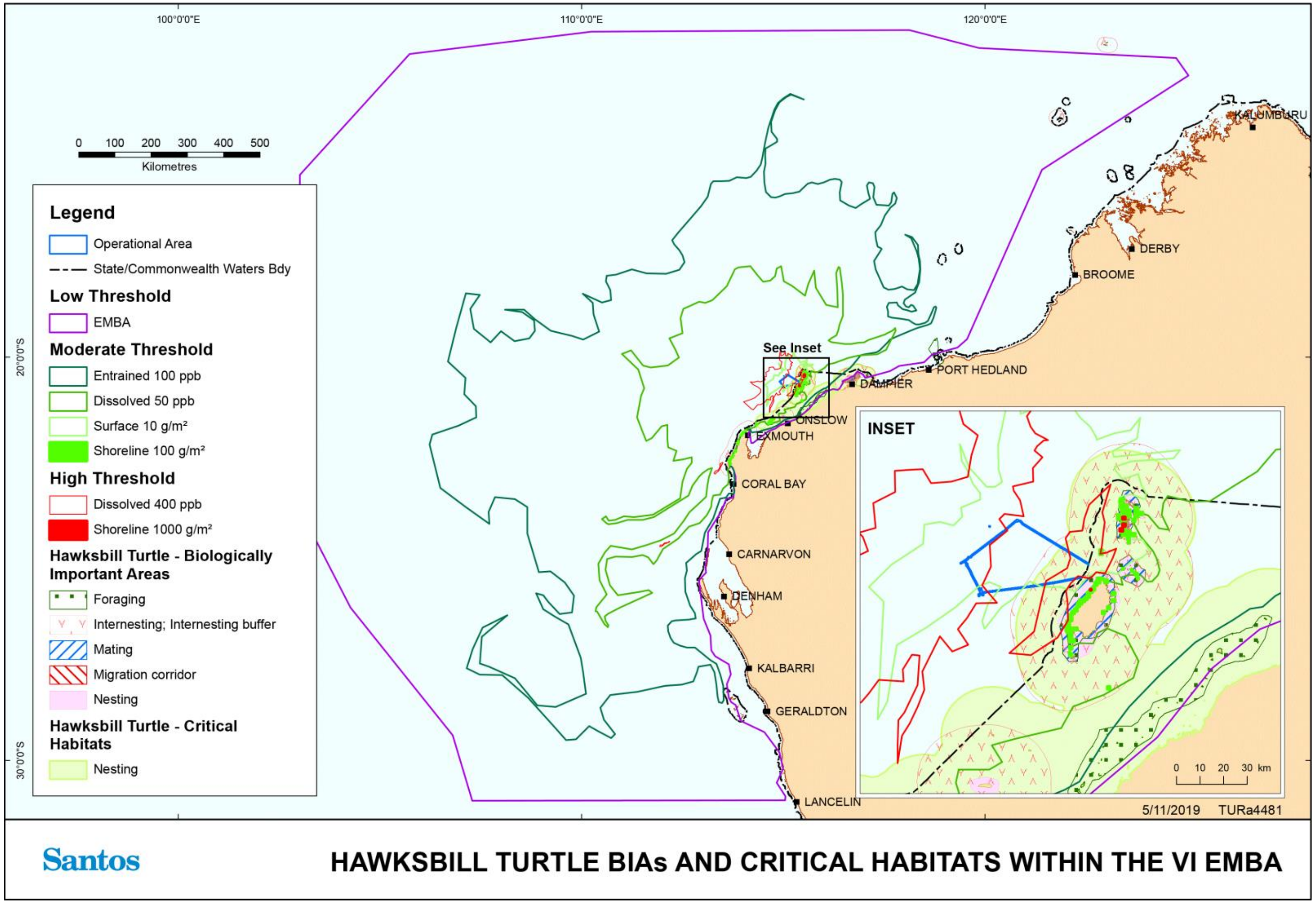

Figure 3-12: Biologically Important Areas and Critical Habitats for the Hawksbill Turtle in the Vicinity of the EMBA and Operational Area

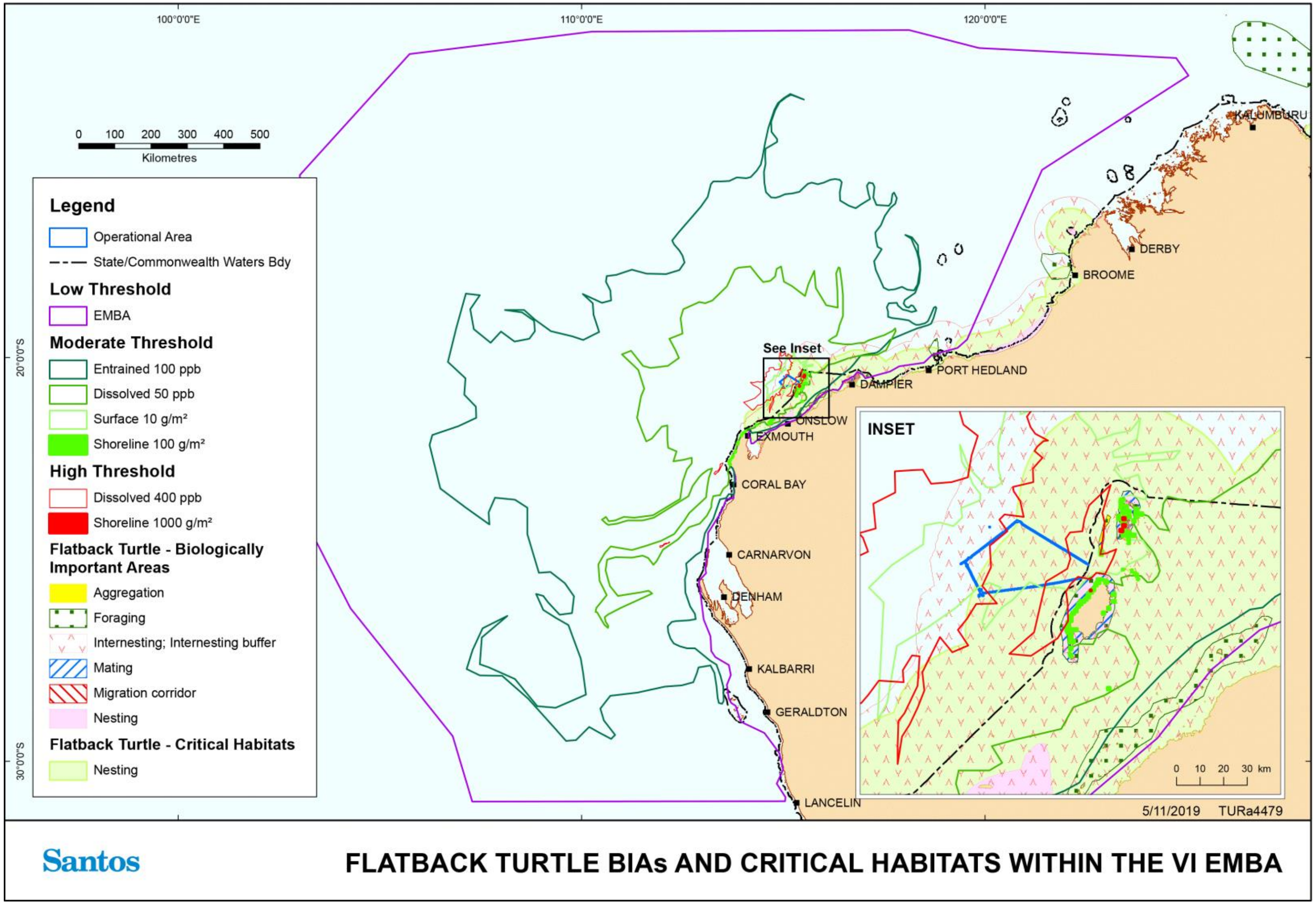

Figure 3-13: Biologically Important Areas and Critical Habitats for the Flatback Turtle in the Vicinity of the EMBA and Operational Area

Santos

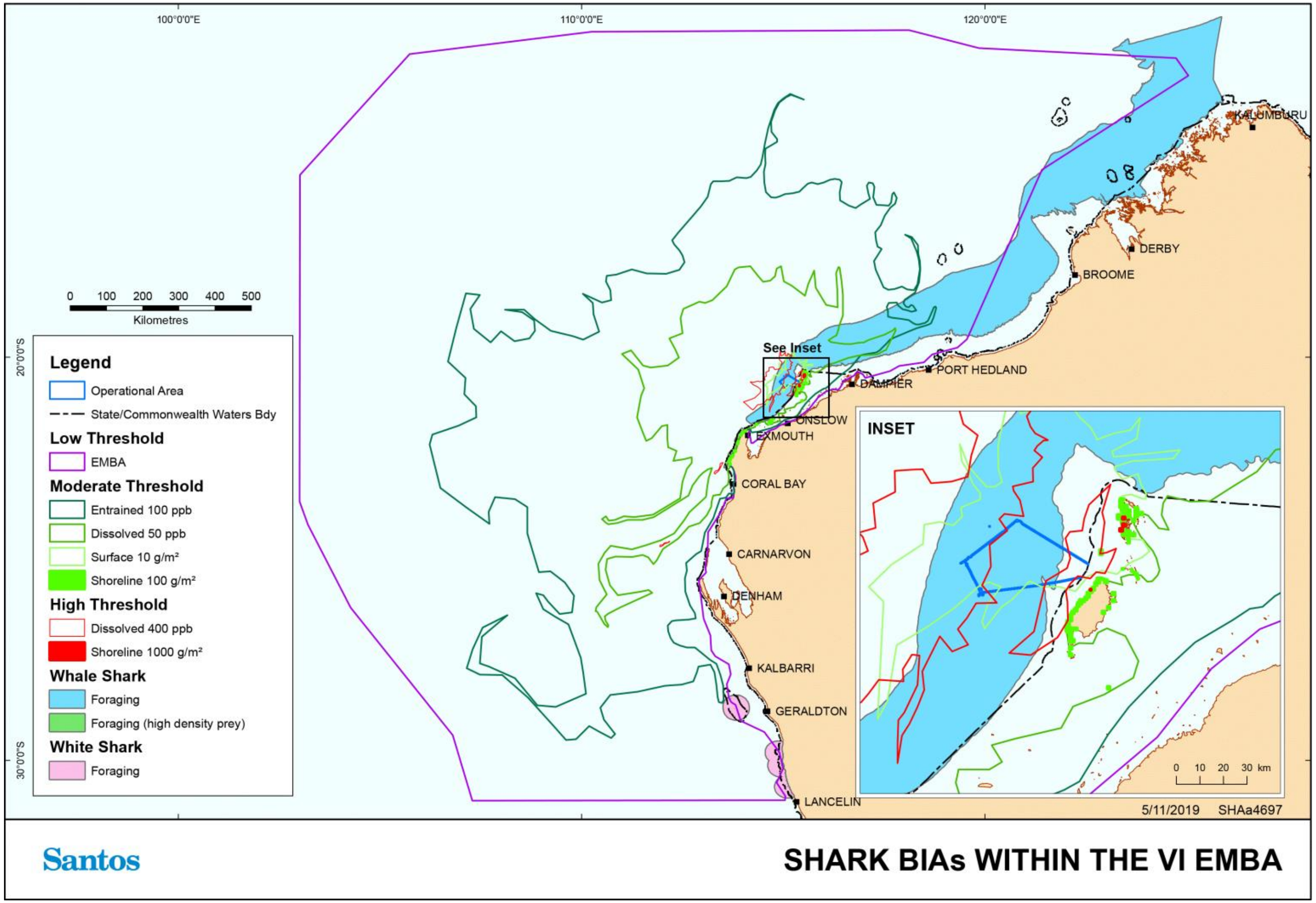

Figure 3-14: Biologically Important Areas for EPBC Protected Sharks in the Vicinity of the EMBA and Operational Area

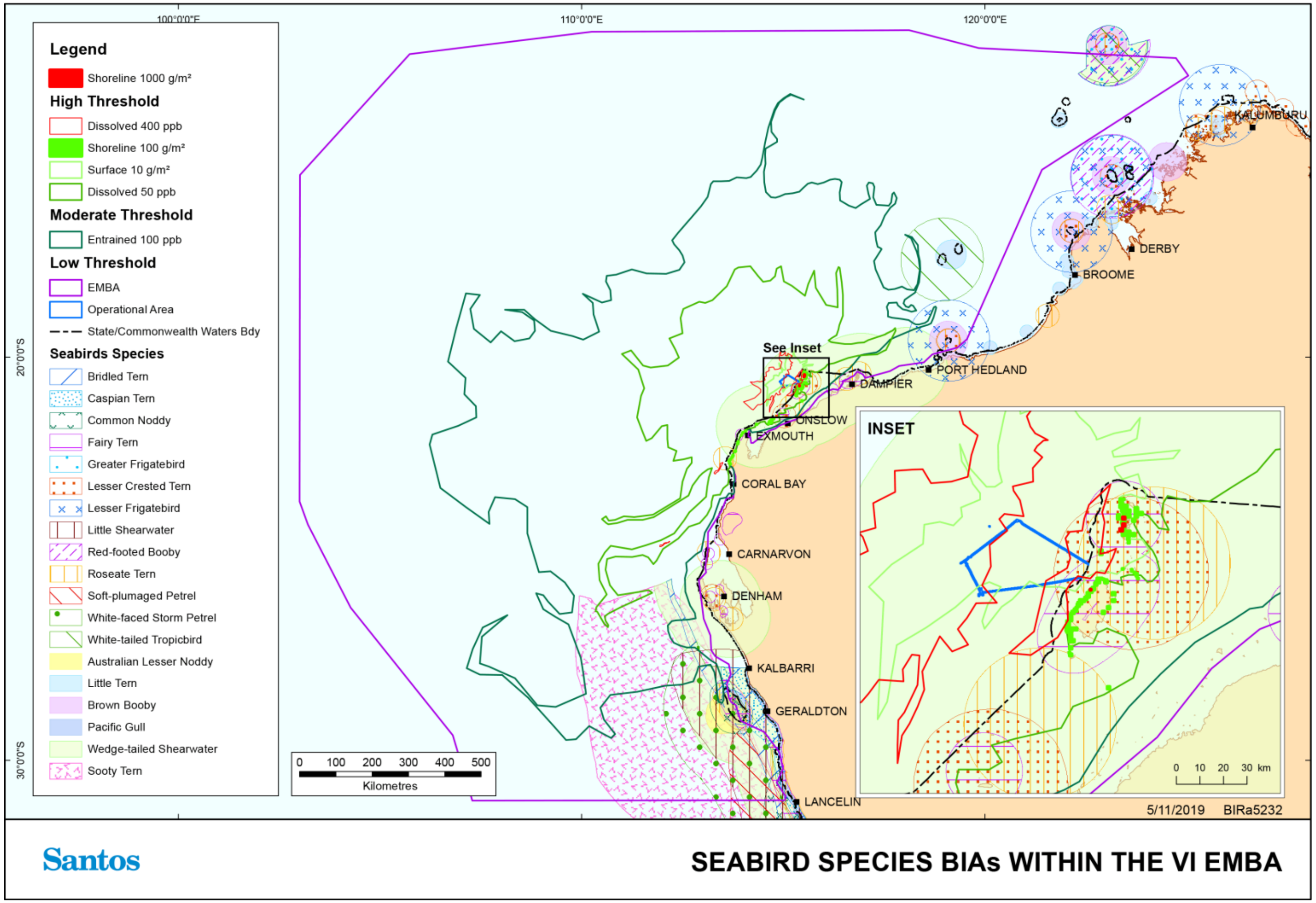

Figure 3-15: Biologically Important Areas for EPBC Protected Seabird Species in the Vicinity of the EMBA and Operational Area

3.2.4.1 Recovery Plans

Relevant conservation advices, recovery plans and management plans for marine fauna are provided in **Table 3-7,** along with cross-references to the relevant EP section for the assessment of impacts. Species that occur in the EMBA only may be affected by marine pollution (from unplanned hydrocarbon release); species that occur in the operational area have the potential to be impacted by other planned events (e.g., noise emissions) and unplanned events (e.g. vessel strike).

Table 3-7: Threats and Strategies from Recovery Plans, Conservation Advice and Management Plans Relevant to the Activity

Receptor	Name	Recovery Plan, Conservation Advice or Management Plan	Threats/Strategies Identified as Relevant to the Activity	Addressed Where Relevant for Receptor Groups in EP Section
Fish and Sharks	Dwarf sawfish	Sawfish and River Sharks Multispecies Recovery Plan (DoE, 2015a)	Habitat degradation due to increasing human development	**6.4**, **7.6** to **7.9**
		Approved Conservation Advice on *Pristis clavata* (Dwarf Sawfish) (2009)		
	Green sawfish	Commonwealth Conservation Advice on *Pristis zijsron* (green sawfish) (DoEE, 2008a)	Habitat degradation and modification	**6.4**, **7.6** to **7.9**
		Sawfish and River Sharks Multispecies Recovery Plan (DoE, 2015a)		
	Great white shark	Recovery Plan for the White Shark (*Carcharodon carcharias*) (DSEWPaC, 2013a)	Ecosystem effects as a result of habitat modification and climate change	**6.4**, **7.6** to **7.9**
	Grey nurse shark	Recovery Plan for the Grey Nurse Shark (*Carcharias taurus*) (DoE, 2014)	Pollution and disease	**7.6** to **7.9**
			Ecosystem effects - habitat modification and climate change	**6.4**, **7.6** to **7.9**
	Whale shark	Approved Conservation Advice for *Rhincodon typus* (whale shark) (TSSC, 2015a)	Boat strike from large vessels	**7.2**
			Habitat disruption from mineral exploration, production and transportation	**7.6** to **7.9**
			Marine debris	**7.3**
	Northern river shark	Approved Conservation Advice for *Glyphis garricki* (northern river shark) (2014)	Habitat degradation and modification	**6.4**, **7.6** to **7.9**
			Marine debris (potential)	**7.3**
	Largetooth sawfish	Approved Conservation Advice for *Pristis pristis* (largetooth sawfish)	Habitat degradation and modification	**6.4**, **7.6** to **7.9**
			Marine debris (potential)	**7.3**
		Sawfish and River Sharks Multispecies Recovery Plan (2015a)	Habitat degradation and modification	**6.4**, **7.6** to **7.9**
	Blind gudgeon	Approved Conservation Advice for *Milyeringa veritas* (blind gudgeon) (DoEE, 2008b)	Habitat degradation and modification (as relevant to unplanned discharges, given the habitat of this species)	**7.6** to **7.9**
	Blind cave eel	Approved Conservation Advice for *Ophisternon candidum* (blind cave eel) (DoEE, 2008c)	Habitat degradation and modification (as relevant to unplanned discharges, given the habitat of this species)	**7.6** to **7.9**
Mammals	Blue whale	Blue Whale Conservation Management Plan 2015 - 2025 (DoE, 2015c)	Noise interference	**6.1**
			Habitat modification	**6.4**, **7.6** to **7.9**
			Vessel disturbance	**6.1** and **7.2**
	Southern right whale	Conservation Management Plan for the Southern Right Whale 2011 – 2021 (DSEWPaC, 2012)	Vessel disturbance	**6.1** and **7.2**
			Habitat modification	**6.4**, **7.6** to **7.9**
			Noise interference	**6.1**
	Fin whale	Approved Conservation Advice for *Balaenoptera physalus* (fin whale) (TSSC, 2015b)	Anthropogenic noise and acoustic disturbance	**6.1**
			Habitat degradation including coastal development, port expansion and aquaculture	**6.4**, **7.6** to **7.9**
			Pollution (persistent toxic pollutants)	**7.6** to **7.9**
			Vessel strike	**7.2**

Receptor	Name	Recovery Plan, Conservation Advice or Management Plan	Threats/Strategies Identified as Relevant to the Activity	Addressed Where Relevant for Receptor Groups in EP Section
	Sei whale	Approved Conservation Advice for *Balaenoptera borealis* (sei whale) (TSSC, 2015c)	Anthropogenic noise and acoustic disturbance	**6.1**
			Habitat degradation including pollution (increasing port expansion and coastal development)	**6.4**, **7.6** to **7.9**
			Pollution (persistent toxic pollutants)	**7.6** to **7.9**
			Vessel strike	**7.2**
	Australian sea lion	Recovery Plan for the Australian Sea Lion (*Neophoca cinerea*) (DSEWPaC, 2013b)	Noise	**6.1**
			Entanglement in marine debris (primary threat)	**7.3** to **7.9**
			Human disturbance	**7.2**
			Direct killing (deliberate)	**7.2**
			Habitat degradation	**7.3** to **7.9**
			Pollution and oil spills	**7.3** to **7.9**
	Humpback whale	Approved Conservation Advice for *Megaptera novaeangliae* (humpback whale) (TSSC, 2015d)	Noise interference	**6.1**
			Vessel disturbance and strike	**7.2**
			Habitat degradation including coastal development and port expansion	**7.3** to **7.9**
Reptiles	Loggerhead turtle (WA genetic stock)	Recovery Plan for Marine Turtles in Australia 2017 – 2027 (DoEE, 2017)	Marine debris – entanglement and ingestion (moderate, unknown)	**7.3**
			Vessel disturbance (moderate)	**6.1** and **7.2**
			Habitat modification – infrastructure/coastal development (moderate)	**7.3** to **7.9**
			Chemical and terrestrial discharge – acute (high), chronic (low)	**6.6, 7.4** to **7.9**
			Noise interference – acute (moderate), chronic (moderate, unknown)	**6.1**
			Diseases and pathogens (low; unknown)	**7.1**
			Light pollution (moderate)	**6.2**
	Green turtle (NWS genetic stock [NWS], Scott-Browse genetic stock [ScBr], Ashmore genetic stock [AR])	Recovery Plan for Marine Turtles in Australia 2017 – 2027 (DoEE, 2017)	Chemical and terrestrial discharge – acute (NWS, AR, ScBr – high), chronic (NWS – moderate, AR – high, ScBr – high).	**6.6, 7.4** to **7.9**
			Habitat modification – infrastructure / coastal development (NWS – moderate, AR – low, ScBr – high)	**7.3** to **7.9**
			Marine debris – entanglement (NWS – moderate, AR – very high, ScBr – moderate; unknown) and ingestion (NWS – low; unknown, AR – moderate, ScBr – moderate).	**7.3**
			Vessel disturbance (moderate)	**6.1** and **7.2**
			Noise interference – acute (NWS – moderate; unknown, AR – low, ScBr – moderate), chronic (NWS – moderate; unknown, AR – low, ScBr – moderate; unknown)	**6.1**
			Diseases and pathogens (low; unknown for AR and ScBr)	**7.1**
			Light pollution (NWS – high, AR – moderate, ScBr – moderate)	**6.2**

Receptor	Name	Recovery Plan, Conservation Advice or Management Plan	Threats/Strategies Identified as Relevant to the Activity	Addressed Where Relevant for Receptor Groups in EP Section
	Leatherback turtle	Approved Conservation Advice on *Dermochelys coriacea* (DoE, 2008)	Boat strike	**7.2**
			Changes to breeding sites	**7.6** to **7.9**
			Ingestion of marine debris	**7.3**
		Recovery Plan for Marine Turtles in Australia 2017 – 2027 (2017)	Chemical and terrestrial discharge – acute (low), chronic (low; unknown)	**6.6**, **7.6** to **7.9**
			Marine debris – entanglement (moderate) and ingestion (high)	**7.3**
			Habitat modification – infrastructure/coastal development (moderate)	**7.6** to **7.9**
			Vessel disturbance (moderate)	**6.1** and **7.2**
			Noise interference – acute (low; unknown), chronic (low; unknown)	**6.1**
			Light pollution (low)	**6.2**
	Hawksbill turtle (WA genetic stock)	Recovery Plan for Marine Turtles in Australia 2017 – 2027 (DoEE, 2017)	Chemical and terrestrial discharge – acute (moderate), chronic (moderate)	**6.6, 7.4** to **7.9**
			Marine debris – entanglement (moderate) and ingestion (low; unknown)	**7.3**
			Habitat modification – infrastructure/coastal development (moderate)	**6.4**, **7.6** to **7.9**
			Vessel disturbance (moderate)	**6.1** and **7.2**
			Noise interference – acute (moderate), chronic (moderate; unknown)	**6.1**
			Light pollution (high)	**6.2**
	Olive ridley turtle (NT genetic stock)	Recovery Plan for Marine Turtles in Australia 2017 – 2027 (DoEE, 2017)	Chemical and terrestrial discharge – acute (high), chronic (moderate)	**6.6, 7.4** to **7.9**
			Marine debris – entanglement (very high) and ingestion (moderate; unknown)	**7.3**
			Habitat modification – infrastructure / coastal development (low)	**6.4**, **7.6** to **7.9**
			Vessel disturbance (moderate)	**6.1** and **7.2**
			Light pollution (moderate)	**6.2**
	Flatback turtle (Pilbara coast genetic stock (Pil) and South-west Kimberley coast genetic stock (swKim))	Recovery Plan for Marine Turtles in Australia 2017 – 2027 (DoEE, 2017)	Chemical and terrestrial discharge – acute (high), chronic (moderate)	**6.6, 7.4** to **7.9**
			Marine debris – entanglement (moderate) and ingestion (low)	**7.3**
			Habitat modification – infrastructure / coastal development (Pil – high, swKim – moderate)	**6.4**, **7.6** to **7.9**
			Vessel disturbance (moderate)	**6.1** and **7.2**
			Light pollution (Pil – high, swKim – moderate)	**6.2**
	Short-nosed seasnake	Approved Conservation Advice on *Aipysurus apraefrontalis* (Short-nosed Seasnake) (DSEWPaC, 2011a)	Degradation of reef habitat, primarily as a result of coral bleaching (primary threat)	**7.6** to **7.9**
			Oil and gas exploration	**6.1**, **6.2**, **6.6**, **7.6 to 7.9**
	Leaf-scaled seasnake	Approved Conservation Advice for *Aipysurus foliosquama* (Leaf-scaled Seasnake) (DSEWPaC, 2011b)	Degradation of reef habitat, primarily as a result of coral bleaching (primary threat)	**7.6** to **7.9**
			Oil and gas exploration	**6.1**, **6.2, 6.6, 7.6** to **7.9**

Receptor	Name	Recovery Plan, Conservation Advice or Management Plan	Threats/Strategies Identified as Relevant to the Activity	Addressed Where Relevant for Receptor Groups in EP Section
Birds	Southern giant-petrel and albatrosses (including Campbell Albatross)	National Recovery Plan for Threatened Albatrosses and Giant Petrels 2011-2016 (DSEWPaC, 2011c)	Marine pollution	**6.6, 7.6 to 7.9**
	Curlew sandpiper	Approved Conservation Advice for *Calidris ferruginea* (Curlew Sandpiper) (DoEE, 2015)	Habitat loss and degradation from pollution	**7.6** to **7.9**
	Eastern curlew	Approved Conservation Advice for *Numenius madagascariensis* (Eastern Curlew) (DoEE, 2015)	Habitat loss and degradation from pollution	**7.6** to **7.9**
	Australian fairy tern	Approved Conservation Advice for *Sternula nereis* (Fairy Tern) (DSEWPaC, 2011d)	Oil spills, particularly in Victoria (potential threat)	**7.6** to **7.9**
	Red knot	Conservation Advice *Calidris canutus* (Red Knot) (TSSC, 2016a)	Habitat loss and habitat degradation	**7.6** to **7.9**
			Pollution/contamination impacts	**7.6** to **7.9**
			Direct mortality (bird strike)	**7.2**
	Western Alaskan bar-tailed godwit	Wildlife Conservation Plan for Migratory Shorebirds (DoE, 2015d)	Habitat loss and habitat degradation	**7.6** to **7.9**
		Conservation Advice for *Limosa lapponica baueri* (Bar-tailed godwit (western Alaskan)) (TSSC, 2016b)	Pollution/contamination impacts	**7.6** to **7.9**
	Northern Siberian bar-tailed godwit	Wildlife Conservation Plan for Migratory Shorebirds (DoE, 2015d)	Habitat loss and habitat degradation	**7.6** to **7.9**
		Conservation Advice *Limosa lapponica menzbieri* (Bar-tailed godwit (northern Siberian)) (TSSC, 2016c)	Pollution/contamination impacts	**7.6** to **7.9**
	White-winged fairy-wren (Barrow Island)	Approved Conservation Advice for *Malurus leucopterus edouardi* (White-winged Fairy-wren (Barrow Island)) (DEWHA, 2008a)	Degradation of habitat by fire and development	**7.6** to **7.9**
	White-winged fairy-wren (Dirk Hartog Island)	Approved Conservation Advice for *Malurus leucopterus* (White-winged Fairy-wren (Dirk Hartog Island)) (DEWHA, 2008b)	N/A – all threats are related to terrestrial environment	N/A
	Australian lesser noddy	Approved Conservation Advice for *Anous tenuirostris melanops* (Australian lesser noddy) (TSSC, 2015e)		
	Soft-plumaged petrel	Approved Conservation Advice for *Pterodroma mollis* (soft-plumaged petrel) (2015f)		
	Christmas Island frigatebird	Approved Conservation Advice for *Fregata andrewsi* (Christmas Island frigatebird) (TSSC, 2016d)		
	Australian painted snipe	Approved Conservation Advice for *Rostratula australis* (Australian painted snipe) (DSEWPaC, 2013)		
	Abbott's booby	Approved Conservation Advice for *Papasula abbotti* (Abbott's booby) (TSSC, 2015g)		
	Night parrot	Approved Conservation Advice for *Pezoporus occidentalis* (night parrot) (TSSC, 2016e)		
Protected	Montebello Islands Marine Park	Management Plan for the Montebello/Barrow Islands Marine Conservation Reserves 2007–2017 (DEC, 2006)	Encourage a policy of zero discharge where alternatives to discharge exist	**6.6**
			Develop and enforce controls on the discharge of sewage from vessels in the reserves, including the prohibition of discharge in areas designated 'Zone 1'	**6.6**

Receptor	Name	Recovery Plan, Conservation Advice or Management Plan	Threats/Strategies Identified as Relevant to the Activity	Addressed Where Relevant for Receptor Groups in EP Section
			Ensure relevant industry activities are undertaken at times and places that do not conflict with humpback whale migration through the reserves	**6**
			Maintain records of the incidence of entanglement, boat collisions and stranding of marine mammals in the reserves	**8**
			Maintain a database of turtle mortality and incidents of entanglement in the reserves	**8.12**
			Ensure that important seabird and shorebird breeding and feeding areas are not significantly affected by human activities	**6** and **7**

3.2.5 Socio-economic Receptors

Socio-economic activities that may occur in 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 3-8**. More detailed descriptions of socio-economic considerations are provided in Sections 3.2.5.1 to 3.2.5.5.

Table 3-8: Summary of Socio-economic Activities that May Occur in the Operational Area

Value/ Sensitivity	Description	Operational Area Presence	Relevant Events Within Operational Area	Relevant Events Within EMBA
Commercial fisheries – Commonwealth (Figure 3-16)	Three Commonwealth fisheries overlap the operational area: the Western Tuna and Billfish Fishery, the Southern Bluefin Tuna Fishery, and the Western Skipjack Tuna Fishery (**Section 3.2.5)** In recent years, fishing effort associated with the Western Tuna and Billfish Fishery has concentrated off south-west Western Australia and South Australia, with no current effort on the NWS (Patterson et al., 2018). 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 is no current effort on the NWS (Patterson et al., 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 (Patterson et al., 2018).	✓	**Planned** Interaction with other users (**Section 6.5**)	**Unplanned** Unplanned hydrocarbon spills (**Sections 7.6** to **7.9**)
Commercial fisheries – State (Figure 3-17 and **Figure 3-18)**	State fisheries active within the operational area are the Pilbara Trap, Line and Fish Trawl Managed Fisheries, the Mackerel Fishery Area 2, the Onslow and Nickol Bay Prawn Limited Entry Fishery, Pearl Oyster Managed Fishery, and Pilbara Developing Crab Fishery (**Table 3-9**).	✓	**Planned** Interaction with other users (**Section 6.5**)	**Unplanned** Unplanned hydrocarbon spills (**Sections 7.6** to **7.9**)

Oil and gas (Figure 3-19)	Various petroleum exploration and production activities have been undertaken within the North West Shelf. In the operational area, East Spar pipeline is crossed by four pipelines, two flowlines and two umbilicals owned by Chevron. Outside of the operational area, but within the permit area, the Pluto gas pipeline transects the southwest corner (approximately 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' below. Oil and gas facilities occur within the EMBA, as do permits operated by other titleholders. Thus, oil and gas activities could be impacted by unplanned events.	✓	**Planned** Interaction with other users (**Section 6.5**)	**Unplanned** Unplanned hydrocarbon spills (**Sections 7.6** to **7.9**)
Shipping (Figure 3-19)	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 proposed operational area does not overlap any major shipping lanes (more than 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.	✓	**Planned** Interaction with other users (**Section 6.5**)	**Unplanned** Unplanned hydrocarbon spills (**Sections 7.6** to **7.9**)
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**	**Unplanned** Unplanned hydrocarbon spills (**Sections 7.6**to **7.9**)
Defence	In consultation, Defence has advised no concerns with this proposed activity (**Section 3.2.5**).	–	**N/A**	**N/A**

Shipwrecks	One hundred and thirty three shipwrecks are sited within the EMBA. The closest shipwreck to the operational area is the Perentie, wrecked in 1976 on Barrow Island.	**–**	**N/A**	**Unplanned** Unplanned hydrocarbon spills (**Sections 7.6** to **7.9**)
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, Barrow Island Marine Park and Marine Management Area, Jurien Bay Marine Park and Rowley Shoals Marine Park; shoreline accumulation of oil may also occur within the Ningaloo Marine Park and Muiron Islands Marine Management Area (**Section 3.2.3**). Thus, ecotourism based on specific local values (game fish, nearshore reef snorkelling and diving) could be impacted by unplanned events.	**–**	**N/A**	**Unplanned** Unplanned hydrocarbon spills (**Sections 7.6** to **7.9**)
Cultural Heritage	No known sites of Aboriginal Heritage significance occur within the operational area. Within the EMBA, Barrow Island, Montebello Islands, Exmouth, Dampier Peninsula, Kimberley coast, Eighty-mile beach, Ningaloo Reef and the adjacent foreshores have a long history of occupancy by Indigenous communities.	**–**	**N/A**	**N/A**

3.2.5.1 Commercial Fisheries

Commonwealth and State fisheries overlapping with the operational area and the EMBA are illustrated in **Figure 3-16, Figure 3-17** and **Figure 3-18** respectively. **Table 3-9** describes each of these fisheries and indicates which events associated with the activity may impact on these.

Consultation with the Department of Primary Industries and Regional Development (DPIRD) has previously identified commercial fishing interests that exist in or in close proximity to proposed activities under this EP. This includes commercial fisheries identified in **Table 3-9**. This consultation also identified key fish species that may be aggregating or spawning in the EMBA. This information is provided, together with other key periods of sensitivity for socio-economic receptors in **Table 3-10**.

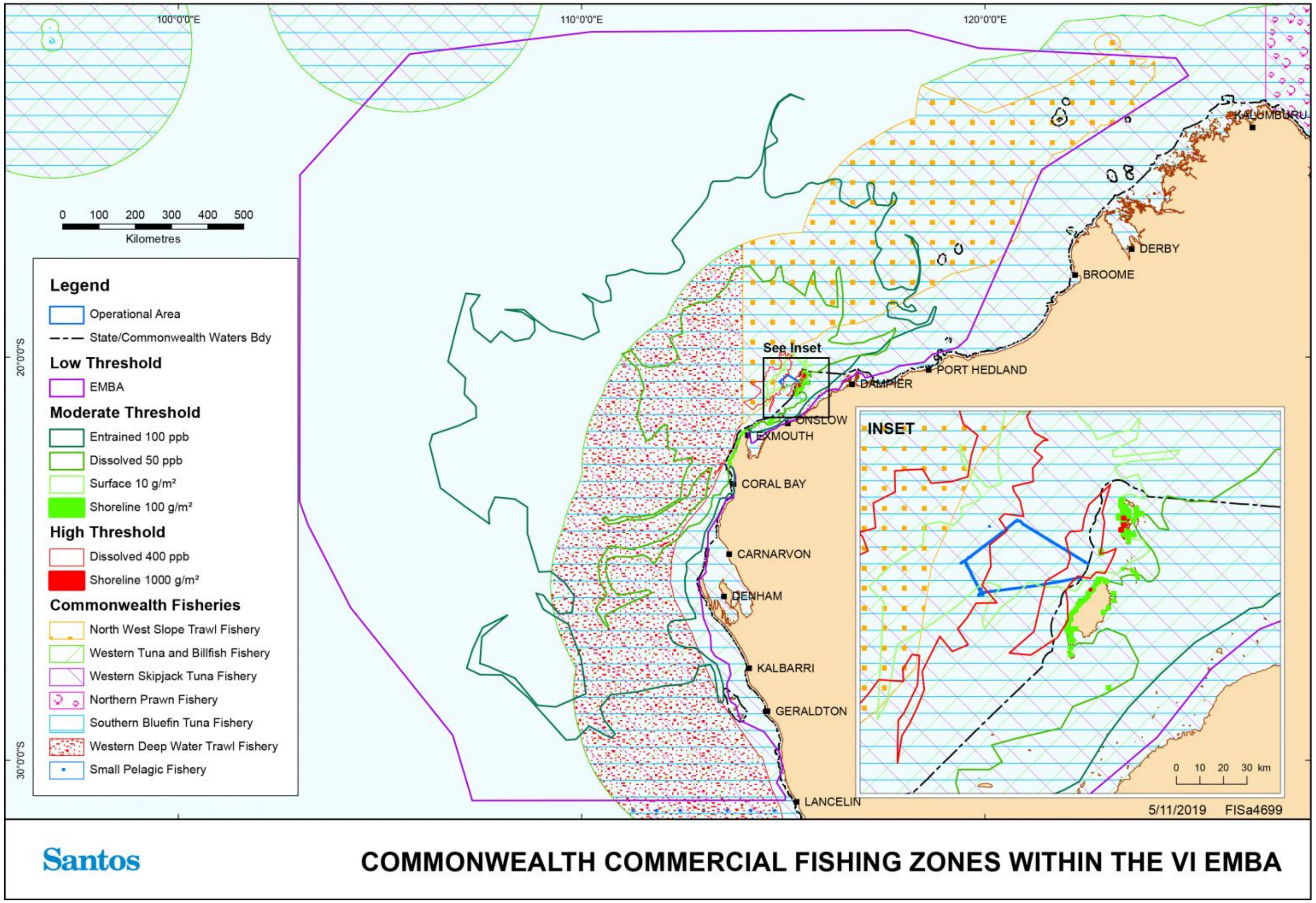

Figure 3-16: Commonwealth Commercial Fishing Zones in the EMBA and Operational Area

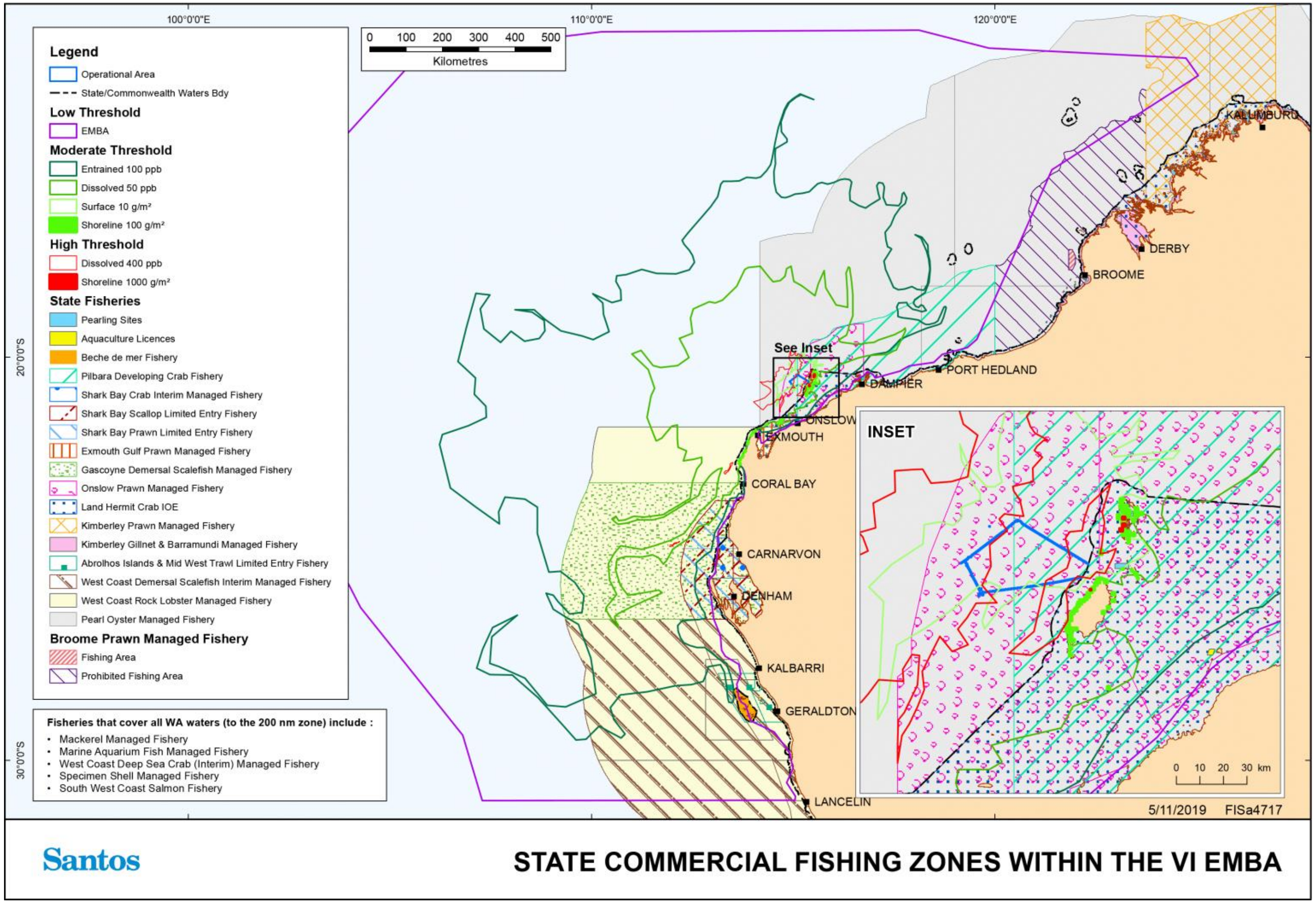

Figure 3-17: State Commercial Fishing Zones in the EMBA and Operational Area

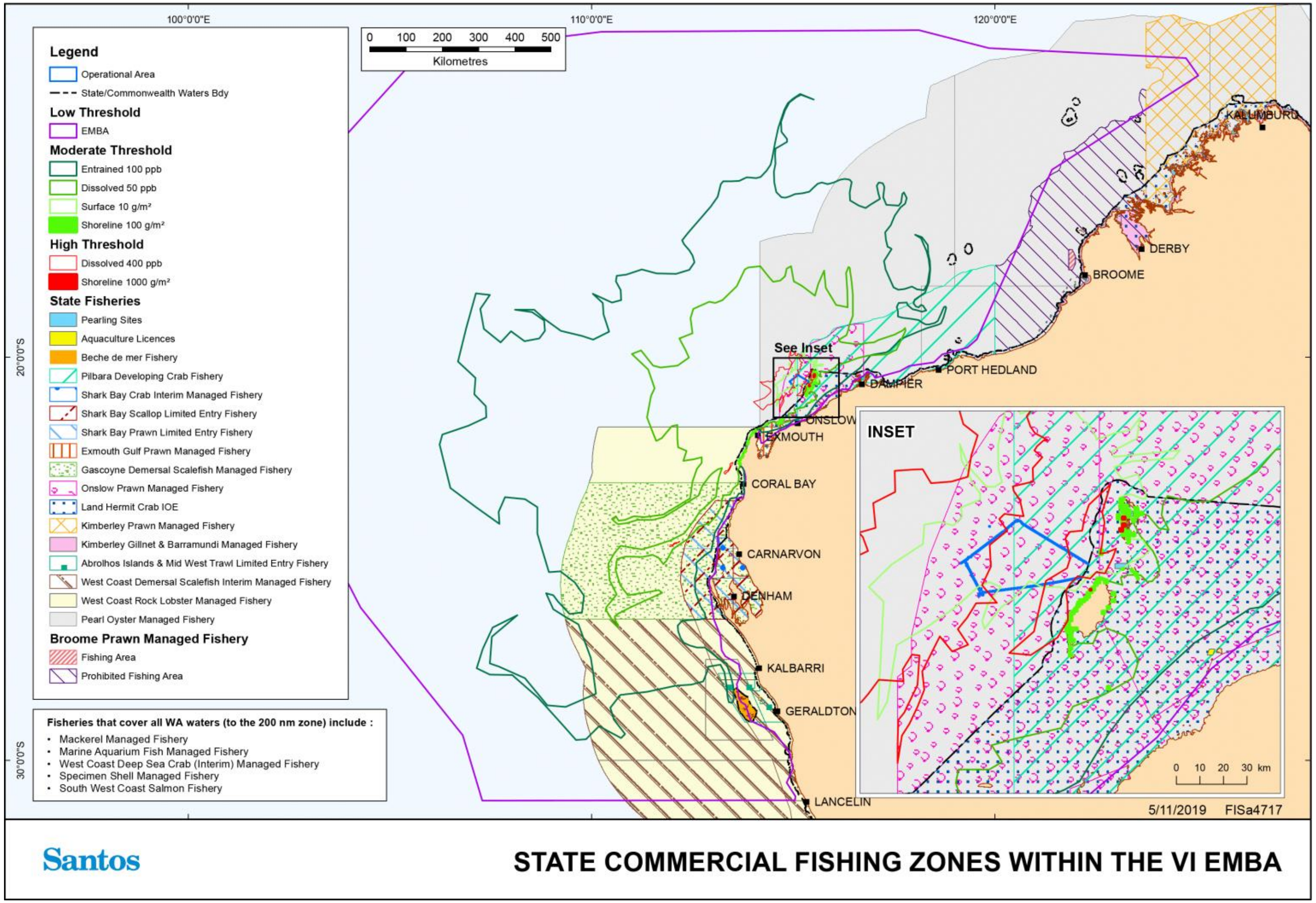

Figure 3-18: State Commercial Fishing Zones in the EMBA and Operational Area

Table 3-9: Commonwealth and State Fisheries in the Vicinity of the Operational Area and EMBA

Value/Sensitivity	Description	Operational Area Presence	EMBA Presence	Relevant Events within the Operational Area and the EMBA
Commonwealth-managed Fisheries				
North West Slope Trawl	Extends from 114° E to approximately 125° E off the WA coast between the 200 m isobath and the outer limit of the Australian Fishing Zone.	X	✓	Historical effort in the EMBA, targeting scampi and prawns.
Western Deepwater Trawl Fishery	Demersal trawl seaward of the 200 m isobaths.	X	✓	Fishing effort for a diverse range of tropical and temperate species.
Small Pelagic Fishery	Purse-seine and midwater trawling	X	✓	Historical effort in the EMBA, targeting sardines, mackerel and redbait.
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.	✓	✓	No active commercial fishing in the area in the past years. However, fisheries overlap the EMBA and therefore fishing vessels could be encountered in low density.
Western Skipjack Tuna Fishery	There has been no fishing effort since the 2009 season in South Australia. No current effort on North West Shelf.	✓	✓	
Southern Bluefin Tuna	No current effort on North West Shelf.	✓	✓	
State-managed Fisheries (North, Gascoyne and West Coast Bioregions)				
Abrolhos Islands and Mid-West Trawl Managed Fishery	All the waters of the Indian Ocean adjacent to Western Australia between 27°51' S latitude and 29°03' S latitude on the landward side of the 200 m isobath.	X	✓	Low opening otter trawl systems operating to target saucer scallops and prawns.
Broome Prawn Managed Fishery	Operates off Broome and targets western king and coral prawns.	X	✓	Unplanned events that may occur in the operational area and the EMBA could disrupt fishing activities;

Value/Sensitivity	Description	Operational Area Presence	EMBA Presence	Relevant Events within the Operational Area and the EMBA
				however, the likelihood of these events is low.
Exmouth Gulf Prawn Managed Fishery	Sheltered waters of Exmouth Gulf. Essentially the western half of the Exmouth Gulf (eastern part is a nursery ground). The Muiron Islands and Point Murat provide the western boundary; Serrurier Island provides the northern limit.	X	✓	Unplanned events that may occur in the operational area and the EMBA could disrupt fishing activities; however, the likelihood of these events is low.
Nickol Bay Prawn Managed Fishery	Primarily targets banana prawns using otter trawl methods along the western part of the North West Shelf in coastal shallow waters.	X	✓	Unplanned events that may occur in the operational area and the EMBA could disrupt fishing activities; however, the likelihood of these events is low.
Kimberley Prawn Managed Fishery	Operates off the north of the state between Koolan Island and Cape Londonderry. Primarily targets banana prawns.	X	✓	Unplanned events that may occur in the operational area and the EMBA could disrupt fishing activities; however, the likelihood of these events is low.
Pearl Oyster Managed Fishery	Mostly operate March to June. Operational area does occur within the boundaries of Zone 1 for the fishery. There was no active fishing in Zone 1 of the Pearl Oyster Managed Fishery since 2016, however a small number of culture shells have been taken, which is restricted to shallow diving depths.	✓	✓	Given the water depths of the operational area, disruption to fishing activities are unlikely to occur. Unplanned events that may occur in the operational area and the EMBA could disrupt fishing activities; however, the likelihood of these events is low.
Onslow Prawn Managed Fishery	The boundaries of this 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’.	✓	✓	Significant disruption unlikely to occur due to vast area fished.

Value/Sensitivity	Description	Operational Area Presence	EMBA Presence	Relevant Events within the Operational Area and the EMBA
Pilbara Fish Trawl (interim), Trap and Line Managed 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 Pilbara Fish Trawl fishery is seaward of the 50 m isobath and landward of the 200 m isobaths. The Trap Fishery generally operates in shallow waters around rocky outcrops and reefs. The Line Fishery is seaward of the 30 m isobath and landward of the 200 m isobaths. As the maximum water depth in the operational area is 110 m, significant impacts are not expected. Unplanned events that may occur in the operational area and the EMBA could disrupt fishing activities; however, the likelihood of these events is low.
Pilbara Developing Crab Fishery	Targets blue swimmer and mud crabs. Crabbing activity along the Pilbara coast is centered largely on the inshore waters.	✓	✓	Given the water depths of the operational area, disruption to fishing activities are unlikely to occur.
Northern Demersal Scalefish Managed Fishery	Primarily trap-based fishery targeting red emperor and goldband snapper.	X	✓	Unplanned events that may occur in the operational area and the EMBA could disrupt fishing activities; however, the likelihood of these events is low.
West Coast Demersal Scalefish (Interim) Managed Fishery	The offshore management area targets eightbar grouper, hapuku, blue-eye trevalla and ruby snapper. Fishing method is handline and drop line.	X	✓	Unplanned events that may occur in the EMBA could disrupt fishing activities; however, the likelihood of these events is low.
West Coast Rock Lobster Managed Fishery	This fishery targets the western rock lobster between Shark Bay and Cape Leeuwin. Baited traps (pots) and with a	X	✓	Unplanned events that may occur in the EMBA could disrupt fishing activities; however, the

Value/Sensitivity	Description	Operational Area Presence	EMBA Presence	Relevant Events within the Operational Area and the EMBA
	commercial and recreational fishing season.			likelihood of these events is low.
West Coast Demersal Gillnet and Demersal Longline	This fishery targets gummy, dusky, whiskery and sandbar sharks using demersal gillnets and demersal longline.	X	✓	Unplanned events that may occur in the EMBA could disrupt fishing activities; however, the likelihood of these events is low.
Gascoyne (West Coast) Demersal Scalefish (Interim) Managed Fishery	Handline and drop line for west coast inshore and offshore demersal species.	X	✓	Unplanned events that may occur in the EMBA could disrupt fishing activities; however, the likelihood of these events is low.
Shark Bay Scallop, Crab and Prawn Limited Entry Fishery	Low opening otter trawls. The boundaries of the Shark Bay Prawn Managed Fishery and the Shark Bay Scallop managed Fishery are located in and near the waters of Shark Bay.	X	✓	Unplanned events that may occur in the EMBA could disrupt fishing activities; however, the likelihood of these events is low.
Gasgoyne Demersal Scalefish Managed Fishery	Mechanised handlines. Unlikely to occur.	X	✓	Unplanned events that may occur in the EMBA could disrupt fishing activities; however, the likelihood of these events is low.
Octopus Interim Managed Fishery	Lines and pots, trawl and trap land octopus as by-product. Fishery is in development phase and occurs between Kalbarri and Esperance.	X	✓	Unplanned events that may occur in the EMBA could disrupt fishing activities; however, the likelihood of these events is low.
State Managed Fisheries (Whole of State)				
Marine Aquarium Fish Managed Fishery	All year. Effort in the operational area and the EMBA is unknown but is unlikely due to the depth and the dive-based method of collection.	✓	✓	Disruption to fishing activities unlikely given water depths fisheries operate in. Unplanned events that may occur in the EMBA could disrupt fishing activities; however, the likelihood of these events is low.
Specimen Shell Managed Fishery	All year. Effort in the operational area and the EMBA is unknown, but it is unlikely due to the depth and the	✓	✓	

Value/Sensitivity	Description	Operational Area Presence	EMBA Presence	Relevant Events within the Operational Area and the EMBA
	dive-based method of collection. Unlikely to occur.			
West Coast Deep Sea Crustacean (Interim) Managed Fishery	Baited pots targeting crabs; occurs between Cape Leeuwin and the Northern Territory border on the seaward side of the 150-m isobath.	✓	✓	
Hermit Crab Fishery	Land-based hand collection operating in Western Australian waters north of Exmouth Gulf.	✓	✓	
Western Australian Sea Cucumber Fishery (formerly known as bêche-de-mer)	All year. Although permitted to fish in the operational area and the EMBA, the fishery is restricted to shallow coastal waters suitable for diving and wading. Unlikely to occur.	✓	✓	
Mackerel Fishery	Trolling or handline. Near-surface trolling gear from vessels in coastal areas around reefs, shoals and headlands.	✓	✓	The majority of the catch is taken in the Kimberley area; therefore, disruption is unlikely

3.2.5.2 Recreational Fisheries

The operational area occurs in the Gascoyne Coast Bioregion, which 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, which may include the operational area).

The predominant target species include the tropical species, such as emperors, tropical snappers, groupers, mackerels, 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).

3.2.5.3 Petroleum Industry

There are several exploration and production permits and leases throughout the Western Australian and Commonwealth waters in the operational area and the EMBA, as shown in **Figure 3-19.**

. There are also domestic gas plants on Varanus Island in the North West Shelf, Devil Creek Gas Plant onshore and Macedon Gas Plant in the Pilbara region, and an oil facility near Dongara called Cliff Head.

3.2.5.4 Shipping

Large commercial vessels associated with the oil and gas industry and Western Australian major ports move through the operational area and the EMBA in transit. Closer proximity shipping also includes construction vessels, barges, and dredges; domestic support vessels; and offshore survey vessels.

The Australian Maritime Safety Authority (AMSA) has established a network of shipping fairways off the northwest coast of Australia to manage traffic patterns (AMSA, 2013a). AMSA shipping routes in and in close proximity to the operational area and the EMBA are shown in **Figure 3-20**.

3.2.5.5 Tourism

Tourism is concentrated in the vicinity of population centres in and in the vicinity of the EMBA, such as Dampier, Exmouth, Coral Bay and Shark Bay. Popular water-based activities that may occur in the EMBA include fishing, swimming, snorkelling, diving, surfing, windsurfing, kiting and boating.

Seasonal nature-based tourism, such as humpback whale watching, whale shark encounters and tours of turtle hatching, mainly occurs around Ningaloo Reef and Cape Range National Park (Tourism Western Australia, 2014). 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).

Given the water depths of the operational area and the lack of notable seabed features, there are unlikely to be any tourism-based activities in the surrounding waters of the operational area. The nearest area where recreation is likely to occur is the Montebello Islands, which are located approximately 20 km from the operational area.

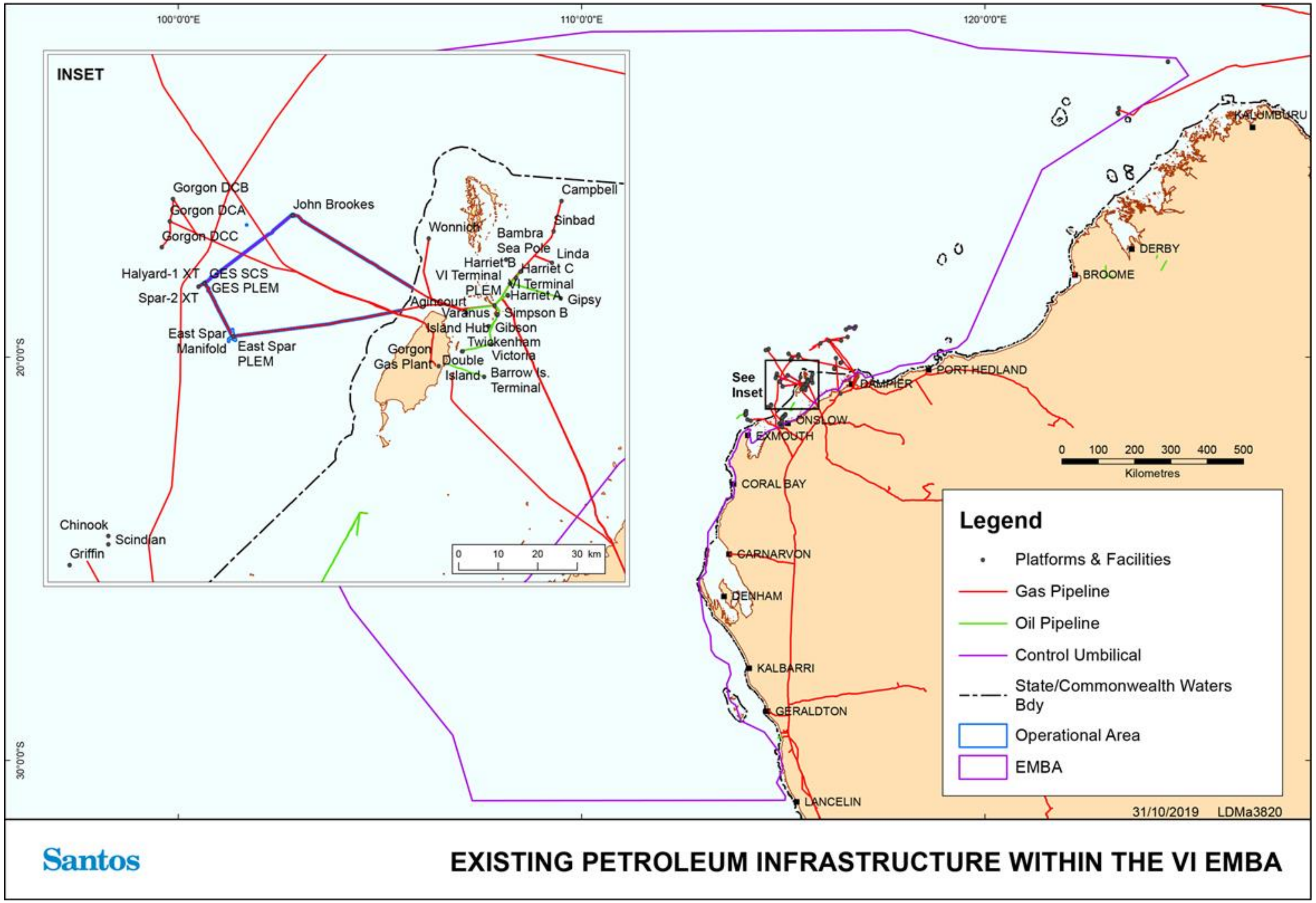

Figure 3-19: Existing Petroleum Infrastructure, Permits and Licences in the EMBA and Operational Area

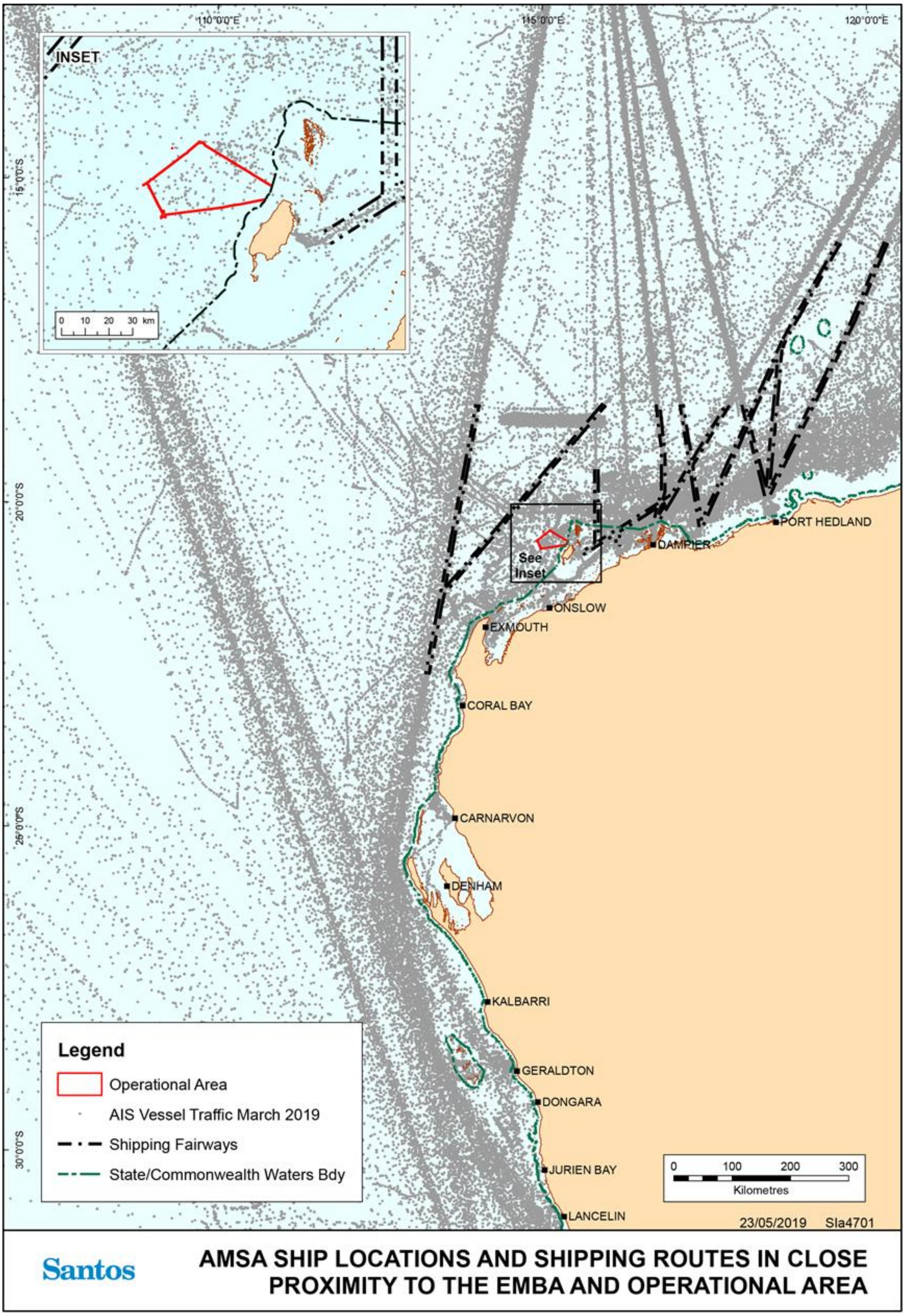

Figure 3-20: AMSA Ship Locations and Shipping Routes in and in Close Proximity to the EMBA and Operational Area

3.2.6 Windows of Sensitivity

Timing of peak activity for threatened species and other relevant, significant sensitivities is given in **Table 3-10**.

Table 3-10: 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 or 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												
	Marine Mammals												
	Dugong (breeding)	breeding								breeding			

Categories	Receptors (Critical Life-cycle Stages)	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
	Australian sea lion (breeding)	Breeding and caring for young											
	Humpback whale (migration)						northern			southern			
	Blue whale (migration)					northern						southern	
	Marine Reptiles												
	Hawksbill turtles (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 turtles (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 turtles (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]												

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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 turtles (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 turtles	Can occur at low density across the North West Shelf year round											
	Olive ridley turtles	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											
	Leaf-scaled 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											

Categories	Receptors (Critical Life-cycle Stages)		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Key / Notes		Peak activity, presence reliable and predictable.						[1] Information provided from Department of Fisheries consultation.						
		Lower level of abundance, activity or presence.						[2] Information provided by K. Pendoley.						
		Very low activity or presence.												
		Activity can occur throughout 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
16 The environment plan must contain the following: (b) a report on all consultations under regulation 11 A 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.

4.1 Summary

The Varanus Island Hub has been in operation since 1986. Activities governed under this EP in Commonwealth waters include the John Brookes platform, Spartan, Greater East Spar and Halyard fields. Stakeholders have been engaged regarding activities in these petroleum permits since their development.

The VI Hub Operations EP for Commonwealth Waters was last revised in 2019 (five yearly revision). Stakeholders were provided a Varanus Island Hub Operations Consultation Package via email on June 15, 2018, to ensure stakeholders were aware the EP was being revised and activities that occur at the facility were reiterated. Stakeholders were then provided a Spartan VI Hub Operations Hub Environment Plan Revision Consultation Package in September 2021 to ensure stakeholders were aware that the following activities were being planned for VI Hub Operations:

- Spartan Development Activities (drilling, installation and pre-commissioning). Refer to the Spartan Development Addendum of this EP for full consultation details (EA-60-RI-10003.02); and
- Varanus Island Hub Operations (Commonwealth waters), including operation of the Spartan facilities.

- Santos notes that information provided to stakeholders referenced some activities taking place in Retention Lease WA-33-R. This petroleum permit has been converted to a Production Licence. Santos has chosen not to provide an update to stakeholders as there has been no change to planned activities and the Operational Areas. There has also been no change to the spatial dimensions of the petroleum permit in the conversion to a Production Licence.

No concerns with the activity were raised during the consultation period. A full summary and records of the Spartan VI Hub Operations EP Revision Consultation Package can be found in Section 4 and Appendix E of the Spartan Development EP Addendum (EA-60-RI-10003.02).

In addition, Santos's wider stakeholder group is regularly updated on Santos's activities through Quarterly Consultation Update documents which list Varanus Island as a key operating facility for the company.

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

Santos considers that consultation with regulators and key stakeholders has been adequate for activities covered under this EP (further detailed in **Table 4-1**). No stakeholder has objected to activities covered under this EP nor claimed that the environmental impacts or risks are unacceptable. Given Santos's long-term presence at Varanus Island, Santos anticipates stakeholders are familiar with the facility.

Consultation that support Santos's oil spill response strategies and tactics is outlined in **Section 4.6**.

4.2 Stakeholder Identification

Santos 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.

In addition, new stakeholders who visit Santos' external facing website may contact the company via contact details provided online, and information about Santos'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's stakeholder list, and of the stakeholders consulted over other recent activities in the area. In particular, the operational area for the activity is used to identify relevant persons and will be used throughout the duration of this EP.

Table 4-1: Stakeholders engaged for VI Hub Operations EP

Group	Stakeholder
Fishers and representative bodies	+ A Raptis and Sons; + Austral Fisheries; + Australian Fisheries Management Authority (AFMA); + Australian Southern Bluefin Tuna Association (ASBTIA); + Commonwealth Fisheries Association (CFA); + Fat Marine; + Marine Tourism WA; + MG Kailis; + Old Brown Dog; + Pearl Producers Association; + Quest Maritime; + Recfishwest; and + Western Australian Fishing Industry Council (WAFIC).
Marine conservation	+ Department of Primary Industries and Regional Development (DPIRD). + Department of Biodiversity, Conservation and Attractions (DBCA); and + Department of Water and Environmental Regulation (DWER).
Shipping safety and security	+ Australian Marine Oil Spill Centre (AMOSC); + Australian Maritime Safety Authority (AMSA); + Department of Defence (DoD); + Department of Transport (DoT); and + Pilbara Port Authority.
Adjacent regulator	+ Department of Mines, Industry Regulation and Safety (DMIRS)
Commonwealth Government departments	+ Australian Antarctic Division; + Department of Agriculture and Water Resources – Biosecurity; + Department of Agriculture and Water Resources – Fisheries; and + Department of Environment and Energy.
Indigenous stakeholders groups	+ Buurabalayji Thalanyji Aboriginal Corporation (BTAC); + Kuruma Marthudhunera Aboriginal Corporation (KMAC); and + Yaburara and Coastal Mardudhunera Aboriginal Corporation (YACMAC).
Regional Stakeholders	+ City of Karratha; + Karratha Districts Chamber of Commerce and Industry; + Kings Bay Fishing Club; and + Pilbara Development Commission (PDC).
Tourism Operators	+ Apache Charters; + Blue Horizon Charters; + Keshimer Expeditions;

Group	Stakeholder
	+ Kimberley Expeditions; + Kings Ningaloo Reef Tours; + Lady M Cruising; + Montebello Tours; + Odyssey Expeditions; + Pelican Charters; + Sail Leeuwin; + Sail Ningaloo; and + Top Gun Charters.
Neighbouring operators	+ Chevron; + Eni Australia; and + Woodside.

4.3 Environment Plan Consultation

A high level overview of the Varanus Island Hub Operations EPs, including activity summary, coordinates, location map and petroleum safety exclusion zone details were distributed to stakeholders in a detailed consultation package on June 15, 2018 and again in September 2021. These consultation packages outlined potential risks and impacts together with a summary of control measures proposed, to ensure stakeholders

No concerns with the activity were raised during this consultation period. Consultation material from the 2018 consultation package is summarised in **Table 4-2** and evidenced in **Appendix E.** Consultation material from the September 2021 consultation package is summarised in Section 4 and evidenced in Appendix E of the Spartan Development EP Addendum (EA-60-RI-10003.02).

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 as potentially being active in the area, and/or their representative bodies.	
A Raptis and Sons	This stakeholder was provided the Varanus Island Hub Operations Consultation Package by email on 15 June 2018, and receive all Santos's *Quarterly Consultation Update* documents. No response regarding the activity has been received to date. No action arising from this consultation for this EP.
Austral Fisheries	This stakeholder was provided the Varanus Island Hub Operations Consultation Package by email on 15 June 2018, and receive all Santos's *Quarterly Consultation Update* documents. No response regarding the activity has been received to date. No action arising from this consultation for this EP.
AFMA	This stakeholder was provided the Varanus Island Hub Operations Consultation Package by email on 15 June 2018, and receive all Santos's *Quarterly Consultation Update* documents. Santos emailed AFMA on 11 December 2019 inviting the Department to provide comment on or discuss Santos' updated Scientific Monitoring Plan and baseline data review and/or receive copies of these for information. No response regarding the activity has been received to date. No action arising from this consultation for this EP.
Australian Southern Bluefin Tuna Association	This stakeholder was provided the Varanus Island Hub Operations Consultation Package by email on 15 June 2018, and receive all Santos's *Quarterly Consultation Update* documents. No response regarding the activity has been received to date. No action arising from this consultation for this EP.
Commonwealth Fishing Association	This stakeholder was provided the Varanus Island Hub Operations Consultation Package by email on 15 June 2018, and receive all Santos's *Quarterly Consultation Update* documents. No response regarding the activity has been received to date. No action arising from this consultation for this EP.
Fat Marine	This stakeholder was provided the Varanus Island Hub Operations Consultation Package by email on 15 June 2018, and receive all Santos'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 Tourism WA	This stakeholder was provided the Varanus Island Hub Operations Consultation Package by email on 15 June 2018, and receive all Santos'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
MG Kailis	This stakeholder was provided the Varanus Island Hub Operations Consultation Package by email on 15 June 2018, and receive all Santos's *Quarterly Consultation Update* documents. No response regarding the activity has been received to date. No action arising from this consultation for this EP.
Old Brown Dog	This stakeholder was provided the Varanus Island Hub Operations Consultation Package by email on 15 June 2018. No response regarding the activity has been received to date. No action arising from this consultation for this EP.
Pearl Producers Association	This stakeholder was provided the Varanus Island Hub Operations Consultation Package by email on 15 June 2018, and receive all Santos's *Quarterly Consultation Update* documents. No response regarding the activity has been received to date. No action arising from this consultation for this EP.
Quest Maritime Services	This stakeholder was provided the Varanus Island Hub Operations Consultation Package by email on 15 June 2018. 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 Varanus Island Hub Operations Consultation Package by email on 15 June 2018, and receive all Santos'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	This stakeholder was provided the Varanus Island Hub Operations Consultation Package by email on 15 June 2018, and receive all Santos's *Quarterly Consultation Update* documents. WAFIC responded to consultation on 18 June 2018, requesting an update on water depths, PSZ and decommissioning. Santos provided water depth and PSZ via email on 21 June 2018, and outlined to WAFIC any decommissioning plans would be covered under a separate approval. Santos understands WAFIC's interest in PSZ, the only PSZ relevant to VI Commonwealth activities exists around the John Brookes platform. Mariners are asked to respect the 500m PSZ for safety reasons. The consultation package provided to all relevant stakeholders advised a 500m PSZ would be in place around each platform on page 3. WAFIC was sent a follow-up email on 8 July 2019 to confirm if there were any additional comments to make on the EP. No further response regarding the activity has been received to date. Santos has also considered advice previously provided by WAFIC on other EPs in the preparation of the Varanus Island Hub Operations EP. WAFIC is a valued stakeholder and Santos commits to ongoing consultation with WAFIC for all offshore activities which may impact fishers.
Marine Conservation – Relevant Government Departments	

Santos

Stakeholder	Assessment of Consultation Undertaken
Department of Primary Industries and Regional Development (Fisheries)	This stakeholder was provided the Varanus Island Hub Operations Consultation Package by email on 15 June 2018, and receive all Santos's *Quarterly Consultation Update* documents. Santos followed up with DPIRD on 19 July 2018, and DPIRD responded to Santos on 26 July 2018, advising DPIRD has no further comment on VI Operational activities. DPIRD was sent a follow-up email on 8 July 2019 to confirm if there were any additional comments to make on the EP. Santos emailed DPIRD on 11 December 2019 inviting the Department to provide comment on or discuss Santos' updated Scientific Monitoring Plan and baseline data review and/or receive copies of these for information. No further response regarding the activity has been received to date. Santos has considered advice previously provided by the Department for activities in the area, including fishing activities (refer **to Section 3.2.5**), pollution emergency plan advice (refer OPEP) and information on biosecurity (refer **Section 7.1**).
Department of Biodiversity, Conservation and Attractions (DBCA)	This stakeholder was provided the Varanus Island Hub Operations Consultation Package by email on 15 June 2018, and receive all Santos's *Quarterly Consultation Update* documents. No further comment on the Commonwealth EP was received. Santos sent a follow-up email to DBCA on 8 July 2019 to confirm if there were any additional comments to make on the EP. No further response regarding the activity has been received to date. Santos emailed DBCA on 4 July 2019 advising it would 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 Environment Plan 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. Santos invited DBCA to receive a copy of these plans for information or comment. Santos emailed DBCA on 11 December 2019 inviting the Department to provide comment on or discuss Santos' updated Scientific Monitoring Plan and baseline data review and/or receive copies of these for information. DBCA contacted Santos by telephone on 10 February 2020 and 11 February 2020 to discuss Santos' email of 11 December 2019 relating to Santos' Offshore Oil Sill Scientific Monitoring Plan. Santos phoned DBCA to discuss the correspondence and emailed a formal response to DBCA on 20 February 2020 attaching, as requested by DBCA the current version of the oil spill scientific monitoring plan and most recent baseline data review. DBCA responded on 20 March 2020 and in summary confirmed it had reviewed the documents and had no specific comment to provide in relation to its Conservation and Land Management Act 1984 or Biodiversity Conservation Act 2016 related responsibilities. Going forward, DBCA does not anticipate a need to review future versions of the Plan but was appreciative of the opportunity to review this version. Santos responded on 23 March 2020 noting the department's position.

Stakeholder	Assessment of Consultation Undertaken
Department of Water and Environmental Regulation	This stakeholder was provided the Varanus Island Hub Operations Consultation Package by email on June 15, 2018, and receive all Santos's *Quarterly Consultation Update* documents. Santos followed up with DWER on 19 July 2018, and DWER confirmed their interest relates to activities covered under Ministerial Statements and any changes to compliance which may be impacted by the revision of this EP. As no VI Commonwealth infrastructure is managed under a Ministerial Statement, DWER does not require any further engagement from a VI Commonwealth waters perspective. Santos will continue to engage with DWER regarding relevant State waters infrastructure. Santos emailed DWER on 11 December 2019 inviting the Department to provide comment on or discuss Santos' updated Scientific Monitoring Plan and baseline data review and/or receive copies of these for information. No response has been received to date.
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 Marine Oil Spill Centre	This stakeholder was provided the Varanus Island Hub Operations Consultation Package by email on 15 June 2018, and receive all Santos's *Quarterly Consultation Update* documents. No response regarding the activity has been received to date. No action arising from this consultation for this EP.
Australian Maritime Safety Authority	This stakeholder was provided the Varanus Island Hub Operations Consultation Package by email on 15 June 2018, and receive all Santos's *Quarterly Consultation Update* documents. No response regarding the activity was received at the time. AMSA was sent a follow-up email on 8 July 2019 to confirm if there were any additional comments to make on the EP. Following advice from AMSA provided for all Santos activities, Santos commits to notifications as per **Section 8.** After NOPSEMA comments were received in relation to notification to the AHO and AMSAs JRCC, Santos has considered the requirement and agrees to notify AHO and the JRCC at least 24 hours prior to IMMR activities commencing at Rosella-1. A control has included a control in Table 8-3 to this effect.
Department of Defence	This stakeholder was provided the Varanus Island Hub Operations Consultation Package by email on 15 June 2018, and receive all Santos'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	This stakeholder was provided the Varanus Island Hub Operations Consultation Package by email on 15 June 2018, and receive all Santos's Quarterly Consultation Update documents. The Department responded via email on 2 July 2018, noting that DoT reviewed the VI Operations OPEP in 2017 and DoT does not need to see the EP unless there are changes to the level of risk or spill response arrangements.

Stakeholder	Assessment of Consultation Undertaken
	DoT was sent a follow-up email on 8 July 2019 to confirm if there were any additional comments to make on the EP. Santos also advised were no significant changes to the spill response strategies and spill risks since the last VI Operations OPEP revision provided to DoT, and will ensure 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). No further response regarding the activity has been received to date. Santos commits to ongoing consultation, as required, with DoT.
Pilbara Port Authority	This stakeholder was provided the Varanus Island Hub Operations Consultation Package by email on 15 June 2018, and receive all Santos's *Quarterly Consultation Update* documents. No response regarding the activity has been received to date. No action arising from this consultation for this EP.
Adjacent Regulators	
State Department of Mines, Industry Regulation and Safety	DMIRS is the regulator for VI State waters and onshore activities, and a stakeholder for activities in Commonwealth waters. DMIRS was provided the Varanus Island Hub Operations Consultation Package by email on 15 June 2018, and receive all Santos's *Quarterly Consultation Update* documents. DMIRS responded by email on 26 June 2018, with thanks noting suggestions for changes to the State Environment Plan which is under DMIRS jurisdiction. Santos responded to DMIRS by email on 2 July 2018, noting any removal of infrastructure would be covered under separate EP and accepting minor editorial notes from DMIRS. No further engagement is required from a Commonwealth waters perspective. DMIRS will assess the VI State EP in line with relevant legislation. DMIRS was sent a follow-up email 8 July 2019 to confirm if there were any additional comments to make on the VI Operations Hub EPs. DMIRS responded on 8 July 2019 advising it had no additional comments to provide on these submissions and notes the Environment Plan for State jurisdiction is due for submission in September 2019.
Commonwealth Government Departments	
Australian Antarctic Division	This stakeholder was provided the Varanus Island Hub Operations Consultation Package by email on 15 June 2018, and receive all Santos'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
Department of Agriculture and Water Resources – Biosecurity	This stakeholder was provided the Varanus Island Hub Operations Consultation Package by email on 15 June 2018. No response was received at the time. The department was sent a follow-up email on 8 July 2019 to confirm if there were any additional comments to make on the EP. In this communication Santos confirmed it was working through the department's recent advice on changes to offshore installation biosecurity guidelines. Santos commits to ongoing discussions with the department as required. Discussion was held with DAWR on 26 August 2019 regarding biosecurity of offshore platforms. The focus largely related to whether Santos had retained a "low risk" quarantine/biosecurity status for its offshore platforms and FPSO, and how Santos will manage the risk for vessels going from port out to these sites and back again. Santos has confirmed a current low risk status of its offshore installations and is continuing to work with DAWR to determine subsequent risk management arrangements.
Department of Agriculture and Water Resources – Fisheries	This stakeholder was provided the Varanus Island Hub Operations Consultation Package by email on 15 June 2018. No response had been received at the time of submission, and is not anticipated as Santos has consulted regularly with the State agency DPIRD. Santos emailed DAWR (Fisheries) on 11 December 2019 inviting the Department to provide comment on or discuss Santos' updated Scientific Monitoring Plan and baseline data review and/or receive copies of these for information. No response has been received to date.
Department of Environment and Energy	This stakeholder was provided the Varanus Island Hub Operations Consultation Package by email on 15 June 2018. No response regarding the activity has been received to date. No action arising from this consultation for this EP.
Indigenous stakeholder groups	
Buurabalayji Thalanyji Aboriginal Corporation (BTAC)	This stakeholder was provided the Varanus Island Hub Operations Consultation Package by email on 15 June 2018. No response regarding the activity has been received to date. No action arising from this consultation for this EP.
Kuruma Marthudhunera Aboriginal Corporation (KMAC)	This stakeholder was provided the Varanus Island Hub Operations Consultation Package by email on 15 June 2018. No response regarding the activity has been received to date. No action arising from this consultation for this EP.
Yaburara and Coastal Mardudhunera Aboriginal Corporation (YACMAC)	This stakeholder was provided the Varanus Island Hub Operations Consultation Package by email on 15 June 2018. No response regarding the activity has been received to date. No action arising from this consultation for this EP.
Regional stakeholders	

Stakeholder	Assessment of Consultation Undertaken
City of Karratha	This stakeholder was provided the Varanus Island Hub Operations Consultation Package by email on 15 June 2018, and receive all Santos's *Quarterly Consultation Update* documents. No response regarding the activity has been received to date. No action arising from this consultation for this EP.
Karratha Chamber of Commerce and Industry	This stakeholder was provided the Varanus Island Hub Operations Consultation Package by email on 15 June 2018, and receive all Santos's *Quarterly Consultation Update* documents. No response regarding the activity has been received to date. No action arising from this consultation for this EP.
Kings Bay Fishing Club	This stakeholder was provided the Varanus Island Hub Operations Consultation Package by email on 15 June 2018, and receive all Santos's *Quarterly Consultation Update* documents. No response regarding the activity has been received to date. No action arising from this consultation for this EP.
Pilbara Development Commission	This stakeholder was provided the Varanus Island Hub Operations Consultation Package by email on 15 June 2018, and receive all Santos's *Quarterly Consultation Update* documents. No response regarding the activity has been received to date. No action arising from this consultation for this EP.
Tourism operators – as advised by DBCA tourism operators who operate in the Montebello/Barrow Islands area.	
Apache Charters	This stakeholder was provided the Varanus Island Hub Operations Consultation Package by email on 15 June 2018, and receive all Santos's *Quarterly Consultation Update* documents. No response regarding the activity has been received to date. No action arising from this consultation for this EP.
Blue Horizon Charters	This stakeholder was provided the Varanus Island Hub Operations Consultation Package by email on 15 June 2018, and receive all Santos's *Quarterly Consultation Update* documents. No response regarding the activity has been received to date. No action arising from this consultation for this EP.
Keshimer Expeditions	This stakeholder was provided the Varanus Island Hub Operations Consultation Package by email on 15 June 2018, and receive all Santos's *Quarterly Consultation Update* documents. No response regarding the activity has been received to date. No action arising from this consultation for this EP.
Kimberley Expeditions	This stakeholder was provided the Varanus Island Hub Operations Consultation Package by email on 15 June 2018, and receive all Santos'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
Kings Ningaloo Reef Tours	This stakeholder was provided the Varanus Island Hub Operations Consultation Package by email on 15 June 2018, and receive all Santos's *Quarterly Consultation Update* documents. No response regarding the activity has been received to date. No action arising from this consultation for this EP.
Lady M Cruising	This stakeholder was provided the Varanus Island Hub Operations Consultation Package by email on 15 June 2018, and receive all Santos's *Quarterly Consultation Update* documents. No response regarding the activity has been received to date. No action arising from this consultation for this EP.
Montebello Tours	This stakeholder was provided the Varanus Island Hub Operations Consultation Package by email on 15 June 2018, and receive all Santos's *Quarterly Consultation Update* documents. No response regarding the activity has been received to date. No action arising from this consultation for this EP.
Odyssey Expeditions	This stakeholder was provided the Varanus Island Hub Operations Consultation Package by email on 15 June 2018, and receive all Santos's *Quarterly Consultation Update* documents. No response regarding the activity has been received to date. No action arising from this consultation for this EP.
Pelican Charters	This stakeholder was provided the Varanus Island Hub Operations Consultation Package by email on 15 June 2018, and receive all Santos's *Quarterly Consultation Update* documents. No response regarding the activity has been received to date. No action arising from this consultation for this EP.
Sail Leeuwin	This stakeholder was provided the Varanus Island Hub Operations Consultation Package by email on 15 June 2018, and receive all Santos's *Quarterly Consultation Update* documents. No response regarding the activity has been received to date. No action arising from this consultation for this EP.
Sail Ningaloo	This stakeholder was provided the Varanus Island Hub Operations Consultation Package by email on 15 June 2018, and receive all Santos's *Quarterly Consultation Update* documents. No response regarding the activity has been received to date. No action arising from this consultation for this EP.
Top Gun Charters	This stakeholder was provided the Varanus Island Hub Operations Consultation Package by email on 15 June 2018, and receive all Santos's *Quarterly Consultation Update* documents. No response regarding the activity has been received to date. No action arising from this consultation for this EP.
Neighbouring operators	
Chevron	This stakeholder was provided the Varanus Island Hub Operations Consultation Package by email on 15 June 2018.

Stakeholder	Assessment of Consultation Undertaken
	No response regarding the activity has been received to date. No action arising from this consultation for this EP.
Eni	This stakeholder was provided the Varanus Island Hub Operations Consultation Package by email on 15 June 2018. No response regarding the activity has been received to date. No action arising from this consultation for this EP.
Woodside	This stakeholder was provided the Varanus Island Hub Operations Consultation Package by email on 15 June 2018. No response regarding the activity has been received to date. No action arising from this consultation for this EP.

4.4 Ongoing Consultation

Santos provides relevant stakeholders with ongoing consultation for regulatory purposes and to ensure community stakeholders are engaged and informed of Santos's activities in the region. Santos 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's stakeholder list and included in all future correspondence as required, including any specific activity notifications and quarterly or annual updates.

4.4.1 Stakeholder Notifications

Stakeholders will be notified of any operational activities relating to the Varanus Island Hub which may impact upon their interests. These activities could be maintenance or ongoing monitoring activities, and may include temporary increased vessel activity. Notifications will be provided to relevant stakeholders when required only, to combat stakeholder fatigue, and while Santos does not expect concerns to be raised regarding activities at Varanus Island, if additional comments do arise Santos will allow an appropriate amount of time to respond and address these comments. Separate notifications for Spartan Development activities including drilling, installation and pre-commissioning will be made under the Spartan Development EP Addendum (EA-60-RI-10003.02).

4.4.2 Quarterly Consultation Update

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

The Varanus Island Hub is listed as an operating facility in all Santos Quarterly Consultation Updates. Any planned activities relating to Varanus Island Hub operations which may be of interest to stakeholders, will be included in a brief operational update within 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 post the preparation of an EP and will be recorded for future reference. Santos commits to respond and address any comments and keep any consultation on file during and post acceptance of an EP. Examples of Quarterly Consultation Update documents are evidenced in **Appendix E**.

4.5 Addressing Consultation Feedback

Santos'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 business has a thorough understanding of how the activity is being received by relevant persons.

If in stakeholder consultation a change to any control measure or activity outlined in this EP is required, Santos would undertake an internal assessment using the management of change process (**Section 8.12.2**).

4.5.1 Environmental Performance Standards and Outcomes

Control measures, environmental performance outcomes (EPOs) and measurement criteria for stakeholder consultation are included in **Table 8-2.**

4.6 OPEP consultation

In preparing the Varanus Island Hub Operations Oil Pollution Emergency Plan (EA-60-RI-00186.02), 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 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 the Varanus Island Hub Operations are outlined in Table 4-3. These stakeholders are relevant to spill response arrangements supporting other Santos activities, including other operations which, like Varanus Island Hub Operations, are continual throughout the year. For that reason engagement with these stakeholders is continual and is largely achieved through Santos'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 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 to maintain best practice in the field of oil spill response. The OPEP will continue to be reviewed, and updated as required, considering any identified improvement opportunities or changes in a stakeholder's position.

Table 4-3: OPEP Stakeholder Consultation Summary

Engaged With Function and/or Stakeholder	Assessment of Consultation Undertaken
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

Engaged With Function and/or Stakeholder	Assessment of Consultation Undertaken
	cooperative arrangement for response to oil spills by Australian oil and associated industries. Continuous consultation with AMOSC occurs through the implementation of Santos'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'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.
Logistics providers	Santos 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 training and exercise schedule.
Vessel providers	Vessel providers operate under contract conditions to provide day to day services to Santos'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 training and exercise schedule.
Aircraft providers	Aircraft providers operate under contract conditions to provide day to day services to Santos'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 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 oil spill contingency plans or OPEPs. The waste management processes do not change between OPEPs, so the original consultation is sufficient for the OPEP.

Engaged With Function and/or Stakeholder	Assessment of Consultation Undertaken
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 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 invited DBCA to comment on Varanus Island Hub Operations Oil Pollution Emergency Plan, including its scientific monitoring plan on 4 July 2019. At the time of submission Santos 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 initially provided a consultation package to DoT on the Varanus Island Hub Operations Oil Pollution Emergency Plan on 15 June 2018. DoT, in their response dated 2 July 2018, clarified that unless there was change to spill risk DoT did not need to see the OPEP, which was last reviewed by DoT in 2017. On July 8 2019, Santos provided correspondence to DoT and explained that the EP/OPEP submission had been delayed but would follow DoT previous advice and most recent relevant advice in relation to similar EP/OPEPs. Santos has provided DoT with the OPEP at time of NOSPEMA submission with an assurance that it did not believe that there was any significant changes to spill risk or arrangements.
Department of Primary Industries and Regional Development – Fisheries (DPIRD Fisheries)	Santos provided a consultation package to DPIRD Fisheries on the Varanus Island Hub Environment Plan on 15 June 2018. On 26 July 2018, DPIRD advised that they had no comment on the EP. On 8 July 2019, Santos advised DPIRD that the EP submission had been delayed and that Santos would consider all relevant advice from DPIRD, including advice that DPIRD had provided on similar OPEPs, including requirements for spill notification and the consideration of fish spawning grounds and nurseries, and relevant baseline data, in its response strategies and monitoring programs.
Spill modelling provider	A spill modelling provider operates under specific contract conditions with Santos to provide forecast spill modelling. All arrangements defined in the OPEP nominating spill modelling reflect contracted services. Engagement and

Engaged With Function and/or Stakeholder	Assessment of Consultation Undertaken
	testing of this service is included in Santos training and exercise schedule.
Waste contractor	A waste service provider operates specific contract conditions with Santos 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 training and exercise schedule.

5 Environmental Impact and Risk Assessment

OPGGS(E)R 2009 Requirements
Regulation 13. Environmental assessment
Evaluation of environmental impacts and risks 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. 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.

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 on the basis of their likelihood of occurrence, which contributes to their level of risk.

Santoshas undertaken environmental impact and risk assessments for the operational activity's planned events (including any routine, non-routine and contingency events) 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 Santos's Environmental Hazard Identification and Assessment Procedure (EA-91-IG-00004_5).

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 Environmental Hazard Identification and Assessment Procedure (EA-91-IG-00004_5).

Table 5-1: Impact and risk assessment terms

Name	Definition
Acceptability	Determined for both impacts and risks. Acceptability of events is in part determined by the consequence of the impact following management controls. Acceptability of unplanned events is in part determined from its risk ranking following management controls. For both impacts and risks, acceptability is also determined from a demonstration of the ALARP principle, consistency with Santos Policies, consistency with all applicable legislation and consideration of relevant stakeholder consultation when determining management controls.
Activity	Specific tasks and actions undertaken throughout the life cycle of oil and gas exploration, production and decommissioning.
ALARP	As Low As Reasonably Practicable. The term refers to reducing risk to a level that is As Low As Reasonably Practicable. In practice, this means showing through reasoned and supported arguments, that there are no other practicable options that could reasonably be adopted to reduce risks further.
Authorised Person	Person with authority to make the decision or take the action. Examples are Vessel Master, Field Superintendent, Supervisor, Person-in-charge, Company Authorised Representative, and Project Manager.
Control Measure	Means a system, an item of equipment, a person or a procedure, that is used as a basis for managing environmental impacts and risks[1].
DMIRS	Department of Mines, Industry Regulation and Safety.
Environment	Includes the natural and socio-economic values and sensitivities which will or may be affected by the activity. Is defined by NOPSEMA and DMIRS as: (a) ecosystems and their constituent parts, including people and communities (b) natural and physical resources (c) the qualities and characteristics of locations, places and areas (d) the heritage value of places (e) the social, economic and cultural features of the matters mentioned in paragraphs (a), (b), (c) and (d).
Environmental consequence	A consequence is the outcome of an event affecting objectives. Note 1 An event can be one or more occurrences and can have several cases. Note 2 An event can consist of something not happening. (Reference ISO 73:2009 Risk Vocabulary).
Environmental impact	Defined by NOPSEMA[1] as any change to the environment, whether adverse or beneficial, wholly or partly resulting from a planned or unplanned event[1]. Defined by DMIRS as any change to the environment, whether adverse or beneficial, that wholly or partly results from a petroleum activity of an operator.

[1] Defined by the Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009

Name	Definition
ENVID	Environmental hazard identification workshop.
Environmental risk	Applies to unplanned events. Risk is a function of the likelihood of the unplanned event occurring and the consequence of the environmental impact that arises from that event.
Hazard	A situation with the potential to cause harm.
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.
Impact assessment	The process of determining the consequence of an impact (in terms of the consequence to the environment) arising from a planned or unplanned event over a specified period of time.
Likelihood	The chance of an unplanned event occurring.
Non-routine planned event	An attribute of the planned activity that may occur or will occur infrequently during the planned activity. A non-routine planned event is intended to occur at the time.
Planned activity	A description of the activity to be undertaken, including the services, equipment, products, assets, personnel, timing, duration and location and aspect of the activity.
Planned event	An event arising from the activity which is done with intent (i.e., not an unplanned event) and has some level of environmental impact. A planned event could be routine (expected to occur consistently throughout the activity) or non-routine (may occur infrequently if at all). Air emissions, bilge water discharge and drill cuttings discharge would be examples of planned events.
Receptor	A feature of the environment that may have environmental, social and/or economic values.
Risk	The effect of uncertainty on objectives.
Risk assessment	The process of determining the likelihood of an unplanned event and the consequence of the impact (in terms of economic, human safety and health, or ecological effects) arising from the event over a specified period of time.
Routine planned event	An attribute of the planned activity that results in some level of environmental impact and will occur continuously or frequently through the duration of the planned activity.
SLT	Senior Leadership Team.
Unplanned event	An event that results in some level of environmental impact and may occur despite preventive safeguards and control measures being in place. An unplanned event is not intended to occur during the activity.

5.2 Summary of the Environmental Impact and Risk Assessment Approach

5.2.1 Overview

Santos operates under an overarching Risk Management Policy. The company Risk Procedure (SMS MS1 ST01) 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**. The forum used to undertake the assessment is the environmental hazard workshop, referred to as an ENVID, which is described in Section 4 of Santos' Offshore Division Environmental Hazard Identification and Assessment Guideline (EA-91-IG-00004_5).Santos

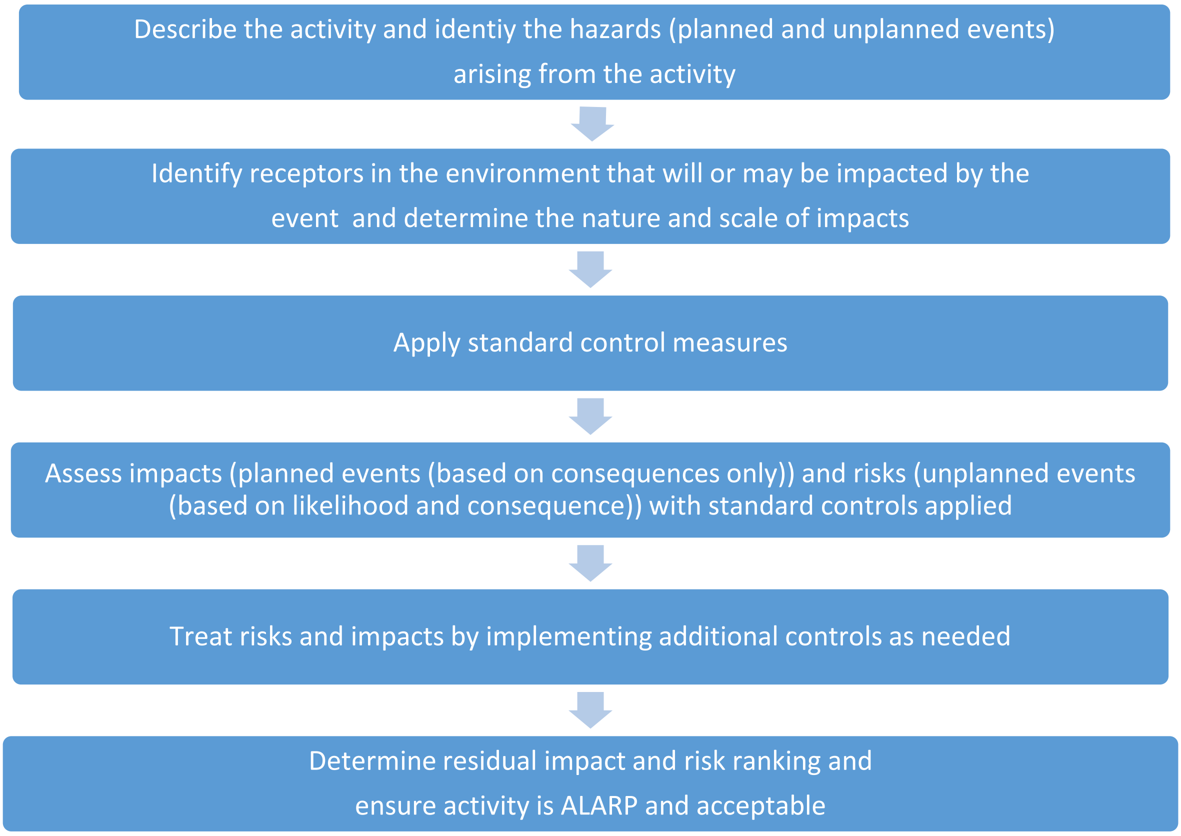

Figure 5-1: Environmental impact and risk assessment process

The Company'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 activities);
- Identification of relevant persons;
- Identification of legal requirements ('legislative controls') that apply to the activity;
- Santos' policy and SMS requirements;
- SantosPrinciples of Ecologically Sustainable Development (ESD); and
- Santos acceptable levels of impact and risk.

These factors were considered in environmental impact and risk assessment workshops held on 23 April 2018, 18 May 2018, 28 June 2018 and 9 August 2018 in which environmental impact identifications (ENVIDs) were made. The risk workshop involved participants from Santos's Health, Safety and Environment (HSE) and Operations departments and specialist environmental consultants. ENVIDs are regularly reviewed for currency during the course of operations and were validated as a part of this five-yearly EP revision on 4 April 2019 and again for this revision in on 28th July 2021.

5.2.2 Describe the Activity and Hazards (Planned and Unplanned Events)

The petroleum activity is described in **Section 2** of this plan. An assessment against the activity was undertaken, and the environmental hazards and aspects were identified. The outcome of this assessment is detailed in the relevant subsections of **Sections 6** and **7**. A summary of the environmental hazards identified for the activity are:

+ Noise emissions;
+ Light emissions;
+ Atmospheric emissions;
+ Seabed and benthic habitat disturbance;
+ Interaction with other marine users;
+ Planned operational discharges (surface and subsea);
+ Spill response operations;
+ Introduction of invasive marine species;
+ Marine fauna interaction;
+ Non-hydrocarbon release of solid objects;
+ Hazardous liquids releases (surface);
+ Surface release of condensate from wellheads at the John Brookes WHP;
+ Subsea release of condensate from a subsea pipeline;
+ Subsea release of condensate of condensate from wellheads; and
+ Surface release of diesel (vessel collision/bunkering).

5.2.3 Determine the Nature and Scale of Impacts and Identify Receptors that Will or May 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 in impacted areas are detailed in **Section 3**.

5.2.4 Describe the Environmental Performance Outcomes and Control Measures

For each planned and unplanned event, a set of environmental performance outcomes, environmental performance standards, control measures and measurement criteria are identified. The definitions of the performance outcomes, standards and measurement criteria are consistent with the OPGGS(E)R 2009 and the NOPSEMA Environment Plan Content Requirements Guidance Note (NOPSEMA, 2019).

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 aspect or hazard 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. Refer to **Section 4** for the impact thresholds applied for surface hydrocarbons, entrained hydrocarbons and dissolved aromatic hydrocarbons used in the hydrocarbon spill modelling study for this EP.

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 nature and scale. 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, it is evident the social and economic values in the region are of interest.

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

Table 5-2: Consequence Level Description

Consequence Level	Consequence Level Description
I	**Negligible** – No impact or negligible impact
II	**Minor** – Detectable but insignificant change to local population, industry or ecosystem factors
III	**Moderate** – Significant impact to local population, industry or ecosystem factors
IV	**Major** – Major long-term effect on local population, industry or ecosystem factors
V	**Severe** – Complete loss of local population, industry or ecosystem factors AND/OR extensive regional impacts with slow recovery
VI	**Critical** – Irreversible impact to regional population, industry or ecosystem factors

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

As planned events are expected to occur during the activity, the likelihood of their occurrence is not considered during the risk assessment, and only a consequence level is assigned in accordance with Santos's Environmental Severity Descriptors and Consequence Levels. 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.

For unplanned events, the consequence level of the impact is combined with the likelihood of the impact occurring (**Table 5-3**), to determine a residual risk ranking using the corporate Santos risk matrix (**Table 5-4**). For oil spill events, potential impacts to environmental receptors are assessed where they occur within the EMBA using results from modelling.

Table 5-3: Likelihood description

No.	Matrix	Description
f	Almost Certain	Occurs in almost all circumstances OR could occur *within days to weeks*
e	Likely	Occurs in most circumstances OR could occur *within weeks to months*
d	Occasional	Has occurred before in Santos OR could occur *within months to years*
c	Possible	Has occurred before in the industry OR could occur *within the next few years*
b	Unlikely	Has occurred elsewhere OR could occur *within decades*
a	Remote	Requires exceptional circumstances and is unlikely even in the long term

Table 5-4: Santos risk matrix

		Consequence					
		I	II	III	IV	V	VI
Likelihood	f	Low	Medium	High	Very High	Very High	Very High
	e	Low	Medium	High	High	Very High	Very High
	d	Low	Low	Medium	High	High	Very High
	c	Very Low	Low	Low	Medium	High	Very High
	b	Very Low	Very Low	Low	Low	Medium	High
	a	Very Low	Very Low	Very Low	Low	Medium	Medium

SantosThe process and definitions supporting the consequence and severity rankings and the likelihood and residual risk ranking determination are included in the Environmental Risk Identification and Analysis Procedure (EA-91-IG-0004_5).

5.2.6 Evaluating if Impacts and Risks are As Low As Reasonably Practicable

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 Evaluating Impact and Risk Acceptability

Santos 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'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 Planned Activities Risk and Impact Assessment

OPGGS(E)R 2009 Requirements
Regulation 13. Environmental assessment.
Environmental performance outcomes and standards 13(7) The environment plan must: (a) set environmental performance standards for the control measures identified under paragraph (5)(c); (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'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 that 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 5.2.5)**. The potential impact assessment for each planned event and the subsequent control and management measures proposed by Santos 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 Reference	Hazard	Residual Consequence Level
6.1	Acoustic Disturbance to Marine fauna	I - Negligible
6.2	Light emissions	I - Negligible
6.3	Atmospheric emissions	I- Negligible
6.4	Seabed and benthic habitat disturbance	I - Negligible
6.5	Interactions with other marine users	I - Negligible
6.6	Operational Discharges	I - Negligible
6.7	Spill response operations	I - 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 John Brookes WHP and associated subsea infrastructure in the operational area. There is little noise generating equipment on John Brookes WHP since processing of hydrocarbons occurs on VI and the WHP is unmanned. The main sources of underwater noise during operational activities are noise from: + The operation of the John Brookes WHP (low-level noise from gas-driven microturbine generator, pumps for chemical injection and hydraulics on the WHP);

	+ Operation of a diesel generator (only used as emergency power supply); + IMMR activities of the WHP and other subsea infrastructure (e.g., use of ROV, geophysical equipment, 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 John Brookes WHP to deter birds for safe helicopter landings and take-offs; 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 activity and adjacent to subsea infrastructure. + Localised: Bird deterrent.
Duration	Intermittently around the subsea infrastructure and John Brookes WHP in the operational area.

6.1.1.1 Noise generated by 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, 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 Generator 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.

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, 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 1,500m 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.

6.1.2 Nature and Scale of Environmental Impacts

Potential receptors: Threatened or migratory fauna (marine mammals, marine turtles, sharks, fish and rays, seabirds)

Noise generated from vessels, subsea and WHP IMMR activities, and helicopters 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 fauna in the following ways:

- Attraction to the noise source;
- Increased stress levels;

+ Localised avoidance of the area;
+ Disturbance, leading to behavioural changes or displacement from areas;
+ Physical injury to hearing or other organs; and
+ Indirectly by inducing behavioural and physiological changes in predator or prey species.

The use of sound in the underwater environment is important for marine animals, particularly cetaceans, 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, such as cetaceans, use sound for navigation and communication and are particularly susceptible to noise impacts. As described in **Table 3-6**, BIAs for humpback whales (migration) and blue whales (migration and distribution) overlap the operational area, and these mammals are likely to be present in the operational area in increased numbers during migration windows. Conservation advices for these species provide guidance on threat abatement activities relevant to noise interference. Santos marine fauna records have previously reported the presence of humpback whales in proximity to the operational area.

Sound levels sufficient to cause physical injury (defined as the onset of permanent threshold shift, PTS) and sublethal 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, which they 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 230 dB (depending on the species), and thresholds for TTS are between 196 and 224 dB. As discussed above, sources of noise may reach these levels during vessel and helicopter activities.

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 160 dB (NMFS, 2018). Avoidance behaviour is likely to be localised within the operational area and for the duration of the helicopter or vessel presence only. Acoustic disturbances to marine fauna due to IMMR activities are expected to be minimal, as the activities are temporary and intermittent in an open-ocean environment.

Reactions of cetaceans 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). Baleen whales sometimes dive or turn away during overflights, but sensitivity seems to vary depending on the activity of the animals. The effects on cetaceans seem transient, and occasional overflights probably have no long-term consequences on cetaceans. Observations by Richardson and Malme (1993) indicate that, for bowhead whales, most individuals are unlikely to react significantly to occasional single-pass low-flying helicopters transporting personnel and equipment 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.

6.1.2.2 Marine Turtles

As described in **Table 3-6**, BIAs for marine turtles, including the loggerhead turtle (internesting) and the green, flatback and hawksbill turtles (internesting and critical nesting habitat), occur within the operational area. 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 and 16 m deep and within 5 to 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. Santos marine fauna records have previously reported the presence of marine turtles in proximity to the operational area.

The Recovery Plan for Marine Turtles in Australia (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.

Marine turtle hearing is thought to be most sensitive in the frequency range of 100 to 700 Hz (Bartol & Musick, 2003), with studies showing that behavioural responses occur to received sound levels of approximately 166 dB re 1 µPa and that avoidance responses occur at around 175 dB re 1 µPa (McCauley *et al*., 2000). These levels overlap with the sound frequencies produced by vessels and helicopters.

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 of metres). Considering the open-ocean location of the operational area, only individual turtles may be affected as they transit the area. No impacts at a population level are anticipated.

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 & Popper, 2004; Braun & 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 207 dB peak sound pressure level (PK) and 213 dB PK (depending on the presence or absence of a swim bladder), and the threshold for TTS is 186 dB cumulative sound exposure level (SEL_{cum}) (Popper *et al*., 2014).Given that there is no exposure criteria for sharks and rays, the same criteria are adopted, although 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 **Table 3-6**, a BIA for whale shark foraging occurs within the operational area.

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

6.1.2.4 Seabirds

Five bird breeding BIAs overlap the operational area (Australian fairy tern, roseate tern, wedge-tailed shearwater, white-tailed tropicbird and lesser crested tern). Noise emitted by the bird-deterrent device aims to have a behavioural impact on birds to prevent them breeding and nesting on the John Brookes WHP. Encouraging them to stay away protects birds from helicopter strike and makes the WHP safe for helicopters to land on and take-off from. If the regular but intermittent use of the bird-deterrent system does not deter birds from using the WHP, 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 Outcomes and Control Measures

EPOs relating to this event include:

+ No injury or mortality to EPBC Act and WA Biodiversity Conservation Act 2016 listed marine fauna during operational activities (EPO-VI-CW-01).

The control measures considered for this event are outlined in **Table 6-2**, and the environmental performance standards and measurement criteria for the EPOs are described in **Table 8-2.**

Table 6-2: Control Measure Evaluation for Acoustic Disturbance

Control Measure Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
Standard Controls				
VI-CW-CM-01	Procedure for interacting with marine fauna.	Reduces risk of physical and behavioural impacts to marine fauna from vessels and helicopters because if marine fauna are sighted, then vessels can slow down or move away.	Operational costs to adhere to marine fauna interaction restrictions, such as vessel 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.
Additional Controls				
N/A	Dedicated Marine Fauna Observer on vessels.	Improved ability to spot and identify marine fauna at risk of impact by vessel noise.	Additional cost of contracting several specialist Marine Fauna Observers while the risk to all listed marine fauna cannot be reduced due to variability in timing of environmentally sensitive periods and unpredictable presence of some species.	**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 are disproportionate to increase in environmental benefit.
N/A	Elimination or reduction of number or size of vessels.	Potential reduction in impact of noise to some sensitive receptors.	Elimination of support vessels from the field would not achieve	**Rejected** – Cost disproportionate to increase in environmental benefit.

Control Measure Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
			Santos's legal requirements for petroleum production or work-plan objectives for oil and gas production and may compromise safety standards to 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 risk of bird strike would create safety issues. Would also require mobilisation of personnel via vessel to the WHP to clean the decks, introducing safety risks to personnel due to climbing the WHP and inhalation of 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

The impacts and consequence ranking of planned noise emissions are outlined in **Table 6-3**.

Table 6-3: Impacts and Consequence Ranking – Acoustic Disturbance

Receptor	Consequence Level
Acoustic Disturbance	
Threatened or migratory 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 that 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 I - Negligible.
Physical environment or habitat	Not applicable – Habitats within the operational area consist of non-coral invertebrates (such as sea fans and gorgonians), which are not impacted by noise emissions. No decrease in local population size or in the area of occupancy of species and no loss or disruption to habitat critical to the survival of a species, disruption to the breeding cycle or introduction of disease is expected.
Threatened ecological communities	Not applicable – No threatened ecological communities identified in the area over which noise emissions are expected.
Protected areas	Not applicable – Noise levels are not expected to impact on habitats or species at a population or community level. Therefore, no significant impacts to Protected Areas, such as the Montebello Marine Park (Multiple Use Zone - IUCN Category VI), are expected.
Socio-economic receptors	Not applicable –Noise levels are not expected to impact on fish communities; therefore, indirect impacts to fisheries are not considered. There are no recreation zones within the area expected to be impacted by noise. The nearest recreation zones are sheltered within the islands of the Montebello Islands State Marine Park (7.5 km from the operational area).
Overall worst-case consequence	I - Negligible

6.1.5 Demonstration of ALARP

The use of support vessels is unavoidable if the operational activities are to proceed as required on a 24 hours a day, 365 days a year basis. Equipment maintenance will keep the vessel noise levels to within normal operating limits, which will also aid in reducing the likelihood of noise impacts to sensitive receptors. A bird-deterrent device for John Brookes WHP is needed for critical safety reasons as outlined in **Section 2.6.3**. The deterrent device is required to be used regularly (such as daily) but intermittently and for a short duration to deter birds from nesting and/or roosting on the WHP.

The use of helicopters as an alternative means to transfer personnel to and from the John Brookes WHP is necessary to allow operational activities to occur safely and effectively, with the ability to maximise the daylight hours, and to provide for a rapid method of transferring to and from the WHP in the case of an emergency situation. Allowing birds to nest in or on the WHP and create guano contamination on the helideck because there is no deterrent or the introduction of a performance standard prohibiting helicopters from landing or taking-off in the presence of marine megafauna would introduce an unacceptable risk to human life.

Management controls are in place to reduce operating noise, including vessel and helicopter operational protocols, through adherence to the Santos's 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 to or collision with EPBC Act– listed marine fauna. Santos has considered the actions prescribed in the Recovery Plan for Marine Turtles in Australia (DoEE, 2017) when developing these controls to minimise noise impacts on marine turtles.

Thus, noise emitted during operational activities is not expected to significantly impact on marine fauna within the receiving environment. There are no additional controls that would further reduce the impact from noise associated with the operational activities without gross disproportionality; therefore, it is considered ALARP.

6.1.6 Acceptability Evaluation

Is the consequence ranked as A or B?	Yes – maximum consequence from acoustic disturbance is I (Negligible).
Is further information required in the consequence assessment?	No – potential impacts and risks are well understood through the information available.
Are the risks and impacts consistent with the principles of ecological sustainable development?	Yes – activity evaluated in accordance with Santos'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**). Management consistent with EPBC Regulations Part 8. Controls implemented will minimise the potential impacts from the activity to species identified in recovery plans and conservation advices 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 the Recovery Plan for Marine Turtles in Australia (DoEE, 2017), Approved Conservation Advice for *Megaptera novaeangliae* (humpback whale) (TSSC, 2015d), Blue Whale Conservation Management Plan 2015 – 2025 (DoE, 2015c), Approved Conservation Advice for *Rhincodon typus* (whale shark) (TSSC, 2015a), and relevant recovery plans and conservation advices for birds.
Are risks and impacts consistent with Santos's Environmental Management Policy?	Yes – aligns with Santos'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'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	During the operational life of the activity, the physical presence of the John Brookes WHP and the supporting vessel and helicopter use will generate light emissions that may impact marine fauna and seabirds. A minimum level of lighting is required for safety and navigational purposes on the John Brookes WHP and on support vessels (as is the intermittent use of a bird-deterrent device with a light-emitting component to provide safe landing conditions on the WHP). Routine operational activities using support vessels (i.e., transfer of personnel to and from the John Brookes WHP) is the most frequent vessel activity. Crew transfers to and from the WHP on support vessels are typically conducted weekly to fortnightly and only during daylight hours for safety reasons. However, lighting will be required for operational, safety and navigational purposes during planned but not routine night operations. Operational lighting may include spot lighting on an as-needed basis (e.g., in-sea ROV inspection, deployment and retrieval). Lighting will typically consist of bright white (i.e., metal halide, halogen, or fluorescent) lights. The installation of temporary lighting (additional lighting) will be required for activities associated with connection of a new Spartan flowline and umbilicals to the John Brookes WHP. The lighting will remain in place for a period of 12 months from late 2021, and will be turned on during two installation campaigns which will each last approximately 2-3 weeks, resulting in greater than normal light emissions during these periods.
Extent	Localised: No lighting directed onto water. Limited light ‘spill’ or ‘glow’ onto waters surrounding facilities from John Brookes WHP or support vessels.
Duration	Artificial lighting is required 24 hours a day on the John Brookes WHP. Lighting may also be required 24 hours a day on support vessels if undertaking non-routine operational activities during night time periods. Temporary lighting associated with the connection of the Spartan infrastructure to the John Brookes WHP will be turned on during two installation campaigns which will each last approximately 2-3 weeks.

6.2.2 Nature and Scale of Environmental Impacts

Continuous lighting in the same location for an extended period of time may result in alterations to fauna behaviour, as discussed below for each fauna group. The combinations of colour, intensity, closeness, direction and persistence of a light source are key factors in determining the magnitude of environmental impact (EPA, 2010).

<u>Potential receptors: Threatened or migratory fauna (marine mammals, marine turtles, sharks, fish and rays, and seabirds).</u>

Marine mammals

As described in **Table 3-6**, BIAs overlap the operational area for humpback whales (migration) and blue whales (migration and distribution) and are likely to be present in the operational area in increased numbers during migration windows. However, cetaceans and other marine mammals are not known to be significantly attracted to light sources at sea; therefore, disturbances to behaviour are unlikely to occur.

Marine turtles

The Recovery Plan for Marine Turtles in Australia: 2017-2027 (DoEE, 2017) highlights artificial light as a threat 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;
+ Disrupting hatchling orientation and sea-finding behaviour; and
+ Creating pools of light that attract swimming hatchlings and increase their risk of predation.

The most significant risk posed to marine turtles from artificial lighting is the potential disorientation of hatchlings following their emergence from nests by light spill on beaches, although breeding adult turtles can also be disoriented (Longcore & Rich, 2016, in EPA, 2010). 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).

As described in **Table 3-6**, BIAs for marine turtles occur within the operational area, including the loggerhead turtle (internesting) and the green, flatback and hawksbill turtles (internesting and critical nesting habitat).These internesting areas are an area around Barrow Island, located approximately 5 km from the operational area. 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).

Due to overlap with the BIAs, it is likely that marine turtles will be encountered in the operational area during the nesting and internesting seasons presented in **Table 3-10**. Given the operational area is located approximately 5 km away from the nearest turtle nesting beaches (Barrow Island), impacts to turtles from operational activity lighting are expected to be restricted to localised attraction and temporary disorientation but with no long-term or residual impact.

Sharks, fish and rays

Fish at the surface of the water have the potential to be impacted by artificial light. Sharks and rays are not known to be significantly attracted to light sources at sea, and therefore disturbances to behaviour are unlikely to occur.

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 low level of light emitted from vessels is unlikely to lead to large-scale changes in species abundance or distribution. Impacts to transient fish from vessels will therefore be limited to short-term behavioural effects with no decrease in local population size or in the area of occupancy of species and no loss or disruption of habitat critical to the survival of a species or disruption to the breeding cycle. Overall, a localised increase in fish activity as a result of WHP and vessel lighting is expected to occur.

Seabirds

Seabirds have been shown to be attracted to artificial light sources. Studies conducted between 1992 and 2002 in the North Sea confirmed that artificial light was the reason that birds were attracted to and accumulated around illuminated offshore infrastructure (Marquenie *et al*., 2008). The light sources associated with the vessels may also provide enhanced capability for seabirds to forage at night. Support vessels will not be stationary or in the operational area for long periods of time and so are unlikely to attract large numbers of seabirds to one fixed location. While the bird-deterrent acoustic device (**Section 2.6.3**) may also include a light component, this is only used intermittently to ensure safe landing and take-off conditions on the WHP by deterring birds from nesting or depositing guano on the WHP surface.

Impacts to transient seabirds from vessels will therefore be limited to short-term behavioural effects with no decrease in local population size or in the area of occupancy of species and no loss or disruption of habitat critical to the survival of a species or disruption to the breeding cycle.

6.2.3 Environmental Performance Outcomes and Control Measures

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

+ Reduce impacts to marine fauna from lighting on the WHP and support vessels through limiting lighting to that required by safety and navigational lighting requirements. [EPO-VI-CW-02].

The control measures considered for this event are outlined in **Table 6-4**, and the environmental performance standards and measurement criteria for the EPOs are described in **Table 8-2.**

Table 6-4 Control Measure Evaluation for Light Emissions

Control Measure Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
Standard Controls				
VI-CW-CM-02	Lighting will be used only as required for safe work conditions and navigational purposes	Light spill from unnecessary lighting reduced, even further lowering likelihood of impacts to the environment	Additional costs associated with implementing control.	**Accepted –** Cost is considered acceptable for the benefit that may be realised from this control
VI-CW-CM-03	Premobilisation review and planning of lighting on support vessels and the WHP is undertaken prior to activities commencing	Lighting is assessed to only provide necessary lighting for safety and navigation during the activity, Reducing the potential for additional light pollution to the environment.	Additional costs associated with implementing control.	**Accepted –** Cost is considered appropriate for the benefit that may be realised from this control.
Additional Controls				
N/A	Review lighting to a type (colour) that has less impact.	Could reduce potential impacts of artificial light on certain fauna	High cost to complete lighting change out on all vessels in area of low sensitivity. Navigational lighting colours are stipulated by law.	**Rejected** – Cost outweighs the benefit.
N/A	Limit or exclude night-time operations.	Would eliminate potential impacts of artificial light during hours of darkness when light sources are more apparent and potential	Would double duration of activity; increase impacts or potential impacts in other areas, including increase in waste, air emissions, risk of vessel collision;	**Rejected** – Given the minimal risk of impacts to EPBC Act listed marine species (e.g. turtles) occurring due to lighting, the

		impacts are greatest.	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.	financial and environmental costs incurred by requiring all works to be undertaken during daylight hours only (therefore disrupting operational activities) is unfeasible. Delay to IMMR works to daylight hours only could also pose a safety risk for any safety critical work which is unacceptable. 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 doesn’t 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 of restricting helicopter use to only daylight hours (thereby disrupting emergency response abilities) is unfeasible.

6.2.4 Environmental Impact Assessment

The impacts and consequence ranking of planned light emissions are outlined in **Table 6-5.**

Table 6-5: Impacts and consequence ranking – light emissions

Receptor	Consequence Level
Light emissions	
Threatened or migratory fauna	Artificial lighting may result in behavioural changes to fauna, particularly marine turtles and seabirds. Impacts to marine fauna are expected to be restricted to localised attraction and temporary disorientation but with no long-term or residual impact and are therefore assessed as negligible (I).
Physical environment or habitat	Not applicable – No physical environments or habitats identified in the area over which light emissions are expected other than open water.
Threatened ecological communities	Not applicable – No threatened ecological communities identified in the area over which light emissions are expected.
Protected areas	Not applicable – The operational area intersects the Montebello Marine Park (Multiple Use Zone - IUCN Category VI). The values of the marine park, with respect to the presence of light-sensitive marine fauna, are described against threatened or migratory fauna.
Socio-economic receptors	Not applicable – Lighting is not expected to cause an impact to socio-economic receptors other than to act as a visual cue for avoidance of the area by other marine users for safety purposes.
Overall worst-case consequence	I - Negligible

6.2.5 Demonstration of ALARP

There are no safe alternatives to the use of artificial lighting on the John Brookes WHP and support vessels. Artificial lighting is required 24 hours a day for navigational safety in the area, and additional light is required to allow operational activities to proceed safely 24 hours a day for occupational health and safety reasons.

A lighting-emitting bird-deterrent device for John Brookes WHP is also required for critical safety reasons as outlined in **Section 2.6.3**. 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 WHP. If the system doesn’t deter birds from using the WHP, then it will also be used prior to helicopter take-off and landing to minimise the risk of bird strike and to provide safe conditions for take-off and landing manoeuvres.

The use of helicopters as an alternative means to transfer personnel to and from the John Brookes WHP is necessary to allow operational activities to occur safely and effectively, with the ability to maximise the daylight hours, and to provide a rapid method of transferring to and from the WHP in the case of an emergency situation. Allowing birds to nest in or on the WHP and create guano contamination on the helideck because there is no deterrent or introducing a performance standard prohibiting helicopters from landing or taking-off in the presence of birds on the WHP would introduce an unacceptable risk to human life.

The impacts of lighting to the receiving environment are well understood, and the consequence is expected to be negligible and cannot be reduced further. Additional controls were identified and considered but rejected, as detailed in **Section 6.2.3.** Therefore, the use of 24-hour per day artificial lighting at an intensity to allow work to proceed is considered ALARP.

6.2.6 Acceptability Evaluation

Is the consequence ranked as A or B?	Yes – maximum consequence from light emissions is I (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 ecological sustainable development?	Yes – activity evaluated in accordance with Santos'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 Navigation Act 2012, Recovery Plan for Marine Turtles in Australia (DoEE, 2017) and relevant recovery plans and conservation advices for birds.
Are risks and impacts consistent with Santos's Environmental Management Policy?	Yes – aligns with Santos'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 on the 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).

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 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	Gaseous greenhouse gas (GHG) emissions, such as carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O), along with non-GHG emissions, such as sulphur oxides (SO_X) and nitrogen oxides (NO_X)), are discharged to the atmosphere during continued operations of the John Brookes, Spartan and Greater East Spar facilities, contributing to a localised reduction in air quality.
	Atmospheric emissions from John Brookes and Greater East Spar operations are derived from:
	+ Hydrocarbon combustion by-products from the operation of power-generating equipment (such as crane engine, microturbines, diesel generator set) or temporary equipment on the WHP support vessels and helicopters;
	+ Venting of:
	  + Volatile organic compounds (VOCs) (primarily CH_4) from drain systems on the WHP and fugitive emissions from flexible flowlines, relief valves and sumps and also their actuation;
	  + Pigging operations, process equipment maintenance, 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.

6.3.2 Nature and Scale of Environmental Impacts

<u>Potential receptors: Physical environment (air quality).</u>

Air quality

Hydrocarbon combustion may result in a temporary, localised reduction of air quality in the environment immediately surrounding the discharge point during the activity. Non-GHG emissions, such as NO_X and SO_X, can lead to a reduction in local air quality. GHG emissions are recognised to also contribute to the greenhouse gas emissions loading globally.

Accidental release and fugitive emissions of ozone-depleting substances have the potential to contribute to ozone layer depletion. Maintenance of refrigeration systems containing ozone-depleting substances is on a routine but infrequent basis; and with controls implemented, the likelihood of an accidental ozone-depleting substance release of material volume is considered rare.

As Santos's operations occur in open-ocean offshore waters, the combustion of fuels and incineration in such remote locations will not impact on air quality in coastal towns. The quantities of gaseous emissions are relatively small and will quickly dissipate into the surrounding atmosphere.

VOCs can be harmful to human health and also to the environment, as they can be toxic; however, this is generally relevant to 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 rapidly disperse 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 during 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 Outcomes and Control Measures

EPOs relating to this event include:

+ Reduce impacts to air and water quality from planned discharges and emissions from operational activities (EPO-VI-CW-03).

The control measures for this event are shown in **Table 6-6,** and the environmental performance standards and measurement criteria for the EPOs are described in **Table 8-2**.

Table 6-6: Control Measure Evaluation for Atmospheric Emissions

Control Measure Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
Standard Controls				
VI-CW-CM-04	Facilities planned maintenance system.	Reduces emissions from the John Brookes 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 will help control emissions created by equipment.
VI-CW-CM-05	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 will help control emissions created by equipment.
VI-CW-CM-06	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.
VI-CW-CM-07	International Air pollution prevention certificate.	Reduces probability of potential impacts to air quality due to ozone-depleting	Personnel cost of ensuring vessel has current international air pollution prevention certificate	**Adopted** – Benefit of ensuring vessel is compliant outweighs the minimal costs and it

Control Measure Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
		substance emissions, high NO_X, SO_X and incineration emissions.	during vessel contracting procedure and in premobilisation audits or inspections.	is a legislated requirement.
VI-CW-CM-08	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 costs.
VI-CW-CM-09	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 associated with transporting waste to shore for landfill.
Additional Controls				
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 or incineration outweighs onboard incineration
N/A	Removal of all ozone-depleting substance–containing equipment.	Eliminates potential of ozone-depleting substance emissions occurring, impacting on air quality.	Lack of refrigeration systems on board the vessels would lead to unacceptable workplace conditions (i.e., air conditioning) and poor food hygiene standards, limiting the vessel's ability to undertake the activity; therefore, there is no practical solution to the use of	**Rejected** – Based on cost to replace all equipment and there is only a low potential for ozone-depleting substance releases.

Control Measure Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
			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.	Practical 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 specifications 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).

6.3.4 Environmental Impact Assessment

The impacts and consequence ranking for atmospheric emissions are outlined in **Table 6-7**.

Table 6-7: Impacts and Consequence Ranking – Atmospheric Emissions

Receptor	Consequence Level
Air emissions	
Threatened or migratory fauna	Not applicable – Gaseous emissions are relatively small, will quickly dissipate into the surrounding atmosphere, and are not considered to be a potential source of impact for threatened or migratory fauna.
Physical environment or habitat	As Santos's operational activities occur in the open ocean and offshore waters, the combustion of fuels in such remote locations will not impact on air quality in coastal towns. 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 vessels or

Receptor	Consequence Level
	WHP. The consequence level is therefore assessed as Negligible (I).
Threatened ecological communities	Not applicable – No threatened ecological communities present.
Protected areas	Not applicable – Gaseous emissions are relatively small, will quickly dissipate into the surrounding atmosphere, and are not considered to be a potential source of impact for protected areas.
Socio-economic receptors	Not applicable – Gaseous emissions are relatively small, will quickly dissipate into the surrounding atmosphere, and are not considered to be a potential source of impact for socio-economic receptors.
Worst-case consequence level	I - Negligible

6.3.5 Demonstration of ALARP

Power generation through combustion of fossil fuels is essential to undertaking the operational activities either by vessel, power generation or helicopters. Given the routine maintenance of these systems by suitably qualified personnel, all practicable management measures are considered to have been implemented and the likelihood of significant impacts occurring has been reduced to ALARP.

6.3.6 Acceptability Evaluation

Is the consequence ranked as A or B?	Yes – maximum consequence from atmospheric emissions is I (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 ecological sustainable development?	Yes – activity evaluated in accordance with Santos'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 – pursuant to Marine Order 97 (Marine pollution prevention – air pollution), which gives effect under Australian law to MARPOL Annex VI.
Are risks and impacts consistent with Santos's Environmental Management Policy?	Yes – aligns with Santos'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 (I) 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 the John Brookes, Spartan and GES operational activities are provided in **Section 2**. Potential seabed disturbance (temporary) may occur in the operational area due to disturbance to seabed from activities such as: + Vessel anchoring (non-routine); + Cleaning of subsea infrastructure; + Sedimentation as infrastructure is placed or relocated on the seabed; + 'Wet parking' of equipment (e.g., ROV basket or clump weight); + Subsea IMMR activities (e.g., diving; AUV survey activities; ROV operations; cutting; welding; pigging; installation, replacement or modification of subsea equipment; free span rectification and stabilisation); + 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 operational life of the activity.

6.4.2 Nature and Scale of Environmental Impacts

<u>Potential receptors: Physical environment (water quality, benthic habitats, shoals and banks, offshore reefs and islands), threatened or migratory fauna (marine reptiles, sharks, fish and rays), protected and significant areas (marine parks).</u>

Operational activities may disturb seabed and benthic habitat through the following impacts:

+ Direct physical disturbance of benthic and seabed habitat, including benthic fauna, by infrastructure;
+ Indirect disturbance to benthic habitats and associated marine fauna by sedimentation;
+ Increased turbidity of the near-seabed water column; and
+ Introduction of artificial habitat for benthic fauna colonisation.

Sensitive receptors identified in the operational area potentially impacted by operational activities include:

+ Soft sediments and benthic fauna;
+ Ancient coastline at 125 m depth contour; and
+ Threatened or migratory fauna habitat.

Physical environment

The installation and placement of offshore infrastructure and equipment will directly contact the seafloor and will inevitably result in localised impact (direct and indirect) to water quality, seabed features and the benthic environment in the operational area.

The operational area does not contain any significant or unique areas of benthic habitat. As described in **Section 3.2.2,** the benthic habitats within the operational area are primarily soft sediments devoid of sensitive benthic habitats and densely bioturbated (less than 75%), epibenthic biota is sparse (less than 5%) and includes invertebrates, such as anemones, sponges and sea urchins . This benthic habitat is widely represented at a regional scale on the North West Shelf (RPS, 2010).

Indirect impacts associated with a temporary (several hours) and localised (within tens of metres) decline in water quality due to increased suspended sediments or sedimentation of the seabed are not expected to affect any key values and sensitivities of regional importance. There are no nearby sensitive benthic habitats to be significantly impacted by localised impacts within the operational area.

Threatened or migratory fauna

Habitat modification is identified as a potential threat to a number of marine fauna species in relevant recovery plans and conservation advices (**Table 3-7**). Disturbance of the seabed is not anticipated to significantly affect mobile marine fauna, such as marine mammals, marine reptiles, fish, sharks and rays. The area of seabed to be disturbed within the operational area also represents a very small portion of the habitat available for these species. No decrease in local population size or in the area of occupancy of species and no loss or disruption of habitat critical to the survival of a species or disruption to the breeding cycle of any of these protected matters is expected.

BIAs for marine turtles occur within the operational area, including the loggerhead turtle (internesting) and the green, flatback and hawksbill turtles (internesting and critical nesting habitat) (**Table 3-6**). However, internesting activities typically occur within shallower waters than those in the operational area (as discussed in **Section 6.1.2**) (Whittock *et al*., 2016; Pendoley, 2017). If a marine turtle was displaced from the area of seabed and benthic habitat disturbance, widespread internesting habitat is available in the immediate vicinity that marine turtles could continue to use within the identified habitat critical to the survival of the species, and BIAs.

Fish, sharks and rays may also forage in the soft sediments for marine invertebrates; however, given the small scale of the activity and the regionally availability of habitat, seabed and benthic habitat disturbance is not expected to affect these species.

Protected and significant areas

The operational area intersects the Montebello Marine Park (Multiple Use Zone - IUCN Category VI); therefore, seabed and benthic habitat disturbance may occur within the marine park. The conservation values of the marine park (as described in **Section 3.2.3**) that will be directly impacted include:

+ Foraging areas for marine turtles that are adjacent to important nesting sites; and
+ Seafloor habitats and communities of the Northwest Shelf Province provincial bioregion, as well as the Pilbara (offshore) meso-scale bioregion.

Impacts to these values from seabed disturbance are discussed above, are localised and are not expected to significantly impact the conservation values of the Montebello Marine Park.

6.4.3 Environmental Performance Outcomes and Control Measures

EPOs relating to this event include:

+ Seabed disturbance is limited to the operational area (EPO-VI-CW-04).

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

Table 6-8: Control Measure Evaluation for Seabed and Benthic Habitat Disturbance

Control Measure Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
Standard Controls				
VI-CW-CM-05	Vessels planned maintenance system.	Reduces likelihood of dropped objects because lifting equipment is operating within its parameters.	Operational costs and labour or access requirements of undertaking equipment maintenance on vessels.	**Adopted –** Benefits of operating equipment within operational parameters will help reduce the likelihood of dropped objects.
VI-CW-CM-10	Planned subsea and offshore maintenance.	Reduces likelihood of dropped objects because lifting equipment is operating within its parameters.	Operational costs and labour or access requirements of undertaking equipment maintenance on vessels.	**Adopted –** Benefits of operating equipment within operational parameters will help reduce the likelihood of dropped objects.
VI-CW-CM-11	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.
Additional Controls				
VI-CW-CM-12	Dropped object recovery.	Requires dropped objects to be recovered (where safe and practicable to do so).	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 outweigh the costs.
VI-CW-CM-13	Anchoring and equipment deployment management.	Requires using existing moorings or Santos–approved anchor locations within operational area, except in case of an emergency,	No additional costs to Santos other than negligible personnel costs of reviewing information in	**Adopted –** Benefits of using existing moorings prevent further disturbance.

Control Measure Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
		to prevent further seabed disturbance.	an emergency situation.	
N/A	Cessation of operations until all dropped objects are located or 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.	Would introduce increased risks for divers or equipment in the water during activities such as diver inspections or maintenance activities.	**Rejected** – Increased (transferred) risk disproportionate to environmental benefit.

6.4.4 Environmental Impact Assessment

The impacts and consequence ranking for seabed and benthic habitat disturbance are outlined in **Table 6-9**.

Table 6-9: Impacts and Consequence Ranking – Seabed and Benthic Habitat Disturbance

Receptor	Consequence Level
Seabed disturbance	
Threatened or migratory fauna	Given the small scale of the activity, minor and short-term nature of indirect impacts and the regional availability of the habitats present, seabed and benthic habitat disturbance is not expected to impact threatened or migratory species at a population level. The consequence level is therefore assessed as negligible (I).
Physical environment or habitat	Impacts from seabed disturbance are expected to be localised, and indirect impacts may result in short-term increases in turbidity in the immediate vicinity. Given that the nature of the habitats within the operational areas are representative of those within the region and the localised nature of any

Receptor	Consequence Level
	disturbance, impacts to the physical environment or habitat are assessed as negligible (I).
Threatened ecological communities	Not applicable – No threatened ecological communities are identified in the area where seabed disturbance could occur.
Protected areas	The operational area intersects the Montebello Marine Park (Multiple Use Zone - IUCN Category VI). The relevant values of the marine park are not anticipated to be significantly affected by seabed distance activities, and therefore the consequence has been assessed as negligible (I).
Socio-economic receptors	Not applicable – Disturbance of the seabed and benthic habitat within the operational area is highly unlikely to impact socio-economic receptors such as shipping and tourism. Any minor alteration or modification to habitats is not expected to impact commercial fisheries' target species based on the small size of disturbance relative to the available fishing grounds. No stakeholder concerns have been raised regarding this aspect.
Worst-case consequence level	I - Negligible

6.4.5 Demonstration of ALARP

Operation, inspection, maintenance, monitoring and repair of John Brookes, Spartan and Greater East Spar facilities are unavoidable. There are no additional practicable alternatives to proceed in a successful and safe manner to reduce seabed disturbance associated with the operational activities. Management controls and installation procedures are designed to further limit the extent of direct seabed disturbance. Additionally, adherence to the materials handling, lifting and transfer procedures results in the likelihood of dropped objects to seabed being minimised.

Impacts will be localised as they will be within the operational area. Dedicated vessel moorings off the John Brooks WHP help minimise the requirement for additional vessel seabed anchoring. The placement of equipment as part of IMMR activities will leave indentations on the seabed and cause a temporary increase in water column turbidity, but this will be limited to the top layer of sediment. The benthic habitat would be expected to recolonise within weeks to months following the completion of the installation, which will create artificial benthic habitat that, over time, is likely to be utilised by marine species.

Given the lack of sensitive receptors within the operational area and the expected rapid recovery time, minor environmental impacts are expected (I – Negligible). Potentially impacted benthic habitats, including soft sediments, are widespread and common throughout the region.

The proposed management controls for seabed disturbance are in accordance with the Santos risk management criteria and are considered appropriate to manage the 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 I (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 ecological sustainable development?	Yes – activity evaluated in accordance with Santos's Environmental Hazard Identification and Assessment Procedure which considers principles of environmentally 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)?	N/A – no relevant requirements regarding this event in this area, given the localised nature and extent of the operational facilities. IUCN principles of nearby reserves (Montebello Marine Park) (Multiple Use Zone – IUCN Category VI) are met (**Table 3-4**).
Are risks and impacts consistent with Santos's Environmental Management Policy?	Yes – aligns with Santos'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 consequence of seabed disturbance on receptors is assessed as negligible (I). With the control measures in place, including compliance with industry standards and legislation, no significant impacts are expected. Therefore, 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 may occur through undertaking operational activities. Support vessels will be regularly transiting the area and, at times of maintenance, inspection, monitoring 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. The presence of vessels and marine infrastructure could pose a collision or snagging risk and inconvenience to fishing practices during these operations, although the WHP, subsea wells and pipelines are charted (see **Section 6.5.3**).
Extent	Localised: Within the operational area.
Duration	Temporary and intermittent interaction with vessels when they are transiting the operational area. Permanent exclusion of other marine users within the 500-m petroleum safety zone (under Section 6 of the OPGGS Act) of the John Brookes WHP for the operational life of the field.

6.5.2 Nature and Scale of Environmental Impacts

Potential receptors: Protected and significant areas (marine parks), socio-economic receptors (fisheries, tourism, shipping traffic and other oil and gas activities).

Commercial and traditional fisheries

Commonwealth and State fisheries that overlap the operational area are described in **Section 3.2.5**. Potential impacts to commercial fisheries include temporary loss of fishing area, target fish species being attracted to the offshore facilities away from fishing areas through lighting or artificial habitat, and damage to fishing equipment that may snag on subsea infrastructure. These impacts could potentially result in reduced catches and associated income.

An analysis of the current fishery closures, depth range of activity, historical fishing effort data, fishing methods and consultation feedback (refer to **Section 4**) has revealed that there is a low potential for interaction with commercial fisheries. None of the Commonwealth fisheries identified in **Section 3.2.5** are likely to be active in the operational area.

For State-managed fisheries, the Mackerel Managed Fishery, Pilbara Trap Managed Fishery and the Pilbara Line Fishery of the Pilbara Demersal Scalefish Fishery may access the operational area. The benthic habitat within the operational area is primarily soft sediments (**Section 3.2.2**), which provide little habitat for the target species of State-managed fisheries occurring in the area. It is possible that demersal fishes may be attracted to subsea infrastructure, while some attraction of pelagic fishes is likely to occur around the John Brookes WHP. However, it is unlikely that the presence of the infrastructure would attract fish away from fishing areas to the extent that fishery-level impacts would be felt. Natural variability in fish stocks and fishing conditions is likely to be on a much greater scale than any impacts that could be associated with the planned operational activities.

As described in **Table 3-8**, indigenous marine users or subsistence or traditional fishers could occur in the operational area. However, there are no recorded seabed Aboriginal sites in the waters of the Montebello Islands and Barrow Island reserves (DEC, 2007), and no interactions with traditional fishers has been recorded during previous activities in the operational area.

Tourism and recreation

Tourism activities, such as snorkelling, diving, surfing and recreational fishing, may occur around the Montebello Islands but are not expected to occur in the operational area, given the water depth (45 m to 100 m), lack of seafloor features and distance from shore.

Recreational fishing practices are typically observed near or around shoal, bank, reef and islands features in the region. Consequently, these practices are generally expected to be geographically separate from the planned project activities that occur within the operational area.

Shipping traffic and other oil and gas activities

There are no recognised shipping routes in or near the operational area, with the nearest designated shipping routes located on the eastern side of Barrow Island **(Figure 3-20**). However, analysis of historical Australian Ship Reporting System shipping data indicates that commercial vessels do use the general area, most likely vessels in the oil and gas industry. Should commercial vessels need to deviate from planned routes to avoid operational vessels, this may slightly increase transit times and fuel consumption. As the operational area is in open waters with no grounding or navigational hazards, it is not likely that any such deviation would increase the potential for vessel collision or grounding. In addition, no concerns have been raised by the shipping industry in the past five years relating to disturbance to shipping routes as a result of activities within the VI Hub operational area.

Protected and significant areas

The operational area intersects the Montebello Marine Park (Multiple Use Zone - IUCN Category VI). Other marine users within the Montebello Marine Park include tourists and recreational visitors, commercial fishers, and other oil and gas operators. These marine users are important socio-economic values for the marine park.

These socio-economic values of the marine park are discussed in the sections above. Activities associated with the operation of the VI Hub are not expected to significantly impact the socio-economic values of the Montebello Marine Park.

6.5.3 Environmental Performance Outcomes and Control Measures

The EPO relating to this event includes:

+ Reduce impacts on other marine users through the provision of information to relevant stakeholders such that they are able to plan for their activities and avoid unexpected interference.

The control measures for this event are shown in **Table 6-10,** and environmental performance standards and measurement criteria for the EPOs are described in **Table 8-2.**

Table 6-10: Control Measure Evaluation for Interaction with Other Marine Users

Control Measure Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
Standard Controls				
VI-CW-CM-14	WHP petroleum safety zone	Petroleum safety zone applies around the John Brookes WHP and is shown on Australian nautical charts.	No additional costs to Santos. Other marine users may be temporarily excluded from areas, disrupting their activities.	**Adopted** – Risk of excluding other marine users within a 500-m radius of the John Brookes WHP is unlikely to significantly impact upon the marine user. The benefits to safety of the activity (thus reducing risk of environmental impacts due to vessel collisions) outweigh potential costs.
VI-CW-CM-16	Navigational charting of infrastructure.	Offshore facilities and subsea infrastructure is charted on Australian Hydrographic Service nautical charts.	No additional costs to Santos. Other marine users may be temporarily excluded from areas, disrupting their activities.	**Adopted** – The positive benefits of identifying subsea infrastructure to other marine users outweigh the process of arranging their charting with Australian Hydrographic Service.

Control Measure Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
VI-CW-CM-17	Navigation lighting and aids.	Reduces risk of environmental impact from vessel collisions due to ensuring safety requirements are fulfilled.	Negligible costs of operating navigational equipment.	**Adopted** –The safety benefits (and thus environmental benefits) outweigh the cost.
VI-CW-CM-18	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.
VI-CW-CM-19	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.
VI-CW-CM-20	Stakeholder consultation.	Santos 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 negligible costs to Santos.
Additional Controls				
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 when operational activities are required all year round. The area that stakeholders 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	**Rejected** – Stakeholders in the area all year round.

Control Measure Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
			through consultation.	
VI-CW-CM-15	Notify AHO and AMSA's JRCC prior to commencement of vessel based IMMR at Rosella-1.	Whilst not a legal requirement the notification provides a mechanism to notify other marine users that an IMMR vessel will be present around Rosella-1.	Time and minimal cost associated with preparing the notifications.	**Adopted –** Benefits considered to outweigh the costs in lieu of no PSZ and given Rosella-1 relative isolation from the cluster of other operational infrastructure.
NA	Notify AHO and AMSA's JRCC prior to commencement of vessel based IMMR at all subsea wells with no PSZ.	Whilst not a legal requirement the notification provides a mechanism to notify other marine users that an IMMR vessel will be present around subsea wells with no petroleum safety zone so that they can avoid the area.	Not practicable when there are multiple trips required, which can be adhoc (not routine). All subsea wells are marked on nautical charts. Even if a PSZ is present, there isn't the ability to ensure a vessel doesn't enter the zone because the zones are subsea.	**Reject –** control unable to be practically implemented for all subsea wells.
N/A	Rock dump of pipeline to protect from external impacts (overtrawl)	Rock dump of pipeline will reduce the risk of dropped objects impact.	Large cost and seabed disturbance associated with rock dump. Burying the infrastructure also causes technical inspection and maintenance activity issues.	**Rejected –** Large cost associated with rock dump disproportionate compared to risk. May also cause operational issues in relation to access for IMMR activities.
N/A	Establish a PSZ around subsea wells that don't currently have a PSZ	Discretionary tool available under S616 of the OPGGS Act as an administrative control preventing interactions between other marine	Impractical to in force as there are no practical ways of remotely monitoring a PSZ.	**Rejected –** control unable to be practically implemented for subsea wells.

Control Measure Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
		users and the subsea wells through the imposition of a 500 m exclusion zone around the subsea well.	Consultation to date. Adding additional PSZ's creates further exclusion zones impacting on fisheries.	

6.5.4 Environmental Impact Assessment

The impacts and consequence ranking for interactions with other marine users are outlined in **Table 6-11**.

Table 6-11: Impacts and Consequence Ranking – Interaction with Other Marine Users

Receptor	Consequence Level
Interaction with other marine users	
Threatened or migratory fauna	Not applicable – related to socio-economic receptors only.
Physical environment or habitat	
Threatened ecological communities	
Protected areas	Commercial tourism, commercial fishing, mining and recreation are important socio-economic conservation values for the Montebello Marine Park. The values of the marine park that would be impacted by interaction with other marine users are described below and are assessed as negligible (I).
Socio-economic receptors	The impact of the VI Hub operations on socio-economic receptors are considered to be negligible (I) due to the fact that: + The operational area is not extensively fished – commercially, traditionally or recreationally – due to a lack of seafloor features. Any behavioural impacts to demersal and pelagic fishes are not considered significant due to the small scale of the infrastructure and the abundance of alternative fishing grounds; + Tourism activities may occur around the Montebello Islands but are not expected to occur in the operational area, given the water depth (45 m to 100 m), lack of seafloor features and distance from shore; and + Stakeholder consultation and a review of recent shipping data did not raise any concerns regarding disruptions to commercial shipping or other oil and gas operators.
Overall worst-case consequence	I - Negligible

6.5.5 Demonstration of ALARP

No alternative options to the use of vessels are possible to undertake marine-based operational activities. The OPGGS Act requires the presence of a 500 m petroleum safety zone. Other navigational controls, as specified in the Navigation Act, will also be implemented (lighting, communication aids and charting). If the management controls are adhered to, then the risk of interacting with other users of the sea will have been reduced to ALARP.

Santos's stakeholder consultation process is described in **Section 4**. Throughout the five-year duration of the EP, details of the ongoing activities have been communicated to relevant stakeholders as appropriate. In consultation, stakeholders are made aware of the proposed area from which other marine users may be excluded.

During operational activities, support vessels may assist in maintaining the 500 m petroleum safety zone around the WHP, to reduce the potential incursion by other marine users. No concerns have been raised by stakeholders regarding the potential exclusion from the proposed operational area (I – negligible).

The proposed management controls for marine user interaction are considered appropriate to manage the risk to ALARP.

6.5.6 Acceptability Evaluation

Is the consequence ranked as A or B?	Yes – maximum interaction with other marine users consequence is I (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 ecological sustainable development?	Yes – activity evaluated in accordance with Santos'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 Safety of Life at Sea (SOLAS) 1974 and Navigation Act 2012. IUCN principles of nearby reserves (Montebello Marine Park) (Multiple Use Zone – IUCN Category VI) are met (**Table 3-4**).
Are risks and impacts consistent with Santos's Environmental Management Policy?	Yes – aligns with Santos'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 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 Planned Operational Discharges

6.6.1 Description of Event

Event	Planned discharges from the John Brookes WHP to the marine environment include: + Sewage and grey water; + Deck drainage; and + Discharges associated with WHP maintenance activities. Planned discharges from support vessels within the operational area may include: + Deck drainage; + Sewage and grey water; + Food wastes; + Cooling water; + Bilge water; + Ballast water; and + Brine. Planned discharges associated with subsea infrastructure within the operational area include: + Hydraulic fluid (valve operation on subsea xmas trees and manifolds); + Cathodic protection system discharges from subsea pipelines; + Discharges from IMMR activities (e.g., from venting or releases during removal, replacement or repair of subsea flowlines, spools, pipelines, umbilicals, wellheads (e.g., valves, chokes), pig launchers and receivers, leak testing, fabric maintenance); and + Paint and chemicals from cleaning, inspection and repair of infrastructure and pipelines. WHP Discharges *Sewage and grey water* A long-drop toilet and hand basin is provided on the WHP for use when the WHP is manned. The toilet does not provide any form of treatment. However, use is very infrequent, and waste is discharged in accordance with Marine Order 96 (Marine pollution prevention – sewage) requirements. *Deck drainage* Drainage water on offshore facilities consists of rainwater and seawater spray and may potentially contain small quantities of oil, grease and detergents if present or used on the decks. However, controls are in place to prevent, contain and clean up such spills. Deck drainage discharges from the WHP will be small volumes and intermittent and will depend on rainfall. Deck drainage from rainfall or washdown operations discharges directly to the marine environment. Assessment of the spillage of hydrocarbons and other environmentally hazardous liquids is discussed in **Section 7.4**. *Discharges associated with WHP maintenance* Typical cleaning of WHP topsides infrastructure involves using high-pressure sprayers or steam cleaning. Cleaning agents (e.g., garnet in the case of grit blasting) are transferred to the WHP and are injected into the cleaning process system. Cleaning wastes (e.g., cleaning agents and cleaning residues) are collected and transferred off the WHP. The discharge of these wastes, which could contain hazardous material (e.g., residual hydrocarbons), is considered as unplanned events in **Section 7.4**. Support Vessel Discharges *Sewage and greywater*

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.

Food waste

Putrescible waste is estimated to consist of approximately 1 L of food waste per person per day.

Deck drainage

As discussed above for WHP discharges.

Vessel cooling water

Seawater may be used by some vessels as a heat exchange medium for the cooling of machinery engines. Seawater is drawn from the ocean and flows counter current through closed-circuit heat exchangers, transferring heat from the vessel engines and machinery to the seawater. The seawater is then discharged to the ocean (i.e., it is a once-through system). Cooling water temperatures may vary depending on the vessel's engines' workload and activity.

Vessel bilge water

While in the operational area, support vessels may discharge oily water after treatment to 15 ppm via a MARPOL-approved oily water filter system.

Vessel ballast water

Ballast water could potentially be discharged to the marine environment from support vessel ballast tanks. The primary concern from ballast discharge is the introduction of marine pest species from ballast water, which is considered an unplanned impact and is assessed in **Section 7.1**.

Brine

Brine generated from the water supply systems on board the support vessels will be discharged to the ocean at a salinity of approximately 10% higher than seawater. The volume of the discharge depends on the requirement for fresh (or potable) water and will vary between the vessels and the number of people on board.

<u>Subsea Discharges</u>

Hydraulic fluid

Hydraulic fluid is used in subsea equipment as a lubricant and sealant, which 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), and there are two subsea valves (**Section 2**).

Vessel and WHP engines and equipment, such as pumps, cranes, winches, power packs and generators, require 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 vessels and the WHP.

Normal ROV operations and valve actuation can result in small releases directly to the marine environment; for instance, when using an ROV hot stab (a hydraulic coupling) to xmas trees or other subsea structures. During the change out or replacement of various subsea infrastructure, such as flowlines or jumpers spools, a small release of hydraulic fluid or residual hydrocarbons may occur. Unplanned discharges (i.e., spills) from marine operations are covered in **Section 7.4**.

Hydraulic fluids are used extensively in the petroleum industry in subsea production systems. Hydraulic fluids are either petroleum or water-based blends with additives. The main properties required of a hydraulic control fluid are low viscosity, low compressibility, corrosion protection, resistance to microbiological attack, and compatibility with seawater.

	Metal ions from cathodic protection Use of sacrificial anodes for cathodic protection or 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 uses aluminium and zinc anodes for cathodic protection. *Discharges from IMMR activities* Residual hydrocarbons, corrosion inhibitor, biocides and treated seawater are likely to enter the subsea marine environment from maintenance and other operations activities. Small volumes of treated seawater will be released into the marine environment during these activities (approximately 19 m^3). Leak testing of the subsea system may occur and result in the release of small volumes (estimated at less than 50 mL) of fluorescein dye. 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 VI processing plant with seawater containing chemicals (biocide) used to preserve the system. By opening the existing system or 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 reasonably 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 it is typically in the order of 2 m^3. As with replaced equipment or infrastructure, new equipment or 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's Operations Chemical Selection Evaluation and Approval Procedure (EA-91-II-10001). *Paint and cleaning* The removal of corrosion, external coating or marine growth from subsea infrastructure during cleaning releases inert materials and marine growth into the marine environment that will either fall to the seabed floor or be dispersed with the prevailing currents. Subsea cleaning may require the use of acid wash chemicals to assist in calcareous marine growth removal. Chemicals will be selected for use during this activity in accordance with Santos's Operations Chemical Selection Evaluation and Approval Procedure (EA-91-II-10001).
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.

6.6.2 Nature and Scale of Environmental Impacts

Potential receptors: Physical environment (water quality, benthic habitats, shoals and banks, offshore reefs and islands), threatened or migratory fauna (sharks, fish, and rays, marine mammals, marine turtles and seabirds), protected and significant areas (marine parks).

Physical environment

A number of planned discharges to the marine environment will be required for the continued operation of the VI Hub (as outlined in **Section 6.6.1**). Planned non-hazardous discharges will be small in volume and intermittent, with volumes dependent on a range of variables. The discharge of non-hazardous wastes to the marine environment will result in a localised reduction in water quality. This would be expected to be temporary (minutes to hours), localised and limited to surface waters (less than 5 m depth). The discharges are expected to be dispersed and diluted rapidly, with concentrations of wastes significantly dropping with distance from the discharge point. Changes to ambient water quality outside of the operational area are considered unlikely to occur.

Specifics of potential impacts to water quality from the discharge of non-hazardous wastes are as follows.

+ Eutrophication impacts from sewage, grey water and putrescible wastes.

The discharges of treated sewage and grey water can result in localised increases in nutrient concentrations (e.g., ammonia, nitrite, nitrate and orthophosphate), organics (e.g., volatile and semi-volatile organic compounds, oil and grease, phenols and endocrine-disrupting compounds) and inorganics (e.g., hydrogen sulphide, metals and metalloids, surfactants, phthalates and residual chlorine). Increased biological oxygen demand on the receiving waters may promote localised elevated levels of phytoplankton and bacteria activity due to nutrient inputs.

However, dispersion and dilution of discharges is expected to be rapid, as the discharges are of low volume (temporary and intermittent vessel use); the discharges are subject to biodegradation of organics through bacterial action, oxidation and evaporation; and the operational area is located in deep offshore waters dominated by swift currents, resulting in short-term changes to surface water quality within the operational area.

Food scraps may be discharged by support vessels on an infrequent basis during their time of operation in the field. Given the small quantities, intermittent nature of disposal and swift currents, no deleterious water quality impacts are predicted that could arise from addition of food wastes (e.g., bacterial loading, dissolved oxygen reduction).

The discharge of sewage, grey water and putrescible wastes is not expected to contact nearby offshore reefs, islands, shoals or banks.

+ Salinity increases.

The desalination of seawater results in a discharge of brine with a slightly elevated salinity (around 10% higher than seawater). On discharge to the sea, the desalination brine, being of greater density than seawater, is expected to sink and disperse in the currents. On average, seawater has a salt concentration of 35,000 ppm. The volume of the discharge depends on the requirement for fresh (or potable) water and the number of people on board.

Given the relatively low-volume, temporary and intermittent nature of brine discharges from support vessels and the deep, open water surrounding the vessels, impact on water quality in the operational area is expected to be low and short term.

The brine discharge is not expected to contact nearby offshore reefs, islands, shoals or banks.

+ Changes in temperature.

Cooling water will be discharged at a temperature above ambient seawater temperature. Upon discharge it will be subjected to turbulent mixing and transfer of heat to the surrounding waters.

Temperature dispersion modelling shows that the water temperature of discharged water will decrease rapidly as the discharge mixes with the receiving waters, with discharged waters being less than CT above background levels within less than 100 m (horizontally) of the discharge point. Vertically, the discharge will be within background levels within 10 m (Woodside, 2011).

Cooling water discharge points vary for each vessel; however, they all adopt the same discharge design, which permits cooling water to be discharged above the water line to facilitate cooling and oxygenation of this wastewater stream before mixing with the surrounding marine environment.

Cooling water discharge to the marine environment could result in a localised and temporary increase in the ambient water temperature. This may cause alteration of the physiological processes (particularly enzyme-mediated processes) in marine biota contributing to benthic ecosystems. Given the relatively low volume of cooling water, the low temperature differential, and the deep, open water surrounding the vessels, impact on water quality is expected to be low and short term.

The cooling water discharge is not expected to contact nearby offshore reefs, islands, shoals or banks.

+ <u>Contamination from releases of bilge water.</u>

Discharges of oily bilge water could result in a localised reduction in water quality with impacts on protected marine fauna and plankton. However, oily water discharged from vessels will be treated to a concentration of less than 15 ppm before release, in accordance with the requirements of Marine Order 91 (Marine pollution prevention – oil), which will be unlikely lead to any impacts to the receiving environment. The concentration and dosage within surface waters is expected to be very low and toxic impacts to water quality and benthic habitats would be on a negligible scale.

+ <u>Contamination from discharges associated with IMMR activities.</u>

Discharges from IMMR may occur at or near to the seabed. Therefore, benthic habitats may be exposed to changes in water quality. Discharges to the physical environment associated with IMMR activities include residual hydrocarbons, treated seawater, dye (for leak testing), hydraulic fluids and residual subsea cleaning products (as outlined in **Section 6.6.1**). Any impact due to discharges associated with IMMR activities will depend upon the toxicity of the chemical, the concentration of chemicals and residual hydrocarbons within the subsea system, the volume and duration of release. The potential impacts associated with discharges associated with IMMR activities such as may result in a localised and temporary (hours) reduction in water quality during the activity, but this will be short term and infrequent.

The removal of paint or external coating and marine growth from infrastructures releases inert materials and fouling organisms into the marine environment which will either fall to the seabed floor or be dispersed with the prevailing currents. Inert material is not expected to have any impact on the marine environment. These activities are carried out infrequently and are not expected to affect the marine environment.

The use of sacrificial anodes for cathodic protection / corrosion prevention continually releases metal ions (typically aluminium and zinc) into the marine environment at an extremely low rate. The release of low levels of metal ions is not known to have any detectable impacts to the physical environment.

As the subsea infrastructure is located in an open oceanic environment where currents would quickly dilute and disperse the planned discharges, and the activities are infrequent (subsea inspection/testing is typically on scale of a year or multiple years between events), it is not expected that impacts to the physical environment will occur.

Threatened or migratory fauna

As discussed in the sections above, the discharge extent for all planned discharges is localised, and rapid dilution is predicted to occur within the deep waters ranging from 45 m to 110 m. Marine fauna within the operational area are likely to be transient. If contact does occur with any marine fauna, it will be for a short duration due to the rapid dispersion of the plume and the transient fauna movement, such that exposure time may not be of sufficient duration to cause a toxic effect.

The Recovery Plan for Marine Turtles in Australia (2017 – 2027) identifies chemical discharge as a threat to marine turtle stocks. However, toxicity impacts to marine fauna from the planned release of chemically-dosed water or leak testing are unlikely to eventuate because:

+ The fluids will be risk assessed for their suitability for discharge to the marine environment prior to use;

- Flowlines will be flushed to ensure residual hydrocarbons are at or below 30ppm prior to disconnection. Given oil in water concentration at or below 30 ppm and the potential volumes released, the potential impacts to the marine environment are negligible (the potential impacts associated with hydrocarbons released to the marine environment are discussed in **Section 7.5** to **7.9**);
- Strong ocean currents mean that treated seawater will become further diluted upon discharge, so the duration of exposure of chemicals to fauna will be minimal;
- Any increased in Biological Oxygen Demand is not anticipated to have an impact on benthic habitats as the habitat is mainly bare sand; and
- Potential discharges will be localised and temporary within the operational area.

Brine discharges may increase local salinity levels on a short-term basis. Most marine species are able to tolerate short-term fluctuations in salinity in the order of 20 to 30% (Walker & McComb, 1990), and it is expected that most pelagic species would be able to tolerate short-term exposure to the slight increase in salinity caused by the discharged brine. Therefore, it is expected that any marine fauna passing through the impacted area would not experience any adverse impacts.

Other planned discharges may cause changes to behaviour in marine fauna (i.e., avoidance or attraction). Fishes and oceanic seabirds may be attracted to the discharge of food scraps. However, such discharges would be isolated occurrences and not in any one location, so no prolonged influence on faunal behaviour is expected. Discharges of cooling water and brine may cause avoidance behaviour in marine fauna. Given the nature of the discharges (localised, rapid dilution, intermittent), any behavioural impacts are expected to be short-term and minimal.

Protected and significant areas

The operational area intersects the Montebello Australian Marine Park (Multiple Use Zone - IUCN Category VI). All conservation values of the marine park (as outlined in **Section 3.2.3**) have the potential to be impacted by planned operational discharges through impacts to the physical environment and marine fauna.

Impacts to the physical environment and marine fauna are discussed in the sections above. Planned operational discharges are not expected to significantly impact the conservation values of the Montebello AMP.

6.6.3 Environmental Performance Outcomes and Control Measures

The EPO relating to this event includes:

- Manage impacts to air and water quality from planned discharges and emissions from operational activities (EPO-VI-CW-03).

The control measures considered for this event are shown in **Table 6-12,** and environmental performance standards and measurement criteria for the EPOs are described in **Table 8-2**.

Table 6-12: Control Measure Evaluation for Planned Operational Discharges

Control Measure Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
Standard Controls				
Sewage				
VI-CW-CM-21	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 vessel is compliant outweigh the minimal costs of personnel time and it is a legislated requirement.
Oily mixtures (bilge)				
VI-CW-CM-22	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).	Additional time and personnel costs in maintaining oil record book.	**Adopted –** Benefits of ensuring vessel is compliant outweigh the minimal costs of personnel time and it is a legislated requirement.
VI-CW-CM-23	Offshore platform deck drain system and bunding.	Reduces potential for oily residue within deck drainage to reach the marine environment.	Operational costs and labour or access requirements of undertaking facility maintenance.	**Adopted –** Benefits of operating equipment within operational parameters will help prevent leaks.
Waste management				
VI-CW-CM-24	Garbage management.	Reduces probability of garbage being discharged to sea, reducing potential impacts to marine fauna. Stipulates putrescible waste disposal conditions and limitations.	Personnel cost of premobilisation 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

Control Measure Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
		Provides compliance with Marine Order 95 (Marine pollution prevention – garbage).		legislated requirement.
Chemical selection and management				
VI-CW-CM-25	Deck cleaning and product selection.	Improves water quality discharge (reduced 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 chemical substitution.	**Adopted –** Benefits of ensuring vessels are compliant and those deck cleaning products planned to be released to sea meet MARPOL criteria.
VI-CW-CM-26	Chemical selection procedure.	Aids in the process of chemical management that reduces the impact of liquid discharges to sea. Only environmentally acceptable products are used.	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 implementation costs.
Subsea discharge management				
VI-CW-CM-27	Pipeline flushing prior to opening of subsea system.	Production fluids (hydrocarbons) will be flushed through with treated water to Varanus Island prior to opening of the subsea system during maintenance activities. Reduces the toxicity of chemicals and residual hydrocarbons in subsea infrastructure before any release to sea during IMMR activities.	Additional costs and time taken to flush pipeline.	**Adopted –** Environmental benefits of flushing outweigh the associated costs.
Additional Controls				
N/A	Scupper plugs on support vessels are	Would eliminate potential impacts of contaminants	Increased health and safety risks from wet deck	**Rejected** – Safety considerations

Control Measure Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
	continuously in place to prevent deck drainage.	being discharged to sea in rainwater.	not draining. Large amounts of water on a vessel's deck can also cause stability issues (free-surface effect).	outweigh the benefit given the 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 minimise 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 results in increased fuel usage, increased safety risks to personnel during transfer (e.g., crushing between skips), increase in crane movements.	**Rejected** – Cost outweighs the benefit given the low impact expected from planned discharges and high potential impacts from risk transfer.
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, reduction in temperature would be minimal compared to cost of altering	**Rejected** – Cost outweighs the benefit given the low impact expected from planned discharges and high potential impacts from risk transfer.

Control Measure Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
			the discharge height.	
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.

6.6.4 Environmental Impact Assessment

The impact and consequence ranking for planned operational discharges are outlined in **Table 6-13**.

Table 6-13: Impact and Consequence Ranking – Planned Operational Discharges

Receptor	Consequence Level
Operational discharges	
Threatened or migratory fauna	Minor behavioural changes may occur to threatened or migratory fauna, which will be short term, localised and intermittent. Only marine fauna present within the discharge mixing zone are expected to be exposed. Given the nature of planned discharges, the small volumes that could be released to the marine environment, the high levels of dilution and the nature of the marine environment in the vicinity of the operational area, impacts to threatened or migratory fauna are expected to be negligible (I).
Physical environment or habitat	Planned operational discharges may result in minor, temporary impacts to water quality and benthic habitat in the immediate vicinity of the discharge mixing zone. The implementation of the key management controls, as outlined in **Section 6.6.3**, will minimise the area influence by planned operational discharges. Given the nature of the planned operational discharges, the small volumes that could be released to the marine environment, the high levels of dilution and the nature of the marine environment in the vicinity of the operational area, impacts to the physical environment and habitat are expected to be negligible (I).
Socio-economic receptors	Not applicable – No planned operational discharges will occur within areas known to be utilised by third-party operators or for tourism and recreation. No impacts to fish stocks are expected to occur; therefore, there is no conceivable impact to commercial, traditional or recreational fisheries.
Threatened ecological communities	Not applicable – No threatened ecological communities identified in the area over which operational discharges are expected.
Protected areas	The operational area intersects the Montebello Marine Park (Multiple Use Zone - IUCN Category VI). The objective is to provide for ecologically sustainable use and the conservation of ecosystems, habitats and native species. The values of the marine park, with respect to the presence of marine species (receptors) and water quality are described above and are assessed as negligible (I).
Overall worst-case consequence	I - Negligible

6.6.5 Demonstration of ALARP

Santos uses a risk-based approach to selecting chemical products ranked under the Offshore Chemical Notification Scheme (OCNS). Central to the fluid selection process is the use of the OCNS. This scheme lists and ranks all chemicals used in the exploration, exploitation, and associated offshore processing of petroleum on the UK Continental Shelf. Santos uses chemicals with the least environmental impact, as determined under the OCNS ranking as a Gold and Silver for chemicals that can be ranked using the Chemical Hazard And Risk Management (CHARM) model, or E and D for chemicals not applicable to the CHARM model (i.e., inorganic substances, hydraulic fluids or chemicals used only in pipelines).

The OCNS system uses the ecotoxicity data for offshore chemical products to assess the potential environmental risk in the marine environment. The least environmentally hazardous grade is Gold (CHARM assessed) and E (through a non-CHARM assessment). The OCNS system requires bioaccumulation and biodegradation data and aquatic toxicity data from three trophic levels (algae, crustaceans and fish) to predict the potential ecosystem risk and, in turn, rank the product by hazard quotient.

Santos's Chemical Selection Procedure for Operational Activities in Commonwealth Waters (EA-91-II-10001) require that chemicals for use and discharge are CHARM rated Gold/Silver, or non-CHARM rated E/D. To achieve these rankings, the chemicals have the least environmental impact in terms of ecotoxicity, biodegradation and bioaccumulation. If they are not highly rated (Gold/Silver/D/E) and no alternative is available, a risk assessment is conducted providing justification for their use. Any chemicals which are not OCNS CHARM or non-CHARM-able rated are risk assessed through the procedure (EA-91-II-10001) to provide for a product that is environmentally acceptable for discharge to the marine environment. All flushing and pipeline testing chemicals used for operational activities will conform to the Santos existing chemical selection procedure (EA-91-II-10001) with all chemicals identified and assessed by the Santos Environment Department prior to commencement of the activity.

IMMR discharges and vessel operational activities cannot be eliminated. Onboard treatment of most wastes and their subsequent discharge to the marine environment is considered to be the most environmentally sound method of disposal, considering that the waste streams will either be treated to a level unlikely to cause significant environmental harm or will be of a nature not considered to pose significant risk to the receiving environment and will meet legislated requirements where they are applicable. The proposed management controls for planned operational discharges are considered appropriate to manage the risk to ALARP.

6.6.6 Acceptability Evaluation

Is the consequence ranked as A or B?	Yes – maximum planned operational discharge consequence is rated I (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 ecological sustainable development?	Yes – activity evaluated in accordance with Santos'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 Protection of the Sea (Prevention of Pollution from Ships) Act 1983, which in Australian waters is enacted by the Marine Orders. IUCN principles of nearby reserves (Montebello Marine Park) (Multiple Use Zone – IUCN Category VI) are met (**Table 3-4**).
Are risks and impacts consistent with Santos's Environmental Management Policy?	Yes – aligns with Santos'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).

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.

Deteriorating water quality is identified as a potential threat to turtles in the Recovery Plan for Marine Turtles in Australia (DoEE, 2017) (**Table 3-7**). However, with the management controls proposed, the operational discharges are not expected to significantly impact the receiving environment because they will be temporary and intermittent in a dispersive open-ocean environment. Therefore, the activities will be result in an acceptable level of impact.

6.7 Spill Response Operations

The spill response strategies that may be adopted in the event of a hydrocarbon spill have been identified in the OPEP. Potential impacts arising from the implementation of the following spill response operations or 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 where possible to reduce environmental impacts to ALARP. The selection of strategies will be undertaken through the net environmental benefit analysis (NEBA) process and evaluation of response strategies outlined in the OPEP. Spill response will be under the direction of the relevant Controlling Agency, as defined in **Section 2.2** of the OPEP, which may be Santos or another agency. In all instances, Santos will undertake a 'first-strike' spill response and will act as the Controlling Agency until the designated Controlling Agency assumes control. The response strategies considered to be appropriate for the worst-case oil spill scenarios identified for the activity are detailed in **Section 6.1** of the OPEP and comprise: + Source control; + Monitoring and evaluating; + 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 upon which poor decisions can be made, 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 Environmental Impacts and Risks for the Activities

Potential receptors: Physical environment, threatened or migratory fauna, protected and significant areas, and socio-economic receptors.

Given that spill response operations will be within offshore waters and will use vessels and aircraft, the types of impacts are consistent with vessel and aircraft operations described in this EP for routine operations. Details of these environmental impacts and risks for spill response operations are provided in **Table 6-14**.

Table 6-14: Detailed Description of the Environmental Impacts and Risks for the Activities – Spill Response Operations

<table>
<tr><th colspan="2">Light emissions:</th></tr>
<tr><td colspan="2">Spill response activities will involve the use of vessels, which 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, which may require lighting.</td></tr>
<tr><td>Potential receptors:</td><td>+ Fauna (including threatened or migratory fauna)
+ Protected areas</td></tr>
<tr><td colspan="2">Lighting may cause behavioural changes to fish, mammals, birds and marine turtles that can have a heightened consequence during key lifecycle activities, such as turtle nesting and hatching. Turtles and birds, which includes threatened and migratory fauna, have been identified as key fauna susceptible to lighting impacts; Section 6.2 provides further detail on the nature of impacts to fish, birds and marine turtles.
Spill response activities that require lighting may take place in protected areas important to turtles and birds, such as shoreline locations of Barrow Island, which are seasonally important for turtles and include BIAs and critical habitats. This could result in indirect impacts on the values of the protected areas.
During nesting and hatching season (primarily over summer months), lighting may cause behavioural impacts to turtles, including aborted nesting attempts and misorientation of newly hatched turtles, which may increase hatchling 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.
Lighting impacts to fauna are not considered to have the potential to impact supported industries such as tourism.</td></tr>
<tr><th colspan="2">Acoustic disturbance:</th></tr>
<tr><td colspan="2">Spill response activities will involve the use of aircraft and vessels, which 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 clean-up of shorelines (e.g., pumps and vehicles), for accessing shoreline areas (e.g., vehicles) and for supporting temporary camps (e.g., diesel generators).</td></tr>
<tr><td>Potential receptors:</td><td>+ Fauna (including threatened or migratory fauna)
+ Protected areas</td></tr>
<tr><td colspan="2">Underwater noise from the use of vessels may impact marine fauna, such as fish (including commercial species), marine reptiles and marine mammals, in the worst instance causing physical injury to hearing organs but more likely causing short-term behavioural changes, e.g., temporary avoidance of the area, which may impact key lifecycle processes (e.g., spawning, breeding, calving). Underwater noise can also</td></tr>
</table>

mask communication or echolocation used by cetaceans. **Section 6.1** provides further detail on these impacts from vessels and helicopters. Cetaceans have been identified as the key concern for vessel noise within the EMBA. The humpback migration BIA and the pygmy blue whale migration and pygmy blue whale foraging BIAs are all within the EMBA. Spill response activities using vessels have the potential to impact fauna in protected areas, which may impact on the conservation values of the protected areas. This includes the Ningaloo Marine Park recreational use zone and the Australian marine parks identified in **Table 3-3**. Noise and vibration from terrestrial activities on shorelines has the potential to cause behavioural disturbance to coastal fauna, including protected seabirds and turtles. Shoreline activities involving the use of noise-generating equipment may take place in important nesting areas for turtles and roosting and feeding areas for shorebirds.	
Atmospheric emissions:	
The use of fuels to power vessel engines, generators and mobile equipment used during spill response activities will result in emissions of greenhouse gases (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 nitrogen oxides (NO_x). Emissions will result in a localised decrease in air quality.	
Potential receptors:	+ Physical environment or habitat (air quality)
Atmospheric emissions from spill response equipment will be localised; and the use of mobile equipment, vessels and vehicles is not considered to create emissions on a scale where noticeable impacts would be predicted.	
Operational discharges and waste:	
Operational discharges include those routine discharges from vessels used during spill response, which 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 and putrescible and municipal waste at camp areas; and + Creation, storage, transport and disposal of oily waste and contaminated organics.	
Potential receptors:	+ Fauna (including threatened or migratory fauna) + Physical environment or habitat + Protected areas
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 increases, as detailed in **Section 6.6**. Vessel discharges may occur in shallower coastal waters during spill response activities than that described in **Section 6.6**. Discharge could potentially occur adjacent to marine habitats, such as corals, seagrass and macroalgae, and in protected areas (i.e., receptors anywhere within the EMBA), which support a more diverse faunal community; however, discharges will be very localised and temporary.	

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Cleaning of oil-contaminated equipment, vehicles and vessels has the potential to spread oil from contaminated areas to areas 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 it back into the marine environment. It results 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 and putrescible 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 of the environment, which may be within protected areas. The creation, storage, transport and disposal of oily waste and contaminated organics has the potential to spread impacts of oil to areas, habitats and fauna not previously contaminated. Sewage and putrescible and municipal waste generated onshore will be stored and disposed of at approved locations.
Physical presence and disturbance:
The movement and operation of vessels, vehicles, personnel and equipment; the undertaking of clean-up activities; and the set-up of temporary camp areas during spill response activities have the potential to disturb the physical environment and marine and coastal habitats and fauna, which may occur within protected areas. Vessel movement and transportation 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, transportation and release of wildlife, which could lead to additional impacts to wildlife.
Potential receptors: + Fauna (including threatened or migratory and 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 booms and from grounding. Vessel use in shallow coastal waters also increases the chance of contact with or physical disturbance of 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 feeding. Vehicles, equipment, personnel and cleaning activities during shoreline response activities have the potential to damage coastal habitats, such as dune vegetation, mangroves and habitats important to threatened and migratory fauna, including nests of turtles and birds and bird roosting and 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 coastal species, such as shorebirds and turtles, and could potentially interfere with nesting and feeding behaviours. Oiled wildlife response may include the hazing, capture, handling, cleaning, rehabilitation, 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 responses can potentially create additional stress and exacerbate impacts from oiling, interfere with lifecycle processes, hamper recovery and, in the worst instance, increase 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 are similar in that the invasive species (e.g., weeds) 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, may occur in specially protected areas and may have flow on impacts to the tourism industry.	
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 the 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 industries such 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

EPOs, control measures, Environmental Performance Standards (EPSs) and measurement criteria for spill preparedness and response activities are outlined within the relevant strategy sections of the OPEP. Control Measures relevant to reducing the potential impacts from spill response operations are shown in **Table 6-15** below.

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Table 6-15: Control Measure for Reducing Potential Impacts from Spill Response Operations

Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
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.
Use of competent vessel crew and personnel.	Reduces potential for environmental impacts from vessel usage.	Personnel and operational costs associated with maintaining contracts with competent vessel crew and personnel.	**Adopted –** Considered a standard spill response control.
Acoustic Disturbance			
Vessels and aircraft compliant with Santos's Protected Marine Fauna Interaction and Sighting Procedure (EA-91-11-00003).	Reduces potential for behavioural disturbance to cetaceans.	No cost/issue associated with this control measure	**Adopted –**Ensures compliance with Part 8 of the EPBC Regulations 2000, which is considered a standard spill response control (regulatory requirement).
Light Emissions			
Select temporary base camps in consultation with DoT and DBCA.	Reduce coastal habitat and fauna disturbance.	No cost/issue associated with this control measure.	**Adopted –** Considered a standard control to be adopted by the relevant Control Agency.
Atmospheric Emission			
If required under MARPOL, vessels will maintain a current International Air Pollution Prevention (IAPP) Certificate	Reduces level of air quality impacts.	Personnel and operational costs associated with maintaining Air Pollution Certificate.	**Adopted –** Considered a standard spill response control (regulatory requirement).
Disruption to Other Marine Users			
Stakeholder consultation	Promotes awareness and reduces potential impacts from response to socio-economic activities	Minimal cost in relation to overall effort/costs in managing incident	**Adopted –** Considered a standard control for incident management

Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
Operational Discharges and Waste			
Vessels meet applicable MARPOL and Marine Park sewage disposal requirements	Reduces potential for water quality impacts.	No cost/issue associated with this control measure.	**Adopted –** Considered a standard spill response control (regulatory requirement).
Vessel meet applicable MARPOL requirements for oily water (bilge) discharges	Reduces potential for water quality impacts.	No cost/issue associated with this control measure.	**Adopted –** Considered a standard spill response control (regulatory requirement).
Approved oily water decanting	Reduces impact from discharge of oily water from storage. Frees up space in liquid waste containers to allow further waste collection.	No cost/issue associated with this control measure.	**Adopted –** Considered a standard spill response control (regulatory requirement).
Compliance with controlled waste, unauthorised discharge and landfill regulations.	Ensures correct handling and disposal of oily wastes.	No cost/issue associated with this control measure.	**Adopted –** Considered a standard spill response control (regulatory requirement).
Physical Presence and Disturbance			
Spill response activities selected on basis of a net environmental benefit analysis.	Provides a systematic and repeatable process for evaluating strategies with net least environmental impact.	No cost/issue associated with this control measure	**Adopted –** Considered a standard spill response control.
Vessels and aircraft compliant with Santos's Protected Marine Fauna Interaction and Sighting Procedure (EA-91-11-00003).	Reduces potential for behavioural disturbance to cetaceans.	No cost/issue associated with this control measure	**Adopted –** Ensures compliance with Part 8 of the EPBC Regulations 2000, which is considered a standard spill response control (regulatory requirement).
Use of shallow draft vessels for shoreline and nearshore operations.	Reduce seabed and shoreline disturbance.	Operational costs associated with operating shallow draft vessels for shoreline and nearshore operations.	**Adopted –** Considered a standard control.

Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
OSR Team Leader assesses and selects vehicles appropriate to shoreline conditions.	Reduce coastal habitat and fauna disturbance.	No cost/issue associated with this control measure.	**Adopted –** Considered a standard control.
Conduct shoreline, nearshore habitat, bathymetry assessment.	Reduce shoreline habitat disturbance.	Operational costs associated with conducting shoreline nearshore habitat assessment.	**Adopted –** Considered a standard control.
Establish demarcation zones for vehicle and personnel movement considering sensitive vegetation, bird nesting and roosting areas and turtle nesting habitat.	Reduce coastal habitat and fauna disturbance.	No cost/issue associated with this control measure.	**Adopted –** Considered a standard control.
Operational restriction of vehicle and personnel movement to limit erosion and compaction.	Reduce coastal habitat erosion and compaction.	No cost/issue associated with this control measure.	**Adopted –** Considered a standard control.
Prioritise use of existing roads and tracks.	Reduce coastal habitat and fauna disturbance.	No cost/issue associated with this control measure.	**Adopted –** Considered a standard control.
Soil profile assessment prior to earthworks.	Reduce habitat disruption and erosion.	Operational costs associated with soil profile assessment.	**Adopted –** Considered a standard control.
Engage advice of Heritage Advisor if spill response activities overlap with potential areas of cultural significance.	Reduce disturbance to culturally significant sites.	Operational costs associated with Heritage Advisor engagement services, if required.	**Adopted –** Considered a standard control to be adopted by the relevant Control Agency.
Pre-cleaning and inspection of equipment (quarantine)	Reduces potential for invasive species to offshore islands	Cost/effort in inspecting equipment	**Adopted –** Considered a standard control.

6.7.4 Environmental Impact Assessment

The impact and consequence ranking for spill response operations are outlined in **Table 6-16**.

Table 6-16: Impact and Consequence Ranking – Spill Response Operations

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*

Receptor	Consequence Level
Spill Response Operations – Atmospheric Emissions	
Threatened, migratory, or local fauna	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*.
Physical environment or habitat	
Threatened ecological communities	
Protected areas	
Socio-economic receptors	
Overall worst-case consequence level	A – *Negligible*
Spill Response Operations – Operational Discharges and Waste	
Threatened, migratory, or local fauna	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 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's appointed waste management contractor;
Physical environment or habitat	
Threatened ecological communities	
Protected areas	
Socio-economic receptors	

Receptor	Consequence Level
	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 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*

Receptor	Consequence Level
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 (NEBA) is the primary tool used during spill response to evaluate response strategies and has the goal of selecting strategies that result in the least net impact to key environmental sensitivities. The NEBA process will identify and compare net environmental benefits of alternative spill response options. The NEBA will effectively determine whether an environmental benefit will be achieved through implementing a response strategy or by undertaking no response. The NEBA will be undertaken by the relevant Controlling Agency for the activity. For those activities under the control of Santos, the Incident Management Team (IMT) Environmental Team Leader will be responsible for reviewing the priority receptors and selected response strategies identified in the OPEP and coordinating the NEBA for each operational period. This will demonstrate 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 on wildlife in offshore waters from oiled wildlife response activities and to shoreline habitats and fauna receptors within shallow waters or on shorelines from nearshore booming and shoreline clean-up activities.

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

Santos considers the actions prescribed in the Recovery Plan for Marine Turtles in Australia 2017 – 2027 (DoEE, 2017) and approved conservation advices for other threatened fauna (**Table 3-7**) relevant to spill responses for the activities to minimise noise and light impacts on cetaceans and marine turtles. The proposed event will not result in significant impacts on these species, and implementation of identified control measures is in line with the relevant conservation advices and recovery plans. Pollution events (such as hydrocarbon spills) could impact on fauna (as described in **Sections 7.4 to 7.9**), 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 6.7.3** 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 disproportionate costs. It is considered therefore that the impact of the activities conducted are acceptable and ALARP.

6.7.6 Acceptability Evaluation

Is the consequence ranked as A or B?	Yes – maximum consequence is B (Minor) from planned events.
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 ecological sustainable development?	Yes – activity evaluated in accordance with Santos'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**). Controls implemented will minimise the potential impacts from the activity to species identified in recovery plans and conservation advices as having the potential to be impacted by spill response operations, with the key objective to minimise extent and impact of a release scenario.
Are risks and impacts consistent with Santos's Environmental Management Policy?	Yes – aligns with Santos's Environmental Management Policy.
Are risks and impacts consistent with stakeholder expectations?	Yes – no concerns raised. During any spill response, a close working relationship with relevant regulatory bodies (e.g., DoT, DBCA, AMSA) will occur; 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 (DPAW, 2014a) and Pilbara Regional Oiled Wildlife Response Plan (DPAW, 2014b).
Are performance standards such that the impact or risk is considered to be ALARP?	Yes – (see ALARP above).

The implementation of spill 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 to an acceptable level.

7 Environmental Assessment for Unplanned Events

OPGGS(E)R 2009 Requirements
Regulation 13. Environmental assessment.
Evaluation of environmental impacts and risks 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. 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. *Environmental performance outcomes and standards* 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's environmental assessment identified eight 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 to reduce the risk and impacts to ALARP are detailed in the following subsections.

The following unplanned event was considered to not be a credible scenario and is not discussed further in this section:

+ Hydrocarbon spill due to vessel grounding.

Vessel grounding can occur due to a loss of propulsion or to navigational error resulting in the vessel running aground in shallow areas. Vessel grounding and subsequent fuel tank rupture were not considered a credible scenario for this activity because the operational area is situated in deep water and there are no charted reefs or islands that could pose a grounding hazard in the operational area.

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

EP Section Reference	Event	Consequence	Likelihood	Residual Risk Level
7.1	Introduction of Invasive Marine Species	IV	a	Low
7.2	Marine fauna interaction	III	b	Low
7.3	Release of solid objects	I	e	Low
7.4	Hazardous liquid releases	I	d	Low
7.6	Surface release of condensate from wellheads at the John Brookes platform	IV	b	Low
7.7	Subsea release of condensate from a subsea pipeline	III	a	Very Low
7.8	Subsea release of condensate from wellheads (Halyard-1/Spar-2/Spartan-2)	III	a	Very Low
7.9	Surface release of diesel (vessel collision/bunkering)	II	a	Very Low

7.1 Introduction of Invasive Marine Species

7.1.1 Description of Event

Aspect	Introduction of invasive marine species may occur due to: + Biofouling on support vessels and external/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, IMS introduced marine species have the potential to out-compete indigenous species and affect overall native 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 Environmental Impacts

Potential receptors: Physical environment (shoals and banks, benthic habitats, offshore reefs and islands), threatened/migratory fauna (marine mammals, marine reptiles, sharks, fish and rays), protected and significant areas (marine parks), socio-economic receptors (fisheries, tourism and recreation).

Invasive marine species (IMS) are marine plants, animals and algae that have been introduced into a region that is beyond their natural range but that have the ability to survive and possibly thrive (DAFF, 2011). The majority of climatically compatible IMS to the North West Shelf are found in southeast Asian countries. Some IMS pose a significant risk to environmental values, biodiversity, ecosystem health, human health, fisheries, aquaculture, shipping, ports and tourism (DAFF, 2011; Wells *et al*., 2009). IMS can cause a variety of adverse effects in a receiving environment, including:

+ Over predation of native flora and fauna;
+ Displacement of native marine species;
+ Outcompeting of native flora and fauna for food;
+ Depletion of viable fishing areas and aquaculture stock; and
+ Reduction of coastal aesthetics.

The above impacts can result in flow-on detrimental effects to marine parks, tourism and recreation.

IMS 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/or polluted habitats in tropical regions are susceptible to invasive marine species introductions, which is why ports are often areas of higher IMS risk (Neil *et al*., 2005). However, in Australia there are limited records of detrimental impact from IMS compared to other tropical regions (such as the Caribbean). Following their establishment, eradication of IMS populations is difficult, limiting management options to ongoing control or impact minimisation. Case studies in Australia indicate that, from detection to eradication, this can take approximately four weeks (Bax *et al*., 2003). 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. 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). The potential biofouling risk presented by vessels will relate to the length of time that these vessels have already been operating in Australian waters or, if they have been operating outside Australian waters, the locations of the operations they have been undertaking, the length of time spent at these locations, and whether the vessels have undergone hull inspections, cleaning and application of new anti-foulant coating prior to returning to operate in Australia.

The risk of introducing IMS is limited by the location of the VI Hub operations in deep (45 m to 110 m), offshore waters that are not directly adjacent to any shoals or banks. IMS are generally unable to establish in deep-water ecosystems (Geiling, 2014), most likely due to a lack of light or suitable habitat to sustain their growth and survival. Most IMS are found in tidal and subtidal zones, with only a few species known to extend into deeper waters of the continental shelf (Bax *et al*., 2003). Further, it is known that highly disturbed environments (such as marinas and jetties) are more susceptible to colonisation than open-water environments where the number of dilutions and the degree of dispersal are high (Paulay *et al.*, 2002).

7.1.3 Environmental Performance Outcomes and Control Measures

EPOs relating to this event include:

+ No introduction of marine pest species (EPO-VI-CW-06).

The control measures for this event are shown in **Table 7-2,** and the environmental performance standards and measurement criteria for the EPOs are described in **Table 8-2.**

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

Control Measure Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
Standard Controls				
VI-CW-CM-28	Implementation of the management controls within the Santos Invasive Marine Species Management Plan (EA-00-RI-10172).	The risk of introducing IMS is reduced due to assessment procedure.	Personnel costs involved in risk assessing vessels in accordance with the management plan. Costs 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.	**Adopted** – Minimal personnel costs and potential delays or costs to project are considered outweighed by the benefits of reducing the risk of IMS.
VI-CW-CM-29	Current anti-foulant system.	The risk of introducing IMS 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 IMS.
VI-CW-CM-30	Ballast water management	Reduces the risk of introducing IMS through procedures managing ballast water exchange and identifying high-risk ballast water.	Personnel costs in producing and implementing ballast water management and in maintaining record books and logs.	**Adopted** – Minimal personnel costs are considered outweighed by the benefits of reducing the risk of IMS and it is a legislated requirement.

Control Measure Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
Additional Controls				
N/A	Heat treatment of ballast water to eliminate IMS.	Would reduce potential for IMS 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.
N/A	Restrict vessel operations to using vessels and equipment that have only operated in local, State or Commonwealth waters to reduce potential for IMS.	Reduce potential for IMS to be transported into area since vessels would not have originated elsewhere.	Vessels and equipment suitable for the activity may not be available in State/Commonwealth waters; therefore, work could not be completed.	**Rejected** – Not feasible.
N/A	Mandatory dry docking of vessels prior to entering field to clean vessel and/or equipment and remove biofouling.	Ensure that no IMS 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 other controls in place already reduce the risk.
N/A	Utilise an alternative ballast system to avoid uptake and discharge of water in vessels.	Eliminate need for ballast water exchange, therefore decreasing risk of introducing IMS through ballast water.	Vessels suitable for the activity may not have options for alternative ballast, therefore would require modification at significant cost.	**Rejected** – Cost disproportionately high compared to environment benefit.
N/A	Zero discharge of ballast water.	Would reduce the potential for IMS by implementation of no ballast water	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.

Control Measure Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
		exchange policy on support vessels.		

7.1.4 Environmental Impact Assessment

The impact, likelihood and consequence ranking for the introduction of IMS are outlined in **Table 7-3**.

Table 7-3: Impact, Likelihood and Consequence Ranking – Introduction Of Invasive Marine Species

Consequence Level	
Receptors	+ Physical environment (shoals and banks, benthic habitats, offshore reefs and islands); + Threatened or migratory fauna (marine mammals, marine reptiles, sharks, fish and rays); + Protected and significant areas; + Socio-economic receptors (marine parks, fisheries, tourism and recreation).
Consequence	IV – Major
	IMS, if they successfully establish, 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. This is primarily through altering benthic habitats, which in turn may result in changes to faunal assemblages and a reduction in diversity. Any such reduction in diversity or health of the ecosystem may result in economic losses with long-term effects on industry (IV – major).
Likelihood	a - remote
	The pathways for IMS introduction are well known; consequently, standard preventive measures are proposed. Santos has an Invasive Marine Species Management Plan (EA-00-RI-10172) that identifies an IMS Management Zone. The Santos IMS Management Zone, which has been developed based on Regulator and industry policies and standards, is defined as all waters extending 12 nm from the territorial sea boundary (including Australian territorial reefs and islands) within the IMCRA Northwest Province bioregion. This zone encompasses the general spatial extent of Santos operations within territorial waters and is complementary to existing international, Commonwealth and State maritime and biosecurity management boundaries, management strategies and legislative frameworks. While the John Brookes, Spartan, Halyard and Greater East Spar facilities are not located within the IMS Management Zone, support vessels are still managed for IMS, as they are likely to transit to and from or through the management zone before operating in the John Brookes operational area. Given the dispersive open-ocean environment of the operational area, the successful translocation to surrounding shallower habitats such as found at VI of an IMS introduced to the operational area is unlikely. With controls in place to reduce the risk of IMS introduction, the likelihood is considered remote.

Consequence Level	
Residual Risk	The residual risk associated with this event is **Low**.

7.1.5 Demonstration of ALARP

The proposed management controls are considered appropriate to manage the risk of introduction of IMS to ALARP.

Ballast water exchange will be managed through Ballast Water Management actions consistent with the Australian Ballast Water Management Requirements (Department of Agriculture and Water Resources), 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 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 will ensure that the Aquatic Resources Management Act 2016[2] and associated regulations prohibiting the introduction of non-endemic fish species will be met.

With adherence to the proposed management controls, the risk to the environment from IMS has been reduced to ALARP.

7.1.6 Acceptability Evaluation

Is the risk ranked between Low to Medium?	Yes – introduction of IMS residual risk ranking is Low
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 ecological sustainable development?	Yes – activity evaluated in accordance with Santos'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's Environmental Management Policy?	Yes – aligns with Santos's Environmental Management Policy.
Are risks and impacts consistent with stakeholder expectations?	Yes – no concerns raised.

[2] 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.

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 to be environmentally acceptable.

7.2 Marine Fauna Interaction

7.2.1 Description of Event

Event	There is the potential for vessels or equipment from the vessels 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, UAV or drone 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 Environmental Impacts

<u>Potential receptors: Threatened or migratory fauna (marine mammals, marine turtles, sharks, fish and rays, and birds).</u>

Marine fauna in surface waters that would be most at risk from vessel collision include marine mammals, marine turtles and whale sharks. As summarised in **Table 3-6**, the operational area overlaps several BIAs, including the loggerhead turtle (internesting), green, flatback and hawksbill turtles (internesting and critical nesting habitat), humpback whale (migration) and blue whale (foraging).

Vessel strike and vessel disturbance are identified as potential threats to a number of marine fauna species in relevant recovery plans and conservation advices (**Table 3-7**). Incidents with marine fauna are recorded and reported by Santos as described in **Section 8.10**.

Marine mammals and sharks

The Approved Conservation Advice for *Megaptera novaeangliae* (humpback whale) (TSSC, 2015d) 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). The increase in vessel numbers (Silber & Bettridge, 2012) is not only a threat to humpback whales in relation to vessel strikes but also in relation to disturbance and displacement from key habitats. Similarly, vessel strike is also recognised by the Approved Conservation Advice for *Rhincodon typus* (whale shark) (TSSC, 2015a) as one of the threats to the recovery of whale sharks.

The most commonly sighted whale in continental shelf waters of the region is the humpback whale. The humpback whale migrates between calving grounds in the Kimberley region of Western Australia to feeding grounds in Antarctica, with the northbound migration from early June to early August (BHPB, 2005) and the peak of the northbound migration between Exmouth Gulf and the Dampier Archipelago occurring around July, concentrated inshore of the 200-m depth contour (Jenner *et al.*, 2001). The southern migration peaks around early September, with pods travelling in shallower waters, typically at 30 m to 100 m and passing west of Barrow Island and north of the Montebello Islands. Higher numbers may be encountered in the operational area during the humpback whale southern migration. However, significant numbers are not expected given the water depths at the operational area of approximately 45 m to 110 m.

Nearly all blue whales sighted in the North West Shelf region are likely to be pygmy blue whales. 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 online national Conservation Values Atlas has identified the pygmy whale migration pathway on the continental shelf edge at a depth of 500 m to 1,000 m (McCauley & Jenner, 2010). 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).

Pygmy blue whales may also transit the operational area during their migrations. However, given the width of the blue whale migration corridor in the region (wider than 200 km) and the whale's preferred water depths (between 300 m and 850 m), significant interactions with pygmy blue whales during operational activities are highly unlikely.

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, 2004). Instances of cetacean deaths as a result of vessel collisions in Australian waters have been recorded (e.g., a Bryde's whale in Bass Strait in 1992) (WDCS, 2004), although the data indicates this is likely to be associated with container ships and fast ferries. The Whale and Dolphin Conservation Society also indicates that some cetacean species, such as humpback whales, can detect and change course to avoid a vessel (WDCS, 2004). The reaction of whales to the approach of a ship is quite variable. Some species remain motionless when in the vicinity of a ship while others are known to be curious and often approach ships that have stopped or are slow-moving, although they generally do not approach and sometimes avoid faster-moving ships (Richardson *et al*., 1995).

Whale sharks are at risk from vessel strikes when feeding at the surface or in shallow waters (where options to dive are limited). Given that the operational area overlaps with whale shark foraging BIA (**Figure 3-14** and **Table 3-6**), individuals may be encountered during operational activities. However, the whale shark presence within the operational area is not expected to comprise significant numbers given that no main aggregation area exists within the operational area; therefore, their presence would be transitory and of a short duration. No constraints within the operational area (e.g., shallow water or shorelines) would prevent whale sharks from moving away from vessels. Vessel speed has been demonstrated to be a key factor in relation to collision with marine fauna, particularly cetaceans, with faster-moving vessels posing a greater collision risk than slower vessels (Laist *et.al.*, 2001; Jensen & Silber, 2003; Hazel, 2009). Laist *et al.*, (2001) suggest that the most severe and lethal injuries to cetaceans are caused by vessels travelling at 14 knots or faster.

Marine turtles

It is likely that loggerhead, green, flatback and hawksbill turtles will be transient within the operational area due to the presence of internesting BIAs and habitat critical for nesting. Disturbance due to vessels has been flagged as a threat to marine turtles that occur within the operational area (DoEE, 2017).

Marine turtle mortality due to vessel 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 vessel 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 vessel strike, possibly due to the relatively low human population density of the North West Shelf coastline.

Turtles will typically avoid vessels by rapidly diving; however, their ability to respond varies greatly depending on the speed of the vessel. Hazel (2009) reported that the number of turtles that fled vessels decreased significantly as vessel speed increased. Turtles are also adapted to detect sound in water (Popper *et al.*, 2014) and will generally move from anthropogenic noise-generating sources, including vessels, within their detection range.

Birds

A number of protected species of marine birds have potential habitats or migratory routes in and around the operational area (**Section 3.2.4**). BIAs occur within the operational area for threatened or migratory bird species, including the wedge-tailed shearwater and Australian fairy tern (breeding and foraging) and the white-tailed tropicbird, roseate tern and lesser crested tern (breeding). In addition, the Approved Conservation Advice for Red Knot (*Calidris canutus*) (TSSC, 2016a) outlined bird strike as a threat through direct mortality.

Seabirds may be attracted to the John Brookes WHP due to increased opportunities to feed 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.

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

During landing and take-off, large slow birds are at risk of strike from helicopter propellers. Ornithological technological specialists have identified no EPBC Protected species within the operation area as having a 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 (MAE) in the John Brookes Safety Case.

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

+ Helideck markings and lights becoming obscured;
+ Safety critical equipment on the WHP becoming obscured and possibly deteriorating at a quicker rate; and
+ Surfaces becoming slippery, particularly after rainfall.

To minimise the risk of bird strike and a serious safety event, bird-deterrent devices may need to be trialled before installation. This will ensure birds safely vacate the WHP prior to helicopter landing and take-off.

7.2.3 Environmental Performance Outcomes and Control Measures

The EPO relating to this event includes:

+ No injury or mortality to EPBC Act and WA Biodiversity Conservation Act 2016 listed marine fauna during operational activities (EPO-VI-CW-01).

The control measures for this event are shown in **Table 7-4**, and the environmental performance standards and measurement criteria for the EPOs are described in **Table 8-2**.

Table 7-4: Control Measure Evaluation for Marine Fauna Interaction

Control Measure Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
Standard Controls				
VI-CW-CM-01	Protected Marine Fauna Interaction and Sighting Procedure.	Reduces risk of physical and behavioural impacts to marine fauna from vessels, helicopters and UAVs because if marine fauna are sighted, then vessels can slow down or	Operational costs to adhere to marine fauna interaction restrictions, such as vessel, helicopter and UAV speed and direction, are	**Adopted** – Benefits in reducing impacts to marine fauna outweigh the costs incurred by Santos.

Control Measure Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
		move away, and helicopters and UAV's can increase distances from sighted fauna if required.	based on legislated requirements and must be accepted.	
Additional controls				
VI-CW-CM-19	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.
N/A	Restrict the timing of activities to operate outside of sensitive periods only.	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 –** Cost disproportionate to increase in environmental benefit and would severely limit operations, which are required to occur 24 hours a 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 duration of the activity as operations only continue for approximately 10 hours per day or less in winter. Increased cost due to increased operation time (more than double the cost	**Rejected –** Substantial additional cost due to doubling of activity duration. No overall environmental benefit as results in increased impacts and risks.

Control Measure Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
			and therefore grossly disproportionate).	
N/A	Adopt further measures to those outlined in 'EPBC Regulations 2000 — Part 8 Division 8.1' during peak periods of ecological sensitivity, e.g. additional management considerations for vessels outlined in the Australian National Guidelines for Whale and Dolphin Watching (2017).	Potentially provide an additional level of protection of marina fauna.	Administrative costs to update existing procedure. Operational costs through interruption to activities through implementation of controls developed for an industry trying to get close to marine fauna, when Santos activities aim to avoid fauna.	**Rejected** - The existing control "procedure for interacting with marine fauna" has been written in accordance with the EPBC Act and other relevant guidelines. A review of this procedure against the Australian National Guidelines for Whale and Dolphin watching found that there are no additional relevant controls in the Australian National Guidelines for Whale and Dolphin watching and therefore adopting this control is not ALARP.

7.2.4 Environmental Impact Assessment

The impact, likelihood and consequence ranking for marine fauna interaction are outlined in **Table 7-5**.

Table 7-5: Impact, Likelihood and Consequence Ranking – Marine Fauna Interaction

Description	
Receptors	Threatened or migratory fauna (marine mammals, marine turtles, sharks, fish and rays, and birds)
Consequence	III - moderate
	The potential exists for death or injury of EPBC Act–listed individual species from interacting with a vessel or helicopter. Any collision with an individual would represent a small proportion of the local population, and it is not expected that it would result in a decreased population size at a local or regional scale. It is expected that the loss of an individual turtle, whale shark, whale or bird would be a moderate (III) consequence.
Likelihood	b - unlikely

Description	
	Given the presence of a number of BIAs for turtles, whale sharks, marine mammals and birds, receptors are expected to be present in the operational area at various times of the year. Marine fauna interaction is considered very unlikely given the small operational area (500 m around the John Brookes WHP and a narrow corridor either side of subsea infrastructure), slow-moving vessels (typically less than 5 knots), open-ocean environment and the ability for fauna to move away. Helicopter operations will occur with the use of the bird-deterrent system. Noise generated from vessel engines and the bird-deterrent system is likely to deter marine fauna from coming in close proximity to vessels or helicopters. With controls in place ensuring the vessel is compliant with EPBC Regulations and with the bird-deterrent system working effectively, the risk of marine fauna interaction is further reduced and is considered unlikely (b).
Residual Risk	The residual risk associated with this event is **Low**

7.2.5 Demonstration of ALARP

No alternative options to the use of vessels are possible for undertaking operational activities. If the management controls are adhered to, then the risk of marine fauna interactions will have been reduced to ALARP.

The proposed management controls for marine fauna interaction are considered appropriate to manage the risk to ALARP.

7.2.6 Acceptability Evaluation

Is the risk ranked between Low to Medium?	Yes – marine fauna interaction residual risk ranking is 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 ecological sustainable development?	Yes – activity evaluated in accordance with Santos'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. Controls implemented will minimise the potential impacts to species identified in recovery plans and conservation advices. Relevant species recovery plans, conservation management plans and management actions, including but not limited to the Recovery Plan for Marine Turtles in Australia (DoEE, 2017), Approved Conservation Advice for *Megaptera novaeangliae* (humpback whale) (TSSC, 2015d), Blue Whale Conservation Management Plan 2015 – 2025 (DoE, 2015c), Approved Conservation Advice for *Rhincodon typus* (whale shark) (TSSC, 2015a), and relevant recovery plans and conservation advices for birds.

Are risks and impacts consistent with Santos's Environmental Management Policy?	Yes – aligns with Santos'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 F**); 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, such as paper and packaging; + Hazardous solid wastes, such as batteries, fluorescent tubes, and aerosol cans; and + Equipment and materials, such as 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 Nature and Scale of Environmental Impacts

<u>Potential receptors: Physical environment (shoals and banks, benthic habitats, offshore reefs and islands), threatened or migratory fauna (marine mammals, marine reptiles, sharks, fish, rays, and birds), protected and significant areas (marine parks) and socio-economic receptors (tourism and recreation).</u>

Physical environment

Objects accidentally dropped to the seabed could occur during support vessel and ROV activities, such as the lifting of objects and equipment. Equipment and other items lost at sea could be caused by crane failure, adverse weather, human error, rigging failure and vessel motions and potentially could lead to loss of or changes to benthic habitats. The area of potential disturbance from a non-buoyant dropped object would be restricted to the operational area.

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. While soft sediment benthic habits will not be destroyed, disturbance of the communities on and within them (i.e., the epifauna) 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.

Impacts to benthic communities from dropped object disturbance are expected to be short term in duration due to the ability for such communities to recover. Recovery is expected within 6 to 12 months, based on previous surveys from drilling impacts (URS, 2010).

Buoyant dropped objects have the potential to be transported by marine currents and may impact on reefs, islands, shoals and banks within the region. Accidentally dropped objects such as plastics have the potential to smother benthic environments, and the release of hazardous solids (e.g., wastes such as batteries) could also impact water quality through pollution of the immediate receiving environment. Impacts from accidentally released liquids are discussed in **Section 7.4**.

Threatened or migratory fauna

Solids such as plastics have the potential to harm marine fauna through entanglement or ingestion. Several BIAs for marine turtles (nesting and internesting), whale sharks (foraging), whales (migration and foraging) and birds (breeding) overlap the operational area; therefore, these receptors are expected to be present.

Marine turtles and seabirds are particularly at risk from entanglement. Turtles are known to be indiscriminate feeders and may mistake plastic for jellyfish (Mrosovsky *et al.*, 2009). The Recovery Plan for Marine Turtles in Australia 2017 – 2017 (DoEE, 2017) identifies ingestion of marine debris as a threat to all species of marine turtles. Seabirds at the sea surface foraging on plankton may eat floating plastic. Once ingested, plastics can damage internal tissues and inhibit physiological processes, which can both potentially result in fatality. Marine debris has been highlighted as a threat to marine turtles, humpback whales, whale sharks, northern river sharks, largetooth sawfish and Australian sea lions in the recovery plans and conservation advice presented in **Table 3-7**. These recovery plan and approved conservation advices, 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 activity is the legislation for the prevention of garbage disposal from vessels.

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

Under management, only limited volumes of solid objects would be expected to be released; therefore, any impacts would be restricted to a small number of individuals.

Protected and significant areas and socio-economic receptors

The operational area intersects the Montebello Marine Park (Multiple Use Zone – IUCN Category VI). All conservation values of the marine park (as outlined in **Section 3.2.3**) have the potential to be impacted by non-hydrocarbon releases through impacts to the physical environment and marine fauna. Impacts to the physical environment and marine fauna are discussed in the sections above.

Other marine users within the Montebello Marine Park include tourists and recreational visitors, which are important to the socio-economic values for the marine park. Tourism activities, such as snorkelling, diving, surfing and recreational fishing, may occur around the Montebello Islands but are not expected to occur in the operational area, given the water depth (45 m to 100 m), lack of seafloor features and distance from shore. Potential impacts to tourists and recreational visitors within the Montebello Marine Park include the aesthetic impacts of buoyant waste floating into the park and potentially washing up on the shores of the Montebello Islands, as well as the aesthetic impacts of any damage to reefs, shoals and banks.

With appropriate management measures in place, solid non-hydrocarbon releases are not expected to occur frequently or to a scale that may cause significant pollution that would impact the conservation or socio-economic values of the Montebello Marine Park.

7.3.3 Environmental Performance Outcomes and Control Measures

EPOs relating to this event include:

+ No unplanned objects, emissions or discharges to sea or air (EPO-VI-CW-07).

The control measures for this event are shown in **Table 7-6,** and the environmental performance standards and measurement criteria for the EPOs are described in **Table 8-2**.

Table 7-6: Control Measure Evaluation for the Release of Solid Objects

Control Measure Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
Standard Controls				
VI-CW-CM-24	Waste (Garbage) Management Plan.	Reduces probability of garbage being discharged to sea, reducing potential impacts to marine fauna. Stipulates putrescible waste disposal conditions and limitations. Marine Order 95 (Marine pollution prevention – garbage).	Personnel cost of premobilisation 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.
VI-CW-CM-04	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.
VI-CW-CM-10	Planned subsea and offshore maintenance.	Reduces likelihood of dropped objects because lifting equipment is operating within its parameters.	Operational costs and labour or access requirements of undertaking equipment maintenance on vessels.	**Adopted –** Benefits of operating equipment within operational parameters will help reduce the likelihood of dropped objects.
VI-CW-CM-05	Vessels 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.
Additional Controls				

Control Measure Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
VI-CW-CM-11	Dropped object prevention (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.
VI-CW-CM-12	Dropped object recovery.	Requires dropped objects are 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, outweigh the costs.
N/A	Eliminate lifting in field.	Eliminate the risk of release of non-hydrocarbon solid to the marine environment due to dropped object.	Operational activities may require lifting from a vessel to the John Brookes WHP, and this cannot be eliminated.	**Rejected** – Not feasible.

7.3.4 Environmental Impact Assessment

The impact, likelihood and consequence ranking for a non-hydrocarbon release (surface, solid) are outlined in **Table 7-7**.

Table 7-7: Impact, Likelihood and Consequence Ranking – Release of Solid Objects

Description	
Receptors	+ Physical environment (shoals and banks, benthic habitats, offshore reefs and islands); + Threatened or Migratory Fauna (marine mammals, marine reptiles, sharks, fish, rays and birds); and + Protected and significant areas and Socio-economic receptors (marine parks, tourism and recreation).
Consequence	I - Negligible
	Physical environment (shoals and banks, benthic habitats, offshore reefs and islands) Non-buoyant dropped objects are expected to impact the seabed and be limited to the size of the dropped object and given the size of standard materials transferred, any impact is expected to be very small and limited to within the operational area. Any area of the seabed impacted through dropped objects would be expected to recover. Buoyant dropped objects have the potential to smother benthic habitats, including shoals, banks and reefs, and could wash up on island beaches. It is considered that the application of management measures will effectively prevent this impact occurring on a

Description	
	significant scale. Therefore, impacts will result in a negligible (I) reduction in habitat area or function.
	Threatened or migratory fauna (marine mammals, marine reptiles, sharks, fish, rays and birds) In the event of a loss of solid waste, the quantities would be expected to be limited. However, entanglement with or ingestion of solid wastes by marine fauna could still occur, which is a particular risk for marine turtles and birds. The limited quantities associated with this unplanned event indicate that, even in a worst-case release of solid waste, the number of fauna fatalities 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 (I).
	Protected and significant areas and Socio-economic receptors (marine parks, tourism and recreation) Impacts to the Montebello Marine Park have the potential to occur through buoyant objects floating into the park, adversely impacting conservation values and creating poor aesthetics. Given the limited quantities associated with this unplanned event, even a worst-case release of solid waste is unlikely to have flow-on effects significant enough to impact the tourism and recreation industries. The consequence level is therefore assessed as negligible (I).
Likelihood	e – Likely
	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. Given the controls in place, the likelihood of releasing non-hydrocarbon solids to the environment resulting in a negligible consequence is considered likely (e).
Residual Risk	The residual risk associated with this event is **Low**.

7.3.5 Demonstration of ALARP

Solid waste will be generated during the activity. Equipment loss and dropped objects, which might occur during vessel to vessel transfers in the field, will be managed through lifting procedures. It is considered that the management controls proposed are sufficient to reduce the risk of non-hydrocarbon solid releases to a level that is ALARP. There are no additional management strategies that would reduce the chance of a loss of solid objects.

7.3.6 Acceptability Evaluation

Is the risk ranked between Low to Medium?	Yes – The release of solid objects 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 ecological sustainable development?	Yes – activity evaluated in accordance with Santos'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 Marine Order 95. Controls implemented will minimise the potential impacts from the activity to species identified in recovery plans and approved conservation advices as having the potential to be impacted by solid objects. Specific actions that contribute to the long-term prevention of marine debris (Objective 1 of the Threat Abatement Plan for the Impacts of Marine Debris on the Vertebrate Wildlife of Australia's Coasts and Oceans (DoEE, 2018)) have been adopted, including compliance with applicable legislation in relation to the improvement of waste management practices.
Are risks and impacts consistent with Santos's Environmental Management Policy?	Yes – aligns with Santos'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 non-hydrocarbon release to the environment is considered to be ALARP and environmentally acceptable.

7.4 Hazardous Liquid Releases

7.4.1 Description of Event

Event	The John Brookes WHP and umbilical lines store chemicals for subsea injection, including MEG, hydraulic fluid and corrosion inhibitor. Storage of chemicals and hydrocarbons is limited to the small amounts of diesel, hydraulic oil, MEG and corrosion inhibitor required for operation of the facility (see **Section 2.6**). Further information on inventories of hydraulic oil, chemical and waste oil is provided below. Hydraulic fluids and lube oils Hydraulic fluids are used on the John Brookes WHP in hydraulic power units for the crane and pig launcher and to control valves in subsea John Brookes, Spartan-2, Halyard-1 and Spar-2 wellheads. Hydraulic oil tanks of 870 L, 3,233 L and 2,337 L are located on the John Brookes WHP. Hydraulic oil for Halyard-1 and Spar-2 well control is provided through the Halyard electro-

hydraulic umbilical. Hydraulic oil for Spartan-2 well control is provided through the Spartan electro-hydraulic umbilical

Hydraulic and lube oils are also used on support vessels within the operational area to carry out subsea inspection and maintenance activities (e.g., dive support vessels, IMMR activities, ROV support vessels, work boats). Hydraulic fluid is used on ROVs during subsea inspection activities. An unplanned leak of hydraulic fluid could occur from the ROV hydraulic system. Such leaks are typically small, and combined simultaneous leaks would likely be less than 50 L.

Small unplanned release of hydraulic fluids could occur from damage to or corrosion of hydraulic oil tanks, loss of integrity of or damage to hydraulic hoses, damage to or loss of integrity of the electro-hydraulic umbilical, or in the event hot-tapping is used to assist in the flushing of lines with seawater or inert gases. Cleaning of bunded areas for maintenance, or suspension of activities are another source of potential unplanned release of hydrocarbons during high-pressure or steam cleaning. Small releases of hydraulic fluids could also occur during transfer of fluid between a support vessel and the John Brookes WHP (i.e., dropped objects that lose integrity and release to the marine environment). Hydraulic fluid transfer between a support vessel and the John Brookes WHP will occur in drums. Given the safe working load of the WHP crane is 4 tonnes, the maximum volume of hydraulic fluid that could be transferred would be less than 4 $m^{3.}$

Chemicals

Corrosion inhibitor for the John Brookes wellheads is supplied in a three-compartment (1,600-L capacity each) stainless steel tank on the mezzanine deck. The Halyard subsea wells are supplied by a corrosion inhibitor tank located on the main deck. Tanks are replenished by vessel and tanks from VI as required. The only continuously used chemical is corrosion inhibitor, which is injected at the wellheads. Other chemicals, including biocide, may be used as required for operations such as pigging or biocide runs.

Other hazardous liquids that may be onboard for transfer to or from the operating facilities include cleaning and cooling agents, recovered solvents, stored or spent chemicals, leftover paint materials, used greases and so forth. These materials may be present on support vessels for the day-to-day operation of the vessels and for carrying out maintenance and inspection within the operational area.

Production chemicals are preferentially delivered to the WHP in transportable tote tanks by a support vessel. Volumes transferred per lift are typically less than 4 m^3 given the safe working load of the WHP crane is 4 tonnes. The transportable tanks are lifted onto the upper deck by the WHP crane from where the chemicals are transferred to the fixed storage tanks by hoses fitted with quick connect/disconnect couplings. Corrosion inhibitor can also be pumped from portable tanks on a support vessel to the WHP via a dedicated pumping and hose transfer facility. Corrosion inhibitor can also be pumped between the Halyard and John Brookes tanks as needed, reducing the frequency of re-supply to the WHP.

Release of the chemicals to the sea could also occur via tank or pipework corrosion or damage on the John Brookes WHP or control umbilicals. Release could also occur from transport of chemicals between support vessels and the John Brookes WHP (i.e. dropped objects that may result in a leak/release or a leak or spill from a transfer hose).

Cleaning for routine maintenance or mothballing of topsides pressure vessels, piping and equipment is undertaken with a zero marine discharge philosophy. Waste is contained and transported back to VI. Options at this stage are then to dispose of it by sending it onshore to a third-party licensed waste disposal facility or through the VI processing facilities.

Waste oil from drainage

Oily water collected from the open-drain system is stored in a 1,600-L atmospheric sump. Hydrocarbons collected from the closed-drainage system (draining liquid knock out from the instrument gas–drying system and gas-powered pump exhausts, drainage of lowliness during maintenance, drainage from the production header during maintenance and pig launcher drainage) are collected in a 2,200-L closed-drain sump. The hydrocarbons collected in both the

	atmospheric and closed sump are pumped into the production stream by gas-driven sump pumps connected to high/low level controllers to prevent any overflow. Maximum credible spill volume The worst-case credible scenarios for spill of hazardous liquid materials (not including diesel or condensate) to the marine environment, in terms of volume of liquids released, are considered to be those resulting from transfer of chemicals or hydraulic oils between a support vessel and the John Brookes WHP. Spills originating from storage tanks on the John Brookes WHP are considered to be small in volume and contained within barriers inherent in the design of these facilities (i.e., bunding or enclosed spaces with drainage systems). Bulk chemical or hydraulic oil transfer is limited to less than 4 m^3 based on the crane safe working load, and this provides a conservative guide to the volume that could be released to the marine environment if a tote tank or any other transportable vessel was ruptured. With respect to the hose transfer of corrosion inhibitor to John Brookes WHP from a support vessel, the AMSA (2013b) guidelines for calculating a maximum credible volume during offshore refuelling (continuous supervision) have been used. These calculate the spill volume based on 15 minutes of flow and on a typical transfer rate of 10 m^3/hr. This equates to a maximum credible spill of 2.5 m^3. The maximum credible spill for any liquid hazardous material is therefore considered to be less than 4 m^3.
Extent	The maximum volume of hazardous liquids that could be released during routine operations is likely to be small (less than 4 m^3) and realistically limited to the volume of individual containers (e.g., drums) stored on deck at the John Brookes WHP and on support vessels.
Duration	For the operational life of the activity.

7.4.2 Nature and Scale of Environmental Impacts

Potential receptors: Physical environment (water and sediment quality, shoals and banks, benthic habitats, offshore reefs and islands), threatened or migratory fauna (marine mammals, marine reptiles, sharks, fish, rays and birds), protected and significant areas (marine parks) and socio-economic receptors (tourism and recreation).

Physical environment

Environmentally hazardous chemicals, hydrocarbon and liquid wastes lost to the marine environment may lead to contamination of the water column in the vicinity of the support vessel or the John Brookes WHP. In the event of a hazardous liquid release, the quantities would be limited to less than 4 m^3. The small volumes, dilution, and dispersion from natural weathering processes such as ocean currents indicate that the extent of exposure will be limited in area and duration.

Hydraulic fluids and lubricating oils behave similarly to diesel when spilt in the marine environment (for information on diesel behaviour in the marine environment refer to **Section 7.9**), although lubricating oils are more viscous and so the spreading rate of a slick of these oils would be slightly slower. Hydraulic fluids are medium oils of light to moderate viscosity and have a relatively rapid spreading rate and, like diesel, will dissipate quickly, particularly in high sea states.

Due to the small volumes and expected rapid dispersal to concentrations below impact thresholds, impacts to water quality are not expected to cause flow-on effects to sediment quality or benthic habitats, including shoals and banks, reefs, and offshore islands.

Threatened or migratory species

Changes to water quality could potentially lead to short-term impacts on marine fauna (e.g. pelagic fish and sharks, marine mammals, marine reptiles and seabirds). As summarised in **Table 3-6**, the operational area overlaps several BIAs, including the loggerhead turtle (internesting); green, flatback and hawksbill turtles (internesting and critical nesting habitat); humpback whale (migration); and blue whale (foraging).

Recovery plans and conservation advices for numerous bird species identify marine pollution and contamination impacts as a threat to the species. This includes the following marine species identified as potentially occurring within the operational area: red knot, southern giant petrel and eastern curlew. In addition, the Recovery Plan for the Grey Nurse Shark (*Carcharias taurus*) (DoE, 2014) identifies pollution as a threat to the species; and the Recovery Plan for Marine Turtles in Australia 2017 – 2027 (DoEE, 2017) identifies chemical discharge as a threat to all species of marine turtles in Australia. These species are expected to be transient within the operational area.

Chemical spills are unlikely to have widespread ecological effects on threatened or migratory fauna, given the nature of the chemicals on board, the small volumes that could be released, and the open-ocean environment of the location. Physical coating of marine fauna, in particular those present at the sea surface (e.g. seabirds), by entrained or surface hazardous liquids and sublethal or lethal effects from toxic chemicals are considered unlikely given the expected low concentrations and short exposure times.

Protected and significant areas and Socio-economic receptors

The operational area intersects the Montebello Marine Park (Multiple Use Zone – IUCN Category VI). The conservation values of the marine park (as outlined in **Section 3.2.3**) have the potential to be impacted by hazardous liquid releases through impacts to the physical environment and marine fauna. Impacts to the physical environment and marine fauna are discussed in the sections above.

Other marine users within the Montebello Marine Park include tourists and recreational visitors, which are important to the socio-economic values for the marine park. Given the localised and temporary impacts of an unplanned hazardous liquid spill, any impact to tourism and recreation activities, such as snorkelling, diving, surfing and recreational fishing, that predominantly occur within the Montebello Islands is considered unlikely. There may be the potential for limited aesthetic impacts, such as a hydrocarbon sheen occurring on the ocean surface.

7.4.3 Environmental Performance Outcomes and Control Measures

The EPOs relating to this event includes:

+ No unplanned objects, emissions or discharges to sea or air (EPO-VI-CW-07).

The control measures for this event are shown in **Table 7-8,** and the environmental performance standards and measurement criteria for the EPOs are described in **Table 8-2**.

Table 7-8: Control Measure Evaluation for Hazardous Liquid Releases

Control Measure Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
Standard Controls				
VI-CW-CM-10	Planned subsea and offshore maintenance.	Reduces likelihood of leaks from equipment and ensures ongoing integrity of subsea infrastructure	Personnel and operational costs associated with undertaking regular inspections of all subsea equipment.	**Adopted** – Benefit of the inspection to determine operational integrity outweighs the cost to undertake the inspection.
VI-CW-CM-11	Dropped object prevention procedure (LEMS).	Impacts to the environment are reduced by preventing dropped objects. Requires	Costs associated with personnel time in implementing procedures and in incident reporting.	**Adopted** – Benefits considered to outweigh costs.

Control Measure Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
		lifting equipment to be certified and inspected.		
VI-CW-CM-31	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** – Benefit of the inspection to determine operational integrity outweighs the cost to undertake the inspection.
VI-CW-CM-23	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 bunding and maintenance of bunding procedure	**Adopted** – Benefit of the inspection to determine operational integrity outweighs the cost to undertake the inspection.
VI-CW-CM-32	Hazardous chemical management procedures.	Reduces the risk of spills and leaks (discharges) to the sea by controlling the storage, handling and clean-up of hazardous chemicals.	Cost associated with permanent or temporary storage areas.	**Adopted** – Benefits of ensuring procedures are followed and measures implemented outweigh the costs of personnel time.
VI-CW-CM-33	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 inspections.	**Adopted –** Benefits of ensuring procedures are followed and measures implemented outweigh the costs of personnel time.
VI-CW-CM-35	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.	**Adopted –** Benefits of stocking, using and maintaining spill response equipment outweigh the costs of personnel time.
VI-CW-CM-36	Vessel spill response plan (SOPEP/SMPEP).	Implements response plans on board vessels to deal with unplanned hydrocarbon releases and spills quickly and efficiently to reduce	Administrative costs of preparing documents. Generally undertaken by vessel contractor so time for Santos personal to confirm and check	**Adopted** – Benefits considered to outweigh costs.

Control Measure Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
		impacts to the marine environment.	SOPEP/ SMPEP is in place.	
Additional Controls				
VI-CW-CM-37	Remotely operated vehicle (ROV) 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

The impact, likelihood and consequence ranking for a hazardous liquid release (surface) are outlined in **Table 7-9**.

Table 7-9: Impact, Likelihood and Consequence Ranking – Hazardous Liquid Release (Surface)

Description	
Receptors	+ Physical environment (water and sediment quality, shoals and banks, benthic habitats, offshore reefs and islands) + Threatened or migratory fauna (marine mammals, marine reptiles, sharks, fish, rays and birds) + Protected and significant areas and Socio-economic receptors (marine parks, tourism and recreation)
Consequence	I - Negligible
	As the operational area overlaps with a number of BIAs (turtle nesting and internesting, whale shark foraging, whale migration and foraging, seabird breeding) threatened or migratory marine fauna have the potential to be exposed to a hazardous liquid spill at the sea surface. The susceptibility of marine fauna to chemicals depends on the type and exposure duration; and given that exposures would be limited, impacts to marine fauna from this hazard are not expected to result in a fatality. Impacts to water quality from small volumes (less than 4 m^3) discharged to the marine environment would be short term and localised, due to the nature and behaviour of the chemicals or liquid wastes identified as being at risk of spilling; only pelagic fauna present in the immediate vicinity of the unplanned event would likely be at risk of impact. As this 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 (I) consequence.
Likelihood	d– Occasional
	A small hazardous liquid release is unlikely to have widespread ecological effects, given the nature of the chemicals on board, the small volume that could be released (less than 4 m^3), the depth and transient nature of marine fauna in this area, and the prevention and management procedures in place to clean up a spill. Santos reviewed hazardous liquid spills and leaks from equipment and machinery in recent history (due to split hoses, small leaks, or handling errors). Most of the spills and

Description	
	leaks reported occurred within bunded areas, were less than 100 L, did not reach the marine environment and were cleaned up immediately. The likelihood of a small hazardous liquids release occurring is limited given the set of mitigation and management controls in place for this program. Consequently, the likelihood of releasing hazardous liquids to the environment, which results in a negligible consequence, is considered to be occasional (d).
Residual Risk	The residual risk associated with this event is **Low**.

7.4.5 Demonstration of ALARP

Hazardous liquids and chemicals are required to undertake the activity, so their removal from the operation is not viable. Dangerous chemicals used during the activity will be managed and appropriately stored. Procedures are in place for the transfer of bulk liquids, reducing the risk of unplanned releases to sea due to equipment failure, operational error, or overflows and leaks. No beneficial additional control measures were identified to further reduce the risk of this hazard. The control measures proposed align with applicable actions described in relevant recovery plans and conservation advices to reduce risk of habitat degradation and deteriorating water quality (e.g., from pollution) to a level considered ALARP by Santos. The assessed residual risk for this impact is low and cannot be reduced further. It is considered therefore that the risk of the activities is ALARP.

7.4.6 Acceptability Evaluation

Is the risk ranked between Low to Medium?	Yes – maximum hazardous liquid release (surface) 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 ecological sustainable development?	Yes – activity evaluated in accordance with Santos'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 Marine Order 91 (Marine pollution prevention – oil) and Marine Order 94 (Marine pollution prevention – packaged harmful substances) and with relevant recovery plans and conservation advices (**Table 3-7)**. IUCN principles of nearby reserves (Montebello Marine Park) (Multiple Use Zone – IUCN Category VI) are met (**Table 3-4)**.
Are risks and impacts consistent with Santos's Environmental Management Policy?	Yes – aligns with Santos'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 controls in place to prevent an accidental release of small volumes of hazardous liquid and the negligible impacts predicted from an unplanned release of such material, 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.

The materials will be managed in accordance with relevant legislation and standards and Santos procedures. The small volumes negate 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 controls in place to prevent accidental spills and the negligible (I) impacts predicted from a spill of this size, the environmental risk of using and handling the required chemicals is considered ALARP and environmentally acceptable.

7.5 Overview of Unplanned Release of Hydrocarbons

7.5.1 Credible Spill Scenarios

A number of accidental events may occur during the operation of the John Brookes, Spartan and Greater East Spar infrastructure and associated activities, resulting in the potential release of hydrocarbons (condensate and diesel) to the marine environment. The spill scenarios assessed in **Sections 7.6 to 7.9** include a description of the variations in the type of hydrocarbon released (i.e. condensate or diesel) and the potential point of release (i.e., sea surface release versus subsea) at a range of locations within the operational area. The credible spill scenarios are summarised in **Table 7-10**.

Table 7-10: Summary of Largest Credible Hydrocarbon Spill Scenarios

Maximum Credible Scenario	Hydrocarbon Type	Maximum Credible Volume	EP Section
Loss of well control or damage to infrastructure causing condensate with gas release from John Brookes wellheads at surface (Worst-case)	John Brookes condensate	39,011 m^3	**Section 7.6**
Loss of integrity or damage causing condensate with gas release from a subsea pipeline in Commonwealth waters.	John Brookes condensate, Spartan Condensate and Halyard condensate	John Brookes: 210 m^3 Halyard-1: 161 m^3 Spartan: 35 m^3	**Section 7.7**
Loss of integrity or damage to infrastructure causing condensate with gas release from Spar-2 subsea wellhead or Spartan-2 well.	Halyard condensate Spartan Condensate	1,269 m^3 (based on 13 m^3 per day)	**Section 7.8**
Surface spill – Release of diesel from support fuel tank (due to vessel collision or dropped object) in Commonwealth waters.	Diesel	329 m^3	**Section 7.9**
Surface spill –Release of diesel fuel from bunker transfer in Commonwealth waters.	Diesel	15 m^3	**Section 7.9**

7.5.2 Spill Scenario Selection

Surface release of condensate from wellheads at John Brookes WHP

A workshop was held on 11 March 2019 with drilling representatives to assess the credibility of a subsea loss of well control from the John Brookes WHP. For the active producing wells associated with the WHP (John Brookes 2, 3, 5, 6 (ST1)) 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-10037, Rev 1, and DR-91-ZG-10045, Rev 0). Therefore, a subsea loss of well control is not considered credible in the event of a loss of platform integrity.

There are currently four production wells (John Brookes 2, 3, 5 and 6) at the WHP. In the event of a vessel collision with the WHP that results in significant damage to the WHP, the fail-safe–close actuated wing valves on the production trees will shut in, and the subsurface safety valves in each well will fail-safe close upon loss of control line pressure. Accordingly, a loss of well control at surface is not considered credible in the event of a vessel collision.

The maximum credible spill scenario at the WHP is a loss of well control at the surface at the WHP from well intervention activities. This is discussed in **Section 7.6**.

Subsea release of condensate from subsea wellheads

Spill scenarios were considered for all producing subsea wells and temporarily abandoned or P&A'd subsea wells **(Table 1-1)**.

For currently producing wells (Halyard-1, Spar-2) and the new Spartan-2 production well, it was assessed that causes of potential subsea releases from wells fell into two categories:

+ External influence, such as anchor or chain drag; and
+ Internal influence, such as loss of integrity from corrosion or erosion, fatigue cracking, over- or under pressure and cementing or seal failures.

The most severe external impact damage would come from a MODU anchor or chain snagging the wellhead. In-field MODUs are not considered, as no MODU will be used to undertake activities for this EP. If a MODU being used in an adjacent field were to break loose from its mooring, it is possible that it could drag anchors or chains. If one of these anchors or chains were to snag a wellhead, considerable force would be applied to the well casings and/or completion. A MODU chain or anchor only has sufficient tensile strength to bend a well completion, not to pull or separate it; therefore, the worst credible result would be a bent wellhead or casing assembly at the mudline with release through holes or cracks. A 100% full-bore blowout is not considered credible.

When considering the worst-case scenario due to internal influences an assessment of the barrier and risk for the producing wells was undertaken (**Table 7-11**). Well integrity failure can occur through a number of causal factors with the most severe of these being internal failure mechanisms as a result of corrosion, erosion, stress or fatigue cracking, over- or under pressure, over- or under temperature, and cementing or seal failures. Internal well integrity failures do not result in simultaneous failure of all barriers. Rather they present through ongoing, sometimes latent, failures that compound over time. The resultant worst-case release would therefore result from a leak due to impairment across multiple barriers, with release through holes or cracks. A 100% full-bore blowout is not considered credible.

A Technical File Note (TFN) – Greater Eastern Spar Worst Credible Hydrocarbon Spill Scenarios: Spar-2 (GE-51-RR-20001) has been developed to outline the worst case credible release from a loss of well integrity at Spar-2. The TFN outlines the loss of integrity calculations for the Spar-2 well given this well has been historically a higher producer than Halyard-1 and therefore release volumes are seen as conservative for the Halyard-1 well. The worst-case credible scenario for the Spartan-2 production well is expected to be less, but similar to that of Spar-2. A wellhead blowout scenario is not considered a credible scenario for this well during operations (as discussed above). Therefore, the Spar-2 worst-case credible scenario is considered representative of a worst-case release from the Spartan-2 well during operations.

For the temporarily abandoned and P&A'd wells a risk assessment of the well integrity and planned management activities was completed to inform the assessment of credible events (**Table 7-11**). Events considered were:

+ Loss of well containment due to barrier damage: Two barriers are in place for all abandoned and P&A'd wells (**Table 7-11)**, so if a wellhead was inadvertently damaged or removed through dropped objects or anchor drag, no loss of containment would occur. Therefore, the scenario of loss of well control from temporarily abandoned wellheads due to external damage is not considered credible and is not assessed further.

- Well leak: Given the leak path the gas would need to travel through the barriers in any of the subsea wells the likelihood of a gas flow to the seabed is assessed as rare but possible however under exceptional circumstances. Any leak would be slow as it would result from impairment across multiple barriers (not a full loss of containment) and duration limited through detection as part of monitoring undertaken in accordance with the WOMPs (**Table 7-11**). Therefore, any impacts would be less than the scenarios considered for the Spar-2 worst-case outlined above so no additional modelling was undertaken.

The subsea release of condensate from a wellhead is considered in **Section 7.8**.

Table 7-11: Well risk and ongoing management

Infrastructure	Status	Well integrity and risk assessment	Ongoing Management
Spartan-2 Well	Expected online Q3/Q4 2022	Full two-barrier envelope to the reservoir. All risks classified as medium or better.	Maintenance and monitoring activities as described in **Section 2** of this EP. Ongoing monitoring and management in accordance with the proposed WOMP.
Spar-2 Well	Active production well	Full two-barrier envelope to the reservoir. Well integrity review undertaken in 2016 and all risks classified as medium risk or better.	Maintenance and monitoring activities as described in **Section 2** of this EP. Ongoing monitoring and management in accordance with the WOMP (DR-91-ZG-10052).
Halyard-1 Well	Active production well	Well integrity review undertaken in 2017 and all risks classified as medium risk or better.	No intrusive well activities planned. Maintenance and ongoing operational activities as described in **Section 2** covered under this EP. Ongoing monitoring and management in accordance with the WOMP (DR-91-ZG-10052).
Rosella-1 (ST 2) Well	Plugged and temporarily abandoned with confirmed double barrier in place. Corrosion cap in place.	Well integrity review undertaken in 2016 and risk of well barrier failure resulting in a leak assessed as low risk. Given the leak path the gas would need to travel through the likelihood (during the period for the current WOMP in force) of a gas flow to the seabed is assessed as rare (possible however under exceptional circumstances).	Maintenance and monitoring as described in Section 2 of this EP. Ongoing monitoring and management in accordance with the WOMP (7735-200-IMP-0001 Rev 1). No plans to carry out further P&A activities unless deterioration detected. Any future well activities which involve contacting or entering the pressure envelope of this well will be covered by revisions to both the current WOMPs and the EP.
East Spar-3 well	Reservoir permanently abandoned. Two verified permanent barriers installed	No risk of loss of containment as reservoir successfully permanently abandoned.	Ongoing monitoring and management in accordance with the WOMP (DR-91-ZG-10051 Rev 2).

	to the reservoir. Well classified as temporarily abandoned due to XT and wellhead remaining in place. HXT protected by HXT debris cap.		Any future well activities which involve contacting or entering the pressure envelope of this well will be covered by revisions to both the current WOMPs and the EP.
East Spar-4A (ST 1) well	Well temporarily abandoned. Confirmed double barrier - Wellhead corrosion caps and guide base protection frame and abandoned.	Well integrity review undertaken in 2016 and risk of well barrier failure resulting in a leak assessed as low risk. Given the leak path the gas would need to travel through the likelihood (during the period for the current WOMP in force) of a gas flow to the seabed is assessed as rare (possible however under exceptional circumstances).	Maintenance and monitoring as described in **Section 2** of this EP. Ongoing monitoring and management in accordance with the WOMP (7915-200-IMP-0001 Rev 0). No plans to carry out further P&A activities unless deterioration detected. Any future well activities which involve contacting or entering the pressure envelope of this well will be covered by revisions to both the current WOMPs and the EP.
East Spar 6 Well	Reservoir permanently abandoned. Two verified permanent barriers installed to the reservoir. Well classified as temporarily abandoned due to XT and wellhead remaining in place. HXT protected by HXT debris cap.	No risk of loss of containment as reservoir plugged and permanently abandoned.	Ongoing monitoring and management in accordance with the WOMP (DR-91-ZG-10051 Rev 2). Any future well activities which involve contacting or entering the pressure envelope of this well will be covered by revisions to both the current WOMPs and the EP.
East Spar-7 Well	Well temporarily abandoned - Xmas tree remains in place (valves closed). Confirmed double barrier. Protected by wellhead corrosion caps installed and guide-base structure	Well integrity review undertaken in 2016 and risk of well barrier failure resulting in a leak assessed as low risk. Given the leak path the gas would need to travel through the likelihood (during the period for the current WOMP in force) of a gas flow to the seabed is assessed as rare (possible however under exceptional circumstances).	In accordance with this EP. Ongoing monitoring and management in accordance with the WOMP (7915-200-IMP-0001 Rev 0). No plans to carry out further P&A activities unless deterioration detected. Any future well activities which involve contacting or entering the pressure envelope of this well will be covered by revisions to both the current WOMPs and the EP.

East Spar-9 Well	Well temporarily abandoned. Confirmed double barrier - Protected by wellhead corrosion caps installed and guide-base structure	Well integrity review undertaken in 2016 and risk of well barrier failure resulting in a leak assessed as low risk. Given the leak path the gas would need to travel through the likelihood (during the period for the current WOMP in force) of a gas flow to the seabed is assessed as rare (possible however under exceptional circumstances).	In accordance with this EP. Ongoing monitoring and management in accordance with the WOMP (7915-200-IMP-0001 Rev 0). No plans to carry out further P&A activities unless deterioration detected. Any future well activities which involve contacting or entering the pressure envelope of this well will be covered by revisions to both the current WOMPs and the EP.

Subsea release of condensate from a Subsea Pipeline

It is considered credible that an unplanned release of condensate and gas could occur from the John Brookes or East Spar subsea pipelines, or the Spartan flowline. 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 John Brookes pipeline (largest hydrocarbon storage capacity of 210 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 a subsea pipeline in Commonwealth waters is considered in **Section 7.7.**

Vessel Release

It is considered credible that a release of diesel to the marine environment could occur from a support vessel collision with the John Brookes 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.

7.5.3 Spill Modelling Information

To assess the potential risks of exposure to hydrocarbons, stochastic spill risk modelling was completed by Asia-Pacific Applied Science Associates (APASA) during 2013/2014 to support the original EP submission (APASA, 2013a to f; APASA, 2014a, b). In 2019, the spill modelling results for these scenarios were reprocessed to reflect revised impact thresholds using a purpose-developed three-dimensional oil spill trajectory and weathering model (SIMAP) (RPS 2019). This model is designed to simulate both the physical transport and weathering processes that affect the outcomes of hydrocarbon spills to the sea. The model also accounts for the interaction between weathering and transport processes. For sub-surface releases, the

SIMAP model is used in conjunction with the Oilmap model which predicts the centreline velocity, buoyancy, width and trapping depth (if any) to supply the rising gas and oil plume dimensions.

Stochastic modelling was performed based on the following inputs:

+ Current drift based on 1997-2006 hindcast BRAN outputs (24 hour averaged, 0.1º horizontal spatial resolution);
+ Tidal circulation based on a variable resolution HYDROMAP model with 15km, 7.5km, 3.75km and 1.88km cell size. Bathymetric data based on CMAP and AHO chart data and Topex/Poseidon global tidal data use tidal forcing data. Validation of the model was undertaken with a very good match for tidal behaviour in terms of amplitude and diurnal and semi-diurnal signals;
+ Spatial wind fields sourced from the National Centre for Environmental Prediction (NCEP) for 1997-2006;
+ Vertical profiles of sea temperature and salinity at the spill location were retrieved from a data point in the World Ocean Atlas 2013 closest to the John Brookes pipeline with monthly averages used as the input; and
+ A horizontal dispersion coefficient of $10m^2/s$ at the surface and $1m^2/s$ in the water column was used to account for dispersive processes that are below the model resolution based on empirical data for the North West Shelf.

Seasonal periods were defined as: Summer (October to March), winter (May to August) and combined transition (April and September). For each scenario, 100 replicate simulations are undertaken for each season giving a total of 300 replicate simulations per scenario.

Each run is initialised at different, randomly selected points in time for that seasonal period and hence under a different time series of environmental conditions. This stochastic sampling approach provides an objective measure of the possible outcomes of a spill, because environmental conditions will be selected at a rate that is proportional to the frequency that these conditions occur over the study area. More simulations will tend to use the most commonly occurring conditions, while conditions that are more unusual will be represented less frequently. This gives the widest possible extent of oil dispersion.

During each simulation the SIMAP model records the location (by latitude, longitude and depth) of each particle (representing a given mass of oil) on or in the water column, at regular steps. For any particulars that contact a shoreline, the model records the accumulation of oil mass that arrives on each section of shoreline over time, less any mass that is lost to evaporation and/or subsequent removal by current and wind forces. The collective records from all simulations are then analysed by dividing the study region into a three-dimensional grid (minimum resolution 0.4 km).

The concentrations of oil may then be analysed to determine whether concentration estimates exceed defined threshold concentrations over time. Risks are then summarised as follows (noting similar treatments for entrained and dissolved aromatic hydrocarbons):

+ The probability of exposure to a location is calculated by dividing the number of spill simulations where any instantaneous contact occurred above a specified threshold at that location by the total number of replicate spill simulations (For example, if contact occurred at a location (above a specified threshold) during 21 out of 100 simulations, a probability of 21% is indicated; and
+ The minimum potential time to a shoreline location is calculated by the shortest time over which oil at a concentration above a threshold was calculated to travel from the source to the locations in any of the replicate simulations.

The stochastic modelling results provides an objective indication of all locations that may be exposed or contacted by oil above the impact thresholds, however it does describe a larger potential area of influence than can be expected from any one single spill event.

7.5.4 Hydrocarbon Characteristics

A summary of the representative hydrocarbon characteristics, as assessed in this EP, is provided in **Table 7-12**.

Table 7-12: Summary of Hydrocarbon Characteristics

Oil Type	Initial Density (g/cm^3)	Viscos-ity (cP)	Component	Vola-tiles (%)	Semi-vola-tiles (%)	Low Volatility (%)	Residual (%)	Aromatics (%)
			Boiling Points (°C)	<180 C4 to C10	180-265 C11 to C15	265 – 380 C16 to C20	>380 > C20	Of Whole Oil < 380
				NON-PERSISTENT			PERSIS-TENT	
Diesel	0.8368 @ 15°C	4 @ 15°C	% of total	6	34.6	54.4	<5	3.0
John Brookes condensate	0.785	1.229		64.0	24.3	9.7	2.0	23.6
Halyard condensate	0.781	1.26		86.4.	10.7	2.8	0.1	15.2
East Spar condensate	0.726	1.26		74.7	19.3	6.0	0.0	6
Spartan condensate	0.797	0.62		73.2	16.8	6.7	3.3	14.9

Note: < = less than; > = greater than.

Source: RPS (2019, 2021).

Further hydrocarbon characteristics for the John Brookes condensate include:

- Water cut = 20%
- Asphaltene content (% mass) = <0.50 resulting in low tendency for the hydrocarbons to take up water to form water-in-oil emulsions.
- Wax Content (% mass) = <5
- Pour Point (ºC) = -36ºC ensuring the hydrocarbon will remain in a liquid state over the annual temperature range observed on the North West Shelf.
- Condensate to Gas ratio= 187.15 scf/bbl

Santos have confirmed the John Brookes condensate hydrocarbon properties through hydrocarbon testing conducted in 2014 (Intertek Commodities, 2014), with these properties used to inform the spill modelling in this EP. The John Brookes condensate properties measured in 2014 are considered to be representative of current condensate properties. There have been no new wells commissioned since the time of testing and the relative contribution of wells to production has been consistent over time from when the assay was conducted.

A series of model weather tests were conducted to illustrate the potential behaviour of John Brookes condensate when exposed at the water surface to different wind conditions. The results indicate that wind conditions will have an impact on the proportion of condensate, with higher winds leading to increased entrainment. The weathering profile for a subsea John Brookes condensate release (**Figure 7-1**) indicated that evaporation would be the major mechanism for reducing the volume of condensate. Approximately 70% of the total volume of John Brookes condensate is predicted to evaporate within one day of release. The portion of John Brookes condensate that is predicted to entrain (5 to 12%) would be subject to dissolution and natural decay within the water column with further resurfacing and evaporation possible, depending on wind and wave conditions.

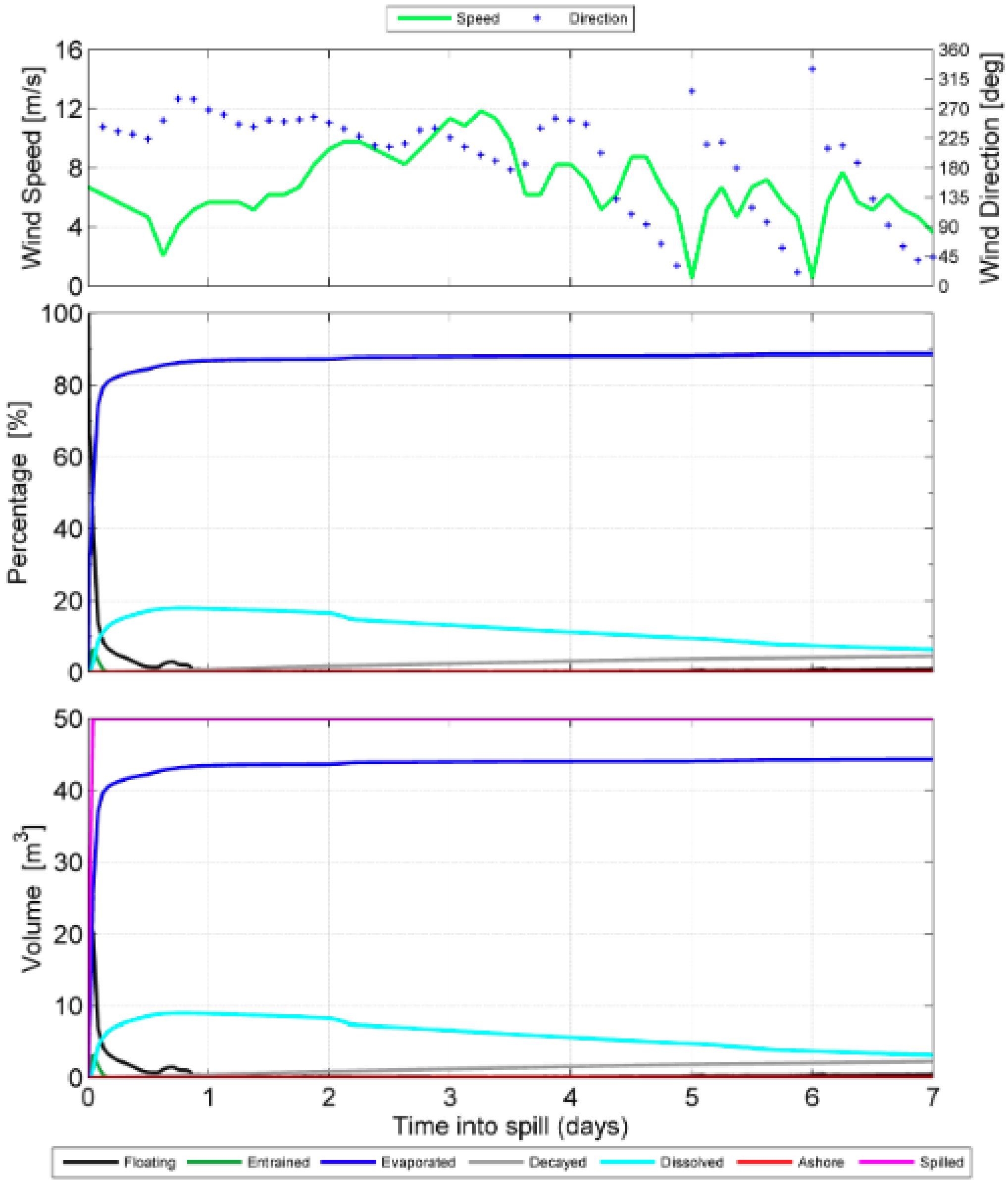

Figure 7-1: Mass balance plot representing, as proportion (middle panel) and volume (bottom panel) the weathering of John Brookes Condensate

Note: This represents spill into the water column as a single release (50m^3 over 1 hour) and subject to variable wind at 27°C water temperature and 25°C air temperature.

7.5.5 Hydrocarbon Exposure Values

The EMBA identified in Figure **3-1** was identified using low exposure values, identifying receptors which might be contacted by hydrocarbons in the highly unlikely event of an oil spill. These low thresholds are not considered environmentally significant (e.g. not representative of a biological impact (NOPSEMA 2019).

The moderate and high hydrocarbon exposure values are modelled for each fate of hydrocarbon to identify what contact is predicted for surface (floating oil), subsurface (entrained oil and dissolved aromatic hydrocarbons), and shoreline accumulation of hydrocarbon at sensitivities. These exposure values then identify predicted levels of contact that are relevant to environmental impact and spill response concentrations.

The determination of environmentally 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 type making the contact. The toxicity of a hydrocarbon will change over time, due to weathering processes altering the composition of the hydrocarbon.

In addition to environmental impact and risk assessment, exposure values meaningful to oil spill response planning have been developed to determine the conditions in which response strategies would be effective (refer to the OPEP).

The selected hydrocarbon exposure values are consistent with NOPSEMA Bulletin #1 Oil Spill Modelling (April 2019) and are discussed further in **Table 7-13**, **Table 7-14**,

Table 7-15 and

Table 7-16.

Table 7-13: Floating hydrocarbons exposure values

Floating Oil Concentration (g/m^2)	Exposure Value	Description
1	Low	**Risk Evaluation (EMBA)** 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. Although this is lower than the threshold for ecological impacts, it may be relevant to socio-economic receptors and has been used as the exposure value to define the spatial extent of the environment that might be contacted (EMBA) from floating oil. **Response Planning** Contact at 1 g/m^2 (as predicted by oil spill trajectory modelling) is used as a conservative trigger for activating scientific monitoring plans as detailed in the OPEP.
10	Moderate	**Risk Evaluation** There is a paucity of data on floating oil concentrations with respect to impacts to marine organisms. Hydrocarbon concentrations for registering biological impacts resulting from contact of surface slicks have been estimated by different researchers at about 10–25 g/m^2 (French et al., 1999; Koops et al., 2004; NOAA, 1996). The impact of floating oil on birds is better understood than on other receptors. A conservative threshold of 10 g/m^2 has been applied for when ecological impacts would commence 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). **Response Planning** Contact at 10 g/m^2 is estimated minimum threshold for commencing operational and/or scientific monitoring components.
25	High	**Risk Evaluation** At greater thicknesses the potential for impact of floating oil to wildlife increases. Studies have indicated that a concentration of surface oil 25 g/m^2 or greater would be harmful for all birds that contacted the hydrocarbon slick (Scholten et al. 1996; Koops et al. 2004). This was chosen as a conservative

Floating Oil Concentration (g/m²)	Exposure Value	Description
		threshold for high impacts due to the foraging (sooty tern), breeding and foraging (lesser frigatebird); and breeding (wedge-tailed shearwater, Australian fairy tern, lesser crested tern, white-tailed tropicbird and roseate tern) that overlap the operational area. **Response Planning** Contact at 25 g/m² is not specifically used for spill response planning.

Table 7-14: Shoreline hydrocarbon accumulation exposure values

Shoreline Accumulation (g/m²)	Exposure Value	Description
10	Low	**Risk Evaluation (EMBA)** An accumulated concentration of oil above 10 g/m² on shorelines is considered to represent a level of socio-economic effect (NOPSEMA, 2019), e.g. reduction in visual amenity of shorelines. This value has been used in previous studies to represent a low contact value for interpreting shoreline accumulation modelling results (French-McCay, 2005, 2006). **Response Planning** Not specifically used for response planning because accumulations at this concentration cannot be effectively cleaned.
100	Moderate	**Risk Evaluation** The 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/m²) 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 exposure value for impacts of 100 g/m² has been applied to impacts from shoreline accumulation of hydrocarbons. **Response Planning** A shoreline concentration of 100 g/m², or above, is likely to be representative of the minimum limit that the oil can be effectively cleaned according (AMSA, 2015; NOPSEMA, 2019) and is therefore used as a guide for shoreline clean-up planning. This threshold equates to approximately ½ a cup of oil per square metre of shoreline contacted.

Shoreline Accumulation (g/m²)	Exposure Value	Description
1,000	High	**Risk Evaluation** At greater thicknesses the potential for impact of accumulated oil to shoreline receptors increases. All other things being equal, accumulation of oil above 1000 g/m² is expected to result in a greater impact. **Response Planning** As oil increases in thickness the effectiveness of oil recovery techniques increases. This value can therefore be used to prioritise oil recovery efforts, assuming oil recovery is deemed to have an environmental benefit.

Table 7-15: Dissolved aromatic hydrocarbon exposure values

Dissolved hydrocarbons (ppb)	Exposure Value	Description
6	Low	**Risk Evaluation (EMBA)** Dissolved Aromatic Hydrocarbons include the monoaromatic 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). Further research by Woodside (Woodside 2019) for Balnaves-3 crude undertook laboratory-based ecotoxicology tests across a range of water accommodated fraction to determine the point of "No observed effect Concentrations (NOECs). The lowest NOEC reported is 123 ppb, from the amphipod acute toxicity tests. All other toxicity tests indicated NOECs ranging from 610 to 6640 ppb, with a median value of 2695 ppb. Based on these ecotoxicology tests, the selected dissolved aromatic hydrocarbon threshold of 6 ppb is considered highly conservative. 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 as the lowest concentration documented in research that could have some potential negative effect on marine organisms. This is considered to be sub lethal, with most marine

		organisms a concentration of between 50 and 400 ppb is considered to be more appropriate for risk assessment. **Response Planning** Contact at 6 ppb (as predicted by oil spill trajectory modelling) is used as a trigger for activating scientific monitoring plans as detailed in the OPEP. Establishes planning area for scientific monitoring based on potential for exceedance of water quality triggers (NOPSEMA, 2019).
50	**Moderate**	**Risk Evaluation** Approximates potential toxic effects, particularly sublethal effects to sensitive species (refer to above text). Consistent with NOPSEMA (2019). **Response Planning** Encompassed by response to 6ppb. There is nothing different for higher exposure values.
400	**High**	**Risk Evaluation** Approximates toxic effects including lethal effects to sensitive species (NOPSEMA, 2019). **Response Planning** Encompassed by response to 6 ppb. There is nothing different for higher exposure values.

Table 7-16: Entrained hydrocarbon exposure values

Entrained hydrocarbons (ppb)	Exposure Value	Description
10	**Low**	**Risk Evaluation (EMBA)** 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 total water accommodated fraction (TWAF (entrained and dissolved)) may 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.

		The 10 ppb threshold represents the very lowest concentration and corresponds generally with the lowest trigger levels for chronic exposure for entrained hydrocarbons in the ANZECC (2019) water quality guidelines. This is consistent with NOPSEMA (2019) guidance. **Response Planning** Contact at 10 ppb (as predicted by oil spill trajectory modelling) is used as a trigger for activating scientific monitoring plans as detailed in the OPEP. Establishes planning area for scientific monitoring based on potential for exceedance of water quality triggers (NOPSEMA, 2019).
100	Moderate	**Risk Evaluation** The 100 ppb exposure value is considered to be more representative of sub-lethal impacts to most species and lethal impacts to sensitive species based on toxicity testing as described above. This is considered conservative as toxicity to marine organisms from oil is likely to be driven by the more bioavailable dissolved aromatic fraction, which is typically not differentiated from entrained oil in toxicity tests using water accommodated fractions (WAFs). Given entrained oil is expected to have lower toxicity than dissolved aromatics, especially over time periods where these soluble fractions have dissoluted from entrained oil, the higher Moderate exposure value for entrained oil over dissolved aromatic hydrocarbons (100 vs 50 ppb) is considered appropriate. **Response Planning** Encompassed by response to 10 ppb. There is nothing different for higher exposure values

7.5.6 Spill Risk Assessment Approach

The spill risk assessment approach adopted is based on Santos' Oil Spill Risk Assessment and Response Planning Procedure (SO-91-II-20003).

A consistent risk assessment approach is applied to unplanned hydrocarbon release scenarios. The spill risk assessment approach is based on Santos' Oil Spill Risk Assessment and Response Planning Procedure (SO-91-II-20003). The procedure describes the spill risk assessment process as follows:

+ identify the spatial extent of the EMBA. This has been completed for this Spartan Development Addendum to the Varanus Island Hub Operations EP as part of the assessment of the existing environment and receptors that are known to occur or may occur within the EMBA are described in **Section 3.2** and **Appendix C**;
+ identify areas of high environmental value (HEV) within the EMBA (HEVs are described in **Section 7.5.6.2**);
+ Identify and then risk assess hot spots. Hot spots are effectively a subset of HEVs, and their determination is described in **Section 7.5.6.3;** and
+ identify priorities for protection (for consideration of spill response strategies in the OPEP)

7.5.6.1 Spill EMBA

Defining the EMBA by an oil spill is the first step in oil spill risk and impact 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 is used to define the overall EMBA for the activity. The EMBA is further described in **Section 3.1**. To determine the potential impact to receptors within the EMBA, the MEVA is used to determine them as described in **Section 3.1**.

7.5.6.2 Areas of High Environmental Value

Santos has predetermined areas of HEV (**Figure 7-2**) 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.

7.5.6.3 Hot Spots

While the entire MEVA 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 – considered by Santos to be HEV areas ranked 1 to 3;
- highest probability of contact by oil (either floating, entrained or dissolved aromatic); and
- greatest potential concentration or volume of oil arriving at the area.

These areas are termed 'hot spots'. Defining hots pots 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 exposure value 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 DAH above contact exposure values described in **Section 7.5.5**.

A workshop was held to review the hotspots for the Varanus Island Hub operations activities worst case oil spill scenario. During the workshop, additional hotspots may be included through discretion of workshop attendees where they do not strictly meet all of the above criteria. E.g. an HEV ranked 1-3 with <5% probability, or an HEV ranked 4 or 5 with >5% probability, depending on the concentrations and volumes presented in the modelling report.

During a hotspot workshop, an environment consequence assessment is conducted against each of the hotspots identified using the Santos risk assessment process identified in **Section 5**, the outcome of this is provided in **Appendix G**.

7.5.6.4 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 (emergent features) should have specific spill response planning conducted. This final determination of '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 exposure value concentrations.

Further detail on selection of Protection Priority Areas process is detailed in the Oil Spill Risk Assessment and Response Planning Procedure (SO-91-II-20003).

The following Hot Spot locations have been identified as Priorities for Protection areas for oil spill response planning within the Varanus Island Hub Operations OPEP and are based on the worst-case estimate of surface oil concentration, shoreline loading and minimum contact time at exposure value concentrations for the Varanus Island Hub operations activities:

+ Muiron Islands;
+ Barrow and Montebello Islands Surrounds
+ Montebello Islands; and
+ Barrow Island

The oil spill response strategies for Priority for Protection areas are undertaken within the Varanus Island Hub Operations OPEP.

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.

7.5.7 Spill Response Strategies

Numerous oil spill response strategies are available to be implemented in the event of a spill. These are generally strategies that have been implemented in the past or are considered good industry practice. Section 7 of the OPEP provides a detailed description of the applicable response strategies for this activity, which include, depending on the type and size of the spill:

+ source control
+ monitor and evaluate
+ mechanical dispersion
+ shoreline protection and deflection
+ shoreline clean-up
+ oiled wildlife
+ scientific monitoring.

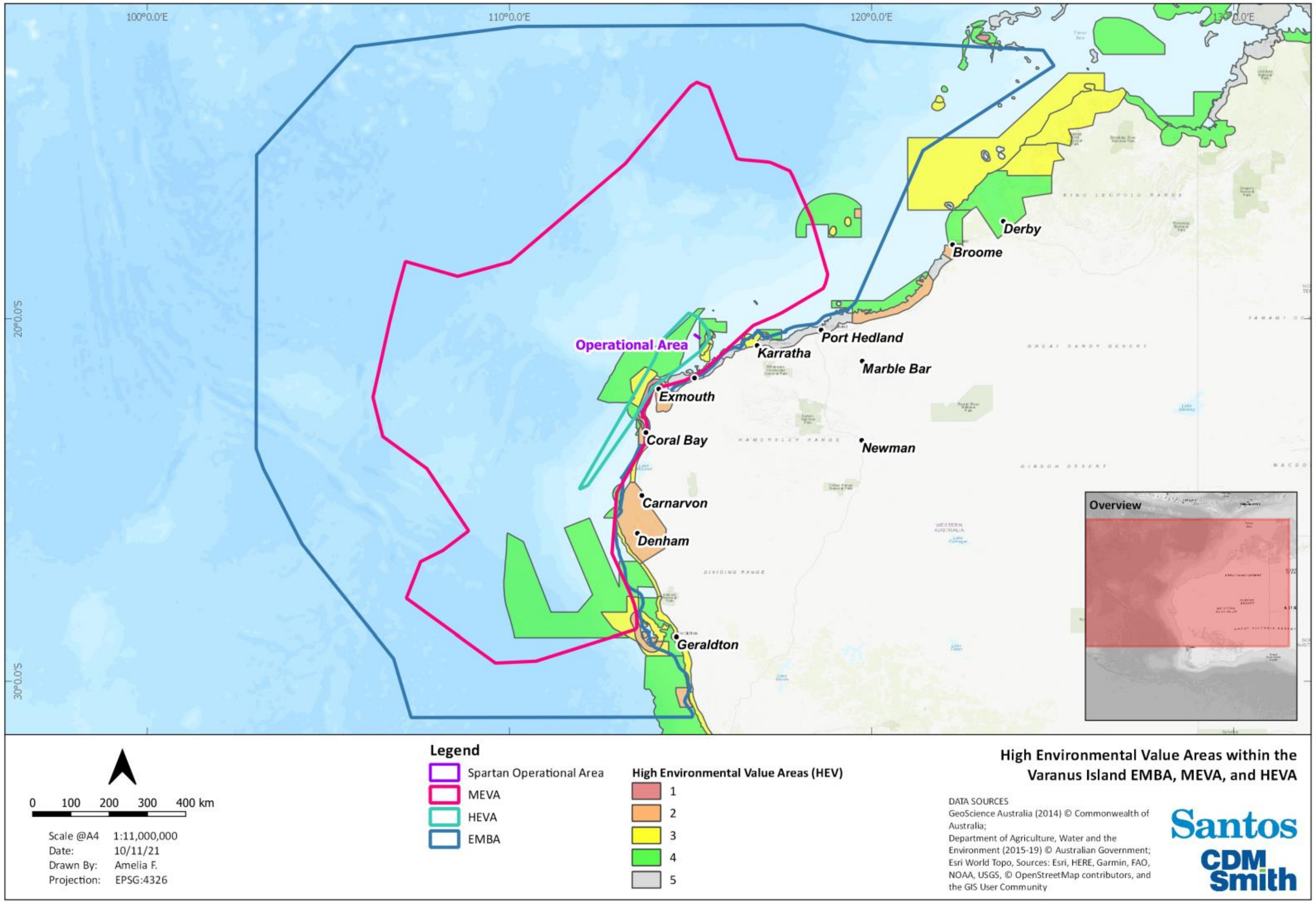

Figure 7-2: High Environmental Value Areas

7.5.7.1 Potential Hydrocarbon Impact Pathways

To help inform the hydrocarbon spill risk assessment generic receptors and potential impact pathways have been defined (**Table 7-17**). The potential impact pathways considered physical and chemical affects. Physical pathways include contact from floating oil, accumulated shoreline oil, or entrained oil droplets. Chemical pathways include ingestion, inhalation or contact from any hydrocarbon phase. These are summarised in **Table 7-17** and the information is drawn upon within the hydrocarbon risk assessment for each spill scenario (**Section 7.6 - 7.9). Table 7-18** further describes the nature and scale of the hydrocarbons spills for this activity on marine fauna and socio-economic receptors found within the EMBA and moderate exposure value contour.

Table 7-17: Physical and Chemical Pathways for Hydrocarbon Exposure and Potential Impacts to Receptors

Receptor	Physical Pathway	Potential Impacts	Chemical Pathway	Potential Impacts
Rocky shore	Shoreline loading and attachment may result in thin and sporadic coating of hydrocarbon residues. Degree of oil coating depends on the energy of the shoreline area, the type of the rock formation and continual weathering of the oil.	Impacts to flora (mangroves) and fauna further described below.	Chemical pathway to fauna and flora via adsorption through cellular membranes and soft tissue, ingestion, irritation/burning on contact and inhalation	Impacts to flora (mangroves) and fauna further described below.
Sandy shore	Shoreline loading and water movement may allow hydrocarbon 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 oil.	Indirect impacts to nesting and foraging habitats for birds and turtles. Direct impacts to infauna.	Chemical pathway to fauna and flora via adsorption through cellular membranes and soft tissue, ingestion, irritation/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 hydrocarbon residue to filter down into sediment, 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 oil.	Indirect impacts to foraging habitats for birds and turtles. Direct impacts to infauna.	Chemical pathway to fauna and flora via adsorption through cellular membranes and soft tissue, ingestion, irritation/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	Chemical Pathway	Potential Impacts
Mangroves	Coating of root system may reduce 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 oil.	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 or thalli may reduce 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 oil.	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 and shading may result 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 oil.	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.

Receptor	Physical Pathway	Potential Impacts	Chemical Pathway	Potential Impacts
				Reduced reproductive output. 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 oil.	Mortality. Behavioural disruption. Impaired growth.	Ingestion and inhalation. External contact and adsorption across exposed skin and cellular membranes. Uptake of dissolved aromatic hydrocarbons across cellular membranes. Reduced mobility and capacity for oxygen exchange.	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, including sharks and rays	The coating of adults, but primarily eggs and larvae causes reduced mobility and reduced 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.

Receptor	Physical Pathway	Potential Impacts	Chemical Pathway	Potential Impacts
				Reduced egg or larval success. Growth abnormalities. Behavioural disruption.
Birds (seabirds and shorebirds)	Degree of coating depends on the energy and tidal reach of the shoreline, the type of the receptor and continual weathering of the oil.	Feather and skin irritation and damage. It is commonly thought that condensate/diesel does not cause problems to wildlife due to the lack of visible oiling; however, they may suffer toxic effects (DPaW, 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	Degree of coating depends on the energy and tidal reach of the shoreline, the type of the receptor and continual weathering of the oil.	Behavioural disruption. It is commonly thought that condensate/diesel does not cause problems to wildlife due to the lack of visible oiling; however, they may suffer toxic effects (DPaW, 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.

Receptor	Physical Pathway	Potential Impacts	Chemical Pathway	Potential Impacts
				Behavioural disruption.
Marine mammals	Fur damage and matting, reduced mobility and buoyancy (for applicable species). Coating of feeding apparatus in some species (i.e., baleen whales).	It is commonly thought that condensate/diesel does not cause problems to wildlife due to the lack of visible oiling; however, they may suffer toxic effects (DPaW, 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 reproductive output. Growth abnormalities. Behavioural disruption.

Table 7-18: Nature and Scale of Hydrocarbons Spills on Environmental and Socio-economic Receptors

Receptor	Nature and Scale of Hydrocarbon Spills
Marine fauna	
Marine mammals	+ Twelve migratory marine mammal species were identified by the EPBC Protected Matters search for the EMBA (**Section 3.2.4**). Of these, two are listed as endangered (blue whale and southern right whale) and three as vulnerable (humpback whale, fin whale and sei whale). + The Blue whale and humpback whale BIAs (**Figure 3-7**) and a dugong BIA for foraging, breeding, calving and nursing (**Figure 3-8**) are within the extent of the moderate exposure value described in **Section 7.5.5**. + Other migratory marine mammals may encounter either surface or water-column hydrocarbons within the extent of the moderate exposure value; however, in the absence of any known feeding, resting or breeding areas, significant numbers are unlikely to be contacted.
Marine reptiles	+ Six species of threatened marine reptile were identified as possibly being contacted by a spill. Short-nosed seasnake, 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 hydrocarbon spill occurring, individuals traversing open water may come into contact with water-column or surface hydrocarbons. + BIAs and critical habitat for four turtle species (flatback, green, hawksbill and loggerhead) are found within the extent of the moderate exposure value. + Significant green turtle and flatback turtle rookeries are located, respectively, on the western side of Barrow Island and on the Montebello Islands within the extent of the moderate exposure value. + Other important nesting beaches for other species are present within the extent of the moderate exposure value including accumulation on shorelines.

Receptor	Nature and Scale of Hydrocarbon Spills
Seabirds and shorebirds	+ Forty-two threatened species of seabirds and shorebirds were identified by the EPBC Protected Matters database search (**Table 3-6**). The Australian lesser noddy, lesser crested tern and Australian fairy tern (all vulnerable status) have BIAs for foraging that overlap the extent of the moderate exposure value. + The fairy tern has a BIA for breeding within the EMBA and moderate exposure threshold value (**Figure 3-15**). Therefore, the species may be contacted by surface, entrained or dissolved aromatic hydrocarbons while foraging (dive and skim feeding), with higher numbers expected during the breeding period of August to February. + Surface and entrained condensate/diesel is unlikely to contact nesting or egg-laying individuals in colonies; however, it is possible that individuals could come in contact with surface or entrained hydrocarbons or dissolved aromatic hydrocarbons while foraging.
Fish, sharks and rays	+ Threatened species identified by the EPBC Protected Matters search include the white shark, whale shark, grey nurse shark and green and dwarf sawfish, which may be present in the EMBA. However, given the absence of critical habitat for most of these species, significant numbers are not expected to be exposed to hydrocarbons in the event of a spill. + Grey nurse sharks and white sharks could be present at low densities all year round within the operational area and EMBA; with no known feeding, resting or breeding areas. + The operational area and therefore the hydrocarbon moderate exposure value overlaps the whale shark foraging BIA (**Table 3-6**). However, the main whale shark aggregation location (Ningaloo Marine Park) is 129 km southwest of the operational area. + While the BIA is for foraging, it is not for high-density prey where congregations are expected, so hydrocarbon contact is expected to be limited to transient migrating individuals.
Plankton (including zooplankton and fish and coral larvae)	+ 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 contacted by hydrocarbons (condensate, diesel) entrained in the water column. + Given the duration of fish spawning periods, lack of suitable habitat for aggregating fish populations near the surface, and the quick evaporation and dispersion of condensate and diesel, contact to overall fish populations are not expected to be significant. + Contact will be greatest in the upper 10 m of the water column and in areas close to the spill source where hydrocarbon concentrations are likely to be highest.

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Receptor	Nature and Scale of Hydrocarbon Spills
Socio-economic	
Protected areas	Protected areas within the moderate hydrocarbon exposure value are listed in **Section 3.2.3**, described in **Appendix C**, and summarised below. + Ningaloo Coast World Heritage Area o Includes important and significant natural habitats for in-situ conservation of biological diversity, including threatened species. Significant geomorphic features, natural phenomena and areas of exceptional natural beauty. + Shark Bay, Western Australia o The Shark Bay region represents a meeting point of three major climatic regions and contains abundant marine flora and fauna. In particular, it has extensive seagrass meadows that support a large dugong population. + Australian Marine Parks: Montebello Marine Park, Ningaloo Marine Park, Gascoyne Marine Park, Carnarvon Canyon Marine Park, Shark Bay Marine Park, Abrolhos Marine Park, Argo-Rowley Terrace Marine Park. o Include habitat for foraging and migratory seabirds and foraging or breeding areas for marine turtles and dugongs. + State Marine Parks and Marine Management Areas: Barrow Island Marine Park, Barrow Island Marine Management Area, Montebello Islands Marine Park, and Muiron Islands Marine Management Area. + Includes foraging and nesting areas for marine turtles and feeding, resting and breeding areas for seabirds and migratory shorebirds.
KEFs	One KEF is within the moderate hydrocarbon exposure value: + Glomar Shoals The Glomar Shoals are a submerged feature situated at a depth of 33 to 77 m, approximately 150 km north of Dampier on the Rowley Shelf. Modelling predicted entrained oil at Glomar Shoals reaching the moderate exposure value A surface release of hydrocarbons to the marine environment would result in a localised reduction in water quality in the upper surface waters of the water column (particularly the top 10 m). Therefore, hydrocarbon contact to the habitats of the KEFs from a surface release is not considered likely. However, a subsea release from a wellhead may cause a reduction in water quality with exposure to entrained and/or dissolved aromatic hydrocarbons extending for up to several hundred kilometres for the worst-case credible spill scenario (loss of well control). Potential contact to values and sensitivities within the above KEFs are described above for the specific receptor groups (e.g., fish, marine mammals). Are described in **Section 3.2.3** and **Appendix C** and are summarised below.

Receptor	Nature and Scale of Hydrocarbon Spills
Fisheries	+ Several commercial and state fisheries are found within the EMBA (captured in **Table 3-8**) and moderate hydrocarbon exposure value described in **Section 7.5.4.**
Tourism	+ There are many sources of marine-based tourism within the EMBA (**Table 3-8**), and moderate hydrocarbon exposure value described in **Section 7.5.4**. + Aquatic recreational activities, such as boating, diving and fishing, do occur around the Montebello Islands but are predominantly concentrated in the vicinity of the population centres, such as Exmouth, Dampier and Onslow. In particular, tourism is expected in the Ningaloo region. + In the waters within and immediately surrounding the operational area, tourism activities are expected to be low. However, exclusion zones surrounding a spill will reduce access for vessels for the duration of the response undertaken for spill clean-up (if applicable) and may prevent water based tourism activities in certain areas.
Shipping	+ Three shipping fairways intersect the EMBA (**Table 3-8; Figure 3-20)** Hydrocarbons in the water column will have no effect on shipping. + Exclusion zones surrounding a spill may reduce access for shipping vessels for the duration of the response undertaken for spill clean-up (if applicable) meaning vessels may have to take 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, interference with defence activities due to a hydrocarbon spill is expected to be minimal (**Table 3-8)**.
Shipwrecks	+ The closest historic shipwreck (the *Trial*) is located approximately 15 km on the western side of the Montebello Islands. Shipwrecks may be of important heritage value and/or act as dive sites (**Table 3-8**). + Surface hydrocarbons will have no impact on shipwrecks. + Hydrocarbons in the water column either as entrained oil or dissolved aromatic hydrocarbons may extend several hundreds of kilometres from the release location. The potential for in-water hydrocarbons to impact on shipwrecks is poorly documented; however, it has been proposed that exposure to oil and/or dispersant may alter bacterial community composition (biofilms) inhabiting shipwrecks, possibly altering corrosion potential (Salerno *et al*., 2016).
Indigenous users	+ Marine resource use by indigenous people is generally restricted to coastal waters. Fishing, hunting and the maintenance of maritime culture and heritage through ritual, stories and traditional knowledge continue as important uses of the nearshore region and adjacent areas. The level of activities undertaken by indigenous users is expected to be low; therefore, interference due to a hydrocarbon spill is expected to be minimal (**Table 3-8**).

Receptor	Nature and Scale of Hydrocarbon Spills
Existing oil and gas activity	+ Exclusion zones surrounding spills will reduce access, potentially resulting in delays to work schedules with possible subsequent financial implications. Chevron’s Gorgon and WA Oil operations on Barrow Island may be impacted in the event of an unplanned spill event through exclusion or access restrictions in the event of spill response and clean-up activities (if applicable).

7.6 Surface Release of Condensate from Wellheads at the John Brookes WHP

7.6.1 Description of Event

Event	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 surface, and a loss of well control at surface through the completion string is considered credible (although very unlikely) and represents the worse-case discharge scenario for the wells during the production lifecycle phase. The maximum credible spill volume from a loss of well control at surface is estimated at 39,011 m^3 released over 100 days (rate of 16.25 m^3/hr). The 16.25 m^3/hr flow rate represents the maximum possible 100% flow rate estimated for these wells.
Extent	At the surface-concentration environmental impact threshold of 10 g/m^2, the potential extent of floating surface oil is approximately 26.5 km west from the release site. Surface oil may be visible 160 km from the release site at concentrations above the 1 g/m2 threshold. Direct contact of shorelines with slicks (greater than 10 g/m^2) was not predicted. However, there was a potential for thinner sheens (at or below 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 the Montebello Islands (33 m^3) within 171 hours (approximately 7 days). Entrained oil in the water column above the impact threshold of 100 ppb is predicted to occur within a region up to 1,143 km from the release site. Dissolved aromatic hydrocarbons in the water column above an impact threshold of 6 ppb are predicted to occur up to 1,370 km from the release site.
Duration	In determining the worst-case volume that could be released from a John Brookes production well loss of containment, the guidance provided in the AMSA Technical Guideline for the Preparation of Marine Pollution Contingency Plans for Marine and Coastal Facilities (AMSA, 2015) has been used. Specifically, the calculations presented in Table 10 of the AMSA guideline for a production platform blowout have been considered. AMSA (2015) determines the volume released from a production platform blowout as the predicted flow rate per day x days estimated to get a relief rig on site + 20 days to cap a well. A maximum 100% flow rate of 390.11 m^3/d for 100 days has been determined to yield a total release volume of 39,011 m^3 of condensate. Rather than using the AMSA assumption of mobilisation time + 20 days to cap a well, the release period herein (100 days) is based on a conservative rig mobilisation and relief-well drilling schedule. The longest duration blowouts in recent history (Montara at 75 days and Macondo at 86 days) have been capped in less time than this. Further information on the spill modelling is provided in the relevant spill risk sections below (**Section 7.7** and **Section 7.8**).

7.6.2 Nature and Scale of Environmental 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: Physical environment (water and sediment quality, shoals and banks, benthic habitats, offshore reefs and islands), threatened or migratory fauna (marine mammals, marine reptiles, sharks, fish, rays and birds), protected and significant areas (marine parks, heritage areas, key ecological features (KEFs)), socio-economic receptors (fisheries, tourism, recreation and other third-party operators).

A surface release of John Brookes condensate to the marine environment would result in a localised reduction in water quality in the upper surface waters of the water column. There is a low probability (less than 14%) that condensate will contact shorelines. However, a worst-case shoreline accumulation was predicted at the Montebello Islands (29 m^3). The potential impact pathways (physical and chemical) of hydrocarbon exposure to relevant habitat and marine fauna receptors are summarised in **Table 7-17.**

Based on similarities in density and persistence if spilled in the marine environment, potential impacts to relevant receptors that may interact with hydrocarbon spills within the EMBA are further described in **Table 7-18**.

7.6.3 Modelled scenario

To determine the spatial extent of impacts from a potential surface release of condensate from a John Brookes production well blowout and the dispersion characteristics over time, stochastic modelling was completed by APASA (APASA, 2014a). The representative hydrocarbon characteristics used to inform the model are described in **Section 7.5.4**, with a summary of the parameters used is described in **Table 7-19**.

Table 7-19: Loss of well control or damage to infrastructure causing condensate with gas release from John Brookes wellheads at surface scenario parameters

Condensate characteristics modelled	Released volume (m^3)	Discharge rate (m^3/day)	Release location	Release Depth	Spill duration
John Brookes condensate	39,011	390.11	John Brookes WHP	At surface	100 days

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

7.6.3.1 Spill Modelling Results

Weathering profiles generated under a range of representative wind conditions indicated that, for a surface release, evaporation would be by far the major mechanism for reducing the volume of condensate released on the sea surface, with entrainment and dissolution accounting for a lower proportion of the volume left on the sea surface. Approximately 70% of the total volume of John Brookes condensate is predicted to evaporate within one day of release. The portion of John Brookes condensate that is predicted to entrain (5 to 12%) would be subject to dissolution and natural decay within the water column with further resurfacing and evaporation possible, depending on wind and wave conditions.

The modelling results are summarised below for the fate of hydrocarbon (floating, entrained, dissolved and accumulated) at the exposure values described **in Section 7.5.4**. **Appendix G** includes the full results and has been provided for the purposes of risk evaluation.

Further parameters required to inform spill response strategies are described further in the OPEP.

Floating Oil

Low (1g/m^2)

Floating oil above the low exposure value of ≥1 g/m² are most likely to occur to the southwest or northeast of the hypothetical blowout site, with the outer contours of probability indicating that floating oil concentrations could potentially occur up to 150 km southwest. Modelling results indicate that the buffer zone around the Montebello Islands has 5% probability of contact by floating oil ≥1 g/m². A probability of 1% is forecasted for contact greater than or equal to the exposure threshold for the buffer zones around Barrow-Montebello shallows, Barrow Island, Lowendal Islands, Muiron Islands and Ningaloo Coast. Probabilities of <1% are forecasted for all other receptors.

Moderate (10g/m^2)

Stochastic modelling determined that surface oil at the 10 g/m^2 the moderate exposure value would be limited to approximately 26.5 km west of the release location. The modelling reported that floating oil at concentrations greater than or equal to 10 g/m^2 is unlikely (probability less than 1%) to reach any shoreline.

High (25g/m^2)

Floating hydrocarbon above the high exposure threshold is predicted to be limited to the vicinity of the release only.

Shoreline accumulation

The highest estimates of potential shoreline accumulation is forecasted for shorelines among the Montebello Islands (1.5 kg/m^2), with a total accumulation volume of 33 m^3. Potential for thinner sheens to reach shorelines and accumulate to concentrations ≥1 g/m2 is indicated for a number of shoreline sections.

Low (10g/m^2)

The modelling predicted that the highest probability of contact at 10g/m2 may occur at Barrow Island (21%). Other location that are predicted to be contacted include: Muiron Islands (2%), Ningaloo Coast North (5%), Barrow-Montebello surrounds (19%), Montebello Islands (20%), Middle Islands Coast (2%), Southern Islands Coast (5%), Thevenard Islands (7%), Barrow Island (8%).

Moderate (100g/m^2)

The modelling reported indicates the shoreline loading above 100 g/m^2 at multiple locations, including: Muiron Islands (1%), Ningaloo Coast North (2%), Barrow-Montebello surrounds (8%), Montebello Islands (13%), Barrow Island (8%).

High (1000g/m^2)

No receptors have a probability of greater than 1% contact at this threshold.

Entrained Oil

Worst-case estimates of entrained concentrations greater than 1,000 ppb, are forecast for the buffer zones around the Barrow-Montebello shallows, Montebello Islands and Barrow Island (1,077-1,216 ppb).

Low (10ppb)

Entrained oil above the 10 ppb threshold is predicted to potentially occur at: Outer Ningaloo Coast North (64%), Muiron Islands (25%), Ningaloo Coast Norther (31%), Abrolhos West (3%) Jurien AMP (2%), Barrow-Montebello Surrounds (43%), Montebello Islands (34%, Barrow Island (35%, Lowendal Islands (25%) Outer NW Ningaloo (95%), Outer Shark Bay Coast (3%), Outer Abrolhos Islands- Shoals (4%), Montebello AMP (84%), Offshore Ningaloo (100%), Dampier Archipelago (2%), Dampier AMP (2%), Eighty Mile Beach AMP (2%), Rowley Shoals and surrounds (7%), Shark Bay AMP (5%) Offshore Abrolhos NW (23%), Offshore Abrolhos- Perth North (2%), Middle Islands Coast (7%), Rankin Bank (62%), Northern Islands Coast (3%), Southern Islands Coast (26%) Thevenard Islands (8%) and Glomar Shoals (10%).

Moderate(100ppb)

Entrained oil above the exposure threshold of 100 ppb is predicted to occur due to wind and wave mixing of sea surface condensate. The probability contours calculated for entrained oil indicate that concentrations greater than or equal to 100 ppb are most likely to occur in waters southwest and east of the release site and may move up to 1000 km from the release site. Entrained oil concentrations of more than 100 ppb are predicted to potentially contact a number of locations including the buffer zones around Barrow/Montebello shallows (5%), Montebello Islands (9%), Barrow Island (11%) and Ningaloo Coast (5%). Probabilities of contact greater than 1% are also forecast for Lowendal Islands, Middle Island Coast, Southern Island Coast, Thevenard Islands and Muiron Islands.

Dissolved Aromatic Hydrocarbons

The maximum instantaneous DAH concentration is forecasted for nearshore waters of Barrow Island (414 ppb).

Low (6ppb)

Modelling results indicated concentrations of dissolved aromatic hydrocarbons could exceed the low exposure threshold of 6 ppb up to approximately 1,370 km from the release site. Dissolved aromatic hydrocarbon concentrations higher than 6 ppb are predicted to potentially contact a number of locations, most notably offshore Ningaloo Reef (100%), outer northwest Ningaloo (82%), Montebello AMP (87%), the Barrow-Montebello shallows (38%), Barrow Island (24%) and Montebello Islands (9%).

Moderate (50ppb)

Results indicate that dissolved aromatic hydrocarbons could occur at instantaneous concentrations ≥50 ppb up to 350 km to the southwest of the release site. The highest probability of instantaneous DAH concentrations ≥50 ppb is forecast for nearshore waters of Barrow Island (7%). Probabilities of 4% or less are also forecast to potentially contact the buffer zones around Barrow-Montebello shallows, Montebello Islands, Lowendal Islands, Southern Islands Coast, Muiron Island and Ningaloo Coast. It is unlikely (probabilities <1%) that DAH at concentrations ≥50 ppb would reach nearshore waters of all other receptors.

High (400 ppb)

Instantaneous DAH concentrations >400ppb are only forecast at Offshore Ningaloo (7%). All other receptors have a probability of 1% or less.

7.6.4 Environmental Performance Outcomes and Control Measures

The EPO relating to this event includes:

- No loss of containment of hydrocarbon to the marine environment (EPO-VI-CW-07).

Control measures applied to prevent an oil spill are shown in **Table 7-20**, and corresponding EPOs and measurement criteria are described in **Table 8-2.**

Selection of oil spill response strategies and associated EPOs, control measures and EPSs, including those required to maintain preparedness and for response, are detailed within the OPEP. The OPEP contains an evaluation of oil spill preparedness arrangements to demonstrate that oil spills will be mitigated to ALARP.

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 7-20: Control Measure Evaluation for the Surface Release of Condensate from Wellheads at the John Brookes WHP

Control Measure Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
Standard Controls				
VI-CW-CM-10	Planned subsea and offshore maintenance.	Reduces likelihood of leaks from equipment and ensures ongoing integrity of infrastructure	Personnel and operational costs associated with undertaking regular inspections of all equipment.	**Adopted** – Benefit of the inspection to determine operational integrity outweighs the cost to undertake the inspection.
VI-CW-CM-38	NOPSEMA-accepted WOMP in place.	Includes control measures for well integrity and well control as well as ongoing inspection requirements.	Costs associated with personnel time in writing, reviewing and implementing the WOMP.	**Adopted** – Benefits considered to outweigh costs. Regulatory requirement must be adopted.
VI-CW-CM-39	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.
VI-CW-CM-31	Inspection of platform structures and hydrocarbon-containing equipment.	Regular inspections reduce the risk of leaks from platform structures and hydrocarbon-containing equipment by confirming	Costs associated with personnel time in performing the inspection, reporting of inspections and follow up actions.	**Adopted** – Benefits considered to outweigh costs.

Control Measure Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
		appropriate integrity.		
VI-CW-CM-46	Inspection and corrosion monitoring of pipelines.	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, reporting of inspections and follow up actions.	**Adopted** – Benefits considered to outweigh costs.
VI-CW-CM-42	Emergency power equipment is provided on John Brookes 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 operation situations.	Costs associated with personnel time in performing the testing and maintenance.	**Adopted** – Benefits considered to outweigh costs.
VI-CW-CM-40	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.
VI-CW-CM-41	Incident Response Plan detailing the requirements for preparedness and response to emergencies and crises to protect people and the environment.	Provides detail to ensure the ESD system is activated quickly and efficiently if it has not automatically activated, to reduce the extent of impacts to the marine environment.	Administrative costs of preparing documents.	**Adopted** – Benefits considered to outweigh costs.

Control Measure Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
VI-CW-CM-14	WHP petroleum safety zone and cautionary area	A petroleum safety zone applies around the John Brookes WHP and is on Australian nautical charts. The presence of the petroleum safety zone reduces the potential for vessels to collide with the WHP resulting in a loss of well control.	No additional costs to Santos. 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 John Brookes WHP is unlikely to significantly impact upon the marine user. The benefits to safety of the activity (thus reducing risk of environmental impacts due to vessel collisions) outweigh potential costs.
VI-CW-CM-16	Navigational charting of infrastructure.	Provides a means for other marine users to be aware of the presence of the WHP and support vessels.	Costs associated with personnel time in issuing notifications.	**Adopted** – Benefits considered to outweigh costs.
VI-CW-CM-17	Navigational lighting and aids.	Reduces risk of environmental impact from vessel collisions by ensuring safety requirements are fulfilled.	Negligible costs of operating navigational equipment.	**Adopted** – The benefits to safety of the activity (thus reducing risk of environmental impacts due to vessel collisions) outweigh potential costs.
VI-CW-CM-43	Oil pollution emergency plan (OPEP).	Implements response plans to deal with an unplanned hydrocarbon release quickly and efficiently to reduce impacts to the marine environment.	Administrative costs of preparing documents and large costs of preparing for and implementing response strategies.	**Adopted –** Benefits of ensuring procedures are followed and measures implemented and that the vessels are compliant outweigh the costs. Regulatory

Control Measure Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
				requirement must be adopted.
VI-CW-CM-47	Operational monitoring of low flow well leak	Ensures potential leaks from wells are investigated and monitored until negligible risk to the environment is confirmed and there is no risk of escalation	Costs associated with personnel time undertaking risk assessments. Costs of monitoring including ROV and vessel hire	**Adopted -** Benefits considered to outweigh costs.
Additional Controls				
VI-CW-CM-11	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.
VI-CW-CM-44	Support vessel positioning.	Allows the vessel to maintain accurate positioning and reduces potential to impact the WHP.	Costs associated with requiring vessels 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.
VI-CW-CM-48	Santos' decommissioning framework (refer to **Section 8.8**).	Ensures an appropriate level of planning for the eventual permanent plug and abandonment of all wells and removal of property.	Organisational costs to prepare plans prior to EOFL.	**Adopted -** Benefits considered to outweigh costs. Regulatory obligation to remove property.

Control Measure Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
		Ensures Santos has plans in place to meet its regulatory obligation to remove property in accordance with the requirements of s.572 of the OPGGS Act.		
N/A	Dedicated resources (e.g., dedicated spill response facilities) on location in the event of loss of hydrocarbons to allow rapid response.	Limited benefit as no applicable response strategies that require immediate application at the release site and existing resources (personnel, vessels and equipment) are located nearby at Varanus Island – closer to shorelines that may need protection.	Large costs associated with dedicated resources.	**Rejected –** Costs grossly disproportionate to environmental benefit and resources already positioned at Varanus Island.
N/A	Standby vessel in situ 24 hours/day at unmanned WHP.	Monitor the WHP 500-m petroleum safety zone and be equipped with an automatic identification system to aid in its detection at sea and with 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	High cost associated with contracting standby vessel. Negligible costs of operating navigational equipment.	**Rejected** – The costs associated with having a vessel on location 24/7 are considered infeasible, particularly given the WHP and infrastructure are marked on charts and navigational aids are present.

Control Measure Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
		marine environment.		
N/A	Source control plans in place for all wells.	May allow for quicker response to a loss-of-well-control scenario, thereby limiting potential spill extent and volume.	Costs associated with personnel time in writing and reviewing relief well plans.	**Rejected** – Santos only has relief well 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.

7.6.5 Environmental Impact Assessment

The below environmental impact assessment follows the risk assessment approach detailed in **Section 7.5.6.**

7.6.5.1 Identification of Hotspots for Consequence Assessment

As described in **Section 7.5.6,** all HEV's within the EMBA for the surface release of hydrocarbons from WHP (low exposure threshold) are listed in **Table 7-21** below. The values and sensitivities associated with these HEVs have been described in **Appendix C**. Further to this, **Table 7-21** filters the HEV to identify the hotspots where they meet the criteria.

Table 7-21 Identified High Environmental Value and Hotspot receptors

Receptor	HEV Value	Exposure Threshold			Hotspot
		Low	Moderate[1]	High[1]	
Montebello Islands	3	✓	✓	✓	✓
Barrow Island	3	✓	✓	✓	✓
Outer Ningaloo Coast North (submerged)	2	✓	✓	✓	✓
Ningaloo Coast North (Emergent)	1	✓	✓	✓	✓
Muiron Islands	2	✓	X	X	X
Exmouth Gulf Coast	2	✓	X	X	X
Abrolhos West	2	✓	X	X	X
Abrolhos Islands Wallabi Group	2	✓	X	X	X
Abrolhos Islands Easter Group	2	✓	X	X	X
Jurien AMP	2	✓	X	X	X
Barrow-Montebello Surrounds	3	✓	X	X	X
Lowendal Islands	3	✓	X	X	X
Outer NW Ningaloo	3	✓	X	X	X
Ningaloo Coast South	3	✓	X	X	X
Outer Shark Bay Coast	3	✓	X	X	X
Outer Abrolhos Islands - Shoals	3	✓	X	X	X
Montebello AMP	4	✓	X	X	X
Offshore Ningaloo	4	✓	X	X	X
Dampier Archipelago	4	✓	X	X	X
Dampier AMP	4	✓	X	X	X
Rowley Shoals surrounds	4	✓	X	X	X
Shark Bay AMP	4	✓	X	X	X
Offshore Abrolhos NW	4	✓	X	X	X
Nearshore Abrolhos	4	✓	X	X	X

Receptor	HEV Value	Exposure Threshold			Hotspot
		Low	Moderate[1]	High[1]	
Offshore Abrolhos - Perth North	4	✓	X	X	X
Middle Islands Coast	5	✓	X	X	X
Northern Islands Coast	5	✓	X	X	X
Southern Islands Coast	5	✓	X	X	X
Rankin Bank	5	✓	X	X	X
Thevenard Islands	5	✓	X	X	X
Glomar Shoals	5	✓	X	X	X

[1] >5% probability of contact at the medium/high exposure value for consideration for further hotspot assessment.

This process identified the following Hotspots:

+ Montebello Islands;
+ Barrow Island;
+ Outer Ningaloo Coast North; and
+ Ningaloo Coast North.

Appendix G2 provides a simplified summary of the consequence assessment results for each of the Hotspot areas. The consequence assessment was based on predicted contact and concentration of floating oil, accumulated oil, entrained oil and dissolved aromatic hydrocarbons (DAHs). For each Hotspot area the consequence to the key values were assessed using the methodology described in **Section 5.2.5.**

The impact, likelihoods and consequence ranking for a subsea release of condensate from wellheads are outlined in **Table 7-22**.

Table 7-22: Impacts, Likelihood and Consequence Ranking – Subsea Release of Condensate from surface release of condensate from John Brookes WHP

Description	
Receptors	Marine fauna (plankton, fish, cetaceans, marine mammals, marine reptiles, seabirds/shorebirds) Physical environment or habitats Protected areas Socio-economic receptors
Consequence	IV - Major

The detailed consequence assessment for each priority area is provided in **Section 7.6.5**. A summary of the consequence assessment for each receptor category is presented below.

Physical environment or habitat

In the event of a condensate spill at the John Brookes WHP, hydrocarbons that reach nearshore environments in the Montebello Islands, Barrow Island and Ningaloo Coast hotspots have the potential to impact benthic coral reefs and mangrove areas at these sites, which may result in a long-term decrease in ecological values given toxicity impacts associated with hydrocarbon exposure (**Table 7-18**).

Threatened or migratory fauna

A surface release of John Brookes condensate to the marine environment would result in a localised reduction in water quality in the upper surface waters of the water column. There is a low probability (less than 1%) of condensate contacting shorelines. However, a worst-case shoreline accumulation was predicted at the Montebello Islands (33 m^3). The potential pathways and impacts to shoreline receptors through hydrocarbon exposure and potential toxicity effects are summarised in Table 7-18. Marine fauna present in the area may be potentially impacted by a spill through exposure to floating oil, entrained oil, or dissolved aromatic hydrocarbons. There is potential for impact via these pathways to important marine turtle sites at the hotpots with one of the most significant rookery for the Green turtle on the western side of Barrow Island. Significant flatback turtle rookeries are also located on the Montebello Islands which is a hotspot.

In the unlikely event that a surface release of condensate did occur within the operational area, the potential impacts to the environment would be greatest within several kilometres of the spill location, when the toxic aromatic components of the fuel will be at their highest concentration and when the hydrocarbon is at its thickest on the surface of the receiving waters. 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 in **Table 7-18**.

Habitat modification, degradation, disruption or loss; chemical discharge ; and marine pollution are identified as potential threats to a number of marine fauna species in relevant recovery plans and conservation advice (**Table 3-7**). In line with the relevant actions prescribed in Recovery Plan for Marine Turtles in Australia 2017 – 2027 (DoEE, 2017) and conservation advice for humpback (TSSC, 2015d) , fin (TSSC, 2015b), sei (TSSC, 2015c) and blue (TSSC, 2015c) whales and whale sharks (TSSC, 2015a), 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 2007 – 2017 (DEC, no date) states that DPaW should 'Ensure that important seabird and shorebird breeding and feeding areas are not significantly affected by human activities'. It has also been identified that Barrow Island has predominantly migratory waders but few breeding seabirds (Surman 2003), which means population scale impacts given the low volumes and limited breeding are expected to be minimal. The potential impacts of a hydrocarbon release on seabird breeding and feeding areas are discussed in **Table 7-18**. Impacts in relation to human activities from responding to a spill are described in **Section 6.7**.

Protected areas

<table>
<tr><th colspan="2">Description</th></tr>
<tr><td colspan="2">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. The Ningaloo World Heritage Area has been identified as a hotspot, with impacts to the habitat or fauna receptors described above therefore have an impact on the listed values. The Montebello Islands CP and Barrow Island NR have also been identified as impact hotspots. Sub-tidal and marine values surrounding these reserves could be impacted. This 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 moderate-term effects to 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 (Table 3-8).

Entrained oil at 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. 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 as 1,198 ppb. Additionally, pearling leases identified in the region are currently inactive; and no stakeholder concerns have been raised. However, if these leases were to become active within the life of this EP, then some loss of value to the local industry could occur in the event of a loss of well control or a vessel collision that results in a condensate spill at the John Brookes WHP.

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 spill at the John Brookes WHP 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 as described in Table 7-18.

Marine habitats may also be impacted with relatively small volumes (worst case 33 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 at the John Brookes WHP 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 (IV).</td></tr>
<tr><th>Likelihood</th><td>b – unlikely</td></tr>
<tr><td colspan="2">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 very unlikely (2). The low shipping and fishing activity expected in the operational area and the management controls in place are considered to result in a low risk of a collision occurring between the John Brookes WHP and an errant vessel.

This assessment of likelihood (for a loss of well control event occurring during the well intervention) is further supported when considering industry statistics, Santos statistics and the preventive control measures in place. Wells are designed with essential engineering and safety control measures to prevent a loss of containment occurring. Production well blowout events (not including external causes) have been reported at a frequency of 7.2 x 10-5 for gas wells (IOGP, 2019; normal operations on deep, normal wells of North Sea standard). This frequency is based on 11 blowout incidents (gas and oil wells) occurring in the UK , Norway and the Gulf of Mexico between 1980 and 2014 during development well drilling (IOGP, 2019) and supports the likelihood of ‘has occurred elsewhere OR could occur within decades’</td></tr>
</table>

Description	
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, safety case, crew training and awareness, and a spill response plan (the 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 John Brookes WHP resulting in a Major (IV) consequence is considered to be unlikely (b).	
Residual Risk	The residual risk associated with this event is **Low**.

7.6.6 Demonstration of ALARP

Preventative controls

Well intervention is required for the ongoing safe and efficient operation of the John Brookes production wells and is a standard industry activity. Removing well intervention and other well maintenance activities is therefore not a practicable option to reducing spill risk.

It is considered that there are no controls additional to those outlined in **Table 7-20** that would reduce the likelihood of a loss of containment 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 trained and competent personnel. Ongoing monitoring and management of the active production and plugged and abandoned wells are stipulated within the John Brookes WOMP, which has regulatory acceptance from NOPSEMA. It is therefore considered that the risk of a loss of containment occurring has been reduced to ALARP.

The controls in place for preventing vessel impact to the WHP are consistent with those provided in the John Brookes Safety Case and are considered to reduce risk of a collision to ALARP. The John Brookes WHP is an unmanned platform, and while the manning of the WHP 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 as per the Varanus Island Hub facilities) are commonplace on the North West Shelf, and the likelihood of a collision with the John Brookes WHP is no more likely than a collision with one of these other hazards.

The primary mechanism to immediately respond to a release of hydrocarbon from the subsea production system is via the emergency shutdown system managed through the Varanus Island Incident Response Plan (SO-00-ZF-00044). This system responds to both automatic and manual activation, with automatic activation triggered by abnormal process conditions, such as pressure drop across the subsea production system. The emergency shutdown system functionality and reliability is maintained through regular testing of the shutdown systems and the subsea valves. The regular testing and maintenance of the emergency shutdown and blowdown systems are managed through Performance Standard Assurance Plans (PSAPs), which provide the work instructions and performance criteria to test and service the shutdown and blowdown systems against. The relevant PSAPs contain specific performance criteria as detailed below:

+ PS-06 ESD and Blowdown: Emergency Shutdown Valves (ESDVs) (QE-00-RG-00218). The performance criteria specified in PS-06 includes:
  - Appropriate ESDV location, ESDV close on demand timings, process safety time calculation, acceptable leak rates of the ESDV (as per American Petroleum Institute), ESDV signage, ESDV alarm, leakage testing, position testing alarms.
+ PS-07 ESD and Blowdown: Reservoir Isolation (including Surface-controlled Subsurface Safety Valves and Christmas tree valves (SCSSVs)) (QE-00-RG-00219). The performance criteria specified in PS-07 includes:

  - SCSSV and Christmas tree valves actuation, SCSSV and Christmas Tree failure, SCSSV and Christmas Tree close timings, SCSSV acceptable leakage rates, SCSSV and Christmas tree valve position indication.
+ PS-08 ESD and Blowdown: Safety Instrumented Systems (QE-00-RG-00220). The performance criteria for Safety instrumented Systems in PS-08 includes:
  - Sensor for emergency shutdown events, ESD, PSD pushbuttons, electrical tripping device.
+ PS-10 ESD and Blowdown: Pressure Safety Valves (QE-00-RG-00222). The performance criteria specified in PS-10 includes:
  - Relief system designed and operated in accordance with American Petroleum Institute, set PSV relief pressure, PSV function testing and examinations, safe relief through critical manual valve position.

The relevant PSAPs are listed as control measures with relevant performance standards in **Table 7-20**.

The maintenance and regular testing of the shutdown systems and the subsea valves managed through the PSAPs ensures an available, reliable, survivable and independent control ensuring the emergency shutdown and blowdown functionality, resulting in near-instantaneous shut in following loss of pressure, and is considered to reduce the spill volume to ALARP for a unplanned release of John Brookes condensate and gas from a production well at the John Brookes WHP.

The ongoing general inspection and maintenance regime that is completed in accordance with the NOPSEMA-accepted WOMPs and Santos procedures, ensures that property is maintained in good condition and repair until the point in time when the property is removed from the title. Well integrity risks will continue to be managed in accordance with the WOMPs until they are permanently plugged and abandoned. The WOMPs require wellhead monitoring for leak detection. Santos will undertake any necessary actions, potentially in advance of EOFL, should the well integrity risk level or risk tolerance change on any of these wells. It is through the implementation of this monitoring regime that Santos will meet its obligations under the OPGGS Act (s.572(2)) to 'maintain in good condition and repair all structures that are, and all equipment and other property that is, in the title area and used in connection with the operations'.

Also, through the development and eventual implementation of the Decommissioning Plan, Santos will meet its obligations under s. 572 (3) of the OPGGS Act 'to remove from the title area all structures that are, and all equipment and other property that is, neither used nor to be used in connection with the operations'.

<u>Source control</u>

A number of source control options have been evaluated for the activity (refer to OPEP). Of these source control options, the drilling of a relief well is considered the primary means of controlling the source in the event of an unplanned well release. Spill response and impact assessment for this activity has been based on the relief well taking 77 days (11 weeks) to execute. A breakdown of the key tasks and their timeframe to drill a relief well in 11 weeks have been included in Section 8.3.3 of the OPEP.

Supporting controls to allow the relief well schedule to be met include:

+ "Assurance Review 4: Readiness to Spud" is conducted under the Drilling & Completions Management Process (DCMP).
+ Rig capability register is maintained.
+ A well-specific Source Control Plan (SCP) is prepared in accordance with the Santos Source Control Planning and Response Guidelines. The SCP contains information and considerations for relief well operations including but not limited to:
  - Relief well surface locations (primary and secondary)
  - Relief well trajectory and interception target point
  - Dynamic well kill modelling calculations for controlling a worst-case discharge (e.g. kill mud weight, kill pump rate/pressure and kill mud volume required)

- Status of relief well tangible equipment.
- Australian Petroleum Production and Exploration Association (APPEA) Memorandum of Understanding (MoU) provides for access to other Operator rigs.
- Contracts and MoUs for 3rd party independent well control specialist personnel are in place.

The implementation timeframe of this control is key to its effectiveness. A second MODU positioned on standby in the vicinity of the activity during the drilling activity 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. The cost of having a MODU and personnel/equipment on standby (at a rate of ca. $250,000/day) would double the cost of the activity and introduce additional safety and environmental risks due to presence of an additional MODU and support vessels/equipment being on standby. This is considered grossly disproportionate to the environmental benefit (a potential reduction of two weeks to stop the LOWC, particularly considering the likelihood of a LOWC and the existing preventative control measures in place to prevent a well blowout. Having a dedicated second MODU on standby for the purpose of relief well drilling was therefore rejected as a control measure.

In order to minimise lead times a rig with a NOPSEMA approved Safety Case will be preferred. These rigs are tracked on the Rig Capability Register and access is covered under the APPEA MoU. For the water depths at this location it is possible that a semi-submersible MODU may be feasible to drill the relief well instead of a jack-up, but this would also depend on the exact circumstances of the LOWC scenario and therefore feasibility is not guaranteed. The well specific Source Control Plan will assess the feasibility and availability of suitable MODUs prior to each drilling activity occurring.

Direct surface intervention (i.e., deployment onto the jack-up rig) using specialised well control personnel is a strategy that could be adopted and supported through contractual arrangements with well control vendors. 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. For this reason, the current preparedness measures for well intervention experts is considered ALARP.

Santos has access to a subsea first response toolkit (SFRT) and deployment personnel through contract to AMOSC and Oceaneering respectively. Deployment of a capping stack is not feasible for jack-up wells. Consequently, the majority of items in the SFRT are of no use in a LOWC event. However, some items can be used to gather information or increase situation awareness. Additionally, the SFRT can be used to inject dispersant subsea which may have an environmental benefit in reducing the volume of hydrocarbons reaching shorelines. Notwithstanding the above, the use of SFRT is considered unlikely due to safety and technical constraints (i.e., shallow water depths and high predicted gas release rates).

In the unlikely event SFRT was required, SFRT equipment can be mobilised to Dampier from the Jandakot storage yard in two days, under existing arrangements. Locating this equipment in Dampier could potentially reduce deployment time by two days providing a suitable vessel was on standby for immediate mobilisation. However, the equipment is a shared resource across AMOSC SFRT subscription members so relocating for a drilling campaign is not considered viable. Providing a vessel on standby for SFRT deployment could reduce deployment time, but given SFRT deployment may not be suitable or feasible a potential reduction in deployment time due to a vessel being on standby is not seen to offer sufficient environmental benefit given crewed vessel standby costs would be tens of thousands of dollars each day over the drilling period.

Spill mitigation controls

Santos considers that through the resourcing arrangements outlined within the OPEP (including spill response equipment and personnel from internal and external sources including Santos, 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. A detailed ALARP assessment on the adequacy of arrangements available to support spill response strategies and control measures is presented in the OPEP.

The combination of the standard prevention control measures (**Section 7.6.4**) (which reduce the likelihood of the event happening) and the spill response strategies outlined in the OPEP (which may reduce the consequence) together reduce the overall hydrocarbon spill risk.

7.6.7 Acceptability Evaluation

Is the risk ranked between Low and Medium?	Yes - maximum credible hydrocarbon spill volume from John Brookes wells (39,011 m^3 of condensate) 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 ecological sustainable development?	Yes – activity evaluated in accordance with Santos'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(E)R 2009 Regulations, including safety case and WOMP. Santos has considered the values and sensitivities of the receiving environment, including but not limited to: + Conservation values of the identified protection priorities, including the Montebello Marine Park (AMP), the Barrow Island Marine Park Management Area, Montebello Islands Marine Park (State Marine Park), Muiron Island Marine Management Area, and Ningaloo Marine Park; and + Relevant species recovery plans, conservation management plans and management actions, including but not limited to Recovery Plan for Marine Turtles in Australia (DoEE, 2017), Approved Conservation Advice for *Megaptera novaeangliae* (humpback whale) (TSSC, 2015d), Approved Conservation Advice for *Balaenoptera physalus* (fin whale) (TSSC, 2015b), Approved Conservation Advice for *Rhincodon typus* (whale shark) (TSSC, 2015a), and relevant recovery plans and conservation advices for birds. Management is also consistent with the zoning of the Australian marine parks, in that risks have been reduced to ALARP, e.g., implementation of spill response activities will limit impacts, thereby conserving the marine park values.
Are risks and impacts consistent with Santos's Environmental Management Policy?	Yes – aligns with Santos'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 NEBA 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 (unlikely) when considering industry statistics, Santos statistics and the preventive controls in place. Additional industry-standard 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'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 and gas could occur from either the John Brookes or East Spar pipeline, or the Spartan flowline. Dropped objects, anchor drag or loss of pipeline integrity causing a loss of containment is considered 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. The maximum credible spill is therefore calculated based on the entire condensate volume within the pipeline between isolation points. Based on the respective pipeline inventories, the John Brookes pipeline would result in a release volume of 210 m^3, and the East Spar pipeline would result in a release volume of 161 m^3. The Spartan flowline would result in a release volume of approximately 35 m^3 of Spartan condensate.
Extent	The spill scenario is credible anywhere along the pipelines in Commonwealth waters. Due to the larger pipeline inventory of the John Brookes pipeline, predictive oil spill modelling for a subsea release of 210 m^3 of John Brookes condensate at the State waters boundary has been modelled. This modelling is considered appropriate for both pipeline release scenarios in terms of the similarities in hydrocarbon type, water depth and environmental conditions. A 210 m^3 subsea release of John Brookes condensate predicted floating oil concentrations at the sea surface above the impact threshold of 10 g/m^2 extending for 22 km from the release site. The locations at the highest risk of contact by floating oil are predicted to be the waters of the Montebello Marine Park with an 81% probability of more than 10 g/m^2 and the Barrow and Montebello Shallows with a 48% probability of more than 10 g/m^2. Concentrations of shoreline hydrocarbons above the 100 g/m^2 impact threshold were predicted for three locations: Barrow Island (1,110 g/m^2), the Lowendal Islands (860 g/m^2) and the Montebello Islands (764 g/m^2) with maximum accumulations of 20 m^3, 6 m^3 and 12 m^3 respectively. Times for floating hydrocarbons to contact shorelines ranged from 11 to 16 hours. Entrained oil in the water column above the impact threshold of 100 ppb is predicted to occur within a region up to 190 km southwest of the release site, with the highest concentrations predicted at the Montebello Marine Park (2,394 ppb) with a 23% probability, the Barrow and Montebello Shallows (2,010 ppb) with a 20% probability and Barrow Island (803 ppb) with a 10% probability. Dissolved aromatic hydrocarbons in the water column above an impact threshold of 6 ppb is predicted to occur up 409 km southwest of the release site, with the highest concentrations predicted at the Montebello Marine Park (1,181 ppb) with an 81% probability, the Barrow and Montebello Shallows (978 ppb) with an 81% probability, Barrow Island (719 ppb) with a 52% probability and the Montebello Islands (396 ppb) with a probability of 55%.
Duration	Release over 5.4 hours.

7.7.2 Nature and Scale of Environmental 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: Physical environment (water and sediment quality, shoals and banks, benthic habitats, offshore reefs and islands), threatened or migratory fauna (marine mammals, marine reptiles, sharks, fish, rays and birds), protected and significant areas (marine parks, KEFs), socio-economic receptors (fisheries, tourism and recreation).

A subsea release of condensate from the John Brookes pipeline or the East Spar 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. The Zone of Impact from a subsea pipeline release is smaller spatially than the Surface Release of Condensate from Wellheads Zone of Impact. Therefore, the potential impacts provided in **Section 7.6** and the scale of impact described provides a conservative assessment of potential impacts.

Potential impact pathways (physical and chemical) of hydrocarbon exposure for receptors are summarised in **Table 7-17**, and potential impacts to receptors found within the EMBA are further described in **Table 7-18**.

A detailed risk assessment of impacts to the Lowendal Islands, which was ranked as a HEV/Hot Spot for the pipeline release scenario only, is described in **Appendix G2.**

7.7.2.1 Modelled scenario

To determine the spatial extent of impacts from a potential surface release of condensate from a subsea pipeline and the dispersion characteristics over time, stochastic modelling was completed by RPS in 2019. The modelled scenario was based on the largest credible spill scenario (**Section 7.5.1**) with a summary of the parameters used is described in **Table 7-23.**

Table 7-23: Scenario parameters for modelling loss of integrity or damage causing condensate with gas release from a subsea pipeline in Commonwealth waters

Condensate characteristics modelled	Released volume (m^3)	Discharge rate	Release location	Release Depth (BMSL)	Spill duration	Simulation duration
John Brooke condensate	210	38.9	20º36’33.60”S 115º23’11.20”E	20m	5.4hrs	21 days

The modelling for this scenario assumed no mitigation efforts are undertaken to collect or otherwise affect the natural transport and weathering of the oil.

7.7.2.2 Spill Modelling Results

During a subsea release, the low discharge velocity and turbulence generated by the expanding gas plume is predicted to generate large sized oil droplets (<9000 µm). 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 modelling results are summarised below for the fate of hydrocarbon (floating, entrained, dissolved and accumulated) at the exposure values described **in Section 7.5.4**. **Appendix G** provides the full modelling results for the purposes of risk evaluation.

Further parameters required to inform spill response strategies are described further in the OPEP.

Floating Oil

Low (1 g/m²)

The stochastic modelling results indicates that floating oil is expected to remain localised around the release site, with the maximum distance travelled at 1 g/m² exposure threshold 58 km. The greatest probability of floating oil contact at the 1 g/m^2 threshold is predicted at Montebello Marine Park (91%). Contact at this threshold is also precited at: Barrow-Montebello surrounds (71%), Barrow Island (10%), Lowendal Islands (8%), Montebello Islands (8%)

Moderate (10 g/m^2)

The maximum distance travelled at the 10g/m^2 exposure threshold is 23km. The highest probability of contact at this exposure value across all seasons is at Montebello AMP (81%). Contact is also predicted at Barrow-Montebello surrounds (48%).

High (~~50~~25g/m^2)

The greatest probability of floating oil contact at 25g/m^2 is predicted at Montebello AMP (65%) in summer with contact probabilities also predicted at this exposure level at Barrow-Montebello surrounds (26%).

Shoreline accumulation

Low (10 g/m^2)

Summer represented the worst-case potential volume of oil accumulating on a shoreline at concentrations greater than 10 g/m^2 is forecast at Barrow Island as 20 m^3. Predicted probability of contact at this exposure value is Montebello Islands (18%), Lowendal Islands (10%) and Barrow Island (5%).

Moderate (100 g/m^2)

Shoreline accumulation at the moderate threshold is expected at multiple locations including Barrow Island (2%), Lowendal Island (7%) and Montebello Island (7%).

High (1000 g/m^2)

There is no probability of contact greater than 1% at this exposure level.

Entrained Oil

The maximum entrained oil concentration is predicted at the Montebello Marine Park as 2,394 ppb.

Low (10 ppb)

Entrained oil concentrations exceeding 10 ppb may potentially occur 449 km from the spill site. The probability of contact at concentrations equal to or greater than 10 ppb is predicted to be greatest at the Montebello AMP (65-71%) and Barrow-Montebello Surrounds (55-67%). The shortest time for entrained oil at or above 10 ppb to contact any receptor is forecast for the Montebello MP as 1 hour.

Moderate (100 ppb)

Entrained oil concentrations exceeding 100 ppb may potentially occur 319 km from the spill site.

Dissolved Aromatic Hydrocarbons

The worst-case instantaneous concentration of dissolved aromatic hydrocarbons is predicted at Montebello Marine Park as 1,181 ppb.

Low (6 ppb)

Dissolved aromatic hydrocarbons concentrations at or above 6 ppb may potentially occur 410 km from the spill site. The highest potential contact to receptors by dissolved aromatic hydrocarbons at or above 6 ppb is expected to occur at Montebello Marine Park (76-84%) and Barrow-Montebello Surrounds (70-81%). The highest probability across all seasons of contact at this threshold is predicted to be: Muiron Islands (8%), Ningaloo Coast North (5%), Barrow Island (78%), Lowendals (19%), Montebello Islands (55%), Outer NW Ningaloo (12%), Offshore Ningaloo (29%), Southern Islands Coast (3%), Thevenard Islands (2%), Outer Ningaloo Coast North (3%).

Moderate (50 ppb)

Across all seasons the highest potential contact to receptors by dissolved aromatic hydrocarbons at or above 50 ppb is expected to occur at Barrow-Montebello surrounds (35%), Barrow Island (16%), Lowendal Islands (5%), Montebello Islands (13%), Montebello AMP (32%), Outer Ningaloo (2%) and Offshore Ningaloo (4%).

High (400 ppb)

Dissolved aromatic hydrocarbons concentrations at or above 400 ppb may potentially occur 49 km from the spill site. The highest predicted contact across all seasons at or above 400ppb is Barrow-Montebello surrounds (3%), Montebello AMP (3%).

7.7.3 Environmental Performance Outcomes and Control Measures

The EPO relating to this event includes:

+ No loss of containment of hydrocarbon to the marine environment (EPO-VI-CW-08); and
+ 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 are shown in **Table 7-24**, and corresponding EPSs and measurement criteria for the EPO described in **Table 8-2**.

Selection of oil spill response strategies and associated EPOs, control measures and EPSs, including those required to maintain preparedness and for response, are detailed within the OPEP. The OPEP contains an evaluation of oil spill preparedness arrangements to demonstrate that oil spills will be mitigated to ALARP.

Table 7-24: Control Measure Evaluation for the Subsea Release of Condensate from Subsea Pipeline

Control Measure Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
Standard Controls				
VI-CW-CM-10	Planned subsea and offshore maintenance.	Reduces likelihood of leaks from equipment and ensures ongoing integrity of infrastructure	Personnel and operational costs associated with undertaking regular inspections of all equipment.	**Adopted** – Benefit of the inspection to determine operational integrity outweighs the cost to undertake the inspection.
VI-CW-CM-45	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.
VI-CW-CM-46	Inspection and corrosion monitoring of pipelines.	Regular inspections reduce the risk of leaks from subsea pipelines by	Costs associated with personnel time in performing the inspection, monitoring	**Adopted** – Benefits considered to outweigh costs.

Control Measure Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
		confirming appropriate integrity.	and reporting of inspections and follow-up actions.	
VI-CW-CM-42	Emergency power equipment is provided on John Brookes 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 operation situations.	Costs associated with personnel time in performing the testing and maintenance.	**Adopted** – Benefits considered to outweigh costs.
VI-CW-CM-40	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.
VI-CW-CM-41	Incident Response Plan detailing the requirements for preparedness and response to emergencies and crises to protect people and the environment.	Provides detail to ensure the ESD system is activated quickly and efficiently if it has not automatically activated, to reduce the extent of impacts to the marine environment.	Administrative costs of preparing documents.	**Adopted** – Benefits considered to outweigh costs.
VI-CW-CM-16	Navigational charting of infrastructure.	Provides a means for marine users to be aware of the presence of the WHP and subsea infrastructure.	Costs associated with personnel time in issuing notifications.	**Adopted** – Benefits considered to outweigh costs.
VI-CW-CM-11	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.
VI-CW-CM-43	Oil pollution emergency plan (OPEP)	Implements response plans to deal with an	Administrative costs of preparing documents and large costs of	**Adopted -** Benefits of ensuring

Control Measure Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
		unplanned hydrocarbon release quickly and efficiently to reduce impacts to the marine environment.	preparing for and implementing response strategies.	procedures are followed and measures implemented and that the vessels are compliant outweigh the costs. Regulatory requirement must be adopted.
Additional Controls				
VI-CW-CM-13	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.
VI-CW-CM-48	Santos' decommissioning framework (refer to **Section 8.8**).	Ensures an appropriate level of planning for the eventual removal of property. Ensures Santos has plans in place to meet its regulatory obligation to remove property in accordance with the requirements of s.572 of the OPGGS Act.	Organisational costs to prepare plans prior to EOFL.	**Adopted -** Benefits considered to outweigh costs. Regulatory obligation to remove property.
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

Control Measure Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
				conditions and sea state would need to be perfect. Based on these limitations, this is not considered an effective stand-alone control.

7.7.4 Environmental Impact Assessment

The below environmental impact assessment follows the risk assessment approach detailed in **Section 7.5.6**.

7.7.4.1 Identification of Hotspots for Consequence Assessment

As described in **Section 7.5.6,** all HEV's within the EMBA (low exposure threshold) for the subsea release of condensate from a subsea pipeline were previously described in **Table 7-21**. One new hotspot was identified for this scenario (**Table 7-25**).

Table 7-25 Identified High Environmental Value and Hotspot receptors

Receptor	HEV Value	Exposure Threshold			Hotspot
		Low	Moderate[1]	High[1]	
Lowendal Islands	3	✓	✓	✓	✓

Appendix G2 Error! Reference source not found. provides a simplified summary of the consequence a ssessment results for this Hotspot.

The impact, likelihoods and consequence ranking for a subsea release of condensate from a subsea pipeline are outlined in **Table 7-26**.

Table 7-26: Impacts, Likelihood and Consequence Ranking – Subsea Release of Condensate from Subsea Pipeline

Description	
Receptors	Physical environment (water and sediment quality, shoals and banks, benthic habitats, offshore reefs and islands) Threatened or migratory fauna (marine mammals, marine reptiles, sharks, fish, rays and birds) Protected and significant areas (marine parks and KEFs) Socio-economic receptors (fisheries, tourism and recreation)
Consequence	III - Moderate
Physical environment In the event of a subsea pipeline release, hydrocarbons will likely reach both subsea and shoreline habitats (Barrow Island, Lowendal Islands and Montebello Islands), which may result in a long-term decrease in ecological values given the toxicity impacts associated with hydrocarbon exposure (**Table 7-17** and **Table 7-18**). *Threatened or migratory 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, either 35 m^3 from Spartan flowline, 161 m^3 from East Spar or 210 m^3 from John Brookes of condensate based on the pipeline inventories. 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 of marine fauna to 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.** Habitat modification, degradation, disruption or loss, chemical discharge and marine pollution are identified as potential threats to a number of marine fauna species in relevant recovery plans and conservation advices (**Table 3-7)**. With controls in place that align with relevant actions described in various recovery plans, the activity will be conducted in a manner that reduces potential impacts to ALARP and an 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 will be at their highest concentration. Condensate will rapidly lose toxicity with time and will spread thinner as evaporation continues. The	

Description	
potential sensitive receptors in the surrounding areas of 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 (**Table 7-17** and **Table 7-18**). Potential impacts to these receptors from a larger condensate release are described in detail in **Section 7.6.** *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.** *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 (**Table 3-8**). Entrained oil at concentrations 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 as described in **Table 7-17** and **Table 7-18**. 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 moderate extent, the worst-case consequence is considered to be Moderate (III).	
Likelihood	a - Remote
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, the 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 (DoEE, 2017), and some bird and shark species (**Table 3-7)**. Habitat modification, degradation, disruption, pollution and/or 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 caused by dropped object are not expected to significantly impact the receiving environment with 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 caused by a dropped object is limited given the set of mitigation and management controls in place. Consequently, the likelihood of a pipeline rupture releasing hydrocarbons to the environment that results in a moderate consequence is considered to be remote (a).	
Residual Risk	The residual risk associated with this event is **Very Low**.

7.7.5 Demonstration of ALARP

It is considered that there are no additional practicable risk reduction measures further to those described in **Section 7.7.3**, that would provide benefit to the environment as detailed below.

Since transferring condensate and gas to Varanus Island Hub 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 for 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 or divers) and equipment or materials are required to be loaded onto the John Brookes WHP.

The subsea pipelines are designed to reduce the potential for rupture and release of condensate and gas to the marine environment. The integrity of the subsea production system is maintained through planned inspection, monitoring and testing of its components, which ensure that the system operates within its design requirements and that there is no unacceptable degradation of the system (e.g., materials, emergency shutdown valve shutdown time or leakage) including when pipelines are suspended.

The primary mechanism to immediately respond to a release of hydrocarbon from the subsea production system is via the emergency shutdown system managed through the Varanus Island Incident Response Plan (QE-00-ZF-00044). This system responds to both automatic and manual activation, with automatic activation triggered by abnormal process conditions, such as pressure drop across the subsea production system. The emergency shutdown system functionality and reliability is maintained through regular testing of the shutdown systems and the subsea valves. The regular testing and maintenance of the emergency shutdown and blowdown systems are managed through Performance Standard Assurance Plans (PSAPs), which provide the work instructions and performance criteria to test and service the shutdown and blowdown systems against. The relevant PSAPs contain specific performance criteria as detailed below:

+ PS-06 ESD and Blowdown: Emergency Shutdown Valves (ESDVs) (QE-00-RG-00218). The performance criteria specified in PS-06 includes:
  - Appropriate ESDV location, ESDV close on demand timings, process safety time calculation, acceptable leak rates of the ESDV (as per American Petroleum Institute), ESDV signage, ESDV alarm, leakage testing, position testing alarms.
+ PS-07 ESD and Blowdown: Reservoir Isolation (including Surface-controlled Subsurface Safety Valves and Christmas tree valves (SCSSVs)) (QE-00-RG-00219). The performance criteria specified in PS-07 includes:
  - SCSSV and Christmas tree valves actuation, SCSSV and Christmas Tree failure, SCSSV and Christmas Tree close timings, SCSSV acceptable leakage rates, SCSSV and Christmas tree valve position indication.
+ PS-08 ESD and Blowdown: Safety Instrumented Systems (QE-00-RG-00220). The performance criteria for Safety instrumented Systems in PS-08 includes:
  - Sensor for emergency shutdown events, ESD, PSD pushbuttons, electrical tripping device.
+ PS-10 ESD and Blowdown: Pressure Safety Valves (QE-00-RG-00222). The performance criteria specified in PS-10 includes:
  - Relief system designed and operated in accordance with American Petroleum Institute, set PSV relief pressure, PSV function testing and examinations, safe relief through critical manual valve position.

The relevant PSAPs are listed as control measures with relevant performance standards in **Table 7-24**.

The maintenance and regular testing of the shutdown systems and the subsea valves managed through the PSAPs ensures a functional, available, reliable, survivable independent control ensuring the emergency shutdown and blowdown functionality, resulting in near-instantaneous shut in following loss of pressure and is considered to reduce the spill volume to ALARP for a major leak/rupture scenario.

The ongoing general inspection and maintenance regime that is completed in accordance with Santos procedures, ensures that Santos will meet its obligations under the OPGGS Act (s.572(2)) to 'maintain in good condition and repair all structures that are, and all equipment and other property that is, in the title area and used in connection with the operations'.

Also, through the development and eventual implementation of the Decommissioning Plan, Santos will meet its obligations under s. 572 (3) of the OPGGS Act 'to remove from the title area all structures that are, and all equipment and other property that is, neither used nor to be used in connection with the operations'.

In terms of spill response activities, Santos will implement oil spill response as specified in the OPEP. A detailed ALARP assessment on the adequacy of arrangements available to support spill response strategies and control measures is presented in the OPEP.

7.7.6 Acceptability Evaluation

Is the risk ranked between Low to Medium?	Yes –maximum credible spill volume from a subsea pipeline (210 m^3) residual risk is ranked as very 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 ecological sustainable development?	Yes – activity evaluated in accordance with Santos'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 (E) R 2009 Regulations, including safety case and WOMP. Santos has considered the values and sensitivities of the receiving environment, including, but not limited to: + Conservation values of the identified protection priorities, including the Montebello Marine Park, the Barrow Island Marine Park Management Area, Montebello Marine Park, Muiron Island Marine Management Area, and Ningaloo Marine Park; and + Relevant species recovery plans, conservation management plans and management actions, including but not limited to Recovery Plan for Marine Turtles in Australia 2017 – 2027 (DoEE, 2017), Approved Conservation Advice for *Megaptera novaeangliae* (humpback whale) (TSSC, 2015d), Approved Conservation Advice for *Balaenoptera physalus* (fin whale) (TSSC, 2015b), Approved Conservation Advice for *Rhincodon typus* (whale shark) (TSSC, 2015a), and relevant recovery plans and conservation advices for birds.
Are risks and impacts consistent with Santos's Environmental Management Policy?	Yes – aligns with Santos'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 likelihood of a subsea condensate release from a pipeline is extremely low (remote) when considering industry statistics, Santos 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, WOMP, personnel training and awareness, and a spill response plan (the OPEP). In accordance with Santos's risk assessment process, the residual risk is considered to be 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 Subsea Release of Condensate from Wellheads

7.8.1 Description of Event

Event	Credible spill scenarios were considered for all producing subsea wells and temporarily abandoned or P&A'd subsea wells (**Section 7.5.1**). This assessment determined that the worst case credible subsea wellhead release would occur from an active producing subsea well (Spartan-2, Halyard 1 or Spar-2) and would result from a leak due to impairment across multiple barriers, with release through holes or cracks. A 100% full-bore blowout is not considered credible. The assessment detailed in **Section 7.5.1** concluded that any leak event from the temporarily abandoned wells would have an impact less than the worst case leak modelled here for Spartan-2, Halyard-1 and Spar-2. A worst case leak of 5,637 m^3 was determined from Halyard-1, Spar-2. Spar-2 was selected to for the event as Spar-2 well has been historically a higher producer than Halyard-1 and therefore release volumes are seen as conservative for the Halyard-1 well. The Spartan-2 scenario is expected to be similar (smaller) than Spar-2, and therefore the Spar-2 scenario is seen as representative for Spartan-2. The existing model was based on a total subsea release volume of 3,393 m^3 (28.3 m^3 per day for 120 days). While the modelled volume is less than the credible spill volume of 5,637 m^3, use of this modelling is considered reasonable in the overall context of this EP given that a much larger loss of well control event has been assessed at the nearby John Brookes WHP (**Section 7.6**) and it is this event that has the major influence on the overall EMBA, exposure value contours and spill response planning in this EP. Furthermore, given the light and volatile nature of this condensate, which is considered to have no persistent components, the difference in volume between modelled and credible volumes is considered to have a low influence on the spatial extent of impact from a subsea release from wellheads.
Extent	The East Spar condensate is wholly volatile, with approximately 75% of the oil, by mass, expected to evaporate within the first 12 hours if exposed to the atmosphere. A further 19% has moderate volatility and will evaporate over the first 24 hours, while the remaining 6% will evaporate over a few days. The condensate does not contain persistent components, and it is therefore not expected to linger in the marine environment for an extended period. As the discharge is released at the seabed, the oil will only be exposed to atmospheric conditions and evaporative processes if it reaches the surface. Concentrations of floating oil on the sea surface were not predicted for any season (less than 2% probability for either 1 g/m^2 or 10 g/m^2 thickness), and no shoreline accumulation was predicted. At the surface-concentration environmental impact threshold of 10 g/m^2, there was no contact predicted at any receptor. The potential extent of visible floating surface oil (below 10 g/m^2) is approximately 8 km from the release site. Entrained oil in the water column, above the impact threshold of 100 ppb, is predicted to occur within a region up to 420 km southwest of the release site, with the highest concentration predicted offshore Ningaloo (3,579 ppb) with a 100% probability. Dissolved aromatic hydrocarbons in the water column above an impact threshold of 6 ppb are predicted to occur up to 440 km southwest of the release site, with the highest concentration predicted offshore Ningaloo (640 ppb) with a 100% probability.
Duration	Rather than using the AMSA assumption of mobilisation time + 20 days to cap a well, the release period of 100 days has been selected based on a conservative rig mobilisation and relief-well drilling schedule. The longest duration blowouts in recent history (Montara at 74 days and Macondo at 87 days) have been capped in less time than this.

7.8.2 Nature and Scale of Environmental Impacts

Potential receptors: Physical environment (water and sediment quality, shoals and banks, benthic habitats, offshore reefs and islands), threatened or migratory fauna (marine mammals, marine reptiles, sharks, fish, rays and birds), protected and significant areas (marine parks, KEFs), socio-economic receptors (fisheries, tourism and recreation).

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. A subsea release of condensate from wellheads (Halyard-1 and Spar-2) 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 from a larger spill volume than the 3,393 m^3 predicted for this scenario, condensate contacting shorelines was not predicted to occur. Potential impact pathways (physical and chemical) of hydrocarbon exposure for receptors are summarised in **Table 7-17**, and potential impacts to receptors found within the EMBA are further described in **Table 7-18**.

7.8.2.1 Modelled scenario

The modelled scenario was based on the credible spill scenario (**Section 7.5.1**), with a summary of the parameters used is described in **Table 7-27**. Oil spill modelling of East Spar condensate was used to assess the above identified spill scenarios from the Halyard-1, Spar-2 and Spartan-2 wells, The characteristics of all three condensates are similar, with all being highly volatile and the majority of surface oil (< 90%) is predicted to evaporate in the first 24 hours (**Table 7-12**) . The existing model was based on a total subsea release volume of 3,393 m^3 (28.3 m^3 per day for 120 days).

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 from a spill.

Table 7-27: Loss of well control or damage to infrastructure causing condensate with gas release from the Halyard-1 or Spar-2 subsea wellhead

Condensate characteristics modelled	Released volume (m^3)	Discharge rate (m^3/day)	Release location	Release Depth	Spill duration
East Spar condensate	3,393	28.3	East Spar-2	115m	120 days

7.8.2.2 Spill Modelling Results

The condensate does not contain persistent components, and it is therefore not expected to linger in the marine environment for an extended period of time. As the discharge is released at the seabed, the oil will only be exposed to atmospheric conditions and evaporative processes if it reaches the surface.

During a subsea release, the low discharge velocity and turbulence generated by the expanding gas plume is predicted to generate large sized oil droplets (<9000µm). 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 modelling results are summarised below for the fate of hydrocarbon (floating, entrained, dissolved and accumulated) at the exposure values described **in Section 7.5.4**. **Appendix G2** provides the full modelling results for the purposes of risk evaluation.

Further parameters required to inform spill response strategies are described further in the OPEP.

Floating Oil

Low (1 g/m²)

Floating oil concentrations are not forecast to exceed 1 g/m², so no receptors are forecast to have ≥1% probability of contact. Potential for thinner sheens to reach shorelines and accumulate to concentrations ≥1 g/m² is indicated for Montebello Islands and Barrow Island.

Moderate (10 g/m²)

No contact at greater than 1% probability predicted at this exposure level.

High (25 g/m²)

No contact at greater than 1% probability predicted at this exposure level.

Shoreline accumulation

No shoreline accumulation was predicted for this scenario.

Low (10 g/m²)

No contact at greater than 1% probability predicted at this exposure level.

Moderate (100 g/m²)

No contact at greater than 1% probability predicted at this exposure level.

High (1000 g/m²)

No contact at greater than 1% probability predicted at this exposure level.

Entrained Oil

Worst-case estimates of entrained concentrations greater than 1,000 ppb, at any depth, are forecast for the buffer zones around the Southern Island Coast and Ningaloo Coast (1,204 ppb and 1,720 ppb, respectively).

Low (10 ppb)

The modelling indicates that Outer Ningaloo Coast Norther, Ningaloo Coast North, Offshore Ningaloo, Outer NW Ningaloo are all predicted to be contacted at this exposure level with 100% probability. Also predicted to be contacted includes: Muiron Islands (80%), Exmouth Gulf Coast (20%), Lowendal Islands (14%), Ningaloo Cost South (50%), Montebello MP (55%), Southern Islands Coast (50%), Thevenard Islands (52%), Northern Islands Coast (6%), Rankin Bank (48%, Glomar Shoals, (8%). All other receptors have a probability of 2% or less.

Moderate (100 ppb)

The probability contours calculated for entrained oil indicate that concentrations ≥100 ppb are most likely to occur in waters to the southwest and the east of the blowout site. The outer contours of probability indicate the potential for transport of entrained oil at concentrations >100 ppb as far as 600 km southwest of the blowout site. Entrained oil concentrations >100 ppb are predicted to potentially contact the buffer zones around Barrow-Montebello shallows, Montebello Islands, Barrow Island, Lowendal Islands and Southern Islands Coast with probabilities between 19% and 25%. Probabilities of contact greater than 1% are also forecast for Thevenard Islands, Muiron Islands and Ningaloo Coast. For all other receptors, probabilities of ≤1% are predicted for a blowout commencing during any month.

Dissolved Aromatic Hydrocarbons

Low (6 ppb)

Offshore Ningaloo has a 100% probability of contact at this exposure value as predicted by the modelling. Contact is also predicted for: Outer Ningaloo Reef (62%), Muiron Islands (18%), Ningaloo Coast North (46%), Barrow-Montebello Surrounds (10%, Barrow Island (6%), Montebello Island (10%), Outer NW Ningaloo (80%), Ningaloo Coast South (4%), Montebello AMP (34%), Southern Islands Coast (8%), Thevenard Islands (8%), Rankin Bank (18%).

Moderate (50 ppb)

Results indicate that dissolved aromatic hydrocarbons could occur at instantaneous concentrations ≥50 ppb up to 400 km to the southwest of the blowout site. The highest probability of instantaneous DAH concentrations ≥50 ppb is forecast for nearshore waters of Barrow Island and Southern Islands Coast (17%). Probabilities between 3% and 13% are forecast to potentially contact the buffer zones around Barrow-Montebello shallows, Montebello Islands, Lowendal Islands, Thevenard Islands, Muiron Island and Ningaloo Coast.

High (400 ppb)

All receptors have a less than 2% contact probability predicted at this exposure level.

7.8.3 Environmental Performance Outcomes and Control Measures

The EPO relating to this event includes:

+ No loss of containment of hydrocarbon to the marine environment (EPO-VI-CW-08).

Control measures applied to prevent an oil spill are shown in **Table 7-28** and corresponding EPSs and measurement criteria for the EPOs described in **Table 8-2**.

Selection of oil spill response strategies and associated EPOs, control measures and EPSs, including those required to maintain preparedness and for response, are detailed within the OPEP. The OPEP contains an evaluation of oil spill preparedness arrangements to demonstrate that oil spills will be mitigated to ALARP.

Table 7-28: Control Measure Evaluation for the Subsea Release of Condensate from Wellheads

Control Measure Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
Standard Controls				
VI-CW-CM-38	NOPSEMA-accepted WOMP in place.	Includes control measures for well integrity and well control as well as ongoing inspection requirements.	Costs associated with personnel time in writing, reviewing and implementing the WOMP.	**Adopted** – Benefits considered to outweigh costs. Regulatory requirement must be adopted.
VI-CW-CM-39	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.
VI-CW-CM-31	Inspection of WHP structures and hydrocarbon-containing equipment.	Regular inspections reduce the risk of leaks from WHP structures and hydrocarbon-containing equipment by confirming appropriate integrity.	Costs associated with personnel time in performing the inspection, reporting on the inspection and follow-up actions.	**Adopted** – Benefits considered to outweigh costs.

Control Measure Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
VI-CW-CM-10	Planned subsea and offshore maintenance.	Reduces likelihood of leaks from equipment and ensures ongoing integrity of infrastructure	Personnel and operational costs associated with undertaking regular inspections of all equipment.	**Adopted** – Benefit of the inspection to determine operational integrity outweighs the cost to undertake the inspection.
VI-CW-CM-46	Inspection and corrosion monitoring of pipelines.	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.
VI-CW-CM-42	Emergency power equipment is provided on John Brookes 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 operation situations.	Costs associated with personnel time in performing the testing and maintenance.	**Adopted** – Benefits considered to outweigh costs.
VI-CW-CM-40	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.
VI-CW-CM-41	Incident Response Plan detailing the requirements for preparedness and response to emergencies and crises to protect people and the environment.	Provides detail to ensure the ESD system is activated quickly and efficiently if it has not automatically activated, to reduce the extent of impacts to the marine environment.	Administrative costs of preparing documents.	**Adopted** – Benefits considered to outweigh costs.

Control Measure Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
VI-CW-CM-11	Dropped object prevention procedure (LEMS).	Impacts to the environment are reduced by preventing dropped objects. Ensures lifting equipment is certified and inspected.	Costs associated with personnel time in implementing procedures and in incident reporting.	**Adopted** – Benefits considered to outweigh costs.
VI-CW-CM-43	Oil pollution emergency plan (OPEP)	Implements response plans to deal with an unplanned hydrocarbon release quickly and efficiently to reduce impacts to the marine environment.	Administrative costs of preparing documents and large costs of preparing for and implementing response strategies.	**Adopted** – Benefits of ensuring procedures are followed and measures implemented and that the vessels are compliant outweighs the costs. Regulatory requirement must be adopted.
VI-CW-CM-16	Navigational charting of infrastructure.	Provides a means for marine users to be aware of the presence of the WHP and subsea infrastructure.	Costs associated with personnel time in issuing notifications.	**Adopted** – Benefits considered to outweigh costs.
VI-CW-CM-47	Operational monitoring of low flow well leak	Ensures potential leaks from wells are investigated and monitored until negligible risk to the environment is confirmed and there is no risk of escalation	Costs associated with personnel time undertaking risk assessments. Costs of monitoring including ROV and vessel hire	**Adopted -** Benefits considered to outweigh costs.
VI-CW-CM-48	Santos' decommissioning framework (refer to **Section 8.8**).	Ensures an appropriate level of planning for the eventual permanent plug and abandonment of wells and removal of property. Ensures Santos has plans in place to meet its regulatory obligation to remove property.	Organisational costs to prepare plans prior to EOFL.	**Adopted -** Benefits considered to outweigh costs. Regulatory obligation to remove property.

Control Measure Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
Additional Controls				
N/A	Relief-well plans in place for all wells.	May allow for quicker response to a loss of well control scenario, thereby limiting potential spill extent and volume.	Costs associated with personnel time in writing and reviewing relief-well plans.	**Rejected** – Santos only has relief well 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.
N/A	Standby vessel in situ 24 hours/day at unmanned WHP.	Monitor the WHP 500-m 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. Negligible costs of operating navigational equipment.	**Rejected** – The costs associated with having a vessel on location 24/7 are considered infeasible, particularly given the WHP and infrastructure are marked on charts and navigational aids are present.

7.8.4 Environmental Impact Assessment

The below environmental impact assessment follows the risk assessment approach detailed in **Section 7.5.6.**

7.8.4.1 Identification of Hotspots for Consequence Assessment

As described in **Section 7.5.6,** the process to identify any HEV's within the EMBA (low exposure threshold) for the subsea release of condensate from wellheads was followed. No new Hotspots were identified.

The impact, likelihoods and consequence ranking for a subsea release of condensate from wellheads are outlined in

Table 7-29.

Table 7-29: Impact, Likelihoods and Consequence Ranking – Subsea Release of Condensate from Wellheads

Description	
Receptors	Physical environment (water and sediment quality, shoals and banks, benthic habitats, offshore reefs and islands) Threatened or migratory fauna (marine mammals, marine reptiles, sharks, fish, rays and birds) Protected and significant areas (marine parks and KEFs) Socio-economic receptors (fisheries, tourism and recreation)
Consequence	III - Moderate
Physical environment and threatened or migratory fauna In the event of a subsea release from wellheads (Halyard-1 or Spar-2 and , temporarily abandoned wells described in **Section 7.5.1**), the volume of condensate released would result in a localised reduction in water quality with the potential to impact marine fauna. Any release from a temporarily abandoned well would be slower and less volume than that considered above, thus the consequences would be less. A description of impacts to marine fauna from exposure to condensate is provided in **Table 7-18** and in **Section 7.6**. 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 advices (**Table 3-7**). With controls in place that align with relevant actions described in various recovery plans, the activity will be conducted in a manner that reduces potential impacts to ALARP and an acceptable level. Impacts from a subsea condensate release would be greatest within several kilometres from the spill when the toxic aromatic components of the fuel will be at their highest concentration. Therefore, potential sensitive receptors include those in the water column, such as fish, marine mammals, marine reptiles and submerged habitats. As no surface slick is predicted larger than 10 g/m^2 for a larger spill volume, no impacts to receptors at the sea surface are predicted, and no impacts to shoreline receptors are expected. *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 are described in detail in **Section 7.6.** *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 (**Table 3-9**). Entrained oil at more 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 as described in **Table 7-17** and **Table 7-18**. 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 subsea wells has the potential to impact receptors predominantly in the water column only. As such, the worst-case consequence is considered to be Moderate (III).	

Likelihood	a– remote
The likelihood of a loss of well control event occurring either due to well integrity failure or due to anchor or chain drag is extremely low when considering industry statistics, Santos statistics and the preventive control measures in place. Wells are designed with essential engineering and safety control measures to prevent a loss of containment occurring. 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, safety case, crew training and awareness, and a spill response plan (OPEP). In conjunction with controls to prevent vessel collision and anchoring incidents, 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 subsea release at the Spartan-2, Halyard-1 or Spar-2 wellheads resulting in a Moderate (III) consequence is considered to be remote (a). For temporarily abandoned wells, the key well integrity risk is related to a failure of well barriers resulting in a leak. Given the leak path the gas would need to travel through as described above, the likelihood (during the period for the current WOMP in force) of a gas flow to the sea-bed is assessed as remote (a).	
Residual Risk	The residual risk associated with this event is **Very Low**.

7.8.5 Demonstration of 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, as detailed below.

Since the purpose of operational activities is to extract, process, store and offload condensate oil, the risk of a condensate oil spill cannot be completely eliminated from the operational area.

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 emergency shutdown valve shutdown time or leakage).

The primary mechanism to immediately respond to a release of hydrocarbon from the subsea production system is via the emergency shutdown system managed through the Varanus Island Incident Response Plan (SO-00-ZF-00044). This system responds to both automatic and manual activation, with automatic activation triggered by abnormal process conditions, such as pressure drop across the subsea production system. The emergency shutdown system functionality and reliability is maintained through regular testing of the shutdown systems and the subsea valves. The regular testing and maintenance of the emergency shutdown and blowdown systems are managed through Performance Standard Assurance Plans (PSAPs), which provide the work instructions and performance criteria to test and service the shutdown and blowdown systems against. The relevant PSAPs contain specific performance criteria as detailed below:

+ PS-06 ESD and Blowdown: Emergency Shutdown Valves (ESDVs) (QE-00-RG-00218). The performance criteria specified in PS-06 includes:
  - Appropriate ESDV location, ESDV close on demand timings, process safety time calculation, acceptable leak rates of the ESDV (as per American Petroleum Institute), ESDV signage, ESDV alarm, leakage testing, position testing alarms.
+ PS-07 ESD and Blowdown: Reservoir Isolation (including Surface-controlled Subsurface Safety Valves and Christmas tree valves (SCSSVs)) (QE-00-RG-00219). The performance criteria specified in PS-07 includes:
  - SCSSV and Christmas tree valves actuation, SCSSV and Christmas Tree failure, SCSSV and Christmas Tree close timings, SCSSV acceptable leakage rates, SCSSV and Christmas tree valve position indication.

+ PS-08 ESD and Blowdown: Safety Instrumented Systems (QE-00-RG-00220). The performance criteria for Safety instrumented Systems in PS-08 includes:
  - Sensor for emergency shutdown events, ESD, PSD pushbuttons, electrical tripping device.
+ PS-10 ESD and Blowdown: Pressure Safety Valves (QE-00-RG-00222). The performance criteria specified in PS-10 includes:
  - Relief system designed and operated in accordance with American Petroleum Institute, set PSV relief pressure, PSV function testing and examinations, safe relief through critical manual valve position.

The relevant PSAPs are listed as control measures with relevant performance standards in **Table 7-28**.

The maintenance and regular testing of the shutdown systems and the subsea valves managed through the PSAPs ensures a functional, available, reliable, survivable independent control ensuring the emergency shutdown and blowdown functionality, resulting in near-instantaneous shut in following loss of pressure and is considered to reduce the spill volume to ALARP for a release of condensate from a wellhead.

The likelihood of a loss of production well control event occurring during the operations is rare when considering industry statistics and the preventive controls in place. In terms of spill response activities, Santos will implement oil spill response as specified in the OPEP. A detailed ALARP assessment on the adequacy of arrangements available to support spill response strategies and control measures is presented in the OPEP.

The listed wells are currently managed in accordance with NOPSEMA-accepted WOMPs. According to the WOMPs, all well integrity risks are ALARP. Well integrity risks will continue to be managed in accordance with the WOMPs until they are permanently plugged and abandoned. The WOMPs require wellhead monitoring for leak detection. Santos will undertake any necessary actions, potentially in advance of EOFL, should the well integrity risk level or risk tolerance change on any of these wells. It is through the implementation of this monitoring regime that Santos will meet its obligations under the OPGGS Act (s.572(2)) to 'maintain in good condition and repair all structures that are, and all equipment and other property that is, in the title area and used in connection with the operations'

There are no current material environmental impacts or risks associated with the abandoned and suspended subsea wells. This will be regularly verified through well integrity monitoring, as required by WOMPs. Given the additional financial cost to permanently plug and abandon the wells (millions of dollars) prior to EOFL and the current low environmental risks, the difference between the high additional costs and low environmental risks is considered to be grossly disproportionate. To this end, permanently plugging and abandoning the wells post EOFL is considered to be environmentally acceptable and as soon as reasonably practicable.

Planning for the removal of the infrastructure will occur prior to EOFL for both the GES and John Brookes fields. This will culminate in the development of a Decommissioning Plan to be completed at least two years prior to EOFL (refer to VI-CW-CM-48). It is through the development and eventual implementation of the Decommissioning Plan that Santos will meet its obligations under s. 572 (3) of the OPGGS Act 'to remove from the title area all structures that are, and all equipment and other property that is, neither used nor to be used in connection with the operations'.

For temporarily abandoned subsea wells, given the controls in place and the assessed risk profile for each of these wells, taking the additional step of accelerating a stand-alone MODU intervention scope to permanently abandon any of the wells ahead of the full field abandonment was seen as disproportional to any improvement in the current risk profile.

7.8.6 Acceptability Evaluation

Is the risk ranked between Low to Medium?	Yes –maximum credible spill volumes from Halyard-1 or Spar-2 wellheads (5,637 m^3) residual risk is ranked as Very 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 ecological sustainable development?	Yes – activity evaluated in accordance with Santos'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(E)R 2009, including safety case and WOMP. Santos has considered the values and sensitivities of the receiving environment, including, but not limited to: + Conservation values of the identified protection priorities, including the Montebello Marine Park, the Barrow Island Marine Management Area, Montebello Islands Marine Park, Muiron Island Marine Management Area, and Ningaloo Marine Park; and + Relevant species recovery plans, conservation management plans and management actions, including but not limited to Recovery Plan for Marine Turtles in Australia 2017 – 2027 (DoEE, 2017), Approved Conservation Advice for *Megaptera novaeangliae* (humpback whale) (TSSC, 2015d), Approved Conservation Advice for *Balaenoptera physalus* (fin whale) (TSSC, 2015b), Approved Conservation Advice for *Rhincodon typus* (whale shark) (TSSC, 2015a), and relevant recovery plans and conservation advices for birds.
Are risks and impacts consistent with Santos's Environmental Management Policy?	Yes – Aligns with Santos'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 likelihood of a loss of well control event is extremely low (remote) when considering industry statistics, Santos statistics and the preventive controls in place. Additional industry-standard 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's risk assessment process, the residual risk is considered to be Very Low 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.

7.9 Surface Release of Diesel (Vessel Collision/Bunkering/dropped object)

7.9.1 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 John Brookes WHP or another vessel within the operational area. Such a collision could have sufficient impact to result in rupture of a 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 John Brookes 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 is 329 m^3, based on the largest single fuel-tank capacity released at the sea surface at the John Brookes WHP in Commonwealth waters. 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. The AMSA (2015) Technical Guidelines for Preparing Contingency Plans for Marine and Coastal Facilities 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.
Extent	A surface release (329 m^3) of diesel was modelled at the John Brookes WHP to represent a worst-case spill from a vessel collision. The surface slick is predicted to spread rapidly out 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 also 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 a low probability (less than 0.5%) of floating oil at more than 10 g/m^2 or 1 g/m^2 thickness. The locations at the highest risk of contact by floating oil are predicted to be the waters of the Montebello Marine Park with a 4% probability of more than 10 g/m^2 and offshore Ningaloo with a 2.5% probability of more than 10 g/m^2. No volumes of oil were predicted to accumulate on shorelines, above the moderate exposure value. At the surface-concentration environmental impact threshold of 10 g/m^2, the potential extent of floating surface oil is approximately 101 km southwest from the release site. Surface oil may be visible 112 km northeast from the release site at concentrations above the 1 g/m^2 threshold. Entrained oil concentrations greater than 100 ppb were predicted, with low probability (less than 2%) for all locations except the waters of the Montebello Marine Park (20.5%) and offshore Ningaloo reef (12.5 %) with minimum time to contact reported as 9 hours and 6 hours respectively. The maximum concentrations of entrained hydrocarbon exposure were predicted to be at the Montebello Marine Park (2,218 ppb) and offshore Ningaloo reef (1,857 ppb). The probability of exposure to dissolved aromatic hydrocarbons above the 6 ppb impact threshold was low for all locations (at or below 0.5%) with the exception of the Montebello 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.
Duration	Following the AMSA (2015) guidelines for 'Other Vessel Collision', for conservatism, the largest single tank inventory for any of the support vessels known to potentially be

	contracted by Santos was assumed to be released from a vessel collision (largest potential tank volume of 329 m^3). It was assumed that this volume would be released over one hour, at the sea surface.

7.9.2 Nature and Scale of Environmental Impacts

Potential receptors: Physical environment (water and sediment quality), threatened or migratory fauna (marine mammals, marine reptiles, sharks, fish, rays and birds), protected and significant areas (marine parks and KEFs), socio-economic receptors (fisheries, tourism and recreation).

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. 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, no volumes of oil were predicted to accumulate on shorelines, with a maximum concentration reported as 2 g/m^2 at Thevenard Island. Waters of the Montebello Marine Park and offshore Ningaloo are predicted to be exposed to surface concentrations of more than 10 g/m^2 with reported probabilities of 4% and 2.5% respectively. 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 **Table 7-17**, and potential impacts to receptors found within the EMBA are further described in **Table 7-18**.

7.9.2.1 Spill Modelling Information

The John Brookes 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 WHP on a fortnightly basis on average. The John Brookes WHP is also a fixed collision hazard and a potential source of dropped objects that could damage a vessel hull. Therefore, this was chosen as the release location for the modelling study.

Weathering studies predicted that approximately 40% of the spill volume would evaporate within 35 hours, depending on the prevailing conditions. The heavier (low-volatility) components of diesel have a tendency to entrain into the upper water column due to wind-generated waves but can subsequently resurface if wind waves abate.

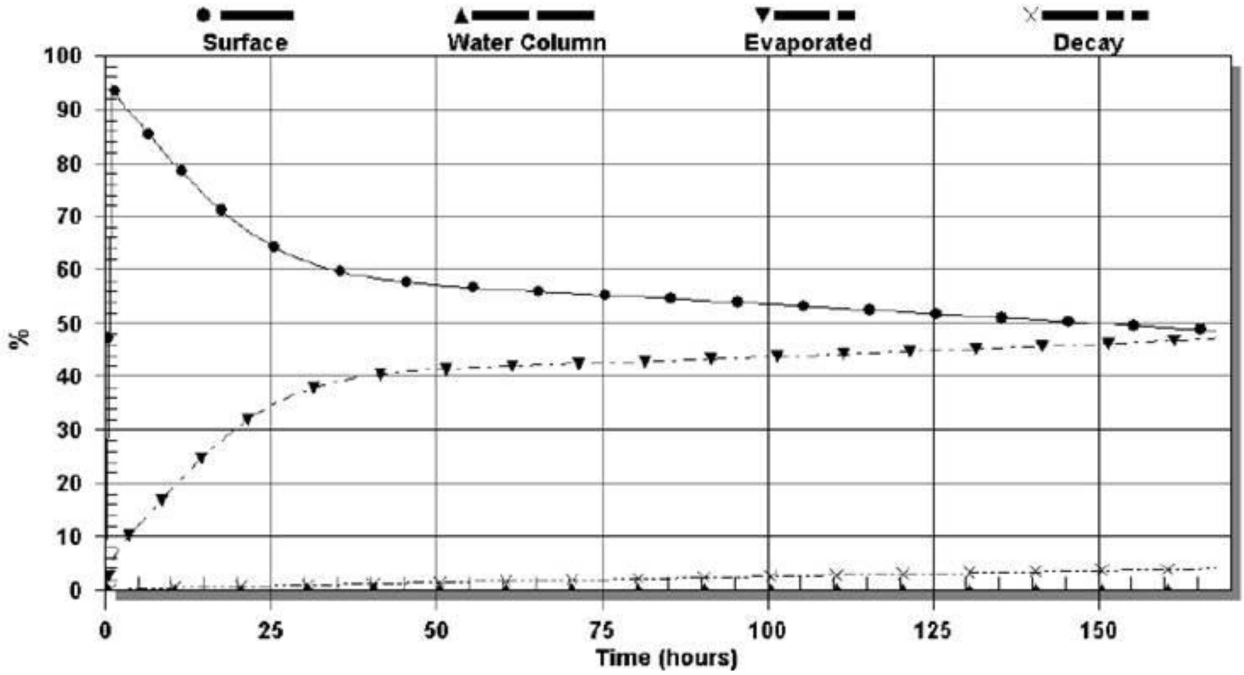
ITOPF (2011) and the AMOSC (2011) categorise diesel as a light ‘group II’ hydrocarbon. In the marine environment, a 5% residual of the total quantity of diesel spilt will remain after the volatilisation and solubilisation processes associated with weathering.

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.

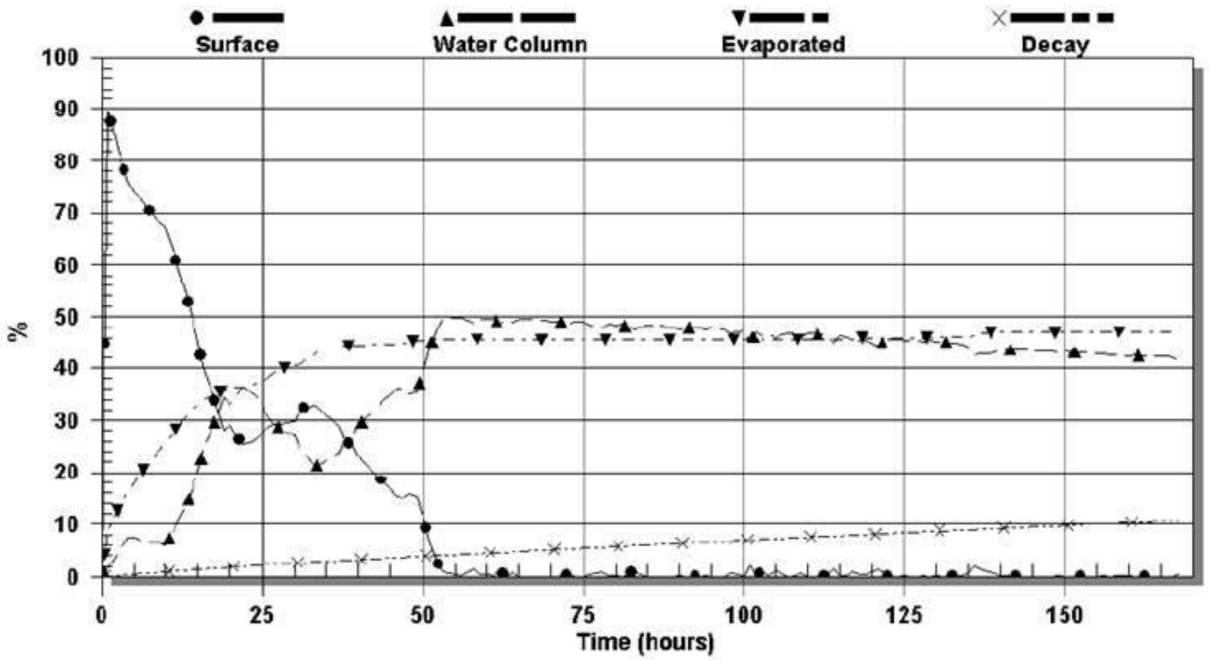
Modelling of surface diesel spills by APASA indicates that at least 40% by volume would evaporate within 40 hours of release under calm conditions (**Figure 7-3**). The remaining diesel would mostly remain on the surface, where it would be subjected to continuing weathering, including evaporation and photo-oxidation, although at a slowed rate (APASA, 2014a). 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, 2014a). At the end of 48 hours (2 days) approximately 45% is predicted to have evaporated (**Figure 7-4**). Under conditions that generate wind waves (i.e., winds at or below approximately 12 knots), an increased portion of the residual component of diesel is predicted to become entrained beneath the surface (APASA, 2014a) with very little on the surface.



Source: APASA (2014a).

Figure 7-3: Proportional Mass Balance Plot Representing the Weathering of Marine Diesel Spilled onto the Surface as a Single Release (50 m^3 over 1 hour) and Subject to a Constant 5-Knot Wind at 27°C Water Temperature and 25°C Air Temperature



Source: APASA (2014a).

Figure 7-4: Proportional Mass Balance Plot Representing the Weathering of Marine Diesel Spilled onto the Surface as a Single Release (50 m^3 over 1 hour) and Subject to Variable Wind at 27°C Water Temperature and 25°C Air Temperature

7.9.2.2 Spill Modelling Results

A surface release of 329 m^3 of diesel was modelled at the John Brookes WHP. Upon release, the diesel is forecast to spread rapidly out to a thin film on the sea surface; and evaporation is forecast to remove approximately 50% of the released volume within several days of release. The diesel will also become increasingly subject to entrainment into the water column as the density increases after losing the lighter components through evaporation.

The offshore location of the spill and distance from receptors means floating oil slicks would be subject to considerable evaporation and weathering before any contact to sensitive shorelines, reflected in the low probability (less than 0.5%) of floating oil greater than 10 g/m^2 or 1 g/m^2 thickness occurring. The receptors at highest risk were predicted to be the waters of the Montebello Marine Park at a 4% probability of contact by floating oil at concentrations greater than 10 g/m^2 within 9 hours and offshore Ningaloo at a 2.5% probability of contact by floating oil at concentrations greater than 10 g/m^2 within 5 hours. In the worst-case simulation, the maximum local accumulated concentrations on shorelines was predicted to be at Thevenard Island with 2 g/m^2, the Muiron Islands with 0.9 g/m^2 and the Southern Islands Coast with 1.8 g/m^2, all below the moderate exposure value of 100 g/m^2.

Entrained oil concentrations greater than 100 ppb were predicted with low probability (less than 2 %) for all simulations. The maximum concentrations were predicted at the Montebello Marine Park (2,218 ppb) and offshore Ningaloo reef (1,857 ppb). Dissolved aromatic hydrocarbons are highly volatile with a large proportion expected to evaporate at the sea surface unless the oil becomes entrained. Exposure to dissolved aromatic hydrocarbons above the 6 ppb impact threshold was low for all locations (at or less than 0.5%) with the exception of the Montebello Marine Park (57 ppb) and offshore Ningaloo (39 ppb).

7.9.3 Environmental Performance Outcomes and Control Measures

The EPO relating to this event includes:

+ No loss of containment of hydrocarbon to the marine environment (EPO-VI-CW-08).

The control measures applied to prevent an oil spill are shown in **Table 7-30,** and corresponding EPSs are described in **Table 8-2.**

Selection of oil spill response strategies and associated EPOs, control measures and EPSs, including those required to maintain preparedness and for response, are detailed within the OPEP. The OPEP contains an evaluation of oil spill preparedness arrangements to demonstrate that oil spills will be mitigated to ALARP.

Table 7-30 Control Measure Evaluation for the Surface Release of Diesel (Vessel Collision/Bunkering)

Control Measure Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
Standard Controls				
VI-CW-CM-18	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.

Control Measure Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
VI-CW-CM-17	Navigational lighting and aids.	Vessels meet minimum safety standards, thereby reducing potential for vessel collision events with associated diesel spill to the environment.	Costs associated with personnel time in checking vessel certifications are in place.	**Adopted** – Benefits considered to outweigh costs.
VI-CW-CM-44	Support vessel positioning.	Vessels maintain accurate positioning and reduce potential to impact the WHP.	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.
VI-CW-CM-16	Navigational charting of infrastructure.	Provides a means for marine users to be aware of the presence of the WHP and subsea infrastructure.	Costs associated with personnel time in issuing notifications.	**Adopted** – Benefits considered to outweigh costs.
VI-CW-CM-11	Dropped object prevention (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.

Control Measure Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
VI-CW-CM-14	WHP petroleum safety zone and cautionary area.	Exclusion zone applies around offshore platforms and is marked on Australian nautical charts to prevent vessel collision with an offshore platform.	No additional costs to Santos. 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 an offshore platform is unlikely to significantly impact upon the marine user. The benefits to safety of the activity (thus reducing risk of environmental impacts due to vessel collisions) outweigh potential costs.
VI-CW-CM-36	Vessel spill response plan (SOPEP/SMPEP).	Implements response plans on board vessels to deal with unplanned hydrocarbon releases and spills quickly and efficiently to reduce impacts to the marine environment.	Administrative costs of preparing documents. Generally undertaken by vessel contractor so time for Santos personnel to confirm and check SOPEP/SMPEP in place.	**Adopted** – Benefits considered to outweigh costs.
VI-CW-CM-43	Oil pollution emergency plan (OPEP)	Implements response plans to deal with an unplanned hydrocarbon release quickly and efficiently to reduce impacts to the marine environment.	Administrative costs of preparing documents and large costs of preparing for and implementing response strategies.	**Adopted** – Benefits of ensuring procedures are followed and measures implemented and that the vessels are compliant outweigh the costs.
VI-CW-CM-34	Refuelling and Chemical Transfer Procedure.	Minimises risk of pollution to ALARP during chemical transfers from an offshore support	Personnel costs associated with ensuring procedures are in place and	**Adopted** – Benefits of ensuring procedures are followed and

Control Measure Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
		vessel to an offshore facility.	implemented during inspections.	measures implemented outweigh the costs of personnel time.
Additional Controls				
N/A	No diesel bunkering.	Removes potential spill scenario.	Although not expected to occur frequently, the need for operational bunkering may arise during operational activities. Diesel bunkering offshore is considered to be a standard practice, with controls in place and risks well understood by the industry.	**Rejected** – In order to maintain the required level of flexibility, the ability to undertake bunkering of diesel is required. Potential risks are further reduced by not undertaking vessel-to-vessel or vessel-to-platform fuel transfers.
N/A	Require all support vessels involved in the activity to be double hulled.	Reduces the likelihood of a loss of hydrocarbon inventory in the highly unlikely event of a vessel collision, minimising potential environmental impact.	Vessels are subject to availability and are required to meet Santos's standards during activities; requirement of a double hull on vessels would limit the number available to Santos; also, requiring vessels to be refitted to ensure double hulls would be of high cost.	**Rejected** – Large costs associated with vessel selection and by having an activity schedule determined by vessel availability considered to be grossly disproportionate compared to low risk of a vessel collision and low risk of a large diesel spill.

7.9.4 Environmental Impact Assessment

As described in Section 7.5.6, the process to identify any HEV's within the EMBA (low exposure threshold) for the subsea release of condensate from wellheads was followed. No new Hotspots were identified.

The impacts, likelihood and consequence ranking for a surface release of diesel (vessel collision/bunkering) are outlined in **Table 7-31**.

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Table 7-31: Impacts, Likelihood and Consequence Ranking – Surface Release of Diesel (Vessel Collision/Bunkering)

Description	
Receptors	+ Physical environment (water and sediment quality) + Threatened or migratory fauna (marine mammals, marine reptiles, sharks, fish, rays and birds) + Protected and significant areas (marine parks and KEFs) + Socio-economic receptors (fisheries, tourism, and recreation)
Consequence	II - 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 extent 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 hydrocarbon exposure are described in detail in **Table 7-17** and **Table 7-18**. 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 advices (**Table 3-7**). In the unlikely event of a vessel collision/bunkering spill of marine diesel, the potential impacts to the environment would be greatest within several 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 spread thinner as evaporation continues. The potential sensitive receptors in the surrounding areas of the spill will include those in the water column, such as fish, marine mammals, marine reptiles and sensitive receptors such as submerged habitats. There is the potential for surface diesel to disrupt fishing activities if the diesel moves through fishing areas (**Table 3-9**). Tourism could be affected by surface diesel, either from reduced water quality preventing recreational activities or reducing aesthetic appeal or from impacts to marine fauna as described in **Table 7-17** and **Table 7-18**. 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 surface diesel release at the John Brookes WHP has the potential to impact receptors in the water column. Given the limited extent, the worst-case consequence is considered to be Minor (II).	
Likelihood	a – Remote
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/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, is considered to be remote (a).	
Residual Risk	The residual risk associated with this hazard is **Very Low.**

7.9.5 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 to transfer supplies and equipment to the facility; offload equipment and waste; and perform inspection, maintenance, monitoring and repair activities. Helicopters 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 and thus vessel-to-platform loading cannot be substituted.

Offshore refuelling is standard industry practice; and oil pollution legislation, including the 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. The risk of diesel spill during refuelling has been further reduced through the WHP using solar power as the primary energy source, thus reducing the frequency of diesel transfers to the John Brookes 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 will implement oil spill response as specified within the vessel's SOPEP/SMPEP and/or the OPEP. A detailed ALARP assessment on the adequacy of arrangements available to support spill response strategies and control measures is presented in the OPEP.

7.9.6 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 Very 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 ecological sustainable development?	Yes – activity evaluated in accordance with Santos'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 (E) R 2009 including safety case and WOMP. Santos has considered the values and sensitivities of the receiving environment, including, but not limited to: + Conservation values of the identified protection priorities (**Section 3.2**) including the Montebello Marine Park, the Barrow Island Marine Management Area, Montebello Islands Marine Park, Muiron Island Marine Management Area, and Ningaloo Australian Marine Park; and + Relevant species recovery plans, conservation management plans and management actions, including but not limited to Recovery Plan for Marine Turtles in Australia 2017 – 2027 (DoEE, 2017), Approved Conservation Advice for *Megaptera novaeangliae* (humpback whale) (TSSC, 2015d), Approved Conservation Advice for *Balaenoptera physalus* (fin whale) (TSSC, 2015b), Approved Conservation Advice for *Rhincodon typus* (whale shark) (TSSC, 2015a), and relevant recovery plans and conservation advices for birds.

Are risks and impacts consistent with Santos's Environmental Management Policy?	Yes – aligns with Santos'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 activities will be managed in accordance with relevant legislation and standards. With the implementation of industry-standard and activity-specific control measures to reduce the likelihood of a diesel spill event (and minimise impacts), the residual risk is assessed to be very 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.
Regulation 14(10)
The implementation strategy must comply with the Act, the regulations and any other environmental legislation applying to the activity.

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 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 management system exists to support its moral, professional and legal obligations to undertake work in a manner that does not cause harm to people or the environment. The 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, ensure:

+ a common 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 require 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;

- stakeholder consultation is maintained throughout the activity as appropriate.

8.2 Environmental Management Policy

Santos's Environment, Health and Safety Policy (**Appendix A**) clearly sets out Santos'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, 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 (refer to **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 below.

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 8.13**).

Any new, or proposed amendment to a control measure or environmental performance standard or outcome will be managed in accordance with the Environment Management of Change Procedure (EA-91-IQ-10001) (**Section 8.12.2**).

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. These plans, with titles beginning 'PS-*n*', 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 Outcomes

To ensure environmental risks and impacts will be of an acceptable level, environmental performance outcomes have been defined and are listed in **Table 8-1**. Those EPOs relating to oil spill response are listed in the OPEP. These outcomes will be achieved by implementing the identified control measures to the defined environmental performance standards.

Table 8-1: Environmental Performance Outcomes

Reference	Environmental Performance Outcomes
EPO-VI-CW-01	No injury or mortality to EPBC Act and WA Biodiversity Conservation Act 2016 listed marine fauna during operational activities
EPO-VI-CW-02	Reduce impacts to marine fauna from lighting on the WHP and support vessels through limiting lighting to that required by safety and navigational lighting requirements.
EPO-VI-CW-03	Reduce impacts to air and water quality from planned discharges and emissions from operational activities.
EPO-VI-CW-04	Seabed disturbance is limited to the operational area.
EPO-VI-CW-05	Reduce impacts on other marine users through the provision of information to relevant stakeholders such that they are able to plan for their activities and avoid unexpected interference.
EPO-VI-CW-06	No introduction of marine pest species.
EPO-VI-CW-07	No unplanned objects, emissions or discharges to sea or air
EPO-VI-CW-08	No loss of containment of hydrocarbon to the marine environment.

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 8-2**. Measurement criteria outlining how compliance with the control measure and the expected environmental performance could be evidenced are also listed.

All Control Measures and Performance Standards and associated measurement criteria relating to preparedness and response operations are contained within the VI Hub OPEP (EA-60-RI-00186.02).

Table 8-2: Control Measures and Environmental Performance Standards for the Proposed Activity (Environment Plan)

Control Measure	Control Measure Reference No.	Environmental Performance Standard	EPS Reference No.	Measurement Criteria	EPO Reference No.	Relevant Sections of the EP
Procedure for interacting with marine fauna.	VI-CW-CM-01	Vessels comply with Santos'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.	VI-CW-CM-01-EPS 01	Completed vessel statement of conformance.	EPO-VI-CW-01.	**Section 6.1** **Section 7.2**
		Helicopter contractor's procedures comply with Santos'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 interaction with marine fauna.	VI-CW-CM-01-EPS 02	Helicopter contractor's procedures align with Santos's Protected Marine Fauna Interaction and Sighting Procedure.	EPO-VI-CW-01.	**Section 6.1** **Section 7.2**
		UAV contractor's procedures comply with Santos's Protected Marine Fauna Interaction and Sighting Procedure (EA-91-11-00003), which includes controls for minimising the risk of collision with marine fauna.	VI-CW-CM-01-EPS 03	Contractor's procedures align with Santos's Protected Marine Fauna Interaction and Sighting Procedure.	EPO-VI-CW-01.	**Section 6.1** **Section 7.2**
Lighting will be used only as required for safe work conditions and navigational purposes.	VI-CW-CM-02	Where an activity may require 24-hour lighting, a project execution plan, planning and inductions, will include a requirement to minimise external lighting where practicable during the activity.	VI-CW-CM-02-EPS 01	Where an activity may require 24-hour lighting, a project execution plan, planning and inductions, will include a requirement to minimise external lighting where practicable during the activity.	EPO-VI-CW-02.	**Section 6.2** **Section 7.2**
Premobilisation review and planning of lighting on support vessels and the WHP is undertaken prior to IMMR activities commencing	VI-CW-CM-03		VI-CW-CM-03-EPS 01		EPO-VI-CW-02.	
Facilities Planned Maintenance System.	VI-CW-CM-04	Documented maintenance program is in place for equipment on facilities that provides a status on the maintenance of equipment.	VI-CW-CM-04-EPS 01	CMMS records.	EPO-VI-CW-03; EPO-VI-CW-07.	**Section 6.3** **Section 7.3**
Vessels Planned Maintenance System.	VI-CW-CM-05	Documented maintenance program is in place for equipment on vessels that provides a status on the maintenance of equipment.	VI-CW-CM-05-EPS01	Planned Maintenance System records.	EPO-VI-CW-03; EPO-VI-CW-04; EPO-VI-CW-07.	**Section 6.3** **Section 6.4** **Section 7.3**
Fuel Oil Quality.	VI-CW-CM-06	MARPOL-compliant (Marine Order 97) fuel oil (diesel) will be used during the activity.	VI-CW-CM-06-EPS01	Fuel bunkering records.	EPO-VI-CW-03.	**Section 6.3**
International Air Pollution Prevention Certificate.	VI-CW-CM-07	Pursuant to Marine Order 97, vessels will maintain a current International Air Pollution Prevention Certificate, which certifies that measures to prevent ozone-depleting substance emissions and reduce NOx, SOx and incineration emissions during the activity are in place.	VI-CW-CM-07-EPS01	Current International Air Pollution Prevention Certificate. Audit records. Vessel contract and premobilisation audit records.	EPO-VI-CW-03.	**Section 6.3**
Ozone-depleting substance handling procedures.	VI-CW-CM-08	Ozone-depleting substances managed in accordance with Marine Order 97 to reduce the risk of an accidental release of ozone-depleting substances to air.	VI-CW-CM-08-EPS01	Completed ozone-depleting substances record book or recording system	EPO-VI-CW-03;	**Section 6.3**

Control Measure	Control Measure Reference No.	Environmental Performance Standard	EPS Reference No.	Measurement Criteria	EPO Reference No.	Relevant Sections of the EP
Waste Incineration Management.	VI-CW-CM-09	Waste incineration managed in accordance with Marine Order 97.	VI-CW-CM-09-EPS01	Completed waste record book or recording system.	EPO-VI-CW-03;	**Section 6.3**
Planned subsea and offshore maintenance.	VI-CW-CM-10	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 Offshore Subsea Inspection Procedure (QE-35-IS-00001).	VI-CW-CM-10-EPS01	CMMS records.	EPO-VI-CW-04.	**Section 6.4**
		Santos will maintain in good condition and repair all subsea structures that are, and all subsea equipment and other property that is used in connection with the VI Hub operations to ensure Santos can meet obligations under s.572 of the OPGGS Act.. This will be achieved through the application of Santos Offshore Subsea Inspection Procedure (QE-35-IS-00001). The procedure shall include a description of subsea inspection philosophies, procedures and reporting. Inspection finding reviews by technical authorities will be used to determine the following requirements to inform next actions: + Detailed engineering assessments. + Detailed risk assessments. + Maintenance and remedial works. + Future inspection schedules. The procedure shall require inspection reviews to be documented and resultant actions to be tracked and completed.	VI-CW-CM-10-EPS02	CMMS Records demonstrate ongoing inspection, and maintenance if required, on all subsea structures (including operational and suspended). Inspection reports	EPO-VI-CW-07	**Section 6.4** **Section 7.3** **Section 7.4** **Section 7.6** **Section 7.7** **Section 7.8** **Section 7.9**
Dropped Object Prevention Procedure (LEMS).	VI-CW-CM-11	Implementation of the Santos Lifting Equipment Management System (QE-91-IF-00011) and 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.	VI-CW-CM-11-EPS01	CMMS records. Lifting Equipment Register. Permit to work records. Training records.	EPO-VI-CW-04; EPO-VI-CW-05; EPO-VI-CW-08.	**Section 6.4** **Section 7.3** **Section 7.4** **Section 7.6** **Section 7.7** **Section 7.8** **Section 7.9**
Dropped Object Recovery.	VI-CW-CM-12	Objects dropped overboard are recovered to mitigate the environmental consequences from objects remaining in the marine environment, unless the environmental consequences are negligible or safety risks are disproportionate to the environmental consequences.	VI-CW-CM-12-EPS01	Fate of dropped objects detailed in incident documents.	EPO-VI-CW-04; EPO-VI-CW-05.	**Section 6.4** **Section 7.3**
Anchoring and Equipment Deployment Management.	VI-CW-CM-13	If anchoring or placement of equipment is required vessels will anchor or place equipment on seabed only at Santos pre-approved locations.	VI-CW-CM-13-EPS01	Incident database records show no anchoring or placement of equipment occurred at non-approved locations.	EPO-VI-CW-04 EPO-VI-CW-08	**Section 6.4** **Section 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	VI-CW-CM-13-EPS02	Records of anchor watch.	EPO-VI-CW-04; EPO-VI-CW-08.	**Section 6.4** **Section 7.7**

Control Measure	Control Measure Reference No.	Environmental Performance Standard	EPS Reference No.	Measurement Criteria	EPO Reference No.	Relevant Sections of the EP
		drag an anchor, in accordance with the Mooring Operations Procedure (QE-91-IT-10001).				
WHP Petroleum Safety Zone.	VI-CW-CM-14	A 500-m radius petroleum safety zone is defined around the offshore platforms and marked on Australian Hydrographic Service nautical charts.	VI-CW-CM-14-EPS01	Incident records show that no breaches have occurred of unauthorised access within the petroleum safety zone.	EPO-VI-CW-05; EPO-VI-CW-08.	**Section 6.5** **Section 7.6** **Section 7.9**
Notify AHO and AMSA's JRCC prior to commencement of vessel based IMMR at Rosella-1.	VI-CW-CM-15	Santos notified AHO and AMSA's JRCC prior to commencement of IMMR activities (using vessels) on Rosella-1.	VI-CW-CM-15-EPS01	Records of transmittal	EPO-VI-CW-05.	**Section 6.5**
Navigational charting of infrastructure.	VI-CW-CM-16	The offshore facilities and subsea infrastructure are charted on Australian Hydrographic Service nautical charts.	VI-CW-CM-16-EPS01	Australian Hydrographic Service nautical charts show Santos's offshore facilities are charted.	EPO-VI-CW-05; EPO-VI-CW-08.	**Section 6.5** **Section 7.6** **Section 7.7** **Section 7.8** **Section 7.9**
Navigational lighting and aids.	VI-CW-CM-17	Navigational lighting and communication aids on offshore platforms are provided and inspected at frequencies outlined within PS-04 Navigational Aids (QE-10-RG-0004), which manages the methods to alert marine vessels and aircraft of the position of the facility to minimise the potential for collision.	VI-CW-CM-17-EPS01	CMMS records	EPO-VI-CW-05; EPO-VI-CW-08. EPO-VI-CW-05; EPO-VI-CW-08.	**Section 6.5** **Section 7.6** **Section 7.9**
		Support-vessel navigation equipment is compliant with SOLAS/AMSA Marine Order 30 (Prevention of collisions), and with Marine Order 21 (Safety and emergency arrangements).	VI-CW-CM-17-EPS02	Vessel inspection records.		**Section 6.5** **Section 7.6** **Section 7.9**
Seafarer Certification.	VI-CW-CM-18	Vessel crew are trained and competent, in accordance with ~~Marine Order 70~~ with Flag State regulations, to navigate vessels and reduce interaction with other marine users.	VI-CW-CM-18-EPS01	Training records. Vessel contract and premobilisation audit records.	EPO-VI-CW-05; EPO-VI-CW-08.	**Section 6.5** **Section 7.9**
Constant Bridge watch on Support Vessels.	VI-CW-CM-19	Monitoring of surrounding marine environment undertaken from vessel bridge.	VI-CW-CM-19-EPS01	Records of bridge watch.	EPO-VI-CW-05. EPO-VI-CW-01.	**Section 6.5** **Section 7.2**
Stakeholder Consultation.	VI-CW-CM-20	Santos provided a quarterly consultation update to relevant stakeholders, and all stakeholder correspondence has been recorded in stakeholder database.	VI-CW-CM-20-EPS01	Records of transmittal. Stakeholder communications database.	EPO-VI-CW-05.	**Section 6.5**
Sewage System.	VI-CW-CM-21	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.	VI-CW-CM-21-EPS01	Current International Sewage Pollution Prevention Certificate.	EPO-VI-CW-03.	**Section 6.6**
		Preventive maintenance on sewage treatment equipment is completed as scheduled.	VI-CW-CM-21-EPS02	Maintenance records.		**Section 6.6**
		Sewage from vessels or offshore platforms is discharged or retained, in accordance with Marine Order 96.	VI-CW-CM-21-EPS03	Records demonstrate that sewage was appropriately discharged or retained.		**Section 6.6**

Control Measure	Control Measure Reference No.	Environmental Performance Standard	EPS Reference No.	Measurement Criteria	EPO Reference No.	Relevant Sections of the EP
Oily Mixture System.	VI-CW-CM-22	Oily mixtures (bilge water) only discharged to sea in accordance with Marine Order 91.	VI-CW-CM-22-EPS01	Oil record book.	EPO-VI-CW-03.	**Section 6.6**
		Preventive maintenance on oil-filtering equipment completed as scheduled.	VI-CW-CM-22-EPS02	Maintenance records.		**Section 6.6**
		Pursuant to Marine Order 91, support vessels larger than 400 t will have an International Oil Pollution Prevention Certificate, which certifies that required measures to reduce impacts of planned oil discharges are in place.	VI-CW-CM-22-EPS03	Current International Oil Pollution Prevention Certificate.		**Section 6.6**
Offshore Platform Deck Drain System and Bunding.	VI-CW-CM-23	Preventive maintenance on deck drainage sump and associated equipment completed as scheduled in accordance with John Brookes Performance Standard Assurance Plan PS-14-Bunding and Open Drains (QE-00-RG-00226).	VI-CW-CM-23-EPS01	CMMS records.	EPO-VI-CW-03; EPO-VI-CW-04.	**Section 6.6** **Section 7.4**
Garbage management.	VI-CW-CM-24	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.	VI-CW-CM-24-EPS01	Garbage record book. Audit records. Inspection records.	EPO-VI-CW-03; EPO-VI-CW-05.	**Section 6.6** **Section 7.3**
		Pursuant to Marine Order 95, placards displayed to notify personnel of waste disposal restrictions.	VI-CW-CM-24-EPS02	Audit records. Inspection records.		
		Garbage generated on offshore facilities will not be discharged to the marine environment.	VI-CW-CM-24-EPS03	Incident records.		
Deck cleaning product selection.	VI-CW-CM-25	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.	VI-CW-CM-25-EPS01	Safety data sheet and product supplier supplementary data as required.	EPO-VI-CW-03.	**Section 6.6**
Chemical Selection Procedure.	VI-CW-CM-26	Production or process chemicals potentially discharged to sea are Gold, Silver, D or E rated through the OCNS, are PLONOR (pose little or no risk) substances listed by the OSPAR Commission, or have a complete risk assessment as per Santos's Operations Chemical Selection, Evaluation and Approval Procedure (EA-91-II-10001) so that only environmentally acceptable products are used.	VI-CW-CM-25-EPS01	Completed Santos risk assessments. OCNS List	EPO-VI-CW-03.	**Section 6.6**
Pipeline flushing prior to opening of subsea system.	VI-CW-CM-27	Subsea system flushed to reduce hydrocarbon content prior to opening of subsea system.	VI-CW-CM-27-EPS01	Completed operational records.	EPO-VI-CW-03.	**Section 6.6**
Implementation of the management controls within the Santos Invasive Marine Species Management Plan.	VI-CW-CM-28	Vessels are managed to low risk in accordance with the Santos 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:	VI-CW-CM-28-EPS01	Completed risk assessment demonstrating vessel is low risk.	EPO-VI-CW-06.	**Section 7.1**

Control Measure	Control Measure Reference No.	Environmental Performance Standard	EPS Reference No.	Measurement Criteria	EPO Reference No.	Relevant Sections of the EP
		+ Assessment of applicable vessels using the IMSMP risk assessment; and + The management of immersible equipment to achieve low risk.				
Anti-foulant System.	VI-CW-CM-29	Anti-foulant systems are maintained in compliance with International Convention on the Control of Harmful Anti-Fouling Systems in Ships (IMO, 2001).	VI-CW-CM-29-EPS01	Current International Anti-Fouling System Certificate.	EPO-VI-CW-06.	**Section 7.1**
Ballast Water Management Plan.	VI-CW-CM-30	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 so that marine pest species are not introduced.	VI-CW-CM-30-EPS01	Ballast Water Management Plan. Completed ballast water record book or log.	EPO-VI-CW-06.	**Section 7.1**
Inspection of Platform Structures and Hydrocarbon-Containing Equipment.	VI-CW-CM-31	Structural integrity of offshore platforms meets inspection criteria and frequency as specified in PS-01 Structural Integrity (QE-00-RG-00213) to provide structural support for facilities.	VI-CW-CM-31-EPS01	CMMS records.	EPO-VI-CW-04; EPO-VI-CW-08.	**Section 7.4** **Section 7.6** **Section 7.8**
		Platform hydrocarbon-containing equipment meets inspection criteria and frequency as specified in PS-02 Hydrocarbon Containment: Hydrocarbon Containing Equipment (QE-00-RG-00214), to prevent the uncontrolled release of hydrocarbons. All subsea inspections are carried out in accordance with the Santos Underwater Inspection Manual (QE-00-MG-00005).	VI-CW-CM-31-EPS02			
		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.	VI-CW-CM-31-EPS03			
		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.	VI-CW-CM-31-EPS04			
		Subsea assets will meet the inspection criteria and frequency specified in the Subsea Inspection Procedure (QE-35-IS-00001), which describes the inspection philosophy, procedure and reporting requirements for Santos subsea assets.	VI-CW-CM-31-EPS05			
Hazardous Chemical Management Procedures.	VI-CW-CM-32	For hazardous chemicals, including hydrocarbons, the following standards apply to reduce the risk of an accidental release to sea:	VI-CW-CM-32-EPS01	Audit records. Inspection records.	EPO-VI-CW-04.	**Section 7.4**

Control Measure	Control Measure Reference No.	Environmental Performance Standard	EPS Reference No.	Measurement Criteria	EPO Reference No.	Relevant Sections of the EP
		+ Storage containers are closed when the product is not being used; + Storage containers are managed in a manner that provides for secondary containment in the event of a spill or leak; + Storage containers are labelled with the technical product name as per the safety data sheet; + Spills and leaks to deck, excluding storage bunds and drip trays, are immediately cleaned up; + Storage bunds and drip trays do not contain free-flowing volumes of liquid; and + Spill response equipment is readily available.				
General Chemical Management Procedures.	VI-CW-CM-33	Safety data sheet is available for all chemicals to aid in the process of hazard identification and chemical management.	VI-CW-CM-33-EPS01	Safety data sheet.	EPO-VI-CW-04.	**Section 7.4**
		Chemicals managed in accordance with safety data sheet in relation to safe handling and storage, spill-response and emergency procedures, and disposal considerations.	VI-CW-CM-33-EPS02	Audit records. Inspection records.		**Section 7.4**
		Dangerous goods managed in accordance with International Maritime Dangerous Goods Code (IMDG Code) to reduce the risk of an environmental incident, such as an accidental release to sea or unintended chemical reaction.	VI-CW-CM-33-EPS03	Site records		**Section 7.4**
Refuelling and Chemical Transfer Procedure.	VI-CW-CM-34	Fuel transfers are undertaken in accordance with the Refuelling and Chemical Transfer Management Standard (QE-91-IQ-00098), which details requirements for the refuelling and chemical transfer from an offshore support vessel to an offshore or onshore facility, as well as refuelling of fixed or portable equipment and machinery.	VI-CW-CM-34-EPS01	Completed work permits. Job safety analysis form. Audit records. Inspection records.	EPO-VI-CW-08.	**Section 7.9**
Spill Response Equipment on Producing Platforms.	VI-CW-CM-35	Spill response equipment is present on producing offshore platforms to contain and recover spills, thereby reducing potential for spills to reach the marine environment.	VI-CW-CM-35-EPS01	Audit records. Inspection records.	EPO-VI-CW-04.	**Section 7.4**
Vessel Spill Response Plan (SOPEP/SMPEP).	VI-CW-CM-36	Support vessels have a shipboard oil pollution emergency plan (SOPEP) or shipboard marine pollution emergency plan (SMPEP) that outlines steps taken to combat spills.	VI-CW-CM-36-EPS01	Audit records. Inspection records.	EPO-VI-CW-04; EPO-VI-CW-08.	**Section 7.4** **Section 7.9**
		Spill exercises on support vessels are conducted as per the vessels SOPEP or SMPEP.	VI-CW-CM-36-EPS02	Spill exercise close out reports	EPO-VI-CW-04; EPO-VI-CW-08.	
Remotely operated vehicle (ROV) inspection and maintenance procedures.	VI-CW-CM-37	Preventive maintenance on ROV completed as scheduled to reduce the risk of hydraulic fluid releases to sea.	VI-CW-CM-37-EPS01	Maintenance records.	EPO-VI-CW-04.	**Section 7.4**
		ROV predeployment inspection completed to reduce the risk of hydraulic fluid releases to sea.	VI-CW-CM-37-EPS02	Completed pre-deployment inspection.		**Section 7.4**
NOPSEMA-accepted WOMP	VI-CW-CM-38	A NOPSEMA-accepted WOMP for John Brookes (DR-91-26-10037) and Halyard (DR-91-26-10052) production wells is in place to specifically manage the risks associated with	VI-CW-CM-38-EPS01	NOPSEMA-accepted WOMP. CMMS records demonstrate that inspection and maintenance activities are compliant with the WOMP.	EPO-VI-CW-08.	**Section 7.6** **Section 7.8**

Control Measure	Control Measure Reference No.	Environmental Performance Standard	EPS Reference No.	Measurement Criteria	EPO Reference No.	Relevant Sections of the EP
		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.				
		A NOPSEMA-accepted WOMP is in place for Rosella Well (DR-91-26-10045) to specifically manage the risks associated with this well.	VI-CW-CM-38-EPS02	NOPSEMA-accepted WOMP demonstrate that inspection activities are compliant with the WOMP. CMMS records.		
Well services procedures and criteria.	VI-CW-CM-39	Santos's Asset Integrity Management Program (QE-91-IP-00302) complied with, which includes the framework of policies, procedures, and performance standards for production operation assets.	VI-CW-CM-39-EPS01	Certification and test records confirm compliance with project-specific procedures and Asset Integrity Management Programme (QE-91-IP-00302).	EPO-VI-CW-08.	**Section 7.6** **Section 7.8**
		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's Offshore Drilling and Completions technical standards.	VI-CW-CM-39-EPS02	Completed well acceptance criteria in well program. Incident records confirm no breach of containment.		
Testing and maintenance of emergency shutdown systems and shutdown/safety valves.	VI-CW-CM-40	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 within: + PS-06 ESD and Blowdown: Emergency Shutdown Valves (ESDVs including HIPPS) (QE-00-RG-00218), 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 Subsurface Safety Valves and Christmas tree valves) (QE-00-RG-00219), 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 (QE-00-RG-00220), which applies to the logic solver modules holding the safety logic; and + PS-10 ESD and Blowdown: Pressure Safety Valves (QE-00-RG-00222), 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 location.	VI-CW-CM-40-EPS01	CMMS records.	EPO-VI-CW-08.	**Section 7.6** **Section 7.7** **Section 7.8**

Control Measure	Control Measure Reference No.	Environmental Performance Standard	EPS Reference No.	Measurement Criteria	EPO Reference No.	Relevant Sections of the EP
Incident response plan detailing the requirements for preparedness and response to emergencies and crises to protect people and the environment.	VI-CW-CM-41	In the event that the integrity of a pipeline/valve is compromised or there is an unplanned hydrocarbon release from: + the wellheads at JB platform; + from a subsea pipeline; or + a subsea wellhead. the Varanus Island Incident Response Plan (QE-00-ZF-00044) is initiated to activate the Isolation of the flowline/ pipeline/ wells.	VI-CW-CM-41-EPS01	Varanus Island Incident Response Plan (QE-00-ZF-00044) CMMS records.	EPO-VI-CW-08.	**Section 7.6** **Section 7.7** **Section 7.8**
Emergency power system is provided on John Brookes WHP to secure secondary power source for safety integrity system	VI-CW-CM-42	Uninterruptible power supply meet test and inspection criteria and test and inspection frequency as specified in PS-18 Emergency Power (QE-00-RG-00230).	VI-CW-CM-42-EPS01	CMMS records.	EPO-VI-CW-08.	**Section 7.6** **Section 7.7** **Section 7.8**
Accepted oil pollution emergency plan (OPEP).	VI-CW-CM-43	In the event of an oil spill to sea, the Santos OPEP requirements are implemented to mitigate environmental impacts.	VI-CW-CM-43-EPS01	Completed incident documentation.	EPO-VI-CW-08.	**Section 7.6** **Section 7.7** **Section 7.8** **Section 7.9**
Support Vessel Positioning.	VI-CW-CM-44	As per NOPSEMA-accepted safety case requirements, support vessels will maintain a 'drift-off' position relative to offshore platforms to reduce potential for impact.	VI-CW-CM-44-EPS01	Completed vessel positioning logs.	EPO-VI-CW-08.	**Section 7.6** **Section 7.9** **Section 7.6** **Section 7.9**
		If support vessels are using dynamic positioning, the dynamic positioning system is specified as per the relevant safety case's requirements.	VI-CW-CM-44-EPS02	NOPSEMA-accepted safety case.		
NOPSEMA-accepted Safety Case.	VI-CW-CM-45	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.	VI-CW-CM-45-EPS01	NOPSEMA-accepted safety case. CMMS records	EPO-VI-CW-08.	**Section 7.7**
Inspection and corrosion monitoring of pipelines.	VI-CW-CM-46	Offshore pipelines and risers meet inspection and monitoring criteria and frequency as outlined in PS-03 Hydrocarbon Containment; Risers and Pipelines (QE-00-RG-00215), which manages the inherent safety of risers and pipelines, including all mounted fittings, fixtures and supports.	VI-CW-CM-46-EPS01	CMMS records.	EPO-VI-CW-08.	**Section 7.6** **Section 7.7** **Section 7.8**
Operational monitoring of low flow well leak	VI-CW-CM-47	Low flow well leaks will be subject to operational monitoring as described in Section 9 of the OPEP until a risk assessment indicates negligible risk to the environment and well integrity risk assessment indicates no risk of escalation	VI-CW-CM-47-EPS01	Incident Action Plan	EPO-VI-CW-08.	**Section 7.6** **Section 7.8**
Santos decommissioning framework	VI-CW-CM-48	No later than two years prior to the End of Field Life (EOFL) the Spartan, GES and John Brookes fields, Santos will have in place a Decommissioning Plan. The plan will detail how Santos' intends to meet the following commitments on the titles (WA-29-L, WA-45-L, WA-13-L, WA-63-L):	VI-CW-CM-48-EPS01	Completed Decommissioning Plan	EPO-VI-CW-08.	**Section 7.6** **Section 7.7** **Section 7.8**

Control Measure	Control Measure Reference No.	Environmental Performance Standard	EPS Reference No.	Measurement Criteria	EPO Reference No.	Relevant Sections of the EP
		+ Permanently plug and abandon all exploration and production wells while the titles are still in force. + Remove or cause to have removed from the title all property brought into the titles, as authorised by Santos, while the titles are still in force unless alternative arrangements have been made to the satisfaction of NOPSEMA. + Ensure through monitoring, and if required maintenance, (i) property can be removed when required and (ii) the ongoing presence of the property is not causing unacceptable environmental impacts or risks. The plan will include, as a minimum, the following details: + Regulatory obligations; + Stakeholder engagement plans; + Asset inventory, status and removal plans; + Decommissioning assumptions; + Study requirements; + A schedule including key activity, regulatory approval and project management milestones. + Risk assessments.				

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's Chief Executive Officer (CEO) has the overall accountability for the implementation of the Santos Management System (SMS) and Santos's Environment Team Lead is accountable for ensuring implementation, management and review of this EP.

Effective implementation of this EP will require collaboration and cooperation among Santos and its contractors. This is reflected in **Table 8-3**, which sets out the roles and responsibilities of personnel in relation to the implementation, management and review of the EP.

Table 8-3: Chain of Command, Key Leadership Roles and Responsibilities

Role	Responsibilities
Perth Office-based Roles	
GM – Production Operations	Has overall responsibility for: + Complying with the EP and Santos 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.
Production Manager – WA Gas Assets	Has overall responsibility for: + Implementing the EP and Santos 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 – Varanus Island	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.
Onshore Installation Manager	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.

Role	Responsibilities
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 Manager	Has overall responsibility for: + Ensuring incident preparedness and response arrangements meet Santos and regulatory requirements; + Approving the OPEP; and + Providing ongoing resources to maintain compliance with the OPEP and other Santos incident response requirements.
HSE Team Lead – Security and Emergency Response	Has overall responsibility for: + Overarching incident and crisis management responsibility; + Manage the CMT and IMT personnel training program; + Review and assess competencies for CMT, IMT, and field-based IRT members; + Manage the Duty roster system for CMT and IMT personnel; and + Manage the maintenance and readiness of incident response resources and equipment.
Environment Team Lead	Has overall responsibility for: + Complying with Santos'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's internal incident reporting and investigation procedure.

Role	Responsibilities
Senior Oil Spill Response Advisor	Has overall responsibility for: + Provides upfront and ongoing guidance, framework, and direction on preparation of this OPEP; + Develops and maintains arrangements and contracts for incident response support from 3rd-parties; + Develops and define objectives, strategies and tactical plans for response preparedness defined in this OPEP and IRP; and + Undertaking assurance activities on arrangements outlined within the OPEP.
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.

This section describes the mechanisms that will be in place so that each employee and contractor is aware of his or her responsibilities in relation to the EP and has appropriate training and competencies.

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:

+ Santos' Environment, Health and Safety Policy;
+ regulatory regime (NOPSEMA regulations);
+ operating environment (e.g., nearby protected marine areas, sensitive environmental periods);

+ interaction with other marine users (i.e., topic to reinforce the importance of marine communications regarding any potential interactions with active commercial fishing);
+ activities with highest risk (e.g., invasive marine species and hydrocarbon releases);
+ EP commitments;
+ 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 facilities or support vessels will complete relevant training and hold qualifications and certificates for their role. Santos and its contractors (e.g., support vessel, 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, desktop matrix, staff on-boarding processes, training departments, etc.

Personnel qualification and training records will be sampled before and/or during an activity. Such checks will be performed during the procurement process, facility acceptance testing, inductions, crew change, and operational inspections and audits.

8.6.3 Workforce Involvement and Stakeholder Communications

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 preshift meetings.

Toolbox 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 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'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 Asset Management

Santos' management system defines business expectations and requirements for the management of assets to ensure the strategic and economic value is optimised through the asset life cycle, while preventing harm to people and the environment.

As part of the asset life cycle management requirements, Santos assets are required to have a decommissioning strategy and plan.

Santos' current decommissioning strategy is based on removing property at the end-of-field-life (EOFL).

The current expected date for cessation of production for Halyard-1 is 2021, Spartan-2 is 2030 and for Spar-2 is 2032. Until this time the Spar-2 well will continue to produce hydrocarbons through the existing GES subsea infrastructure. As part of the GES field, the permanent plug and abandonment of these wells and field property removal is planned post EOFL.

Santos' current estimate for the EOFL of the John Brookes field is 2037-2040.

EOFL is reviewed annually as part of Santos' structure reserves audit process. However, this is subject to change, as EOFL is dependent on multiple variables including economic conditions, production performance and forecast, and reserves.

Opportunities to extend the life of the GES, Spartan and John Brookes field infrastructure and associated subsea infrastructure (i.e. the production pipelines) through future gas developments and opportunities will also be regularly considered. As such, property may remain beyond the EOFL and decommissioning activities may be staged.

Santos will have in place a Decommissioning Plan for the GES field and Spartan field no later than two years prior to the EOFL (refer to control measure VI-CW-CM-48, **Table 8-2**). The Decommissioning Plan will be updated to include John Brookes, or a separate plan prepared, as the EOFL is currently estimated to be much later than Spartan and GES, but will be in place no later than two years prior to EOFL for John Brookes.

It is through the development and implementation of the Decommissioning Plan that Santos will meet its obligations under s. 572 (3) of the OPGGS Act 'to remove from the title area all structures that are, and all equipment and other property that is, neither used nor to be used in connection with the operations'.

8.9 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.

Vessels are required to have and implement incident response plans, such as an emergency response plan and SMPEP or SOPEP. Regular incident response drills and exercises (e.g., as defined in emergency response plan, SMPEP or SOPEP) will be carried out on support vessels to refresh the crew in using equipment and implementing incident response procedures.

Santos will implement the Varanus Island Hub Oil Pollution Emergency Plan (EA-60-RI-00186.02) in the event of a hydrocarbon spill. The OPEP details how Santos will prepare and respond to a spill event and meets the requirement of Regulation 14(8).

8.10 Incident Reporting, Investigation and Follow-up Incident Reporting, Investigation and Follow-up

OPGGSR 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. Note: Regulation 26C requires a titleholder to report on environmental performance in accordance with the timetable set out in the environment plan.
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.

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 will be documented in the incident management systems as appropriate. HSE incidents will be investigated using root cause analysis.

Environmental recordable and reportable incidents will be reported to NOPSEMA and to other regulators as required in accordance with **Table 8-4**. The incident reporting requirements will be provided to all crew on board the facilities and support vessels during induction 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 the Santos environmental impact and risk assessment process outlined in **Section 5.** Of the planned and unplanned events assessed within this EP, the following were identified to have a potential consequence level of Moderate or higher if the event were to occur and would therefore be a reportable incident:

+ introduction of IMS (major);
+ marine fauna interaction (moderate);
+ surface release of condensate from the John Brookes platform (major);
+ subsea release of condensate from a subsea pipeline (moderate); and
+ subsea release of condensate form wellheads.

8.11 Reporting and Notifications

OPGGSR 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.

8.11.1 Regulatory Notification and Compliance Reporting

Regulatory, other notification, and compliance reporting requirements are summarised in **Table 8-4**.

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Table 8-4: Activity Notification and Reporting Requirements

Requirement	Required Information	Timing	Type	Recipient
During the Activity				
OPGGS(E) 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
OPGGS(E) 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,	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

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Requirement	Required Information	Timing	Type	Recipient
moderate to significant environmental damage.	A written report 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; + 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.	Must be submitted as soon as practicable, and in any case not later than 3 days after the first occurrence 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.	Written	NOPSEMA NOPTA DMIRS
OPGGS(E) 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

Requirement	Required Information	Timing	Type	Recipient
Under the MoU between Santos and AMSA	Titleholder agrees to notify AMSA of any marine pollution incident[3]	Within 2 hours of incident	Oral	AMSA
	POLREP and SITREP available online (refer OPEP)	POLREP as requested by AMSA following verbal notification SITREP as requested by AMSA within 24 hours of request	Written	AMSA
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
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
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
Any harm or mortality to fauna listed as threatened under the WA Biodiversity Conservation Act 2016	Notification of any harm or mortality to fauna listed as a threatened species under the WA Biodiversity Conservation Act 2016 as a result of Santos activities.	A fauna report will be submitted to DBCA Within 7 days to fauna@dbca.wa.gov.au	Written	DBCA

[3] For clarity and consistency across Santos regulatory reporting requirements Santos will meet the requirement of reporting marine oil pollution by reporting oil spills assessed to have an environmental consequence of moderate or higher in accordance with Santos's environmental impact and risk assessment process outlined in **Section 5**.

Requirement	Required Information	Timing	Type	Recipient
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
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 in the Management Plan for the Montebello/Barrow Islands Marine Conservation Reserves.	Within 48 hours.	Written	DBCA
All actual or impending MOP incidents that are in, or may impact, State waters resulting from an offshore petroleum activity	Notification of actual or impending spillage, release or escape of oil or an oily mixture that is capable of causing loss of life, injury to a person or damage to the health of a person, property or the environment.	Within 2 hours	Verbal	DoT
	WA DoT POLREP and SITREP available online (refer OPEP).	As requested by DoT following verbal notification	Written	DoT

8.11.2 Monitoring and Recording Emissions and Discharges

OPGGS(E)R 2009 Requirements
Regulation 10A(e)
Includes an appropriate implementation strategy and monitoring, recording and reporting arrangements.
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.

Vessel based discharges to the marine environment associated with this activity will be recorded and controlled in accordance with requirements under the relevant marine orders.

Santos 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 records discharges or emissions (where practicable), to the environment as described in **Table 8-5.**

Table 8-5: Emission and discharge monitoring

Discharge/emission	Parameter	Record	Recording frequency
Atmospheric emissions	Green House Gasses total volumes (carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N20))	Production Reporting System (PRS), estimated for NGERS reporting and put into and annual compliance report.	Annually
Chemicals (discharged to marine environment as per Section 6.6)	Volume	Chemical Risk Assessment. Volumes used will be estimated based on known inventories	For every chemical use with a fate to the marine environment
Oily water	Volume and location (support vessels)	Oil Record Book or equivalent report	For every discharge
Garbage (including food scraps)	Volume and location (support vessel)	Garbage Record Book	For every discharge
Sewerage	Volume and location (support vessel)	Garbage Record Book	For every discharge
Unplanned discharge of solid waste	Volume	Incident report	For every discharge
Unplanned discharge of liquid hazardous materials	Volume	Incident report	For every discharge
Unplanned hydrocarbon release	Volume	Incident report	For every discharge

8.12 Document Management

8.12.1 Information Management and Document Control

This EP and OPEP, as well as approved management of change documents, are controlled documents; and current versions will be available on Santos's intranet. Santos contractors are also required to maintain current versions of HSE documents including this EP and OPEP on their facilities.

Environmental performance outcomes and standards will be measured based on the measurement criteria listed in **Table 8-2.** Such records will be maintained for a period of five years. Contractors are required to make these records available upon request.

8.12.2 Management of Change

Proposed changes to this EP and OPEP will be managed in accordance with Santos's Environment Management of Change Procedure (EA-91-IQ-10001), the "MoC process". 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 if a proposed change can proceed and the manner in which it 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 acceptable and ALARP. 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 8-1.**

The MoC procedure also allows for the assessment of new information that may become available after EP acceptance, such as new management plans for Australian marine parks, new recovery plans or conservation advice for species, and changes to the EPBC Protected Matters Search results. If a review identifies new information, this is treated as a "Change that has an impact on Environment Plan", and the MoC process is followed accordingly.

The MoC procedure also includes an assurance check process which applies the MoC process to long term (usually five-year multi-activity EPs) EPs that may have lengthy periods of time between use or acceptance and activity commencement. This helps Santos determine whether the activity will still comply with the EP and is still acceptable, or, if there are any changes to what is covered by the relevant EP. Where there is an identified change from the accepted EP content, a check is done to test the 'significance' of the change, to determine whether it can be accommodated which may then result in an MoC as described above.

Accepted MoCs become part of the in-force EP or OPEP and are tracked on a register and made available on Santos'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 persons identified in **Table 8-3** (excluding the CEO and Directors), and the most relevant management position will be required to communicate the MoC to see it is implemented, which may include crew meetings / briefings / communications as appropriate for the change.

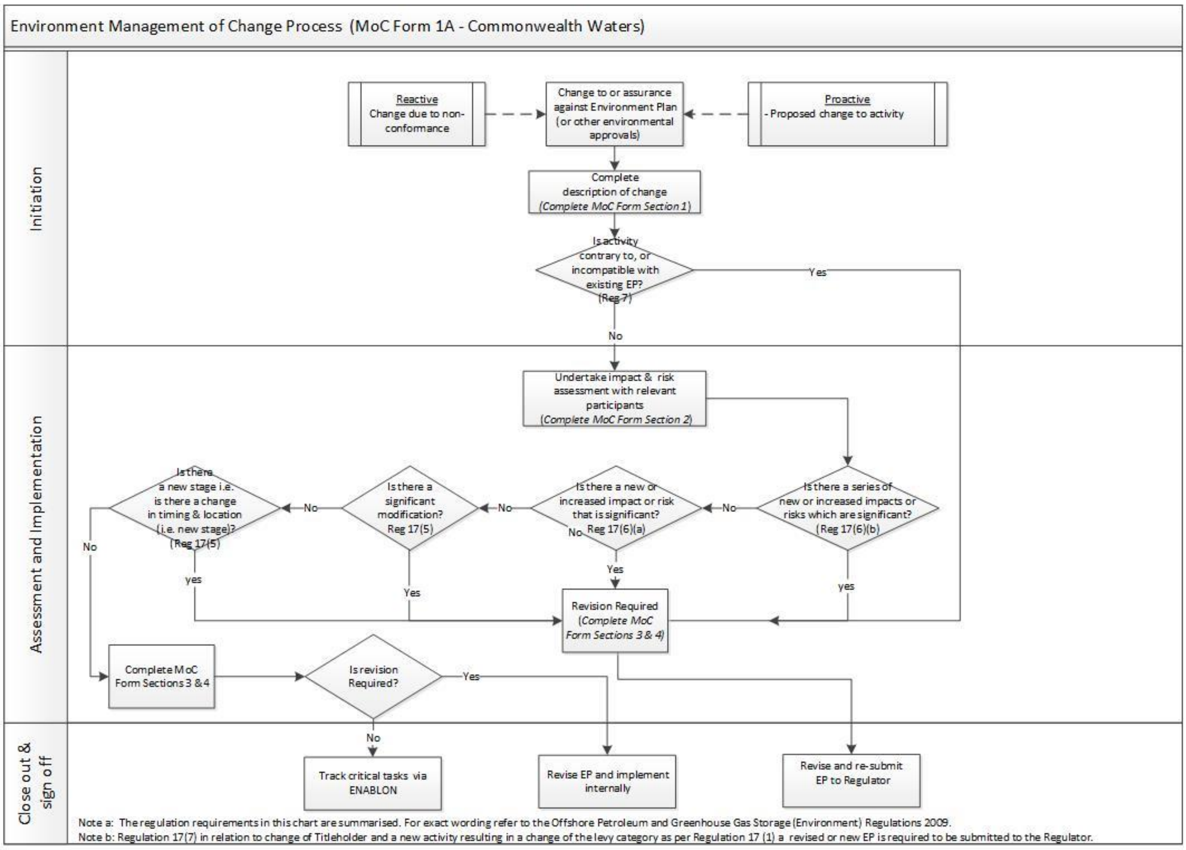

Figure 8-1: Environment Management of Change Process

8.12.3 Reviews

This EP has assessed impacts and risk across the entire 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 validity of this EP:

+ Legislation;
+ Businesses conditions, activities, systems, processes and people;
+ Industry practices;
+ Science and technology; and
+ Societal and stakeholder expectations.

To ensure that Santos 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;
+ 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**;
+ 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;

- Subscriptions to various regulator updates; and
- Regular liaison meetings with regulators.

Through maintenance of up to date knowledge (**Section 8.12**), 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 the Company's MoC procedure (**Section 8.11.2).**

8.13 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.

8.13.1 Audits

Santos audit plans and schedules are reviewed and updated at the beginning of each calendar year and cover all Santos facilities and activities. Santos'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' Management Standard for Assurance SMS MS15.

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 8.13.3.**

8.13.2 Inspections

During an activity, frequent HSE inspections will be conducted to identify hazards, incidents and EP non-conformances. Santos representatives will be conducting EP compliance inspections throughout the activity to check compliance against all of the environmental performance outcomes and standards of this EP (**Table 8-2**). 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 to Santos's relevant personnel (e.g., operations manager, Santos onboard representatives) and HSE Department representatives for review.

8.13.3 Non-conformance Management

EP non-conformances will be addressed and resolved by a systematic corrective action process as outlined in Santos' Management Standard for Assurance (MS15) and the Assurance Procedure (ST01). Non conformances arising from audits and inspections will be entered into Santos' incident and action tracking management system (i.e., EHS Toolbox). Once entered, corrective actions, time frames and responsible persons (including action owners and event validators) will be assigned. Corrective action 'close out' will be monitored using a management escalation process.

8.13.4 Continuous Improvement

For this EP, continuous improvement will be driven by the list below, and may result in a review of the EP with changes applied in accordance with **Section 8.12.2**:

+ Improvements identified from the review of business-level HSE key performance indicators;
+ Actions arising from Santos's 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 through pre-activity reviews and management of change documents;
+ Actions taken to address concerns and issues raised during the ongoing stakeholder consultation management process (**Section 4**); and
+ Identified continuous improvement opportunities will be assessed in accordance with Santos's MoC process to ensure any potential changes to this EP, or OPEP, are managed in accordance with the OPGGS(E)R 2009 and in a controlled manner.

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Appendix A: Santos's 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

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Appendix B: Legislative Framework

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.	No	Commonwealth – Department of Environment and Energy	There are no known sites of Aboriginal Heritage Significance within the operational area or EMBA. This Act would only apply to the activity if there was a discovery of Aboriginal remains, which is not considered likely to occur given the off-shore location of the activity.	N/A
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 three national heritage places found on the National Heritage List, within the EMBA, as identified by the Act.	**Section 3.2.3** – Protected / significant areas

Commonwealth Legislation	Summary	Relevant to activity?	Administering Authority	Relevant aspects of the activity	EP Section
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 Order in Commonwealth waters. This Act 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	AMSA	This Act applies to the use of any vessel associated with operations, and is relevant to the activity in regards to the unplanned pollution from ships.	**Section 7.9** - Hydrocarbon Release (Vessel collision) **Section 7.7** - Hydrocarbon spill from a ruptured flowline as a result of dropped object
Aquatic Resources Management Act 2016	This Act will be the primary legislation used to manage fishing, aquaculture, pearling and aquatic resources in Western Australia. The Act was scheduled for commencement on 1 January 2019,	Yes	Department of Primary Industries and Regional Development	Vessel movements have the potential to introduce invasive marine species (IMS). This Act was considered during development of the Santos IMS Management Zone	**Section 7.1**

Commonwealth Legislation	Summary	Relevant to activity?	Administering Authority	Relevant aspects of the activity	EP Section
	however, this has been deferred while an amendment to the Act is progressed.			(IMSMZ) and IMS Management Plan (EA-00-RI-10172).	
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 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.	Yes	AMSA	Vessel movements, safety, discharges and emissions	**Section 6** and **7** – planned and unplanned events
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.	No	The Department of Immigration and Border Protection	This Act applies to the shipwrecks (over 75 years old) within the EMBA. There is no planned interaction or interference with shipwrecks, and any unplanned impacts is only expected to affect the surface waters.	N/A
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	Yes	Commonwealth – Department of Agriculture and Water Resources	This Act applies to all internationally sources vessels operating in Australian Waters which could have the potential for the introduction of IMS and	**Section 7.1** - Introduction of IMS

Commonwealth Legislation	Summary	Relevant to activity?	Administering Authority	Relevant aspects of the activity	EP Section
	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 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.			potential ballast water exchange.	
Corporations Act 2001	This Act is the principal legislation regulating matters of Australian companies, such as the formation and operation of companies, duties of officers, takeovers and fundraising.	Yes	Commonwealth – Australian Securities and Investments Commission	The titleholder has provided ACN details within the meaning of the Act	**Section 1**
Environment Protection and Biodiversity Conservation Act 1999 Environment Protection and Biodiversity Conservation	The National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) is the sole assessor for offshore petroleum activities in Commonwealth water (as of 28 February 2014). Under the new arrangements, environmental protection will be met through NOPSEMA's decision-making processes. This Act is the Australian Government's key piece of environmental legislation.	Yes	Commonwealth – Department of Environment and Energy	This Act applies to all aspects of the activity that have the potential to impact MNES. Appropriate environmental approvals will be sought from NOPSEMA for all operations (this EP) which outlines compliance with the relevant regulations and plans under the Act.	**Section 6.2** - Light emissions **Section 6.1** - Noise emissions **Section 6.6** – Planned Operational Discharges **Section 7.9** and **7.7** - Hydrocarbon release

Commonwealth Legislation	Summary	Relevant to activity?	Administering Authority	Relevant aspects of the activity	EP Section
Amendment Regulations 2006	The Act focuses on the protection of matters of national environmental significance (MNES). Australian Marine Park Management Plans were also developed under this Act.			Where activities have existing approvals under the Act, these will continue to apply.	(Vessel Collision and pipeline rupture) **Section 7.2** - Marine fauna Collisions
Historic Shipwrecks Act 1976 Historic Shipwrecks Regulations 1978	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. This Act is no longer in effect as it has been replaced by the *Underwater Cultural Heritage Act 2018* (refer to the row below for details).	No	Commonwealth – Department of Environment and Energy	This Act applies to the shipwrecks (over 75 years old) within the EMBA. There is no planned interaction or interference with shipwrecks, and any unplanned impacts is only expected to affect the surface waters.	**Section 7.7** - Hydrocarbon release (pipeline rupture)
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. The Act came into effect on 1 July 2019.	Yes	Commonwealth – Department of Environment and Energy	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. Twelve shipwrecks identified within EMBA.	**Section 7.6, 7.7, 7.8, 7.9** – Unplanned hydrocarbon spills

Commonwealth Legislation	Summary	Relevant to activity?	Administering Authority	Relevant aspects of the activity	EP Section
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	This Act applies to the atmospheric emissions through combustion engine use to operate the vessels associated with the activity. Implementation of the Act will reduce the impact of GHG emissions associated with vessel use for the installation and commissioning activity, through compliance with MARPOL Annex VI (Marine Order 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 and Regional Development.	Implementation of this Act reduces the impact of GHG emissions associated with vessel use for the installation and commissioning activity, through compliance with MARPOL Annex VI (Marine Order Part 97: Marine Pollution Prevention – Air	**Section 6.3** - Atmospheric emissions

Commonwealth Legislation	Summary	Relevant to activity?	Administering Authority	Relevant aspects of the activity	EP Section
				Pollution), and require the use of low sulphur fuel.	
Marine Safety (Domestic Commercial Vessel) National Law Act 2012	This Act is a single regulatory framework for the certification, construction, equipment, design and operation of domestic commercial vessels inside Australia's exclusive economic zone.	Yes	Commonwealth – Australian Maritime Safety Authority (AMSA)	All vessel movements associated with the activity will be governed by AMSA marine safety regulations under the Act.	**Section 6.5** - Interaction with other marine users **Section 7.9 –** Surface release of diesel (vessel collision/bunkering)
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 offshore petroleum exploration and production activities: + Marine Order - Part 21: Safety of navigation and emergency procedures; + Marine Order - Part 30: Prevention of collisions; + Marine Order - Part 70 – Seafarers Certification.	Yes	+ AMSA (operational). + Department of Infrastructure and Regional Development. + Minister for Infrastructure and Regional Development.	All vessel movements associated with the activity will be governed by marine safety regulations and marine orders under the Act.	**Section 6.5** - Interaction with other marine users **Section 7.7** – Hydrocarbon spill from a ruptured flowline as a result of dropped objects.
Offshore Petroleum and Greenhouse	Petroleum exploration and development activities in Australia's offshore areas are subject to the environmental requirements specified in the OPGGS Act and	Yes	NOPSEMA	The activity involves undertaking installation and commissioning subsea equipment, which is a	**Section 6** – Risk Assessments for Planned Events

Commonwealth Legislation	Summary	Relevant to activity?	Administering Authority	Relevant aspects of the activity	EP Section
Gas Storage Act 2006 Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009	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 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			petroleum activity regulated by NOPSEMA under this Act.	**Section 7**– Risk Assessments for Unplanned Events

Commonwealth Legislation	Summary	Relevant to activity?	Administering Authority	Relevant aspects of the activity	EP Section
	activities in areas of Commonwealth jurisdiction. Key objectives of the Environment Regulations include: + to ensure operations are carried out in a way that is consistent with the principles of ecologically sustainable development; + to adopt best practice to achieve agreed environment protection standards in industry operations; and + to encourage industry to continuously improve its environmental performance.				
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 ODS.	Yes	Commonwealth - Department of Environment and Energy	The activity does not include import, export or manufacture activities of ODS. This Act applies where ODS is found on vessel refrigeration systems, however, this is a rare occurrence.	**Section 6.3** – Atmospheric emissions
Protection of the Sea (Powers of Intervention) Act 1981	The Act authorises the Commonwealth to take measures for the purpose of protecting the sea from pollution by oil and other noxious substances discharged	Yes	Commonwealth – Department of Infrastructure and Regional Development.	This Act applies to vessel discharges and movements associated with the activity. The Act is	**Section 6.5** - Interaction with other marine users

Commonwealth Legislation	Summary	Relevant to activity?	Administering Authority	Relevant aspects of the activity	EP Section
Protection of the Sea (Powers of Intervention) Regulations 1983	from ships and provides legal immunity for persons acting under an AMSA direction.			relevant to the extent that Santos 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 Order - Part 91: Marine Pollution Prevention - Oil + Marine Order - Part 93: Marine Pollution Prevention - Noxious Liquid Substances + Marine Order - Part 95: Marine Pollution Prevention – Garbage + Marine Order - Part 96: Marine Pollution Prevention – Sewage + Marine Order - Part 98: Marine Pollution - Anti-fouling Systems	**Section 7.7** – Hydrocarbon spill from a ruptured flowline as a result of dropped object.

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 Order - Part 91: Marine Pollution Prevention - Oil + Marine Order - Part 93: Marine Pollution Prevention - Noxious Liquid Substances + Marine Order - Part 94: Marine Pollution Prevention - Harmful Substances in Packaged Forms + Marine Order - Part 95: Marine Pollution Prevention – Garbage + Marine Order - Part 96: Marine Pollution Prevention – Sewage + Marine Order - Part 97: Marine Pollution Prevention - Air Pollution + Marine Order - Part 98: Marine Pollution - Anti-fouling Systems	Yes	Commonwealth – Department of Infrastructure and Regional Development	This Act applies to vessel discharges and movements associated with the activity. The Act is relevant to the extent that Santos 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 Order - Part 91: Marine Pollution Prevention - Oil + Marine Order - Part 93: Marine Pollution Prevention - Noxious Liquid Substances + Marine Order - Part 95: Marine Pollution Prevention – Garbage + Marine Order - Part 96: Marine Pollution Prevention – Sewage	**Section 7.7** – Hydrocarbon spill from a ruptured flowline as a result of dropped object.

Commonwealth Legislation	Summary	Relevant to activity?	Administering Authority	Relevant aspects of the activity	EP Section
				+ Marine Order - Part 98: Marine Pollution - Anti-fouling Systems	
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	AMSA	This Act applies to diesel refuelling which will be undertaken at sea as part of the activity. Compliance with the Act reduces the risk of bunker oil pollution.	**Section 7.9** - Hydrocarbon Release (vessel collision)
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 and Regional Development and AMSA	This Act applies to vessel movements in Australian Waters associated with the activity. Vessels are required to have biofouling systems in place to prevent introduction of IMS / harmful impact on Australian biodiversity.	**Section 7.1** - Introduction of IMS
State Legislation					
Fish Resources Management Act 1994 *Fish Resources Management*	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	Yes	Department of Primary Industries and Regional Development (DPIRD)	Introduction of invasive marine species.	**Section 7.1** – Introduction of invasive marine species

Commonwealth Legislation	Summary	Relevant to activity?	Administering Authority	Relevant aspects of the activity	EP Section
Regulations 1995.	1994 (FRMA 1994) and associated regulations.				

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 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.	**Section7.6, 7.7, 7.8, 7.9** – Unplanned hydrocarbon spills
Agreement Between the Government of Australia and the Government of the People's	This agreement recognises the special international concern for the protection of migratory birds and	Yes	Only relevant in so far as the credible spill scenario may result in impact to migratory seabirds foraging in area.	**Section 7.6, 7.7, 7.8, 7.9** – Unplanned hydrocarbon spills

International Agreements and Conventions	Summary	Relevant to Activity?	Relevant Aspects	EP Section
Republic of China for the Protection of Migratory Birds and Their Environment 1986 (commonly referred to as the China Australia Migratory Bird Agreement or CAMBA)	birds in danger of extinction that migrate between Australia and China. Implemented in EPBC Act 1999.			
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, 7.6, 7.7, 7.8, 7.9** – 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	Yes	In the event that worse-case credible spill scenarios may enact a national arrangement for response.	**Section 7.6, 7.7, 7.8, 7.9 –** unplanned hydrocarbon spills

International Agreements and Conventions	Summary	Relevant to Activity?	Relevant Aspects	EP Section
	oil handling. The convention recognises that in the event of pollution incident, prompt and effective action is essential.			**Section 6.7 –** Hydrocarbon spill response
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 7.6, 7.7, 7.8, 7.9** – 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	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 Agreements and Conventions	Summary	Relevant to Activity?	Relevant Aspects	EP Section
	Sea (Prevention of Pollution from Ships) Act 1983, the Navigation Act 1912 and several Parts of Marine Orders made under this legislation.			
International Convention for the Safety of Life at Sea 1974	This convention is generally regarded as the most important of all international treaties concerning the safety of merchant ships Implemented in the *Air Navigation Act 1920.*	Yes	Only relevant in so far as SOLAS relates to safety aspects of the activity, such as navigation aids which reduce potential for vessel collision and hydrocarbon release to the environment.	**Section 6.5**– Interaction with other marine users
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	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
	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.			
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 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;	**Section 6.6**–Operational discharges **Section 7.3, 7.4, 7.6, 7.7, 7.8, 7.9** – for unplanned releases **Section 7.1** – Introduction of invasive marine species

International Agreements and Conventions	Summary	Relevant to Activity?	Relevant Aspects	EP Section
			+ Marine Orders - Part 97: Marine Pollution Prevention - Air Pollution; and + Marine Orders - Part 98: Marine Pollution - Anti-fouling Systems.	
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 into the extent that to reduce impact of GHG emissions associated with vessel use, Santos 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: Values and Sensitivities of the Marine Environment

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Values and Sensitivities of the Marine and Coastal Environment

PROJECT / FACILITY	All
REVIEW INTERVAL (MONTHS)	12 Months
SAFETY CRITICAL DOCUMENT	NO

Rev	**Owner**	**Reviewer/s** *Managerial/Technical/Site*	**Approver**
	Environmental Approvals Coordinator	**Environmental Approvals Coordinator**	**Team Leader- Regulatory Approvals**
7	Joanna Edwards	Annette McGovern	Daniel Thompson

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Rev	Rev Date	Author / Editor	Amendment
A	13/0520/14	Oceanica	Technical review
B	13/05/2014	Oceanica	Editorial review
0	30/0720/14	EG/GG	Final
1	30/12/2014	GG	Updated
2	28/07/2016	Jacobs	Updated
3	28/11/2017	Jacobs	Updated
3.1	11/12/2018	Jacobs	Issued for technical review
4	17/12/2018	Jacobs	Issued for use
4.1	09/01/2019	Jacobs	Issued for technical review
5	14/02/2019	Santos	Issued for use
5.1	15/01/2020	CDM Smith	Issued for technical review
6	19/03/2020	CDM Smith	Issued for use
6A	15/11/2020	Astron	Issued Technical review
7	30/11/2020	Astron	Issued for use

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Appendices

1. Introduction

Santos WA Energy Limited (Santos) 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 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.*

The EMBA represents the largest possible spatial extent that could be contacted by the worst-case spill event modelled for Santos activities to date (loss of well control event from drilling an exploration well at Phoenix South). The EMBA encompasses the full range of environmental receptors that might be contacted by surface and subsurface hydrocarbons in the highly unlikely event of a worst case oil spill from Santos's activities. The low hydrocarbon exposure values as defined in NOPSEMA's '*Environmental Bulletin – Oil Spill Modelling*' (April 2019), are used as a predictive tool to set the outer boundaries of the EMBA.

This document describes the values and sensitivities of the marine environment based on the modelling results for the low hydrocarbon exposure values for the surface hydrocarbons and the entrained hydrocarbons from a loss of well control event at Phoenix South 2, as loss of control from this well has the largest spatial spill extent of all Santos' activities.

This document is informed by a search of the protected matters search tool (PMST) provided by the Department of Agriculture, Water and the Environment (DAWE) (previously the Department of the Environment and Energy (DoEE) (dated 10/11/2020 and 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. The PMST is performed annually and any changes from this updated search are detailed in a change register (**Appendix B**). This document is then reviewed annually and updated accordingly.

1.1 Geographical Extent

The EMBA, includes the coastal waters and shoreline habitats of Western Australia (WA), encompassing the south of WA 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). Based on the Integrated Marine and Coastal Regionalisation of Australia (IMCRA) Version 4.0, there are 14 bioregions that occur within the EMBA. These bioregions are based on fish, benthic habitat and oceanographic data (IMCRA v. 4.0). Where relevant, the physical, biological and social environments within the EMBA 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; and
- Southern 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 included in the EMBA and described where relevant throughout this document.

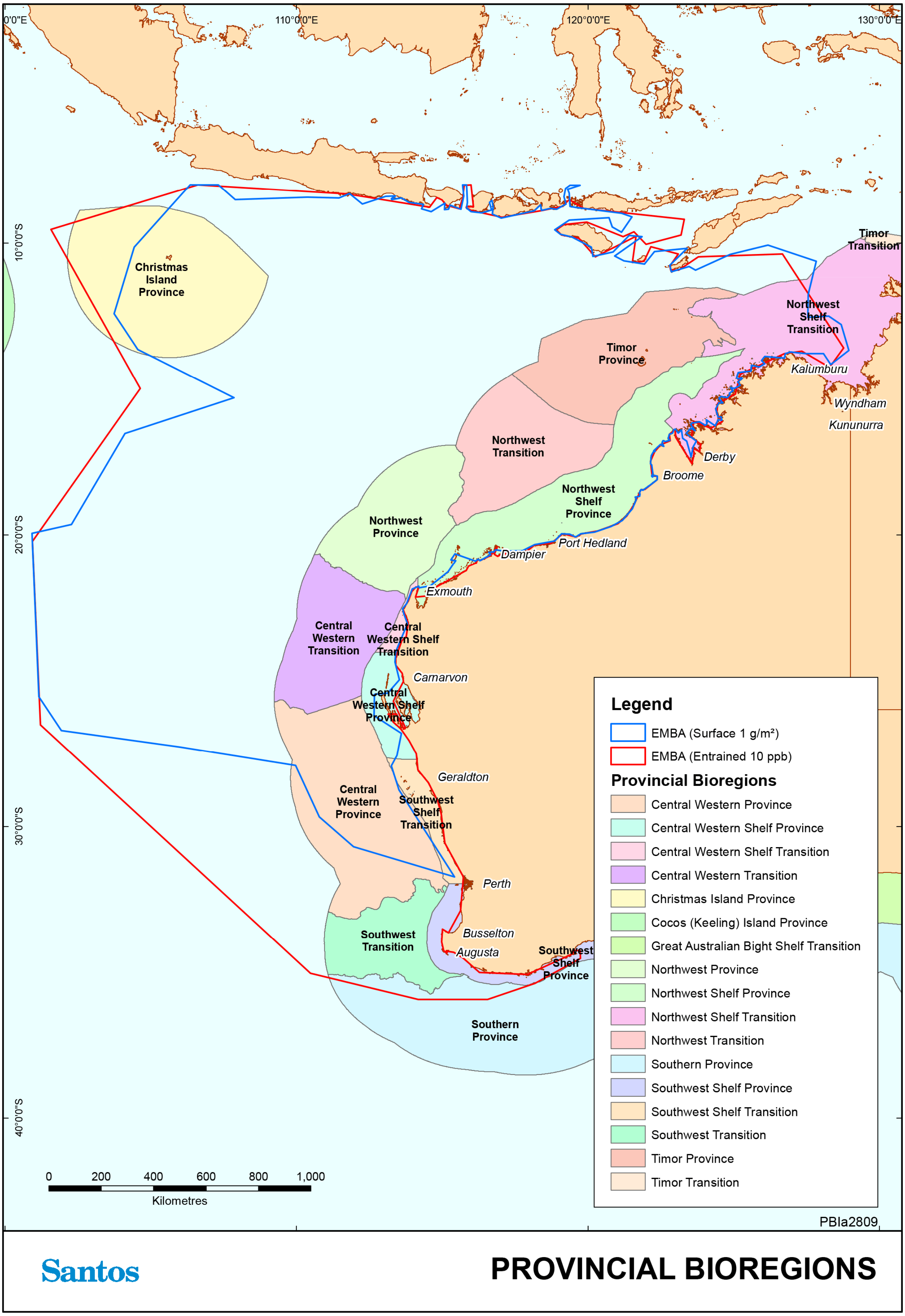


Figure 1-1: EMBA within IMCRA 4.0 Provincial Bioregions

2. Physical Environment

2.1 Geomorphology

2.1.1 Formation History

Approximately 550–160 million years ago, northern and western parts of Australia 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 Department of the Environment, Heritage, Water and the Arts (DEWHA) 2008a). 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 2008a).

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 EMBA consists of five major landform features: continental shelf, continental slope, continental rise, Exmouth plateau and abyssal plain. The majority of the area consists of either continental shelf or continental slope (DEWHA 2008a).

Limited surveys have shown that the continental slope in the EMBA comprises diverse geological features such as canyons, plateaux, terraces, ridges, reefs, banks and shoals (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 2008a).

An important characteristic of the EMBA 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 NT 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 2008a). 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 2008a).

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 Southwest Shelf Province

The Southwest Shelf Province consists of an area of narrow continental shelf from Rottnest to Point Dempster. For the purposes of this document (EMBA), the northern and western limits of the bioregion are the main focus because it is this portion that falls within the EMBA, which are an extension of the seafloor described in the Southwest Shelf Transition (below). It includes features such as limestone ridges, depressions defining an inshore lagoon and a relatively smooth inner shelf plain that meets the South Bank Ridge on the outer shelf, and islands providing important habitat, such as Rottnest Island. The shelf progressively broadens to form the relatively sheltered waters of Geographe Bay before narrowing once again at Cape Mentelle.

2.1.4 Southwest Shelf Transition

The Southwest Shelf Transition is a nearshore bioregion that covers the area of continental shelf from Perth to Busselton, and extends out to the edge of the shelf. This bioregion consists of a narrow continental shelf, ranging from approximately 40–80 km wide. It includes a series of complex nearshore ridges and depressions that form inshore lagoons, a smooth inner shelf plain, a series of offshore ridges and a steep, narrow outer shelf. The near-shore ridges are formed by eroded limestone reefs and pinnacles that stand 10–20 m above the seafloor. The edge of the inner shelf plain is marked by a series of broken offshore ridges that extend north to the northern limits of the bioregion, where they emerge to support the tropical carbonate reef growth of the Houtman Abrolhos Islands.

2.1.5 Southwest Transition

The Southwest Transition is an offshore deep-water bioregion with a submerged continental fragment as its dominant seafloor feature – the Naturaliste Plateau. The Plateau extends across an area of 90,000 km^2 of which only 29,825 km^2 is within Commonwealth waters. It is located west of Cape Leeuwin and Cape Naturaliste in water depths ranging from 2,000–5,000 m. It is relatively flat with a slight northward dip, and has steep southern and western sides and a more gently sloping northern side. The Plateau is separated from the Australian continent by the Naturaliste Trough and two offshore terraces on the continental slope (average depth 780 m). Submarine canyons incise the northern parts of the slope and parts of the Naturaliste Plateau.

2.1.6 Southern Province

The Southern Province is the largest bioregion within Australia's waters stretching from the shelf break south of Kangaroo Island to the southern edge of the Naturaliste Plateau. The bioregion includes the deepest ocean areas within the Australian Exclusive Economic Zone (approximately 5,900 m maximum water depth) and consists of a long continental slope incised by numerous well-developed submarine canyons. Several key ecological features are present within the EMBA and include the Albany Canyons Group, the Ceduna and Eyre Terraces (covering approximately 147,150 km^2) and the Diamantina Fracture Zone.

2.1.7 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 2008a).

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 2008a) and these are discussed in **Section 10**.

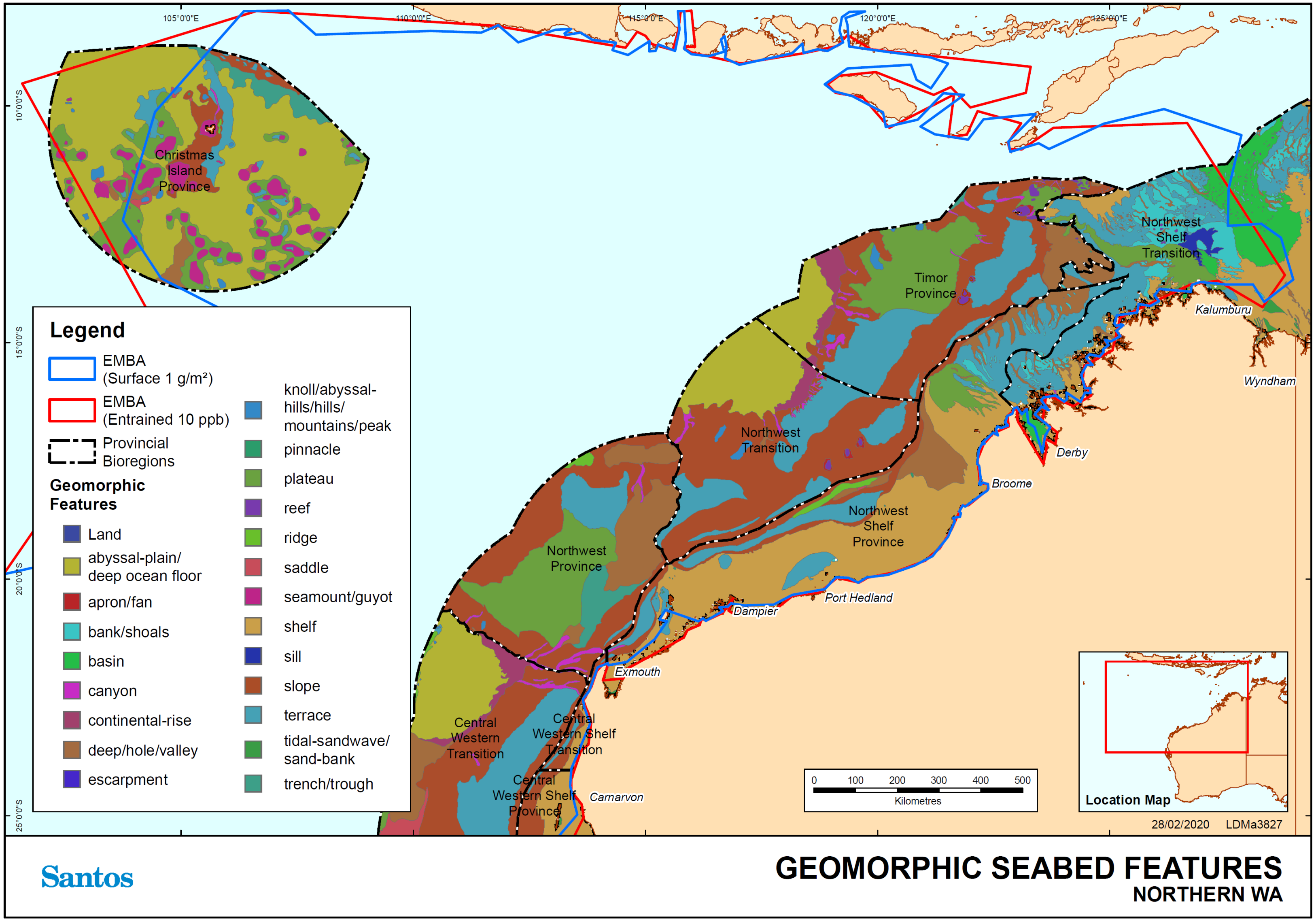


Figure 2-1: Geomorphic/seafloor features of Northern WA

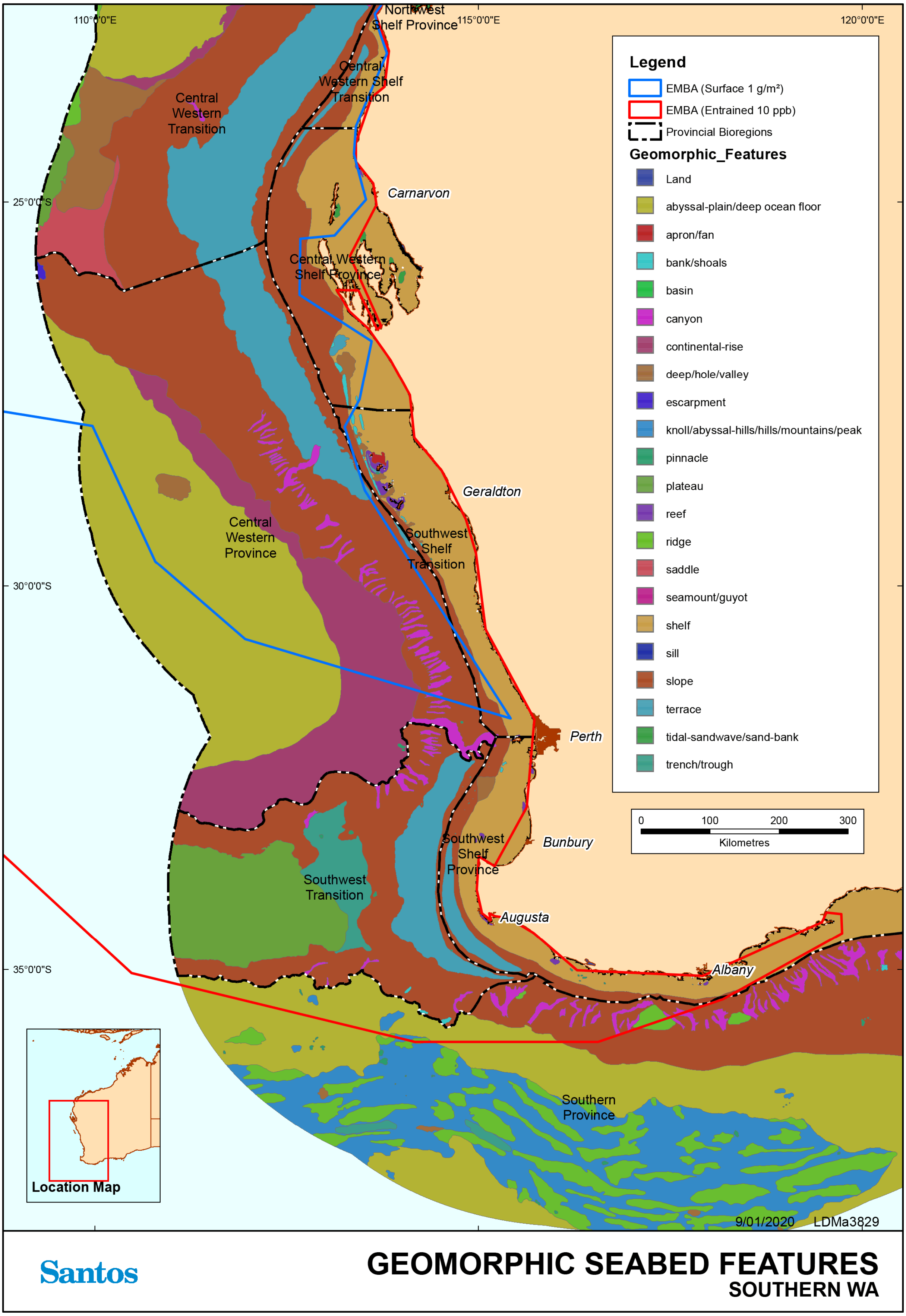


Figure 2-2: Geomorphic/seafloor features of Southern WA

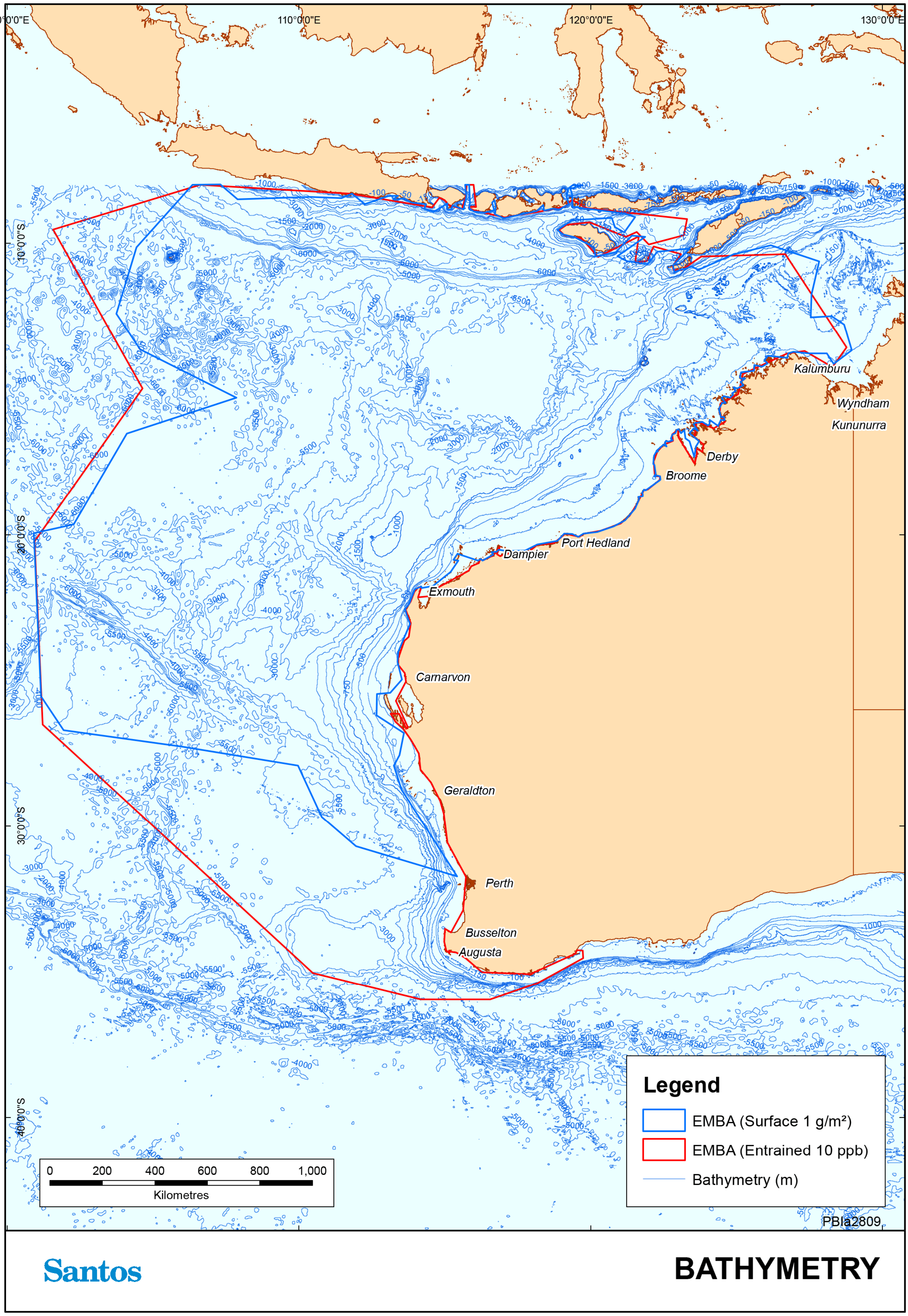


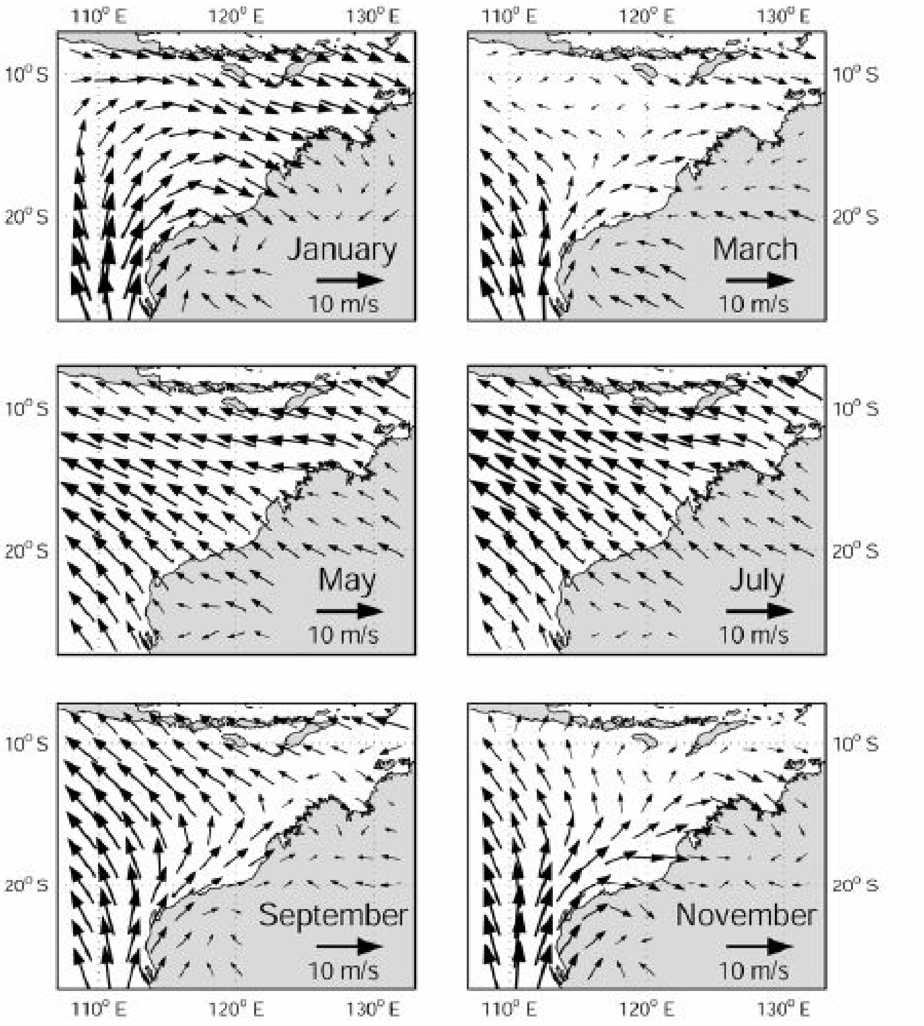
Figure 2-3: Bathymetry of the EMBA

2.2 Climate

Waters in northern Western Australia 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 (Bureau of Meteorology

(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.

Waters in the southwest and southern Western Australia experience 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 2008a). 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 2008a). The strength of the Leeuwin Current is influenced by seasonal variability in the pressure gradient (DEWHA 2008a). The Holloway Current is the prevailing seasonal current, travelling south-west along the north West Australian coast in winter and north-east in summer (Brewer et al. 2007).

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 Commonwealth Scientific and Industrial Research Organisation (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 2008a).

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 nearshore Capes Current, which is to the south of the Ningaloo Current, is a seasonal current that appears strongest between Cape Leeuwin and Cape Naturaliste, in the southwest of Western Australia (Pearce and Pattiaratchi 1999). Strong northwards winds between November and March slow the Leeuwin Current and increase the strength of the Capes Current. Localised upwelling is also known to occur in the area (Pearce and Pattiaratchi 1999).

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 Department of Environment and Conservation (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).

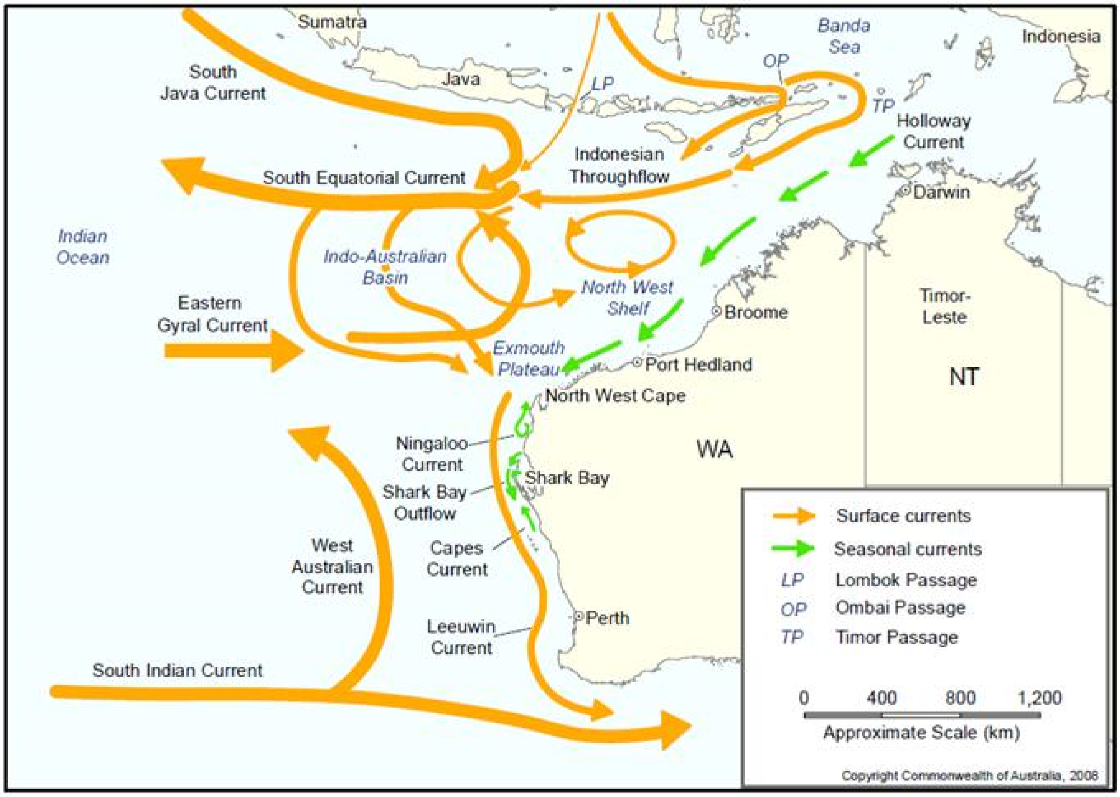


Figure 2-5: Surface currents in WA

Source: DEWHA (2008b)

3. Benthic and Pelagic Habitats

Benthic habitats are defined as those subtidal habitats lying below the lowest astronomical tide (LAT). The benthic habitats within waters in the EMBA lie at depths ranging from LAT down to more than 6,000 m at Argo and Cuvier abyssal plains (DEWHA 2008a, 2008b).

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 (DEWHA 2008b).

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 14 IMCRA v. 4.0 bioregions. Some broad scale benthic habitat mapping exists for the Northwest and Central Western Shelf Provinces and this is shown in **Figure 3-1**.

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 (Conservation and Land Management (CALM) & Marine Parks and Reserves Authority (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 EMBA 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 (Australian Institute of Marine Science (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, Gilmour et al. 2013). 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 Southwest Shelf Transition

The coral reefs of the Houtman Abrolhos Islands are the most southern extensive coral community along the west coast. Smaller localised pockets do occur as far south as Rottnest Island and even extend to Cape Naturaliste in the Southwest Shelf Province. The reefs around the Abrolhos Islands comprise 211 known species of corals and all but two of the coral species are tropical (Department of Fisheries (DoF) 2012). The greatest diversity and density of corals is found on the reef slopes, shallow reef perimeters and lagoon patch reefs in the more sheltered northern and eastern sides of each of the three limestone platforms that support the island groups (DoF 2012).

3.1.2 Central Western Shelf Province

The Central Western Shelf Province occurs on the continental shelf between Coral Bay and Busselton and is generally flat with depths ranging from 0–100 m. The province includes Shark Bay and Bernier, Dorre and Dirk Hartog Islands.

Studies at Shark Bay recorded 80 species of coral (Marsh 1990). The study determined that salinity and seasonal temperature gradients restrict the distribution of corals to areas that have normal salinity in the western half of the Bay, a few species occur in the metahaline waters but none in the hyper saline areas (Marsh 1990). The eastern shores of Bernier, Dorre and Dirk Hartog Islands provide the most favourable habitats for coral growth due to shelter, and water with relatively small salinity and temperature fluctuations. Some sections of these islands support prolific coral growth (up to 100% cover) both in the sheltered leeward and exposed areas. This bioregion is a transitional zone between the predominantly tropical flora and fauna of the north and temperate flora and fauna further south (CALM & NPNCA 1996).

3.1.3 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, are more prevalent (Waples & Hollander 2008).

3.1.4 Northwest Transition

This bioregion lies mostly over the continental slope and the abyssal plain in deep waters that preclude photosynthetic coral growth (DEWHA 2008a). 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 2008a).

A 1993 survey at Mermaid Reef recorded 214 species of scleractinian corals (Done *et al*. 1994). Since 1997, mean coral cover has increased through periods of impact and recovery from cyclones, reaching the highest (71%) on record in 2017 (Gilmour *et al.* 2019). 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.

3.1.5 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 2005). 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.

3.1.6 Timor Province

Although water depths in this province are generally deep (200 m to almost 6,000 m) there are several reefs and islands that are regarded as biodiversity hotspots (DEWHA 2008a).

Ashmore Reef, Cartier Island, Hibernia, Scott and Seringapatam Reefs are areas of enhanced local biological productivity, within an area of relatively unproductive waters. Ashmore Reef National Nature Reserve supports one of the greatest number of coral species of any reef off the West Australian coast, with 255 species of reef-building corals in 56 genera (Veron 1993). Taxonomic revisions and additional surveys have resulted in a net increase in species numbers to 275 (Griffith 1997, Ceccarelli *et al*. 2011). Species are typical of the Indo-pacific region and none are unique or considered endemic. However, 41 species (15% of the total hard coral species at the site) are listed as vulnerable on the IUCN Red List (IUCN 2019). In 1998, hard coral covered an area of around 717 ha at Ashmore Reef. The majority of hard corals occur in the deep lagoon (265 ha) and shallow reef top (315 ha) with small areas in the shallow lagoons, and reef edge/slope habitats (Skewes *et al*. 1999a). The soft, non-reef building corals are less well studied at Ashmore Reef than the hard corals (Hale & Butcher 2013). In 1986, 39 soft coral taxa were recorded within the Ashmore Reef, including the vulnerable blue coral (*Heliopora coerulea*) which was moderately common on the reef flats (Marsh 1993). In 1998, the total cover of soft coral at Ashmore Reef was 323 ha and *Sarcophyton* spp. was the dominant taxa covering around 19 ha in total (Skewes *et al*. 1999b, Hale & Butcher 2013).

The species composition of all the hard coral reefs in the bioregion is very similar and reflects strong links with Indo-West Pacific fauna, largely as a result of the dispersal of coral spawn via regional currents. The reefs and islands in this bioregion are thought to be important biological stepping-stones between centres of biodiversity in the Indo–Pacific and reef ecosystems further south (DEWHA 2008a).

Seringapatam Reef is a regionally important scleractinian coral reef as it has a high biodiversity, which is comparable to Ningaloo Reef. Results from the Western Australian Museum (WAM) survey in 2006 noted 159 species of scleractinian corals with a hard coral cover of approximately 16% (WAM 2009). The dominant benthic habitats of the reef were observed to include hard and soft corals (Heyward et al. 2013 cited in ConocoPhillips 2018).

Scott Reef consists of two reefs, North Scott Reef and South Scott Reef, which are separated by a deep (400–700 m) channel. North Scott Reef is an annular reef which encloses a lagoon that is connected to the ocean. South Scott Reef is a crescent-shaped reef which forms an arc and partially encloses another lagoon. Light penetration at Scott reef is high due to low turbidity. Light penetration depths to the deeper part of South Reef Lagoon are in excess of 50m with corals able to survive at depths of up to 70 m (Woodside Energy Limited *et al.* 2010).

Hibernia Reef consists of an approximately oval-shaped reef, with large areas of the reef becoming exposed at low tide. Hibernia Reef is also characterised by a deep central lagoon and drying sand flats.

There are a number of shoals and banks in the NMR and NWMR. Relatively few studies have been undertaken of these features with the majority of the understanding derived from the Big Bank Shoals study (Heyward *et al*. 1997), PTTEP surveys initiated in response to the Montara incident (Heyward *et al*. 2010; Heyward *et al.* 2011) and ConocoPhillips baseline surveys undertaken to support the Barossa Area Development (Heyward *et al.* 2017). The PTTEP surveys completed at Ashmore, Cartier and Seringapatam Reefs were undertaken during a coral bleaching disturbance likely to be attributed to regional thermal stress indicated by both *in situ* and satellite based data for the region. The condition of the reefs communities was consistent with previous surveys within the area and did not indicate any disturbance from the Montara incident (Heyward *et al*. 2010; Heyward *et al.* 2012).

In general, the submerged features are characterised by abrupt bathymetry, rising steeply from the surrounding outer continental shelf at depths of 100 m–200 m. The shoals and banks tend to flatten at depths of 40-50 m, with horizontal plateau areas of several square kilometres generally present at 20-30 m depths (Heyward *et al*. 2010). The shoals and banks support a diverse and varied range of benthic communities, including algae, reef-building soft corals, hard corals and filter-feeders (Heyward *et al.* 1997, Heyward *et al.* 2012). The plateau areas were dominated by benthic primary producer habitat, with interspersed areas of sand and rubble patches (Heyward *et al*. 2012).

3.1.7 Northwest Shelf Transition

Coral communities of the Northwest Shelf Transition have historically not been well studied. However, based on the scale of reef development and the diversity of coral species recorded through limited surveys, it is highly likely that further surveys will demonstrate that the Kimberley contains a coral reef province of global significance (Masini *et al*. 2009).

Coral reefs in the province include fringing reefs around coastal islands and some mainland shores. Development of coral communities in inshore areas is limited due to persistent high turbidity. Known examples of coral reefs in the bioregion are given below, however further mapping is required.

Benthic habitat surveys at Adele and Long Islands in 2009 and 2010 revealed extensive development of hard and soft coral communities (Richards *et al*. 2013). Scleractinian coral communities at Adele Island were diverse, supporting 176 species in intertidal and subtidal areas up to 14 m depth. At Long Island approximately 200 species of scleractinian corals were recorded in intertidal and subtidal areas. These surveys also identified two significant and unique habitats; a zone of mixed corallith and rhodolith habitat at Adele Island and an Organ Pipe Coral habitat zone with unusually high benthic cover at Long Island (Richards *et al*. 2013).

Studies by DBCA and the LNG industry indicate that fringing and emergent coral reefs are well developed in the Heyward island group, around islands in the Bonaparte Archipelago, and off mainland shores of Cape Voltaire and Cape Bougainville. Surveys by INPEX of Maret, Bethier and Montalivet islands, which were largely restricted to the intertidal zone, have recorded 280 species of coral from at least 55 genera, making the Kimberley Bioregion the most coral-diverse area in WA (INPEX 2008).

Montgomery Reef has been identified as a key feature in the area. Montgomery Reef is a huge submerged rock platform covering approximately 400 km^2. Corals occur in the subtidal area around Montgomery Reef, and in the many rock pools on the platform where there is shaded from the sun by algae or rock ledges (DEWHA 2008a). A survey of benthic habitats at Montgomery Reef was conducted in 2009 by AIMS but a literature search found no published results from this survey (AIMS 2014).

Browse Island is surrounded by a minor fringing coral reef. Assemblages at Browse Island are characteristic of coral platform reefs throughout the Indo-West Pacific region, particularly Cartier Island. Coral diversity was greatest on the reef faces and shallow lagoons but these areas were of very limited extent (URS 2010a).

Hard corals have been recorded at Echuca Shoals but the community was low in both species richness and abundance (URS 2010a). The presence of occasional large outcrops suggests that larger coral structures have occurred previously and may still occur elsewhere on the shoal (RPS Environmental 2008).

3.1.8 International Waters

Important areas outside of the IMCRA bioregions include:

Christmas Island

Fringing coral reefs around Christmas Island are relatively simple with 88 coral species previously identified which are identified to support and over 600 fish species (Director of National Parks 2012).

Indonesia (west)

Indonesia has an estimated 75,000 km^2 coral reef ecosystem distributed throughout the archipelago (Tomascik et al. 1997 cited in Hutumo & Moosa 2005). Fringing reefs are the most common reef types with scleractinian corals as being the most dominant and important group. 452 species of hermatypic scleractinian coral were collected from Indonesian waters by Tomascik et al. (1997 cited in Hutumo & Moosa 2005), a study presented by Suharsono (2004 cited in Hutumo & Moosa 2005), indicated that 590 species of scleractinian corals exist in Indonesian waters. Acropora, Montipora and Porites are the most important reef building corals in Indonesia.

The Lesser Sunda Ecoregion encompasses the chain of islands and surrounding waters from Bali, Indonesia to Timor-Leste. This region contains suitable habitat for corals on shallow water substrates formed by limestone and lava flows and is thought to contain more than 500 species of scleractinian reef-building corals (DeVantier *et al.* 2008). Coral species composition is influenced by regional and local scale seasonal upwellings that typically occur from April to May each year on the southern side of the islands. The ecoregion is considered important for coral endemism, particularly the areas of Bali-Lombok, Komodo and East Flores. Fringing coral reefs tend to be less developed on the southern, more exposed shorelines (Wilson *et al.* 2011).

Timor-Leste

See **Section 3.1.6** for a description of habitat typical of shoals and banks in the Timor Sea.

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 WA, the highest diversity in the world (Masini *et al*. 2009). Waters extending from Busselton to the NT 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 WA (Department of Parks and Wildlife (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 2005, 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 2005, 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 Southwest Shelf Province

Geographe Bay is a large relatively sheltered area with that supports extensive beds of tropical and temperate seagrass that have a high diversity of species and endemism (DEWHA 2008a). They are thought to account for about 80% of benthic primary production in the area. These seagrass beds provide important nursery habitat for many shelf species that use the shallow seagrass habitat as nursery grounds for several years before moving out over the shelf to their adult feeding grounds along the shelf break.

The Geographe Bay seagrass meadows are among the most extensive temperate seagrass communities on the west coast (MPRSWG 1994 cited in DEC 2013), and include 10 species from five genera (*Amphibolis, Posidonia, Halophila, Heterozostera* and *Thalassodendron*). Geographe Bay is dominated by stands of the narrowleaf tape-weed (*Posidonia sinuosa*) that covers approximately 70% of Geographe Bay. It has smaller areas of *Posidonia angustifolia*, *Amphibolis griffithii*, *A. antarctica* and minor species, which have irregular distributions both spatially and temporally (Lord 1995 cited in DEC 2013). *Thalassodendron pachyrhizum*, *Posidonia* spp. and *Amphibolis* spp. are also found in depths of between 27 and 45 m (Walker *et al*. 1994 cited in DEC 2013).

3.2.2 Southwest Shelf Transition

Species diversity of seagrasses in this bioregion is the highest in the world, with 14 species occurring (DEWHA 2008a). In total, 10 seagrass species have been recorded at the Abrolhos ranging from small, delicate species to larger, more robust types that grow in large meadows (DoF 2012). Small paddle-weeds grow in protected lagoon areas or deep waters between the islands, such as Goss Passage and the larger species may be found growing on reef as well as in sandy areas (DoF 2012). *Thalassodendron pachyrhizum*, which is encountered growing on the exposed reef crest area, has been recorded at a number of the island groups. There are also two species of wire-weed (*Amphibolis* species), endemic to southern Australia, found at the Abrolhos (DoF 2012). The most abundant seagrass is *Amphibolis antarctica*, while *Amphibolis griffithii* appears to be restricted to bays such as Turtle Bay in the Wallabi Group.

The larger ribbon-weeds (*Posidonia* species) grow in sheltered bays and lagoons where the sand cover is deeper and more stable (e.g. Turtle Bay, the Gap, East Wallabi Island, the lagoon on the west side of West Wallabi Islands and around North Island) (DoF 2012).

Nine species of seagrass are found in the Perth region, including at Rottnest Island where *Amphibolis* thrives in clear waters overlying limestone rock (Amalfi 2006). Seagrasses are a major component of the ecosystem on the Rottnest Shelf, thriving in waters ranging in depth from intertidal to 45m (Amalfi 2006). All of the seagrass species identified with the exception of *Syringodium isoetifolium* and *H. ovalis* are endemic to temperate areas of southern Australia (Amalfi 2006). At Rocky Bay, on the north side of the island where it is protected from big swells and strong south to south-westerly winds, a mix of dense seagrass meadow consisting of *Amphibolis* and *Posidonia* thrive. The meadows around Rottnest Island serve as nurseries for juveniles of many fish species, and are home to species such as the cobbler and long-headed flathead (Amalfi 2006).

3.2.3 Central Western Shelf Province

Shark Bay contains the largest reported seagrass meadows in the world (approximately 4,000 km^2), as well as some of the most species-rich seagrass assemblages (Walker *et al.* 1989). Twelve species of seagrass are found in the Bay with the dominant species being *Amphibolis antarctica*. Seagrass is a fundamental component of biological processes in Shark Bay; it has modified the physical, chemical and biological characteristics of the Bay and provides food, habitat and nursery grounds for many species (CALM & National Parks and Nature Conservation Authority (NPNCA) 1996).

An inshore survey of benthic habitats near Busselton recorded dense coverage of *Amphibolis* spp. on limestone pavement. *Halophila* spp., *Heterozostera* spp. and *Syringodium isoetifolium* were recorded on sandy substrates (DoF 2007).

3.2.4 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).

3.2.5 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).

3.2.6 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.* 2011).

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 2019).

In the Dampier Archipelago seagrass occurs in the larger bays and sheltered flats of the area (CALM & MPRA 2005). Six species of seagrass, including three Halophila species, have been recorded on the subtidal soft sediment habitats (CALM & MPRA 2005). 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 2005).

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).

3.2.7 Timor Province

Seagrass has been reported on the reef flats of offshore reefs of this bioregion (Whiting 1999, Hale & Butcher 2013). Five species of seagrass were reported at Ashmore Reef with *Thalassia hemprichii* being the dominant species (Pike & Leach 1997, Skewes *et al*. 1999b, Brown & Skewes 2005). The total area of seagrass at Ashmore Reef in 1999 was estimated to be 470 ha (Skewes *et al*. 1999b). However, much of this was very sparse cover and there were only 220 ha of seagrass with a greater than 10% cover (Brown & Skewes 2005). Seagrass grew in a sparse, patchy distribution across the sand flats, but had a higher coverage on the reef flat area, where it extended to within 100 m of the reef crest. The area of greatest cover and diversity was in the west and south-west areas of the reef on the inner reef flat (Brown & Skewes 2005). These seagrass meadows support a small but significant population of dugongs estimated at around 100 individuals comprising all age classes from calves to adults (Hale & Butcher 2005).

Similarly, Scott Reef supports five species of seagrass (URS 2006), with *Thalassia hemprichii* most abundant (Skewes *et al*. 1999a, URS 2006). The area of seagrass at Scott Reef is significantly less than that recorded for Ashmore Reef (approximately 100 ha) (Woodside 2011). The highly energetic environment and significant tidal exposure of Scott Reef restricts the area of habitats potentially suitable for seagrass establishment to a small proportion of the total area, resulting in low abundance (Skewes *et al*. 1999a, URS 2006).

Seringapatam Reef was found to have a seagrass cover of 2 ha out of 5,519 ha (0.04%) composed of *Thalassia hemprichii* and *Halophila ovalis* in approximately equal quantities (Skewes *et al*. 1999a). This finding contrasts with a more recent survey where only one species of seagrass (*Halophila decipiens*) was recorded at Seringapatam (Huisman *et al*. 2009).

Skewes *et al*. (1999a) did not observe any seagrass communities at Hibernia Reef.

3.2.8 Northwest Shelf Transition

Extensive and diverse intertidal seagrass meadows are known from islands in the southern Kimberley, particularly in the Sunday Island One Arm Point area (Walker 1995, Walker & Prince 1987). Ten species of seagrasses have been recorded at One Arm Point, with the majority of meadows low to moderate in abundance and dominated by *Thalassia hemprichii* with *Halophila ovalis*, *Halodule uninervis* and *Enhalus acoroides* (Seagrass-Watch 2019).

While some seagrasses have been collected from intertidal sites in the central and north Kimberley (Walker *et al*. 1996, Walker 1997), these areas were not found to be species rich and did not support extensive seagrass meadows like those found in the southern Kimberley.

Subtidal seagrass meadows in the Northwest Shelf Transition are not well mapped, although dugongs are known to feed on seagrass communities in coastal waters of the Joseph Bonaparte Gulf (DEWHA 2008a).

3.2.9 International Waters

Important areas outside of the IMCRA bioregions include:

Indonesia (west)

Within Indonesian waters, the lower intertidal and upper subtidal zones are considered important areas for the growth of seagrass (Hutumo and Moosa 2005). Pioneering vegetation in the intertidal zone is dominated by

Halophila ovalis and *Halodule pinifolia* while *Thalassodendron ciliatum* dominate the lower subtidal zones. Wide areas of the Indonesian coastal waters are covered by dense beds of seagrass.

Seagrass habitats are widely distributed across the Lesser Sunda Ecoregion. Preliminary data from the United Nations Environment Program's (UNEP) World Conservation Monitoring Centre (WCMC) has identified the following areas as potential areas of importance for seagrass, many of which are outside the EMBA (DeVantier *et al.* 2008):

- North-west Bali;
- South-west and west Lombok;
- North-east Sumbawa;
- Komodo Islands;
- Savu; and
- South coast of Timor-Leste.

The Kepulauan Seribu National Park is also known for its rich diversity of seagrasses (refer to **Section 9.8**).

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 Southwest Shelf Province

Species diversity of macroalgae is very high. The south coast of the bioregion is characterised by a relatively higher diversity of temperate macro-algal species compared with the Southwest Shelf Transition. These colonise the exposed rocky shorelines and rocky reefs (DEWHA 2008a).

3.3.2 Southwest Shelf Transition

The Houtman Abrolhos have known species of benthic algae with macroalgae communities considered important in supporting a diversity of marine life.

More than 340 species of macroalgae (including 54 species of green algae, 71 species of brown algae, and 222 species of red algae) have been recorded from rock platforms around Rottnest Island (Amalfi 2006).

3.3.3 Central Western Shelf Province

Although seagrasses are the most visually dominant organisms found in Shark Bay (Walker *et al*. 1989) macroalgae are also a significant component within the system, with 161 taxa of benthic macroalgae reported from the location (Kendrick *et al*. 1990). The seagrass meadows host a large number of epiphytic algal species (Harlin *et al*. 1985, Kendrick *et al*. 1990), which numerically dominate the algal flora of the area. Eighty algal species were epiphytic on the seagrass *Amphibolis antarctica*, and of these, over half have been reported both as epiphytes and benthic algae. Benthic macroalgae can be found growing on occasional subtidal rock (limestone–sandstone) platforms and extensive sand flats that occur throughout Shark Bay, and as drift within seagrass meadows (Kendrick *et al*. 1990).

The benthic algae of Shark Bay are not predominantly temperate as is the case with the seagrasses (Walker *et al*. 1989) and seagrass epiphytes (Kendrick *et al*. 1990). The majority of taxa are either of tropical or cosmopolitan distribution. Their local distribution within Shark Bay is correlated with salinity, with benthic algal species richness lower in areas of high salinity (Kendrick *et al*. 1990).

Limestone platforms occur along the bioregion's coastline and high energy environments are likely to be dominated by large brown algae including *Ecklonia radiata* and *Sargassum* spp. with articulated coralline algae making up the understorey. More diverse algae assemblages may be observed in sheltered locations such as potholes and ledges (DoF 2007).

3.3.4 Central Western Shelf Transition

Macroalgal beds along the Ningaloo coastline are generally found on the shallow limestone lagoonal platforms and occupy about 2,200 ha of the Ningaloo Marine Park and Muiron Islands Marine Management Area (CALM & MPRA 2005a). Macroalgal communities within the area have been broadly described (Bancroft & Davidson 2000). The dominant genera are the brown algae *Sargassum*, *Padina*, *Dictyota* and *Hydroclathrus* spp. (McCook et al. 1995).

3.3.5 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).

3.3.6 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 Dampier Archipelago (CALM & MPRA 2005). 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).

3.3.7 Timor Province

Macroalgae at Ashmore Reef are estimated to cover over 2,000 ha, mostly on the reef slope and crest areas (Hale & Butcher 2013). The algal community is dominated by turf and coralline algae, with fleshy macroalgae comprising typically less than 10% of total algal cover (Skewes *et al*. 1999b).

Surveys at Scott and Seringapatam Reefs recorded over 100 species of marine algae (Huisman *et al*. 2009). The marine algal community was similar between reefs and also similar to the Rowley Shoals. Algae found at these offshore atolls forms a small subset of the Indo-Pacific algal flora, with virtually all of the species identified thus far having been previously collected from north-western Australia or from localities further north. Although further research is necessary, at present there is nothing to suggest that the macroalgae communities of these offshore atolls are unique within the Indo-Pacific (Huisman *et al*. 2009).

3.3.8 Northwest Shelf Transition

There is a lack of information regarding the marine benthic flora of north-west Western Australia and no comprehensive marine flora list exists for the region (Huisman 2004). However, about 70 algae species were collected during a survey of intertidal reefs on the central Kimberley coast in 1997 (Walker 1997).

Tropical macroalgae species are typically associated with areas of hard substrate and various types of macroalgae occur on rock platforms intermingled with coral and sponge. Abundance and biomass typically exhibit strong seasonal trends (Heyward *et al*. 2006).

The diversity and abundance of algae in the Kimberley is probably linked to the region's extreme tidal exposure and highly turbid waters, reducing light penetration and resulting in deposition of fine sediments (Walker 1997). However, the role of algae appears crucial to the growth of reefs in the highly turbid waters of the Kimberley coast and islands (Brooke 1997). *Sargassum* spp. and coralline algae may be dominant (DPAW 2013).

3.3.9 International Waters

No information on macroalgae in international waters has been identified other than for Timor-Leste waters.

Timor-Leste

See **Section 3.1.6** for a description of habitat typical of shoals and banks in the Timor Sea.

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 Southwest Transition

There is little available information on benthic biological communities of this bioregion however deep sea crabs, such as the champagne crab and crystal crab are known to inhabit the seafloor of the slope (DEWHA 2008b).

3.4.2 Southern Province

There is little information available on the benthic biological communities within the bioregion, however it is described as a unique region of deep-sea habitats that includes the Diamantina Fracture Zone Key Ecological Feature. The Diamantina Fracture Zone is described as structurally complex deep water environment of seamounts and numerous closely spaced troughs and ridges, which represents a unique region of deep-sea habitats including 26 endemic species of demersal fish (DSEWPaC) 2012b).

3.4.3 Central Western Province

The understanding of marine life in this bioregion is mostly confined to the demersal fish on the continental slope. The exception to this is the Perth Canyon which, although poorly understood, is known to have unique seafloor features with ecological properties of regional significance.

3.4.4 Western Shelf Province

The Central Western Shelf Province occurs on the continental shelf in water depths from 0 to 100 m. Biological communities of the shelf are likely to include a sparse invertebrate assemblage of sea cucumbers, urchins, crabs and polychaetes on sand substrates. Hard substrates are likely to contain sessile invertebrates such as sponges and gorgonians. The biological communities of this bioregion share many similarities with the adjoining temperate region (DEWHA 2008a).

Stromatolites occur in Shark Bay. Although they are a microbial colony (prokaryote), and not an invertebrate (eukaryote), they are described here as a unique benthic biological community. Stromatolites are rock-like structures built by cyanobacteria. Shark Bay's stromatolites are 2,000 to 3,000 years old and are similar to life forms found on Earth up to 3.5 billion years ago. Until about 500 million years ago, stromatolites were the only macroscopic evidence of life on the planet; hence they provide a unique insight into early life forms and evolution. The stromatolites are located in the hypersaline environment of Hamelin Pool and are one of the reasons for the area's World Heritage Listing (DPAW 2009).

3.4.5 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 2008a).

3.4.6 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 2008a).

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).

3.4.7 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.

3.4.8 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 (approximately 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 approximately 700 m and approximately 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).

3.4.9 Northwest Shelf Province

This bioregion is located primarily on the continental shelf in water depths from 0 to 200 m (DEWHA 2008a). The sandy substrates on the shelf within this bioregion are thought to support low density benthic communities of bryozoans, molluscs and echinoids (DEWHA 2008a). 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 (approximately 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 (approximately 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).

3.4.10 Timor Province

The Timor Province is located on the continental slope and abyssal plain and water depths range from 200 m to almost 6,000 m. Benthic studies in this bioregion are scarce, however data from the North West Slope Trawl Fishery suggests that muddy sediments in the Timor Province support significant populations of crustaceans (Brewer *et al*. 2007). Additionally, research into the demersal fish communities of the continental slope has identified the Timor Province as an important bioregion. This is due to the presence of a number of endemic fish species, and two distinct demersal community types associated with the upper slope (water depths of 225–500 m) and mid-slope (water depths of 750–1,000 m) (Last *et al*. 2005). The current understanding of the relationship between demersal fish communities and benthic environments on the continental slope is rudimentary (DEWHA 2008a).

Over 130 species of sponges have been recorded at the Ashmore Reef National Nature Reserve (Russell & Hanley 1993).

Studies of Seringapatam Reef have observed the dominant benthic habitats to include filter feeders, such as sponges, gorgonians, hydroids and seapens (Heyward et al. 2013 cited in ConocoPhillips 2018).

3.4.11 Northwest Shelf Transition

The Northwest Shelf Transition is located on the continental shelf with a small area extending onto the continental slope, with water depths ranging from 0–330 m. Nearshore areas may support significant filter feeding communities but these have not yet been described (Masini *et al*. 2009).

Pipeline route surveys north of the Kimberley in water depths from 10–250 m recorded a seabed largely devoid of hard substrate, with only sparse epibenthic fauna noted on the predominantly sandy substrate. Occasional epibenthic fauna (featherstars, gorgonians, bryozoans, sea urchins, hydroids and sponges) were recorded in areas where rocky substrate or outcrops were present (URS 2010a).

In contrast, benthic surveys at Echuca Shoals identified broad areas of hard substrate with substantial epibenthic fauna. The shallow shoal areas were dominated by a flat ‘reef’ platform with crinoids, sea whips, soft corals and low densities of hard corals. With increasing depth (25–80 m) soft corals and sponges became increasingly dominant. At greater depths (80–100 m) the density of epibenthic fauna decreased substantially with sea whips and sea fans became dominant (URS 2010a).

3.4.12 International Waters

No information on non-coral benthic invertebrates in international waters has been identified other than for Timor-Leste waters.

Timor-Leste

See **Section 3.1.6** for a description of habitat typical of shoals and banks in the Timor Sea.

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 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 EMBA, 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) and Cape Mentelle (Pattiaratchi 2007). It is also expected that a high abundance of plankton will occur within areas of localised upwelling in the EMBA 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 (National Aeronautics and Space Administration (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.

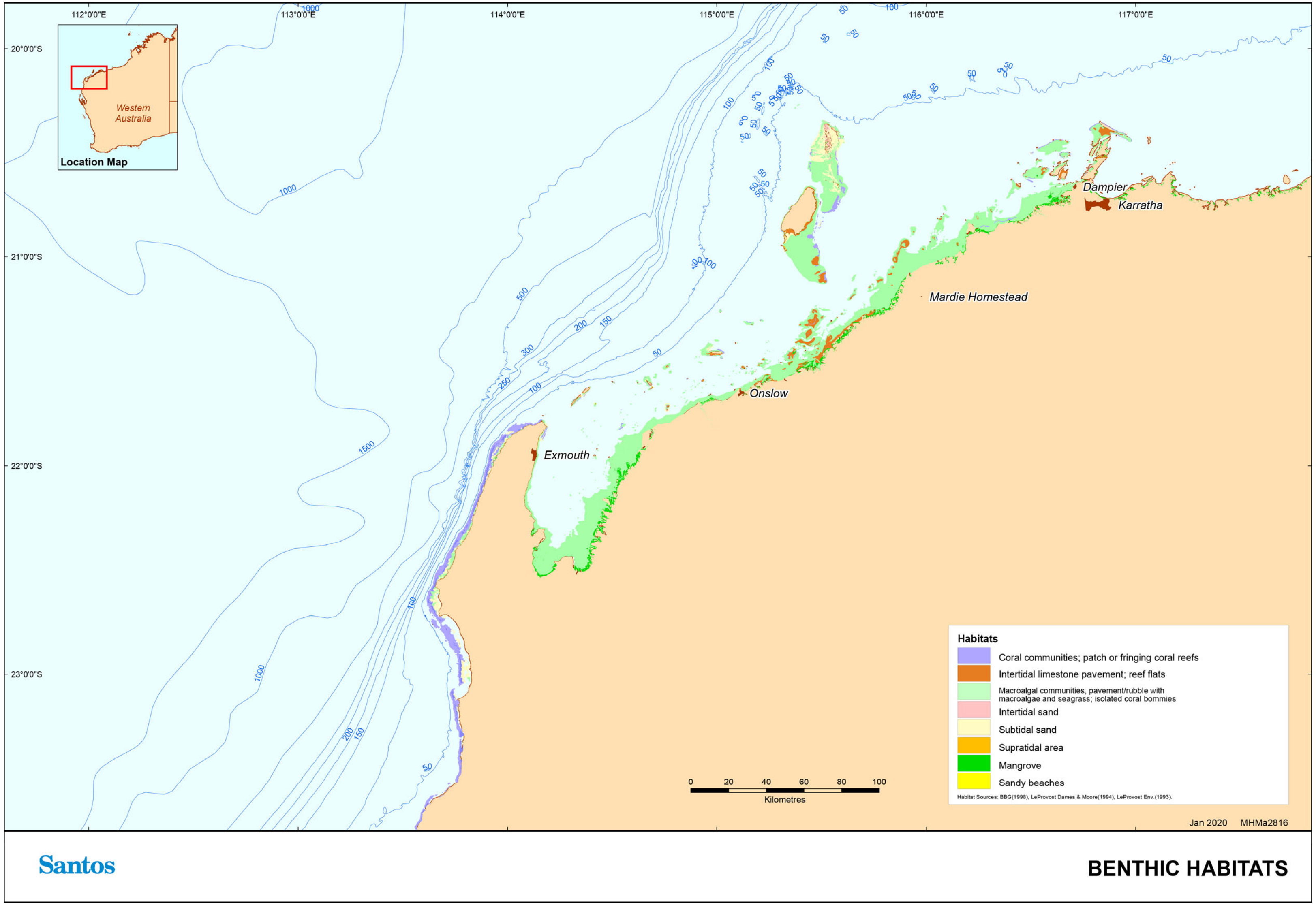


Figure 3-1: Benthic habitats from Coral Bay to Dampier

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 14 IMCRA v. 4.0 bioregions where relevant and where information is available.

Figure 3-1 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 (National Oceanic and Atmospheric Administration (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, Alongi 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).

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 two key State regulatory documents relevant to the protection and management of mangroves in WA are:

- EPA (2001) Guidance Statement for Protection of Tropical Arid Zone Mangroves along the Pilbara Coastline. Guidance Statement No. 1; 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 2014). 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 WA 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 WA 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).

4.1.4 Northwest Shelf Transition

Mangroves are also a prominent feature of the North Kimberley. Fringing mangroves have developed around the edge of Prince Frederick Harbour and to the east of Cape Voltaire extending along the shores of Walmesly Bay and Port Warrender (Zell 2007). This region is humid and *Xylocarpus granatum* is localised here (Cresswell and Semeniuk 2011). The rocky coastline between Cape Pond and Cape Voltaire does not lend itself to mangrove development; instead coastal woodland grows on the shores above high water mark. Mangroves are interspersed with rocky outcrops and beaches around much of the Admiralty Gulf, Vansittart Bay and Napier Broome Bay (with extensive stands around the Drysdale estuary). Cape Londonderry marks the westerly limit of *Scyphiphora hydrophylacea* (Duke *et al.* 2010).

Between Cape Londonderry and Cape Dussejour mangrove communities are sparse, and limited to a few small stands in the bays as this part of the coastline is dominated by high relief rocky shores which are exposed to the prevailing easterly winds (Wilson 1994). Extensive mangroves do however line the shores of the islands and rivers in the Cambridge Gulf, where 12 mangrove species have been recorded (Wilson 2013). The mangroves of the Ord River are notable in terms of their structural complexity and diversity. Fourteen species of mangrove have been recorded in the boundaries (Pedretti and Paling 2001). The mangroves of the Cambridge Gulf are important for saltwater crocodiles and mangrove bird communities. A unique type of flycatcher which is an intermediate between *Microcea flavigater* and *Microeca tormenti* has been identified in the mangroves of the Cambridge Gulf (Johnstone 1984). Additionally, the area is important for maintaining stocks of the commercially exploited species of the Red-Legged Banana Prawns (*Penaeus indicus)* (Kenyon *et al.* 2004).

4.1.5 Timor Province

Details on habitats in the Timor Province is provided in **Section 12.3.12**.

4.1.6 International Waters

Subawa's south coast in Indonesia is thought to contain the most significant stand of mangroves in the Lesser Sunda Ecoregion (DeVantier 2008). Other significant stands have been mapped at the following locations (DeVantier 2008):

- North-west and south east Bali;
- North coast of Nusa Lembongan;
- North-east and east Sumba;
- South-west, north-west, north and east Flores and Maumere;
- Komodo Island, and nearby islands; and
- South west, south, central and north Timor-Leste.

Several Indonesian National Parks, including Karimunjawa National Park, Kepulauan Seribu National Park, Meru Betiri National Park, Bali Barat National Park and Komodo National Park contain mangrove forest (refer to **Section 9.8**).

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 Central Western Shelf Province

Shark Bay in the Central Western Shelf Province has a protected intertidal ecological community 'Subtropical and Temperate Coastal Saltmarsh', as listed under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). It is the northerly limit for this community and there is a transition zone for many saltmarsh species (CALM 1996). The EPBC 'Listed Advice' (DSEWPaC 2013a) reports that sediments associated with these communities generally consist of poorly-sorted anoxic sandy silts and clays, and may have salinity levels that are much higher than seawater due to evaporation. The drainage characteristics of coastal soils, along with tidal patterns and elevation, can strongly influence the distribution of flora and fauna within the Coastal Saltmarsh ecological community (DSEWPaC 2013a).

4.2.2 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 *Biodiversity Conservation Act 2016* (BC Act) or EPBC Act, or listed on the IUCN Red List of Threatened Species (IUCN 2019). 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).

4.2.3 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 WA-NT Border.

4.2.4 Timor Province

Details on habitats in the Timor Province is provided in **Section 12.3.12**.

4.2.5 International Waters

Although no specific areas of intertidal mud or sand flats have been identified for international waters, the southern coasts of the islands that make up the Lesser Sunda Ecoregion of Indonesia and Timor-Leste do contain numerous estuarine habitats. These estuaries are likely to contain intertidal and tidal sand and mud flats that support a range of benthic invertebrate species that in turn attract other species such as birds and fish. Such estuaries in the Lesser Sunda Ecoregion are typically mangrove lined. Within the Lesser Sunda Ecoregion, the following areas are recognised as containing estuarine habitat (Wilson et al. 2011):

+ Lombok;
+ Sumba;
+ Central south and central north coasts of Sumbawa;
+ North-east coast of Flores; and
+ South-west coast of Timor-Leste.

The Irebere Estuary, located on the south-eastern coast, Tilomar located on the southern coast and Nino Konis Santana located on the eastern coast of Timor-Leste has been recognised as an Important Bird Area (Birdlife International 2018).

Several National Parks in the Ecoregion also contain estuarine habitats (likely to include intertidal sand and mud flats), including Karimunjawa National Park (refer to **Section 9.8**).

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 EMBA.

4.3.1 Southwest Shelf Province and Southwest Shelf Transition

Intertidal platforms within the Northwest and Southwest bioregions support a mosaic of fauna and flora that typically exhibits strong variability in percent cover, community composition, abundance and diversity both between and within reefs at varying spatial and temporal scales (SKM 2009, 2011). Reef platforms typically exhibit zonation of fauna and flora from upper to lower levels on the intertidal zone, with increasing diversity, abundance and biomass lower in the intertidal (Morton and Britton in Jones 2004, SKM 2009, 2010, 2011, Hanley and Morrison 2012).

On the south coast of the Southwest Shelf Province, the coastal geomorphology changes from the predominant limestone reefs to eroded Precambrian rocks. Intertidal platforms are also common along the Southwest Shelf Transition. Shark Bay in the Central Western Shelf Province has a high diversity of intertidal marine habitats as a result of the diversity of benthic substrate, salinity and the broad geographical features which influence depth, water movement and turbidity (CALM 1996, DSEWPaC 2013b). This includes extensive, limestone platforms (as well as sand flats, mud flats, salt marsh and mangroves and beaches (CALM 1996).

4.3.2 Central Western Shelf Province and 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.

4.3.3 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.

4.3.4 International Waters

While no significant areas of intertidal platforms have been identified in international waters, the high energy southern coastlines of the islands of the Lesser Sunda Ecoregion of Indonesia (and also including Timor-Leste) are likely to have areas of exposed pavements consisting of limestone and remnant lava flows (Wilson *et al*. 2011).

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 EMBA 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 EMBA.

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 turtles **Section 6.1**).

Sandy beaches also provide important nesting habitat for the six species of marine turtles that nest within WA (refer **Section 6.1**).

4.4.1 Southwest Shelf Province

The hooded plover (*Thinornis rubricollis*) is a shorebird found on several beaches within the South West capes. Hooded plovers live on sandy surf beaches and prefer beaches backed by dunes rather than cliffs (DEC 2013). In addition to this, beaches in the South West province provide a variety of socio-economic values including tourism, commercial and recreational fishing, and support other recreational activities.

4.4.2 Southwest Shelf Transition

Sandy beaches throughout the Abrolhos host breeding populations of the Australian sea lion. The Abrolhos represent the northernmost breeding population of Australian sea lions. The current population at the Abrolhos is estimated to be approximately 90 individuals (DoF 2012).

In addition to this, beaches in the South West province provide a variety of socio-economic values including tourism, commercial and recreational fishing, and support of other recreational activities.

4.4.3 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 2012a). It is also a listed Ramsar wetland (see **Section 9** on Protected Areas).

4.4.4 Northwest Shelf Transition

Sand habitat within the Camden Marine Park is mainly associated with shorelines and inlets on both mainland and island shores. Some beach deposits on islands in the Kimberley are composed of skeletal carbonate sand, while they may also consist of sediments from inland areas carried to the sea by rivers and gullies (DPaW 2013). The sediment coarseness of the sand may vary, and may also be littered with dead shell, rock and/or coral material. Sea cucumbers that ingest sand and filter out microscopic food are often common in this habitat DPaW 2013).

Generally, in this region, sand habitat is adjacent to either dense mangrove stands or rocky cliffs (DPaW 2013). Beaches can be highly influenced by tide and weather conditions. Those that overlie rock are likely to shift and be ephemeral in nature.

4.4.5 International Waters

No significant areas of sandy beaches in international waters have been identified. However, the southern coastlines of the islands of the Lesser Sunda Ecoregion of Indonesia and Timor-Leste are known to contain sandy beaches consisting of soft black sand, formed by volcanic activity. Within this region, a number of National Parks are considered important sites for turtle nesting beaches, including the Meru Betiri National Park (refer to **Section 9.8**).

4.5 Rocky Shorelines

Rocky shorelines are found across the EMBA 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 cited in Jones 2004). For example, oyster catchers and ruddy turnstones feed along beaches and rocky shorelines (see seabirds in **Section 8.2.2**).

4.5.1 International Waters

The Lesser Sunda Ecoregion contains numerous rocky shores, particularly on the exposed southern coastlines of the islands that make up the ecoregion. Areas of rocky shores include the following (DeVantier 2008):

+ The Bukit Peninsula and Nusa Penida areas of Bali;
+ South Lombok;

- South-east Sumbawa;
- Nusa Tengara;
- Sumba; and
- Timor-Leste, including Roti Island, Fatu and Atapupu.

5. Fish and Sharks

Fish distributions in the EMBA 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 EMBA, according to the Protected Matters search (**Appendix A**), are shown in **Table 5-5-1** along with their WA conservation listing (as applicable) and discussed in **Section 5.2** below.

The following WA conservation codes apply to WA conservation significant fauna:

- Threatened species (listed under BC Act):
  - Critically endangered
  - Endangered
  - Vulnerable
- Specially protected species (listed under BC Act):
  - 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 14.7** and detailed in *The State of the Fisheries Report* 2017/2018 (Gaughan *et al.*, 2019).

Table 5-5-1: EPBC listed fish and shark species in the EMBA

Species	Conservation Status			Likelihood of occurrence in EMBA	BIA in EMBA
	EPBC Act 1999	BC 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

[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 BC Act.

Species	Conservation Status			Likelihood of occurrence in EMBA	BIA in EMBA
	EPBC Act 1999	BC Act 2016[1]	Other WA Conservation Code		
Blind cave eel (*Ophisternon candidum)*	Vulnerable	Vulnerable	-	Species or species habitat known to occur within area.	None - No BIA defined
Black-stripe minnow (*Galaxiella nigrostriatal*)	Endangered	Endangered	-	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 EMBA
Great white shark (*Carcharodon carcharias*)	Vulnerable & Migratory	Vulnerable	-	Foraging, feeding or related behaviour known to occur within area.	Yes – Refer to **Table 5-3**
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 5-3**
Northern river shark (*Glyphis garricki)*	Endangered	-	Priority 1	Breeding likely to occur within the area.	None - BIA not found in EMBA
Dwarf sawfish (*Pristis clavata)*	Vulnerable & Migratory	-	Priority 1	Breeding known to occur within area.	Yes – Refer to **Table 5-3**
Freshwater sawfish (*Pristis pristis)*	Vulnerable & Migratory	-	Priority 3	Species or species habitat known to occur within area.	Yes – Refer to **Table 5-3**
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 5-3**
Oceanic whitetip shark (*Carcharhinus longimanus*)	Migratory	-	-	Species or species habitat likely to occur within area.	None - BIA not found in EMBA
Shortfin mako *(Isurus oxyrinchus)*	Migratory	-	-	Species or species habitat likely to occur within area .	None - No BIA defined

Species	Conservation Status			Likelihood of occurrence in EMBA	BIA in EMBA
	EPBC Act 1999	BC Act 2016[1]	Other WA Conservation Code		
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 EMBA:

+ 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 EMBA a number of important geographical areas for fish exist, including Ningaloo Marine Park, Montebello/Barrow Island Marine Park, Abrolhos Marine Park and the Rowley Shoals.

5.1.1 Southwest Shelf Province

At least 150 species have been identified within the capes region as being reef-associated (Hutchins 1994 cited in DEC 2013). Of these, 77% are warm temperate species, 18% are subtropical species and 5% are tropical (DEC 2013).

The most abundant finfish species across the region identified during surveys were the Maori wrasse (*Opthalmolepis lineolatus*), red banded wrasse (*Pseudolabrus biserialis*), McCulloch scalyfin (*Parma mccullochi*), and western king wrasse (*Coris auricularis*). The yellow headed hulafish (*Trachinops noarlungae*), black headed puller (*Chromis klunzingeri*), rough bullseye and common bullseye (*Pempheris multiradiata* and *P. klunzingeri*) were also common at Eagle Bay and Geographe Bay (Westera *et al.* 2007 cited in DEC 2013).

5.1.2 Southwest Shelf Transition

A total of 389 finfish species have been recorded at the Abrolhos (DoF 2012). The Abrolhos and their surrounding coral and limestone reef systems consist of a combination of abundant temperate macroalgae with coral reefs, supporting substantial populations of large species such as baldchin groper and coral trout. Some of the species occurring in the Abrolhos are dependent on larvae carried southward by the Leeuwin

[2] Conservation dependent species are listed species under the EPBC Act and are considered as part of the Commonwealth marine area.

Current from areas further north, such as Shark Bay or Ningaloo Reef. Similarly, populations of some of the species occurring at Rottnest Island are dependent on larvae generated from breeding populations at the Abrolhos (DoF 2012).

More than 20 species of sharks have been identified at the Abrolhos (DoF 2012). These sharks include:

+ Port Jackson sharks (*Heterodontus portusjacksoni*);
+ Tiger shark (*Galeocerdo cuvier*);
+ Whaler sharks (*Carcharhinus brachyurus*); and
+ Wobbegongs (*Orectolobus maculatus*).

Abrolhos waters are considered to be an important food source for sharks, due to the resident fish populations. Various species of rays have been recorded at the Abrolhos. These include the manta ray and the white spotted eagle ray (DoF 2012).

5.1.3 Central Western Province

The Perth Canyon appears to be an important ecological feature attracting krill and fish aggregations that in turn attract larger species such as predatory fish and pygmy blue whales (DSEWPaC 2012). Demersal slope fish assemblages in this bioregion are characterised by high species diversity. Scientists have described 480 species of demersal fish that inhabit the slope of this bioregion and 31 of these are considered endemic to the bioregion. Demersal fish on the slope in this bioregion in particular have high species diversity compared with other more intensively sampled oceanic regions of the world. Below 400 m water depth demersal fish communities are characterised by a diverse assemblage where relatively small, benthic species (grenadiers, dogfish and cucumber fish) dominate.

5.1.4 Central Western Shelf Province

The Central Western Shelf Province is located near Shark Bay and is the northern limit of a transition region between temperate and tropical marine fauna. Of the 323 fish species recorded from Shark Bay, 83% are tropical species with 11% warm temperate and 6% cool temperate species (CALM 1996).

5.1.5 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, in 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, 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 9.2**).

5.1.6 Central Western Transition

The biological communities of the Central Western Transition are thought to be distinctive owing to the proximity of deep oceans areas to the continental slope and shelf, resulting in close interaction between pelagic species of the Cuvier Abyssal Plain and those of the slope and shelf (DEWHA 2008a).

The present level of understanding of the marine environment in this bioregion is generally poor. The diversity of fish and cephalopod species changes with depth, generally decreasing species numbers with increasing depth. The demersal slope fish bioregionalisation identified some endemism in communities in this bioregion (Last *et al*. 2005), however, it is lower than other areas of the North-west Marine Region (DEWHA 2008a).

Bentho-pelagic fish, such as deep-water snappers (e.g. *Paracaesio* spp, and *Eletis* spp.), hatchetfish (*Argyropelecus* spp.), dragonfish (*Melacosteus* spp.), viperfish (*Chauliodus* spp.) and a number of eels species migrate between the benthic and pelagic systems, forming an important link between these systems (DEWHA 2008a).

Transient fish species through the Central Western Transition bioregion include southern bluefin tuna (migrating to and from spawning grounds), broadbill swordfish (*Xiphius gladius*), bigeye tuna (*Thunnus obesus*), yellowfin tuna (*Thunnus albacares*) and striped marlin (*Tetrapturus audax*). Pelagic sharks also range across the bioregion following schools of pelagic fish (DEWHA 2008a).

5.1.7 Northwest Shelf Province and Northwest Province

The demersal zone of the North West Shelf (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 and 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*), freshwater sawfish (*Pristis pristis*) and narrow sawfish (*Anoxypristis cuspidate*).

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 NWMR. 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 North West Shelf 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 North West Shelf 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).

5.1.8 Northwest Shelf Transition

Creek systems, mangroves and rivers, and ocean beaches within this region provide habitat for a variety of species including barramundi, tropical emperors, mangrove jack, trevallies, sooty grunter, threadfin and cods (Fletcher and Santoro 2013). The offshore atolls and the continental shelf waters in the Northwest Shelf Transition are also geographically important for fish species. They support species of recreational and commercial interest, including saddle-tail snapper and red emperor, cods, coral and coronation trout, sharks, trevally, tuskfish, tunas, mackerels and billfish (Gaughan et al. 2019).

The Rowley Shoals within the Northwest Shelf Transition comprise three oceanic reef systems approximately 30–40 km apart, namely Mermaid Reef, Clerke Reef and Imperieuse Reef. The Shoals are thought to provide a source of invertebrate and fish recruits for reefs further south and as such are regionally significant (DEC 2007b). See **Section 11** on State Marine Parks and Nature Reserves for further details on important geographical areas for fish.

5.1.9 Northwest Transition

The Northwest Transition bioregion may support sparse populations of bentho-pelagic fish and cephalopods in low densities. Pelagic fish species likely to be present include grenadiers and hatchetfish (*Argyropelecus* spp.) as well as transient populations of highly mobile pelagic fish. Adult and juvenile southern bluefin tuna are through to migrate through this bioregion on their way to and from spawning grounds in the north-eastern Indian Ocean (DEWHA 2008a).

The slope habitat of this bioregion is associated with important populations of demersal fish species and supports the second richest demersal fish assemblage nationally (Last *et al*. 2005). Over 508 fish species have been identified on the slope in this area and 64 of these species are endemic. The high diversity and endemism of the demersal fish fauna indicates important interactions between physical processes and trophic structures in this bioregion. For more information on the slope habitat for fish and sharks, refer to **Section 10.1.18**.

The Rowley Shoals within the Northwest Transition comprise three oceanic reef systems approximately 30–40 km apart, namely Mermaid Reef, Clerke Reef and Imperieuse Reef. The Shoals are thought to provide a source of invertebrate and fish recruits for reefs further south and as such are regionally significant (DEC 2007b).

5.1.10 Timor Province

The diversity of demersal fish assemblages on the continental slope in the Timor Province (as well as the Northwest Transition and the Northwest Province) is high compared to elsewhere along the Australian continental slope (DSEWPaC 2012). Elements of the Timor Province are not well known, due to limited survey data in the northern limits of the region. The province is geographically extensive and includes 418 fish species, 64 of which are endemic to the region (Last *et al.* 2009). Key indicator species include *Bembrops nelsoni*, *Bythaelurus* sp., *Halicmetus* sp., *Malthopsis* spp, *Neobythites australiensis*, *Nobythites bimaculatus*, *Neobythites macrops*, *Neobythites soelae*, *Parapterygotrigla* sp., *Physiculus roseus* (Last *et al.* 2005).

Scott and Seringapatam Reefs are regionally important for the diversity of their fauna, including 558 fish species (Department of the Environment (DoE) 2014). Scott Reef has enormous habitat diversity and is considered a hot spot for fish, with five endemic species (DoE 2014). Scott Reef has biogeographic significance due to the presence of species which are at or close to the limits of their geographic ranges, including fish known previously only from Indonesian waters such as cardinalfish, azure damselfish (*Chrysoptera hemicyanea*), comb-tooth blenny (*Escnius schroederi*) and several Gobiids (DoE 2014).

The diversity of fish at Ashmore Reef is also higher than other comparable reefs in the bioregion with over 760 species recorded (Russell *et al.* 2005, Kospartov *et al.* 2006. The majority of fish species are shallow water, benthic taxa that typically inhabit depths down to 100 m and are widely distributed throughout the Indo-West Pacific (Russell *et al.* 2005). The most species rich groups are gobies (Gobiidae), damselfishes (Pomacentridae), wrasses (Labridae), cardinal fishes (Apogonidae), moray eels (Muraenidae), butterflyfishes (Chaetodontidae), and rockcods and groupers (Serranidae) (Allen 1989, Russell *et al*. 2005).

5.1.11 Christmas Island Province

The Christmas Island Province is in deep, offshore waters (2,200 m – 6,000 m depth range). These waters provide habitat for pelagic finfish species including tuna (*Thunnus* sp.) and wahoo (*Acanthocybium solandri*), and some demersal species such as ruby snapper (*Etelis carbunculus*).

Table 5-2: Spawning and aggregation times of key commercially caught fish species within the North West Shelf

Species		Month											
Species Common Name	**Species Latin Name**	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Blacktip shark	*Carcharhinus tilstoni* and *C. limbatus*												
Goldband snapper	*Pristipomoides multidens*												
Rankin cod	*Epinephelus multinotatus*												
Red emperor	*Lutjanus sebae*												
Sandbar shark	*Carcharhinus plumbeus*												
Spanish mackerel	*Scomberomorus commerson*												
Pink snapper	*Pagrus auratus*												
Baldchin groper	*Choerodon rubescens*												
Crystal (snow) crab	*Chaceon spp.*												
King George whiting	*Sillaginodes punctate*												
Spangled emperor	*Lethrinus nebulosus*												
Pearl oyster	*Pinctada maxima*												
Blue-spotted emperor	*Charaxes cithaeron*												
Dusky whaler	*Carcharhinus obscurus*	May occur throughout the year											
Whiskery shark	*Furgaleus macki*												
Gummy shark	*Mustelus antarcticus*	Peak pupping periods unknown											
Fish	other species	Timing of spawning activity varies between species											

5.2 Fish Species

Four species of fish listed as Threatened under the EPBC Act (**Table 5-5-1**) were identified in the Protected Matters search (**Appendix A**):

- Balston's pygmy perch (*Nannatherina balstoni*);
- Black-stripe minnow (*Galaxiella nigrostriata*);
- Blind gudgeon (*Milyeringa veritas*); and
- Blind cave eel (*Ophisternon candidum*).

In addition the Barrow cave gudgeon *(Milyeringa justitia*) has been identified as relevant threatened species under the BC Act. 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 Barrow cave gudgeon is listed as Vulnerable under the WA BC Act. 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 Black-stripe minnow

The black-stripe minnow inhabits coastal wetlands of south-west WA between Augusta and Albany. During summer when ephemeral pools dry out, individuals burrow into the moist soil below to aestivate until the rains return in autumn (Bray and Gomon 2017). The Conservation Advice for black-striped minnow in Australia (2018) updated the species listing to endangered status. The species is not expected to occur in significant numbers in marine and coastal environments in the EMBA due to their freshwater distribution, but they may be vulnerable to inflows from permanent rivers and streams (DoE 2018).

5.2.3 Syngnathids

The EPBC Protected Matters search also identified 72 '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, although no species is currently listed as threatened or migratory.

5.3 Sharks, Rays and Sawfishes

The diversity of marine environments in the waters within the NWMR 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 2008a). The EPBC Act Protected Matters search (**Appendix A**) identified four species of shark, and three species of sawfishes listed as threatened within the search area between south west WA and NT border (**Table 5-5-1**), 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 oceanic whitetip shark (*Carcharhinus longimanus*), the narrow sawfish (*Anoxypristis cuspidate*), two species of ray, the reef manta ray (*Manta alfredi*) and giant manta ray (*Manta birostris*), the porbeagle (*Lamna nasus*) and the longfin (*Isurus paucus*) and shortfin (*Isurus oxyrinchus*) mako sharks are listed as migratory within the search area (**Table 5-5-1).**

The Biologically Important Areas (BIAs) for relevant species detailed above are illustrated in **Figure 5-1, Figure 5-2** and **Figure 5-3**.

5.3.1 Grey Nurse Shark

The grey nurse shark (*Carcharias taurus*) is listed as vulnerable under the EPBC Act and the BC Act, and may be found within the EMBA. 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 EMBA.

5.3.2 Great 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 BC Act. 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 North West Shelf waters during humpback migrations (DEWHA 2012b). 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 EMBA are detailed in **Table 5-3** and is shown on **Figure 5-1** (DoEE 2019b).

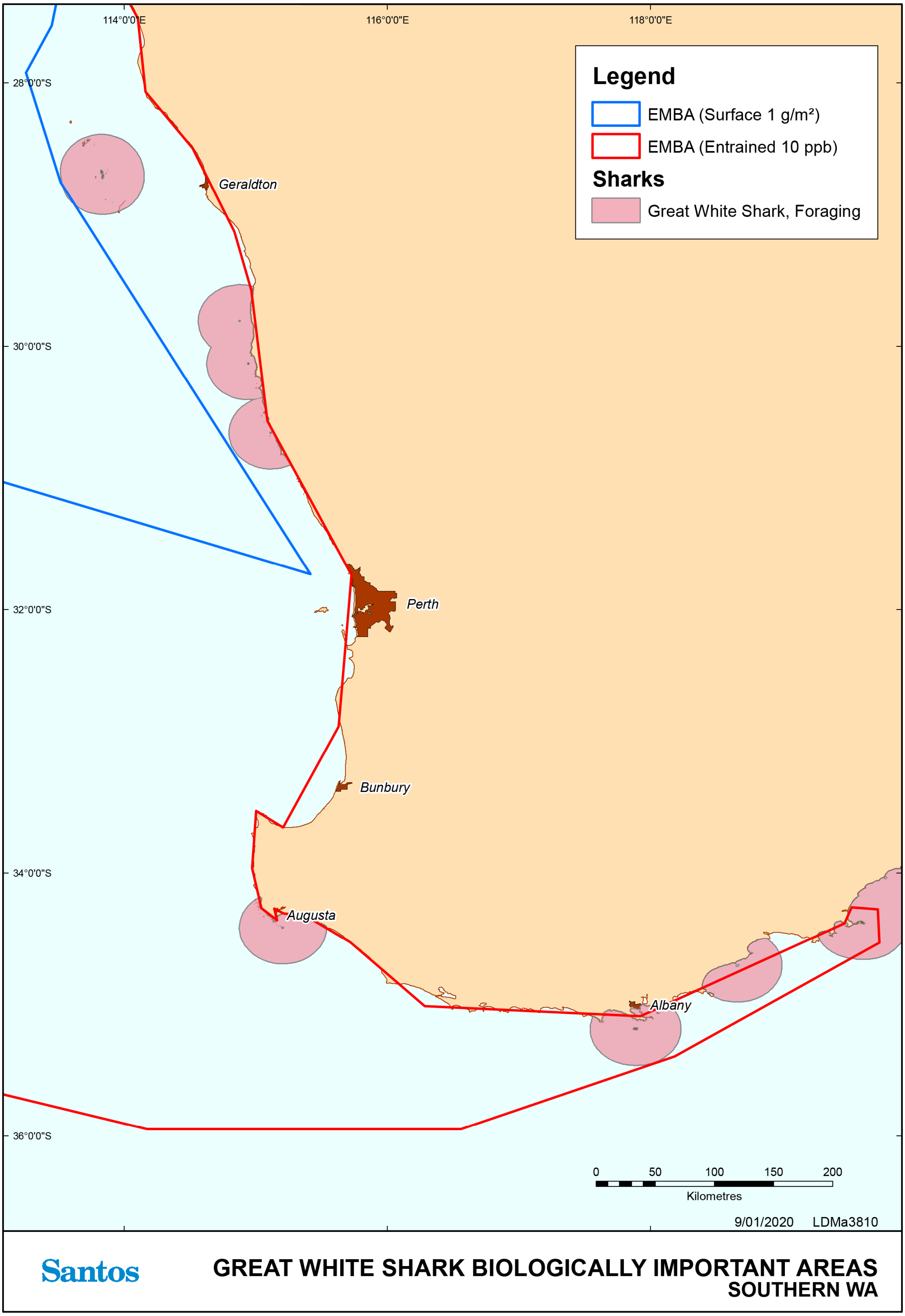


Figure 5-1: Biologically important area – great white shark

5.3.3 Northern River Shark

The northern river shark (*Glyphis garricki*) is listed as endangered under the EPBC Act and is one of the rarest species of shark in the world. Adults only recorded in marine habitats, whereas neonates, juveniles and subadults recorded in freshwater, estuarine and marine environments. It is also listed as a Priority 1 conservation species in WA.

The associated recovery plan (Sawfish and River Sharks Multispecies Recovery Plan, Commonwealth of Australia 2015) identifies adults and juveniles are being known in WA marine waters north of Derby. Pupping and juvenile sharks are identified as known to occur in Cambridge Gulf and pupping is also identified as likely to occur in King Sound. 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.

5.3.4 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 BC Act as a species of special conservation interest (conservation dependent fauna). The species is also classified as vulnerable on the World Conservation Union's Red List of Threatened Species (Norman 2005) and are protected under the WA *Conservation and Land Management Act 1984* and WA *Fish Resources Management Act 1994*.

The whale shark 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 (Clark 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*. 2006, 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 $4 million 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).

Whale sharks are known to be highly migratory with migrations of 13,000 km being recorded (Eckert and Stewart 2001). 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 North West Shelf. 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'' offshore oil and gas facilities on the North West Shelf (Harriet Alpha and Stag platforms). In general, migration along the northern WA coastline broadly follows the 200 m isobath and typically occurs between July and November (DoE 2015).

A biologically important area for whale sharks is located in northern WA, offshore of the Pilbara and Kimberley coastline, and broadly follows the 200 m isobath The relevant whale shark BIAs in the EMBA are detailed in **Table 5-3** and is shown on **Figure 5-2**.

DBCA has a wildlife management program to manage whale shark interactions in reserves - *Whale shark management with particular reference to Ningaloo Marine Park, Wildlife Management Program no. 57 (2013).*

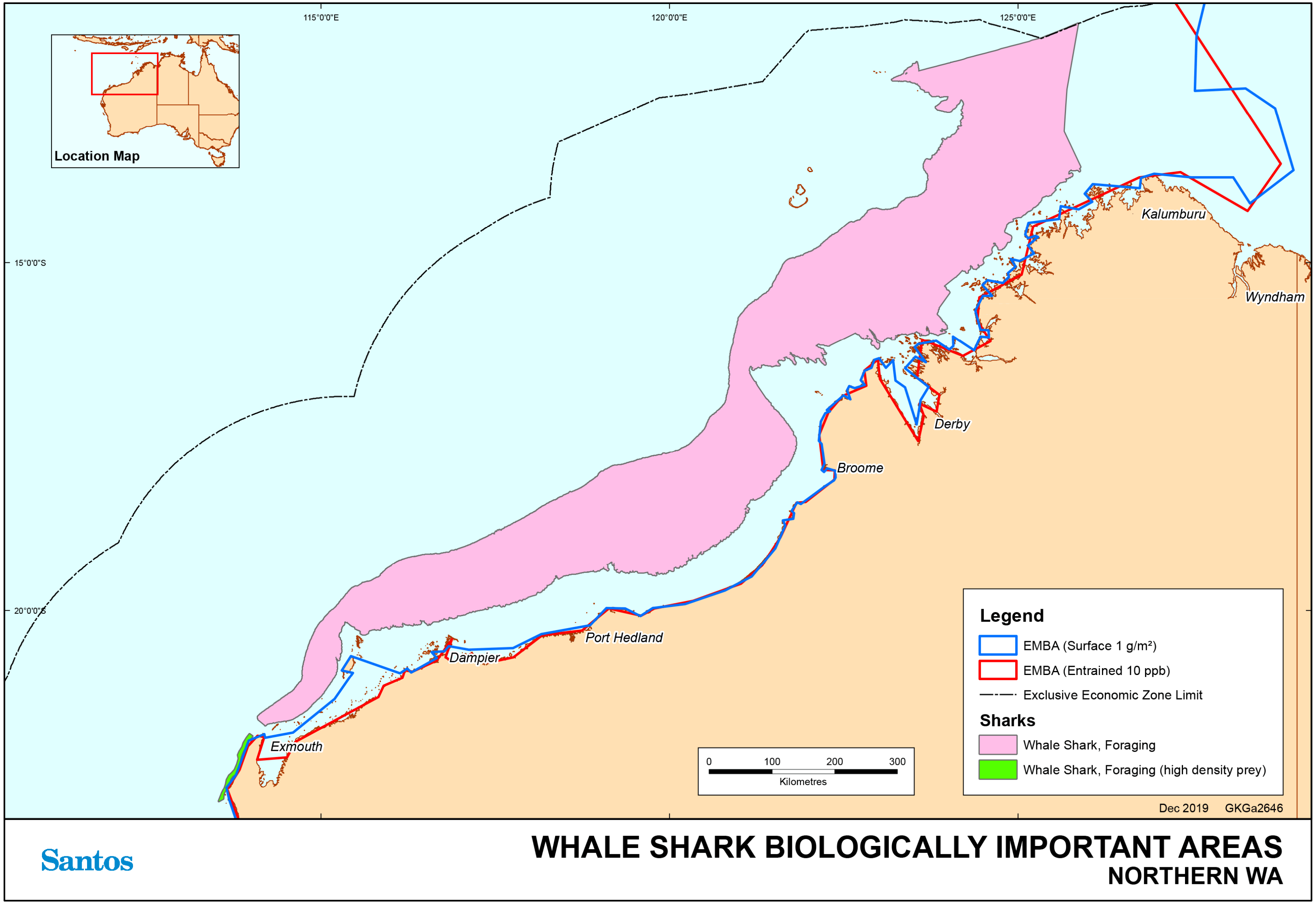


Figure 5-2: Biologically important area – whale shark

5.3.5 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 (Commonwealth of Australia, 2015). 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 EMBA are detailed in **Table 5-3** and are shown on **Figure 5-3**.

5.3.6 Freshwater and 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 3 conservation species in WA, while the green sawfish is listed as Vulnerable under the BC Act.

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).

Baseline surveys undertaken for Chevron's Wheatstone project identified green sawfish habitat and nursery area for juveniles within the north-eastern lagoon of the Ashburton Delta and in Hooley Creek near Onslow. Distribution of sawfish in these creeks is spatially and seasonally variable due to changing tidal and environmental conditions. However, they typically return to inshore waters to breed and pup during the wet season (i.e. January) (Chevron 2011).

The relevant sawfish BIAs in the EMBA are detailed in **Table 5-3** and are shown on **Figure 5-3**.

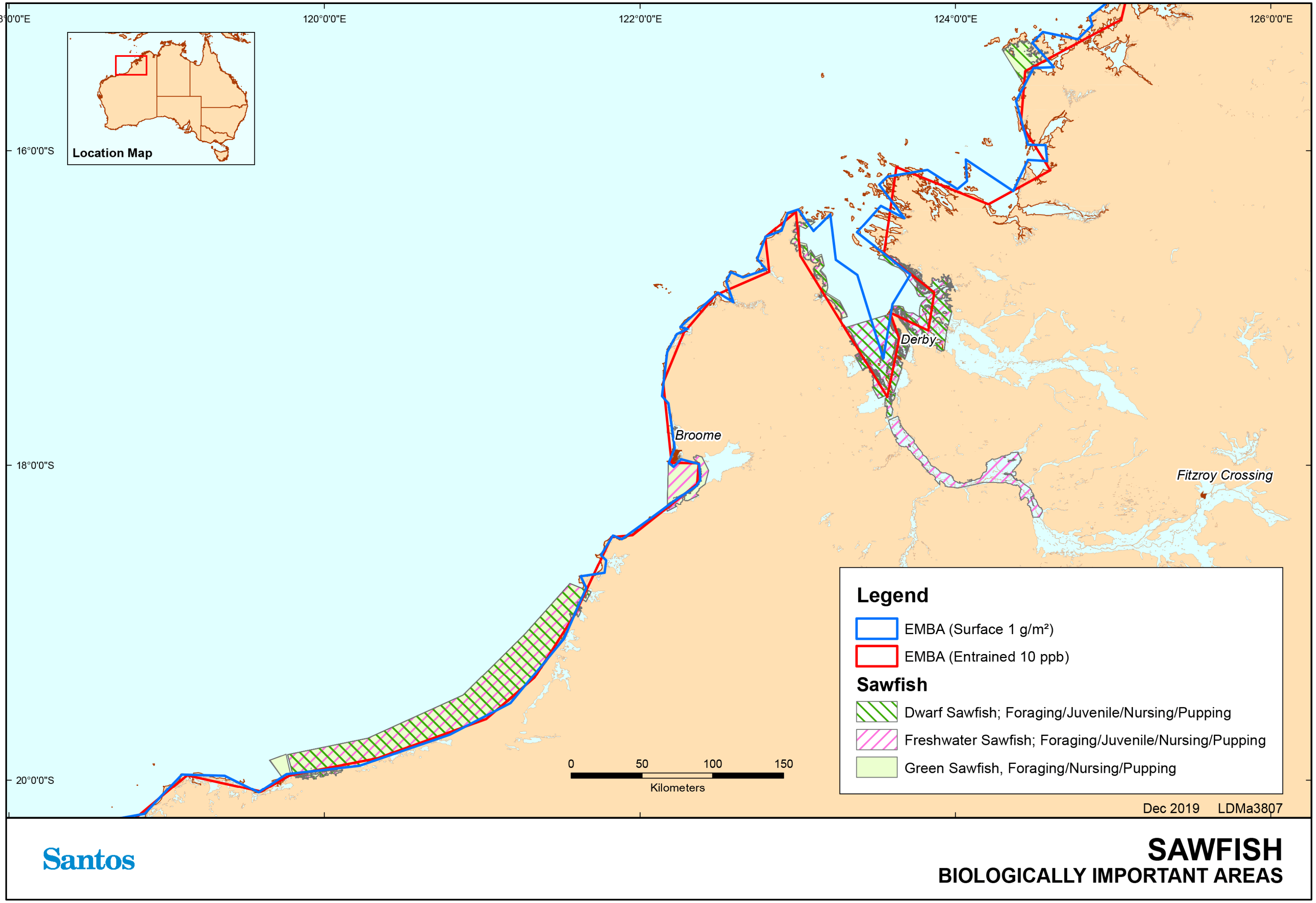


Figure 5-3: Biologically important areas – sawfish

5.3.7 Narrow Sawfish

The narrow sawfish (*Anoxypristis cuspidata*) 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).

5.3.8 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 2019).

The giant manta ray (*Mobula birostris*) 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 2019).

The reef manta ray (*Mobula birostris*) 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 2019). Since the species is migratory it is possible that individuals may be encountered in the operational area, however, given that they generally do not aggregate in large groups, high numbers are not expected to be encountered during the activities.

5.3.9 Oceanic Whitetip Shark

The oceanic whitetip shark (*Carcharhinus longimanus*) is listed as migratory under the EPBC Act. The oceanic whitetip shark is widespread throughout tropical and subtropical waters of the world (30° N to 35° S) (IUCN 2020). They are an oceanic and pelagic species that regularly occurs in waters of 18 to 28°C, usually >20°C (IUCN 2020). Within Australian waters, they are found from Cape Leeuwin (Western Australia) through parts of the Northern Territory, down the east coast of Queensland and New South Wales to Sydney (Last and Stevens 2009). They are usually found in surface waters, though can reach depths of >180 m (Castro et al. 1999). They have occasionally been recorded inshore but are more typically found offshore or around oceanic islands and areas with narrow continental shelves (Fourmanoir 1961, Last and Stevens 1994).

5.3.10 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.

5.3.11 Porbeagle (Mackerel Shark)

The porbeagle (mackerel shark) (*Lamna nasus*) is listed as migratory under the EPBC Act. The porbeagle is wide-ranging, typically occurring in oceanic waters off the continental shelf, although they occasionally enter coastal waters (Francis *et al*. 2002 cited in DoE 2014e). The porbeagle is known to undertake seasonal migrations, although the timing and details of these migratory movements are not well understood (Saunders *et al.* 2011 cited in DoE 2014e).

5.4 Biologically Important Areas / Critical Habitat – Fish

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**.** BIAs are identified by DAWE, however, 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 5-3** below provides an overview of BIAs in the EMBA for fish.

The DAWE may make recovery plans for threatened 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, and summary of relevant recovery plans is listed in **Section 13.2**. BIAs may overlap these sites, but may be identified for other purposes. DAWE state that the criteria used to identify 'habitat critical to the survival of the species' are more complex than those used to identify BIA. Specifically, the Sawfish and River Sharks Multispecies Recovery Plan (DoEE 2015) cites that *"all areas where aggregations of individuals have been recorded displaying biologically important behaviour such as breeding, foraging, resting or migrating, are considered critical to the survival of the species unless population survey data suggests otherwise"*.

In addition, both the EPBC Act and WA BC Act 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.

Table 5-3: 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 and waters off Bremer Bay	Waters off pinniped colonies throughout the South-west Marine Region Waters off Bremer Bay
Whale shark	*Rhincodon typus*	Foraging (high density prey) – Ningaloo Reef Foraging – Wider Ningaloo Region	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 and May Robinson River Pupping – Eighty Mile Beach, King Sound, Fitzroy River and May Robinson River	Eighty Mile Beach Camden Sound - eastern shore Fitzroy River Mouth, May and Robinson River - tidal tributaries King Sound (inshore waters)

Species	Scientific name	Aggregation area and use	Specific geographic locations for species
		Juvenile – King Sound, Fitzroy River and May Robinson River	
Freshwater sawfish	*Pristis pristis*	Nursing – King Sound Foraging – King Sound, Roebuck Bay, Eighty Mile Beach Pupping – Roebuck Bay, Eighty Mile Beach Juvenile – Roebuck Bay	Eighty Mile Beach King Sound - tidal tributaries Roebuck Bay
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, Ashburton River and Hooley Creek near Onslow	Eighty Mile Beach Camden Sound Cape Keraudren Cape Leveque Roebuck Bay Willie Creek Ashburton River Hooley Creek

Santos

6. Marine Reptiles

Thirty-three species of listed marine reptiles under the Commonwealth EPBC Act are known to occur in Australian waters in the EMBA, according to the Protected Matters search (**Appendix A**). An examination of the species profile and threats database (DoEE 2019) showed that some listed reptile species are not expected to occur in significant numbers in the marine and coastal environments in the EMBA due to their terrestrial distributions. Hence, these species are not discussed further.

Of the remaining reptile species identified in the Protected Matters search (**Appendix A**), eight are listed as threatened and seven are listed as migratory. These species are show in **Table 6-1** along with their WA conservation listing (as applicable)[3]. BIAs within the EMBA area discussed in **Table 6-3**.

Table 6-1: EPBC listed marine reptile species in the EMBA

Species	Conservation Status			Likelihood of occurrence in EMBA	BIA in EMBA
	EPBC Act 1999	BC Act 2016	Other WA Conservation Code		
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 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	None - No BIA defined

[3] An overview of WA fauna conservation codes is provided in **Section 5** (fish and sharks).

Species	Conservation Status			Likelihood of occurrence in EMBA	BIA in EMBA
	EPBC Act 1999	BC Act 2016	Other WA Conservation Code		
				occur within area	
Leaf-scaled seasnake (*Aipysurus foliosquama*)	Critically Endangered	Critically Endangered	-	Species or species habitat known to occur within area	None - No BIA defined

6.1 Marine Turtles

Six species of marine turtle occur in, use the waters, and nest on sandy beaches, in WA. 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 BC Act.

A summary of the different habitat types used during the various life stages of marine turtle species identified in the EMBA 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 EMBA (DSEWPaC, 2012b)

Life Stage		Green turtle	Flatback turtle	Hawksbill turtle	Loggerhead turtle	Olive ridley 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 (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.	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.	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 kilometres of nesting beach. Inter-nesting buffers of 20 km identified around all nesting habitats.	Shallow coastal waters within several kilometres of nesting beach. Inter-nesting buffers of 20 km identified around all nesting habitats.	Not recorded within North West Shelf region. 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.	Many feed within continental shelf waters, however it is not known if others are pelagic, as with the east Pacific population.	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 2008b). 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 2008b). Loggerhead turtles have one genetic breeding stock within Western Australia (Commonwealth of Australia 2017a).

The WA distribution of sandy beach nesting areas extends from Shark Bay to the southern area of the North West Shelf, with occasional late summer nesting crawls recorded as far north as Barrow and Varanus Islands 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 internesting 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 (Commonwealth of Australia 2017a).

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 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 2008b).

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 2008b). Shark Bay has been identified as an important foraging habitat for loggerhead turtles (Commonwealth of Australia 2017a). 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 2008b).

Figure 6-1 illustrates the BIAs and habitat critical (draft) for loggerhead turtles (as defined in the Recovery Plan for Marine Turtles in Australia (Commonwealth of Australia 2017a).

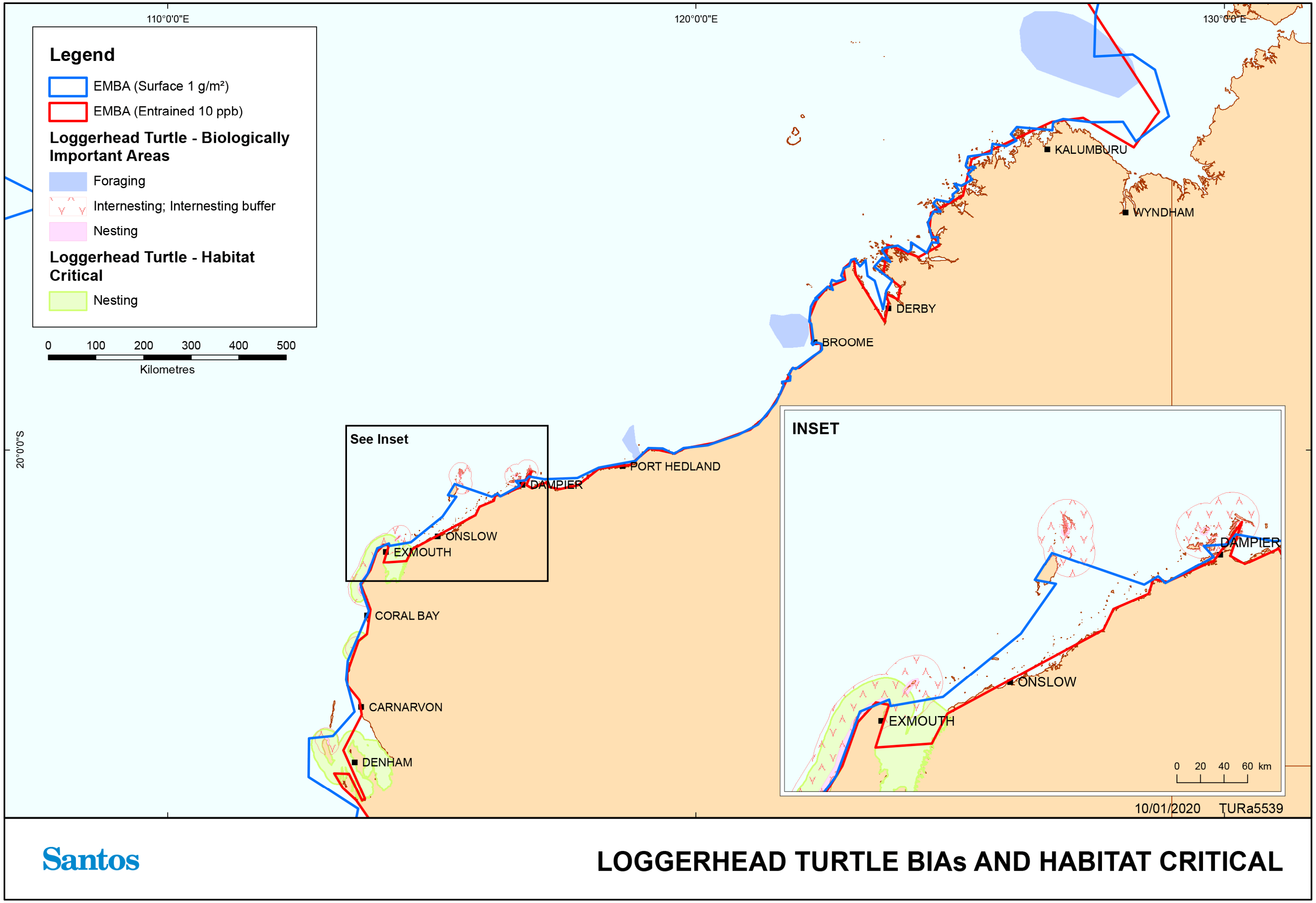


Figure 6-1: Biologically Important Areas and Habitat Critical – Loggerhead Turtle

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 2008a). There are three distinct breeding stocks in WA waters which include: the North west Shelf stock, the Scott-Browse stock and the Ashmore Stock (Commonwealth of Australia 2017a).

The North west Shelf 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 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 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 2017a). 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 2,600 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 offshore waters due to the water depths; however, they may occasionally migrate through it.

Figure 6-2 illustrates the BIAs and habitat critical (draft) for green turtles (as defined in the Recovery Plan for Marine Turtles in Australia (Commonwealth of Australia 2017a).

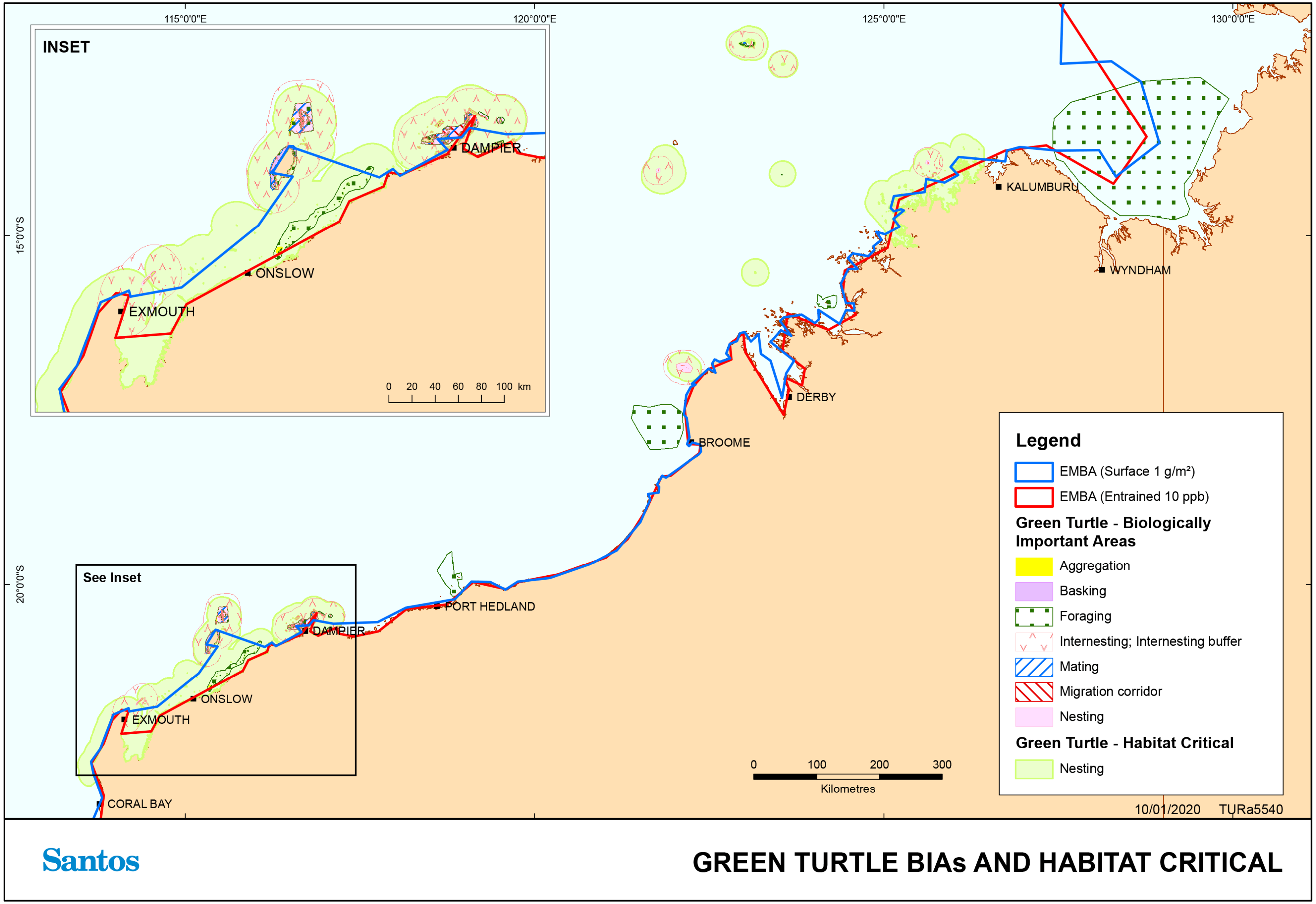


Figure 6-2: Biologically Important Areas and Habitat Critical – Green Turtle

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 North West Shelf (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 North West Shelf 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 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, hawksbill turtle nesting activity is predominantly distributed on the island's east coast, including Pipeline, Harriet, and Andersons beaches (Pendoley Environmental 2019). Individual hawksbill turtles appear to show a strong fidelity to these beaches, often returning to the same beach to nest within the season (Pendoley Environmental 2019). Between 1986 and 2019, a total of 571 individual hawksbill turtles were tagged on Varanus Island.

Nesting is reported to occur between October and February in WA (Commonwealth of Australia 2017a). Hawksbill turtles have been observed breeding on the North West Shelf 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 offshore 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 habitat critical (draft) for hawksbill and olive ridley turtles (as defined in the Recovery Plan for Marine Turtles in Australia (Commonwealth of Australia 2017a).

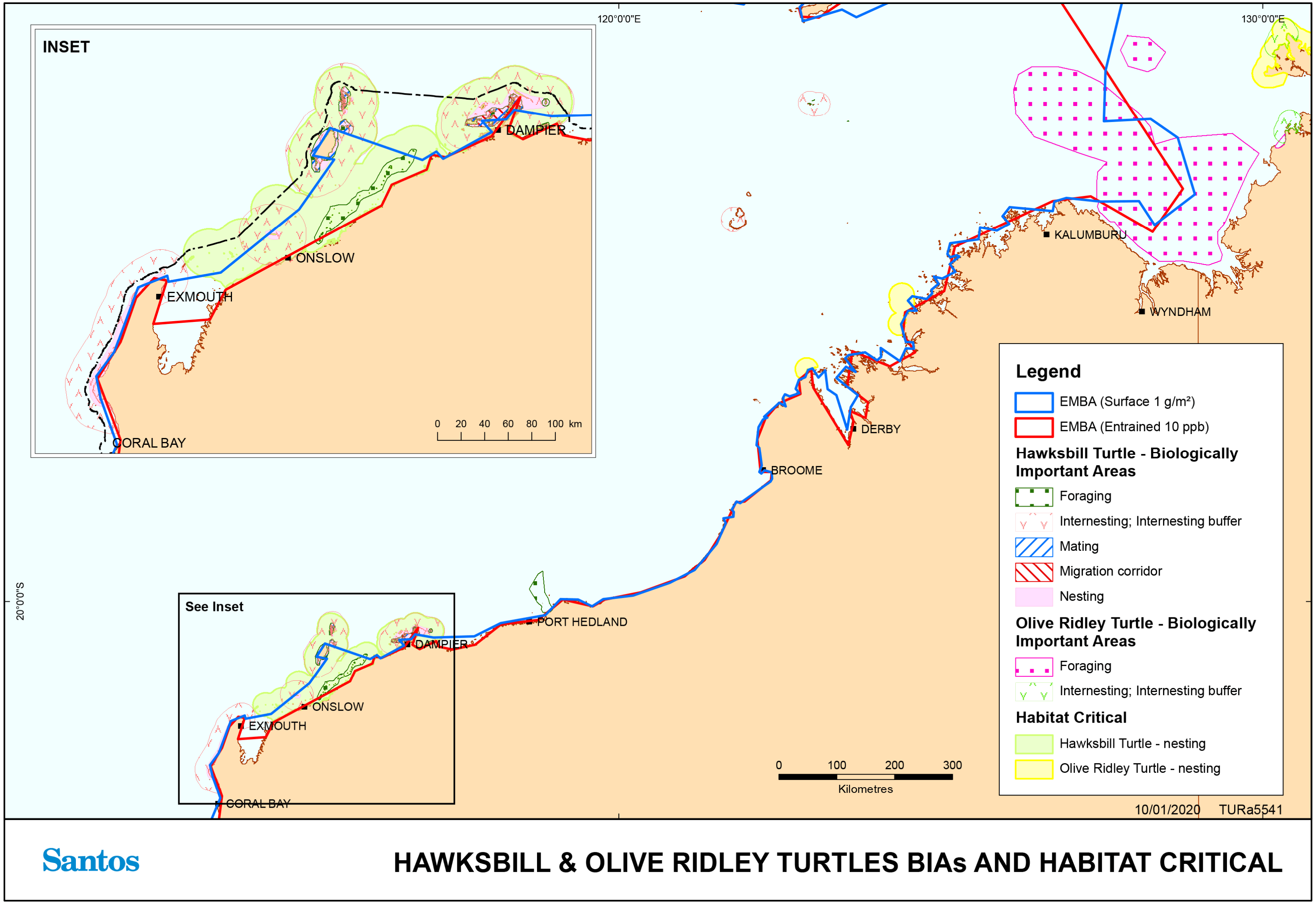


Figure 6-3: Biologically Important Areas and Habitat Critical – Hawksbill and Olive Ridley Turtle

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 five stocks currently described around Australia; eastern Queensland, Arafura Sea, Cape Domett, South-west Kimberley and Pilbara stocks (Commonwealth of Australia 2017). The Pilbara stock nests throughout the North West Shelf and is characterised by summer nesting (October to March), and the northern stock at Cape Domett breeds mainly in winter (July to September) (Commonwealth of Australia 2017a). The South-west Kimberley stock is also characterised by summer nesting.

The southern WA nesting population of flatback turtles occurs from Exmouth to the Lacepede Islands off the Kimberley coast (DSEWPaC 2012c). On the North West Shelf, 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).

Long term monitoring of flatback turtles nesting in the Port Hedland area, specifically at Cemetery Beach and Pretty Pool Beach, was undertaken between 2004 and 2014. Monitoring results indicated the main nesting season of flatback turtles in the area was between mid-October and January, which is consistent with other rookeries in the Pilbara region including Barrow Island, Mundabullangana, Karratha and Onslow (Waayers and Stubbs 2016). The onset of the nesting season appears to be relatively consistent each year and is thought to be associated with the southern movement of warmer sea surface temperatures along the northern WA coast.

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 Hedland 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 appears 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 2017a).

Figure 6-4 illustrates the BIAs and habitat critical (draft) for flatback turtles (as defined in the Recovery Plan for Marine Turtles in Australia (Commonwealth of Australia 2017a).

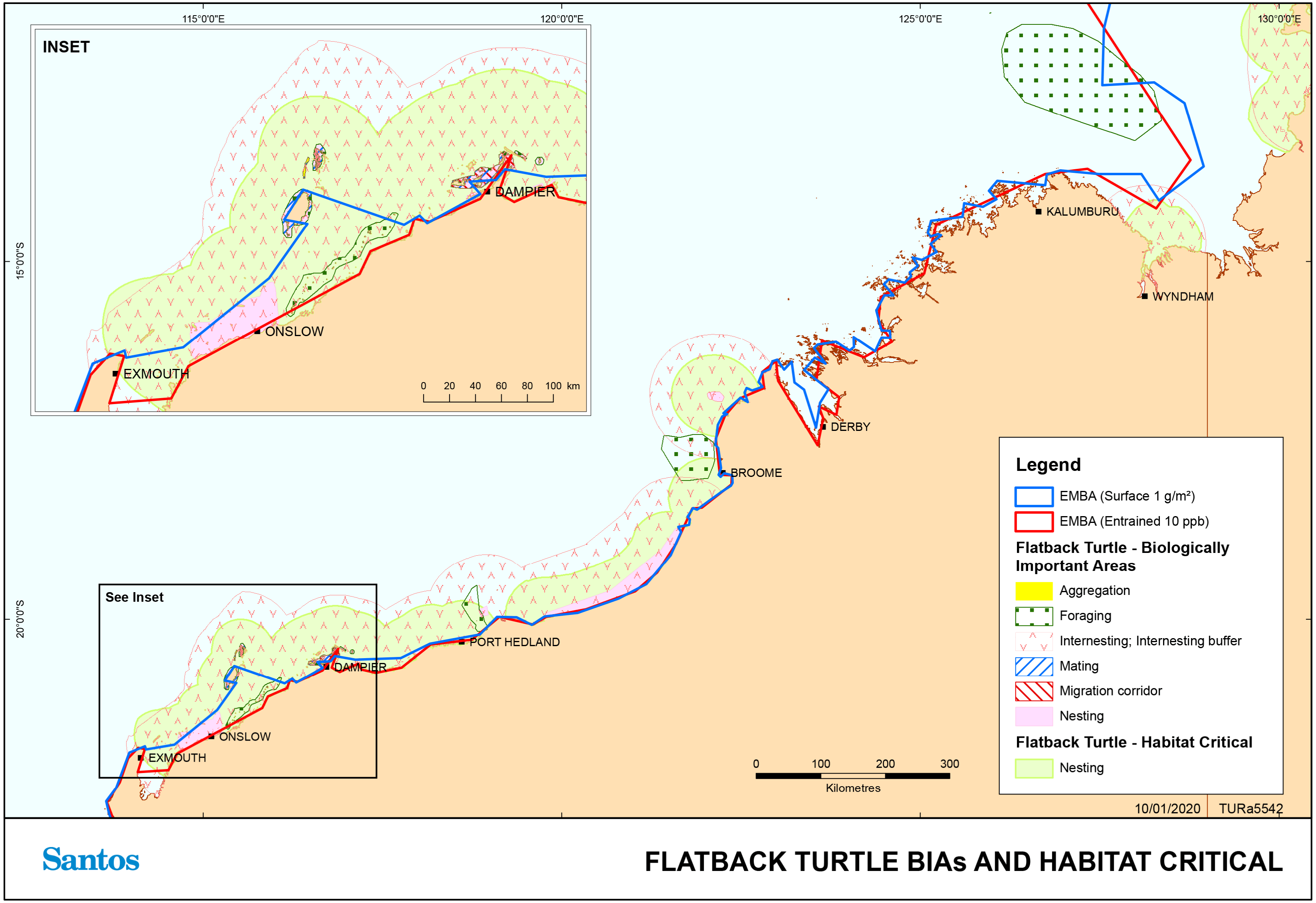


Figure 6-4: Biologically Important Areas and Habitat Critical – Flatback Turtle

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 the coast of WA, but no confirmed nesting sites (Limpus 2009c). Turtle observations have mainly occurred south of the North West Shelf area and in open waters (>200 m deep) (Limpus 2009c). 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 2009c).

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 habitat critical (draft) are found within the EMBA.

6.1.6 Olive Ridley Turtles

Olive ridley turtles (*Lepidochelys olivacea*) are the least common turtle species encountered with critical nesting habitat occurring near Vulcan Island, Darcy Island, Prior Point and Llanggi and Cape Leveque (Commonwealth of Australia 2017). This species forages within the shallow benthic habitats of northern Western Australia and is thought to feed primarily on gastropods and small crabs within the benthic, soft-bottomed communities of the continental shelf (Limpus 2009). Olive Ridley turtles forage as far south as the Dampier Archipelago-Montebello Islands.

BIAs for this endangered species are known to occur in the vicinity of Joseph Bonaparte Depression (DSEWPaC 2012b, Commonwealth of Australia 2017a). See **Figure 6-3** for identified olive ridley turtle BIAs and critical habitats (draft) within the EMBA (as defined in the Recovery Plan for Marine Turtles in Australia (Commonwealth of Australia 2017a).

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. Seasnakes 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). Seasnakes are widespread throughout waters of the North West Shelf 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 seasnakes. However, both Ashmore Reef and Cartier Island are characterised for both a high density and high diversity of seasnakes (DSEWPaC 2012b).

Two species of seasnakes listed as threatened under the EPBC Act were identified in the Protected Matters search within the EMBA (**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 BC Act. 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 offshore, deeper waters.

6.2.2 Leaf-scaled Seasnake

The leaf-scaled seasnake *(Aipysurus foliosquama)* is listed as critically endangered under the EPBC Act and the BC Act. It occurs in shallow water (less than 10 m in depth), in the protected parts of the reef flat, adjacent to living coral and on coral substrates (DoE 2014). The species is found only on the reefs of the Sahul Shelf in WA, especially on Ashmore and Hibernia Reefs (Minton and Heatwole 1975). The leaf-scaled seasnake forages by searching in fish burrows on the reef flat (DoE 2014).

6.3 Crocodiles

The salt-water crocodile (*Crocodylus porosus*) is a migratory species under the EPBC Act and is also listed as a specially protected species (other specially protected fauna) under the BC Act. In WA, the species is found in most major river systems of the Kimberley, including the Ord, Patrick, Forrest, Durack, King, Pentecost, Prince Regent, Lawley, Mitchell, Hunter, Roe and Glenelg Rivers. The largest populations occur in the rivers draining into the Cambridge Gulf and the Prince Regent River and Roe River systems. There have also been isolated records in rivers of the Pilbara region, around Derby near Broome and as far south as Carnarvon on the mid-west coast (DEC 2009a).

6.4 Biologically Important Areas/Habitat Critical – Marine Reptiles

Table 6-3 provides an overview of BIAs in the EMBA for marine reptiles, as identified by the DAWE (Commonwealth) and critical habitats identified in associated recovery plans. The DAWE 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 BC Act and associated regulations (2018) provide for the listing of habitat critical - habitat ‘critical to the survival of the threatened species. To date no habitat critical in WA has been listed under either Act.

[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	BIAs within EMBA	Habitat Critical within EMBA
Loggerhead turtle	*Caretta caretta*	Nesting, migration, foraging and internesting – Islands and coastline of the Kimberley region and islands of the North West Shelf, Ningaloo coast and Jurabi coast	Cohen Island De Grey River to Bedout Island Dirk Hartog Island Gnarloo Bay James Price Point Lowendal Island Montebello Island Muiron 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, aggregation, mating, basking 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 Greens - inshore tidal and shallow subtidal areas around Barrow Island Hawksbills - shallow water coral reef and artificial reef (pipeline) habitat James Price Point Joseph Bonaparte Gulf 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	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 Serrier Island and Thevenard Island Exmouth Gulf and Ningaloo Coast

Species	Scientific name	Aggregation area and use	BIAs within EMBA	Habitat Critical within EMBA
			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	
Hawksbill turtle	*Eretmochelys imbricata*	Nesting, migration, mating, 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 Island 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 Delambre Island (and other Dampier Archipelago Islands) Dixon Island 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	Cape Preston to mouth of Exmouth Gulf (including Montebello Islands and Lowendal Islands) Dampier Archipelago (including Delambre Island and Rosemary Island)
Flatback turtle	*Natator depressus*	Nesting, migration, mating, aggregation, foraging, internesting – Islands of the North West	Eighty Mile beach Barrow Island Cape Domett	Cape Domett and Lacrosse Island Lacepede Islands

Species	Scientific name	Aggregation area and use	BIAs within EMBA	Habitat Critical within EMBA
		Shelf and the Pilbara/Kimberley coastlines Mating, nesting – Barrow Island	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 Island Delambre Island Dixon Island Holothuria Zone (Northern Kimberley, Holothuria Banks) 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 approximately 80 km north-north-east of the nearest town, Wyndham. Thevenard Island - South coast West of Cape Lambert Western Joseph Bonaparte Depression	Eighty Mile beach Cemetary beach Eco Beach Mundabullangana Beach Dampier Archipelago Barrow Island, Montebello Island, coastal islands from Cape Preston to Locker Island
Leatherback turtle	*Dermochelys coriacea*	None within EMBA	None within EMBA	None within EMBA

Species	Scientific name	Aggregation area and use	BIAs within EMBA	Habitat Critical within EMBA
Olive ridley turtle	*Lepidochelys olivacea*	Foraging, migration – Joseph Bonaparte Gulf – Kimberley region	Western Joseph Bonaparte Depression	Cape Leveque Prior Point and Llanggi Darcy Island Vulcan Island

Santos

7. Marine Mammals

Forty-four species of listed marine mammals are known to occur in Australian waters in the EMBA, according to the Protected Matters search (**Appendix A**). An examination of the species profile and threats database (DAWE 2020a) showed that some listed mammal species are not expected to occur in significant numbers in the marine and coastal environments in the EMBA 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 EPBC Act (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 BC Act (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**.

Table 7-1: Marine mammals listed as threatened or migratory under the EPBC Act

Species	Conservation Status			Likelihood of occurrence in EMBA	BIA in EMBA
	EPBC Act 1999 (Cwth)	BC Act 2016 (WA)	Other WA Conservation Code		
Sei whale *(Balaenoptera borealis)*	Vulnerable Migratory	Endangered	-	Foraging, feeding or related behaviour likely to occur within area	None - No BIA defined
Blue whale (*Balaenoptera musculus)*	Endangered Migratory	Endangered	-	Foraging, feeding or related behaviour known to occur within area	Yes – Refer to **Table 7-3**
Fin whale (*Balaenoptera physalus)*	Vulnerable Migratory	Endangered	-	Foraging, feeding or related behaviour likely to occur within area	None - No BIA defined
Southern right whale (*Eubalaena australis)*	Endangered Migratory	Vulnerable	-	Breeding known to occur within area	Yes – Refer to **Table 7-3**
Humpback whale (*Megaptera novaeangliae)*	Vulnerable Migratory	Specially protected (special conservation interest)	-	Breeding known to occur within area	Yes – Refer to **Table 7-3**
Sperm whale (*Physeter macrocephalus)*	Migratory	Vulnerable	-	Foraging, feeding or related behaviour known to occur within area	Yes – Refer to **Table 7-3**
Antarctic minke whale *(Balaenoptera bonaerensis)*	Migratory	-	-	Species or species habitat likely to occur within area	None - No BIA defined
Bryde's whale (*Balaenoptera edeni)*	Migratory	-	-	Species or species habitat likely to occur within area	None - No BIA defined
Pygmy right whale (*Caperea marginate)*	Migratory	-	-	Foraging, feeding or related behaviour likely to occur within area	None - No BIA defined
Killer whale (*Orcinus orca)*	Migratory	-	-	Species or species habitat may occur within area	None - No BIA defined

Species	Conservation Status			Likelihood of occurrence in EMBA	BIA in EMBA
	EPBC Act 1999 (Cwth)	BC Act 2016 (WA)	Other WA Conservation Code		
Indo-Pacific humpback dolphin (*Sousa chinensis)*	Migratory	-	-	Breeding known to occur within area	Yes – Refer to **Table 7-3**
Spotted bottlenose dolphin (Arafura/ Timor Sea Populations) *(Tursiops aduncus)*	Migratory	-	-	Species or species habitat likely to occur within area	Yes – Refer to **Table 7-3**
Irrawaddy dolphin (Australian snubfin dolphin) *(Orcaella heinsohni)*	Migratory	-	P4	Species or species habitat known to occur within area	Yes – Refer to **Table 7-3**
Dusky dolphin *(Lagenorhynchus obscurus)*	Migratory	-	-	Species or species habitat likely to occur within area	None - No BIA defined
Australian sea lion (*Neophoca cinerea)*	Vulnerable	Vulnerable	-	Breeding known to occur within area	Yes – Refer to **Table 7-3**
Dugong (*Dugong dugon)*	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 EMBA. The New Zealand fur seal is listed as a protected species under WA BC Act (other specially protected), but not listed as threatened under the EPBC Act.

7.1 Threatened and 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 (DAWE 2020a). There are no known mating or calving areas in Australian waters (Parker 1978 in DAWE 2020a). The National Conservation Values Atlas currently record no BIAs for this species (DAWE 2020b). Surveys of the Bonney Upwelling (outside of the EMBA) between 2000 and 2003 recorded sightings of sei whales feeding during summer and autumn, indicating that this is potentially an important feeding ground (DAWE 2020b).

7.1.2 Blue Whale

Two sub-species 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 2008a). By this definition all blue whales in waters from Busselton to the NT 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 WA migration path takes pygmy blue whales down the WA 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). Tagging data collected by Gales *et al.* (2010) has provided the first definitive link between the blue whales that feed off the Perth Canyon and those that occur around Indonesia. This is movement is concordant with the proposed 'Tasmania to Indonesia' population described by Branch *et al.* (2007).

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*. 2012a, 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*. 2012b). Generally, they appear to travel as individuals or in small groups based on acoustic data. For example, analysis of pygmy blue whale calls from noise loggers deployed around Scott Reef (2006 to 2009) for the Woodside Browse project showed that 78% of the calls were from lone whales, 18% were from two whales and 4% were from three or more whales (McCauley 2011; Woodside 2014).

Pygmy blue whales appear to feed regularly along their migration route (i.e. at least once per week or more frequently) and are likely to have multiple food caches along their migratory route (e.g. Rowley Shoals and Ningaloo Reef) (ConocoPhillips 2018).

Recognised feeding areas of significance to this species, located within the EMBA include Ningaloo Reef and the Perth Canyon (DoE 2015a). 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). Outside of the recognised feeding areas, possible foraging areas for pygmy blue whales include the greater region around the Perth Canyon, off Exmouth and Scott Reef in WA (DoE 2015a). These steep gradient features tend to stimulate upwelling and, therefore increased productivity (seasonally variable) (ConocoPhillips 2018). Hence, they provide a favourable foraging area.

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, DAWE 2020a). There are no known breeding areas of significance to blue whales in waters from Busselton to the NT 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.**

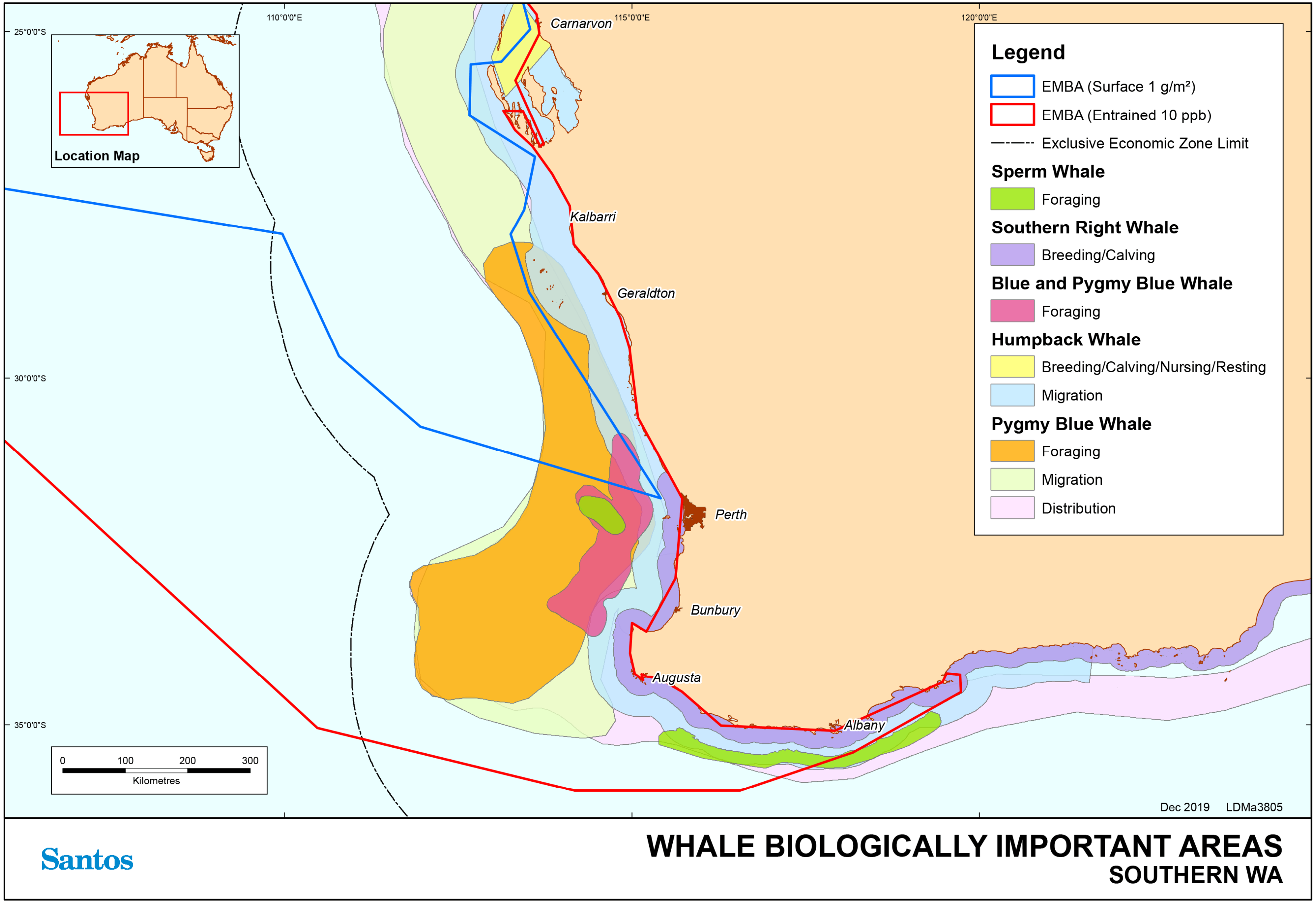


Figure 7-1: Biologically important areas – whales – Southern WA

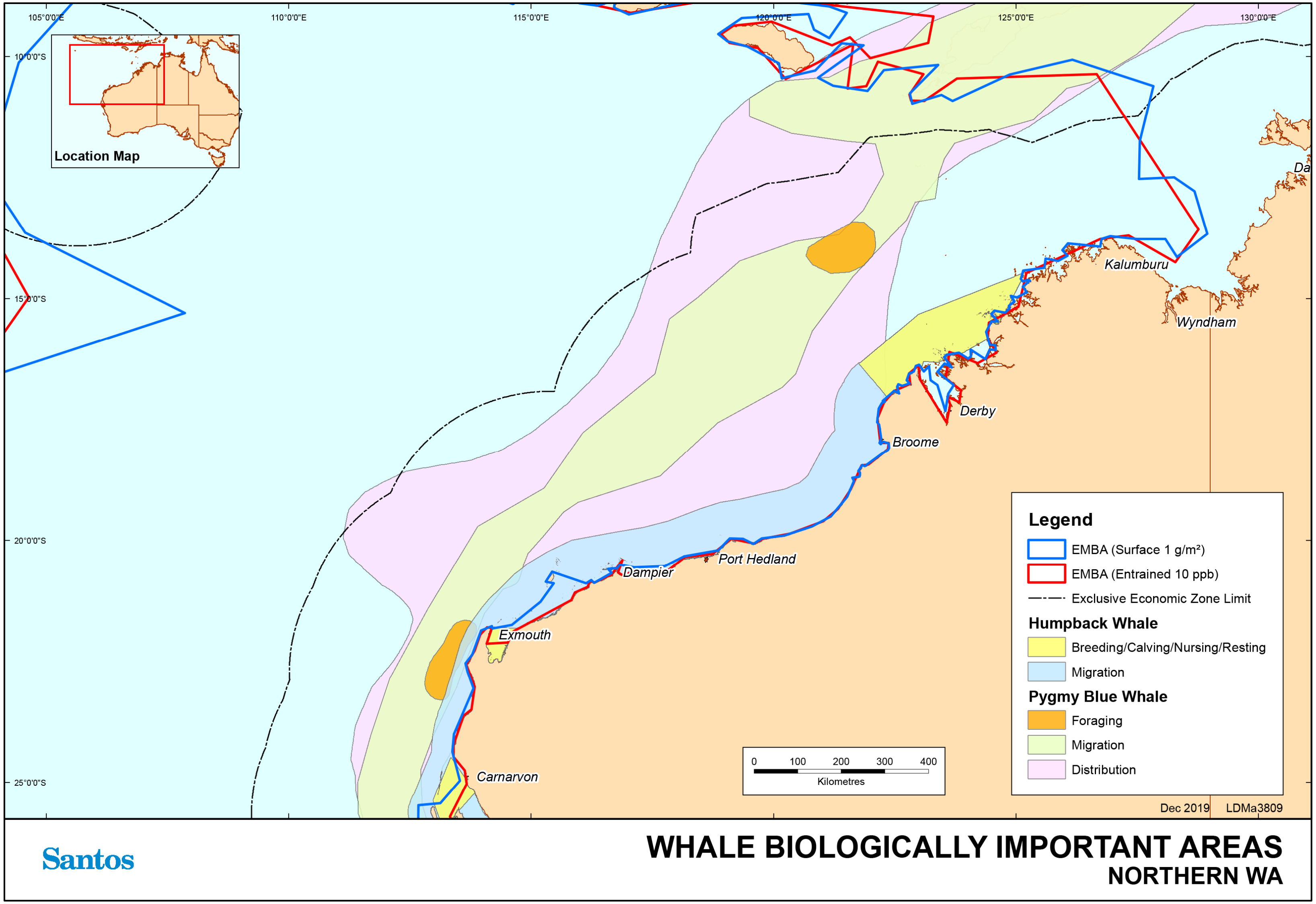


Figure 7-2: Biologically important areas – whales – Northern WA

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 (DAWE 2020a); 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 2019a) and no BIAs for the fin whale are currently identified by the National Conservation Values Atlas (DAWE 2020b).

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 (DAWE 2020b). 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 WA 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 was 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 (DoEE 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 weeks from year to year due to food availability in the Antarctic (DMP 2003).

Satellite tagging data collected for migrating northbound humpback whales identified a consistent narrow inshore distribution, unlike the southward migration. There was little evidence that the whales tended to venture further from shore and into deeper water at any point on their northward migration. Whales were seen with calves off the North West Cape outside the ‘calving grounds; of Lacepede Islands to Camden Sound. This indicates some potential for this area being used as a ‘calving site’ as well as a migratory corridor. Consequently, the region from the Lacepede Islands to Camden Sound should not be seen as the exclusive ‘calving ground’ for this population (Double *et al.* 2012b).

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 breeding 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 2019c). 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 2019c). It is however, suggested that the offshore form migrates seasonally, heading towards warmer tropical waters during the winter.

7.1.9 Pygmy Right Whale

The pygmy right whale is considered the most elusive baleen whale and as a result very little is known about the whale’s distribution in Australian waters. Records of the pygmy right whale in Australian waters are distributed between 32°S and 47°S and are restricted in the west by the Leeuwin current (Kemper 2002). It is possible that the pygmy right whale will be encountered in the southern extent of the EMBA, particularly in coastal areas of upwelling (Kemper 2002).

7.1.10 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.

7.1.11 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 EMBA is detailed in **Table 7-3** and shown on **Figure 7-3**.

7.1.12 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 EMBA is detailed in **Table 7-3** and shown on **Figure 7-3**.

7.1.13 Irrawaddy Dolphin (Australian Snubfin Dolphin)

The Irrawaddy dolphin, also known as the snubfin dolphin (*Orcaella heinsohni*) is known to occur within the waters off northern Australia, extending north from Broome in Western Australia to the Brisbane River in Queensland (DoEE 2016c). Surveys have indicated that the species is typically found in protected shallow nearshore waters, generally less than 20 m deep, adjacent to river and creek mouths close to seagrass beds (DoEE 2016c). The snubfin dolphin was not recorded during any of the aerial surveys undertaken along the Dampier Peninsula coastline in the vicinity of James Price Point but were observed in Roebuck Bay from vessels on several occasions (RPS, 2010b). Based on the extensive survey effort and amenable conditions within the James Price Point coastal area during the survey, it is concluded that this species is seldom found outside of shallow and sheltered bays and inlets (DSD 2010). The Irrawaddy dolphin BIA in the EMBA is detailed in **Table 7-3** and shown on **Figure 7-3.**

7.1.14 Dusky Dolphin

The dusky dolphin's distribution is strongly linked to colder waters. In Australia, the dusky dolphin has been sighted in southern Australia from WA to Tasmania. It is presumed to be primarily an inshore species but has been known to move further offshore, possibly due to its desire for colder waters (Gill *et al.* 2000). Dusky dolphins are expected to be limited in their distribution along the WA coastline due to the presence of the southward-flowing warm water of the Leeuwin Current.

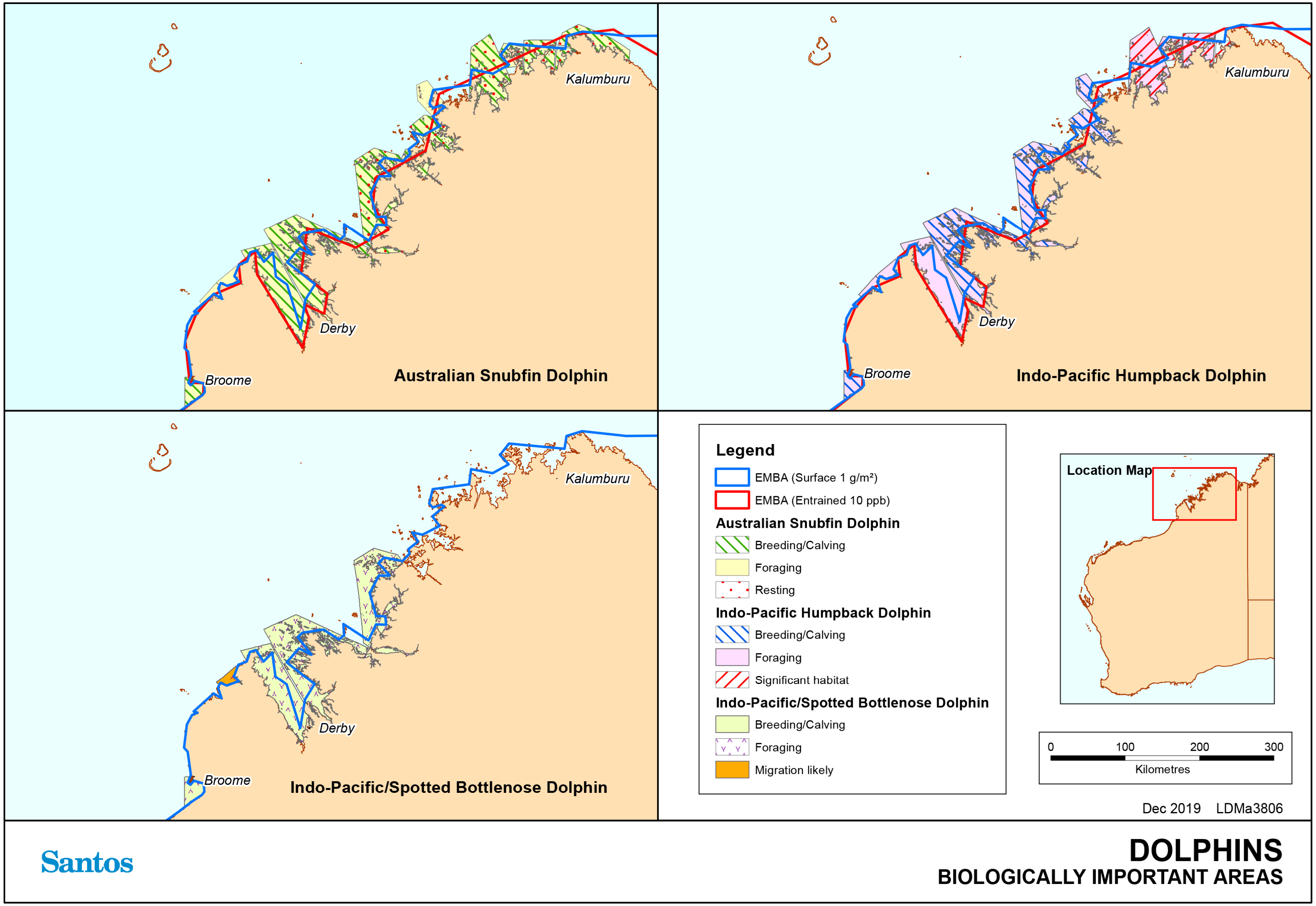


Figure 7-3: Biologically important areas – dolphins

7.1.15 Australian Sea Lion

The Australian sea lion is endemic to Australia. Breeding colonies are found only in South Australian and Western Australian waters. There are currently 76 known Australian sea lion pupping locations along the coast and offshore islands between the Houtman Abrolhos Islands in Western Australia to the Pages Islands in South Australia (DSEWPaC 2013c). The species has also been recorded at Shark Bay (DoE 2014a).

BIAs for foraging, haul-out and breeding sites identified by the National Conservation Values Atlas are located south of the waters from Busselton to the NT border (DAWE 2020b). Male Australian sea lions have been recorded foraging in areas up to 60 km away from their birth colonies, with potentially larger dispersal ranges up to 180 km (Hamer *et al*. 2011). However, female Australian sea lions have restricted home ranges, with high rates of natal site fidelity and limited gene flow with other regions (Campbell 2005). The Australian sea lion BIA in the EMBA is outlined in **Table 7-3** and is depicted in **Figure 7-4.**

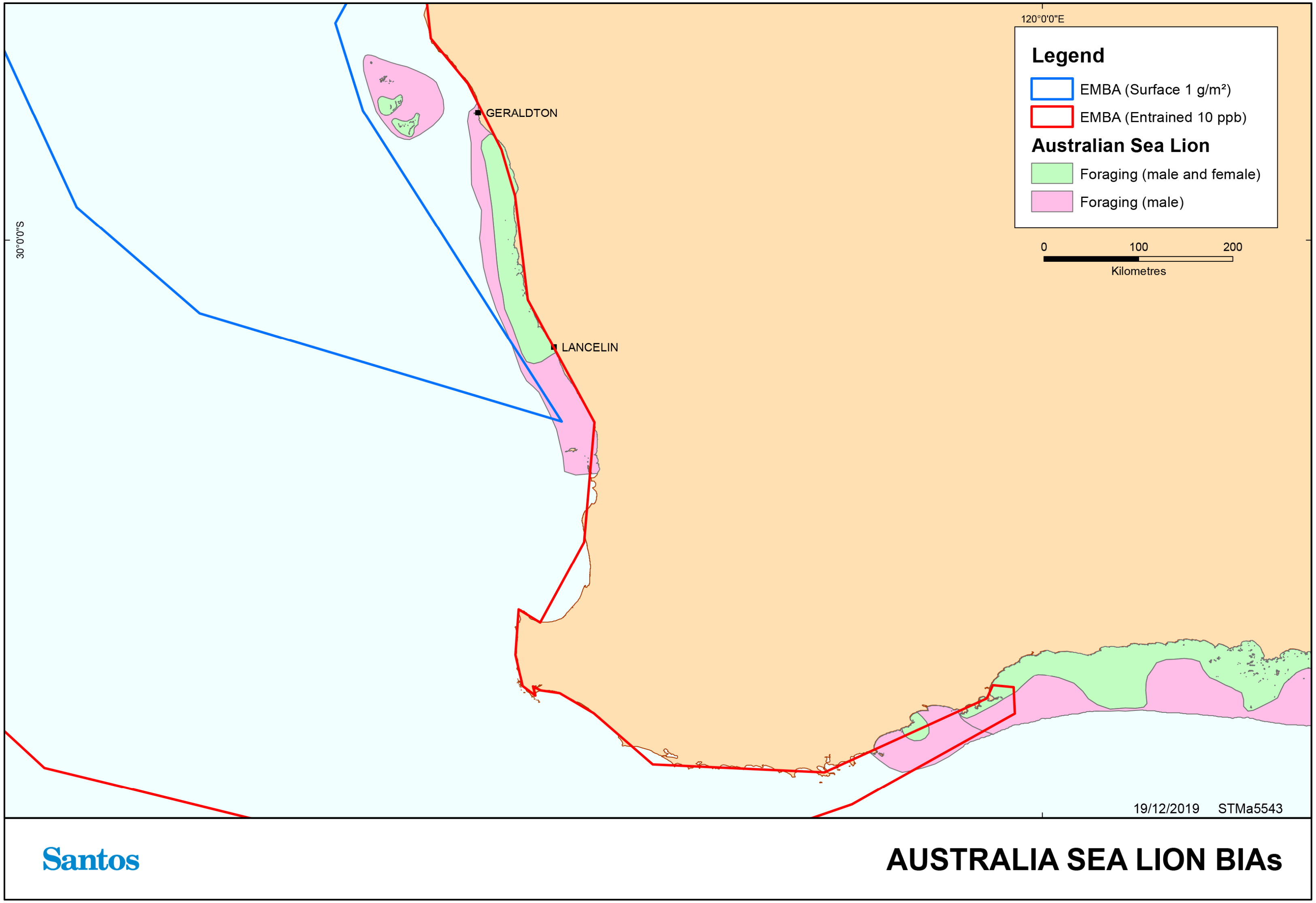


Figure 7-4: Biologically important areas – Australian sea lion

7.1.16 Dugongs

Dugongs (*Dugong dugon*) are large herbivorous marine mammals (up to 3 m) 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 habitats. The dugong BIAs in the EMBA are detailed in **Table 7-3** and shown in **Figure 7-5**.

7.1.17 New Zealand fur-seal

The New Zealand fur-seal (also known as the long-nosed fur seal) (*Arctocephalus forsteri*) is a specially protected species (other specially protected) under the BC Act. The New Zealand fur seal is found in Ngari Capes Marine Park (two colonies) and along other parts of Australia's southern coast.[5]

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[5] Identified as a relevant species through review of *Biodiversity Conservation Act 2016* listed species for marine species without an EBPC Act listing.

Figure 7-5: Biologically important areas – dugongs

Table 7-2: Summary of information for marine mammals listed as threatened under the EPBC Act

Aspect	Sei whale	Blue and pygmy blue whales	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 EMBA for marine mammals

The DAWE 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**[6].

In addition, both the EPBC Act and WA BC Act 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.

Table 7-3: Biologically important areas – marine mammals

Species	Scientific name	Aggregation area and use	BIAs within EMBA
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 Head of the 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 m depth contour Indonesia- Banda Sea Ningaloo Perth canyon Scott Reef

[6] Further background information on BIA and identification of critical habitat in recovery plans is provided in **Section 5.4**.

Species	Scientific name	Aggregation area and use	BIAs within EMBA
Southern right whale	*Eubalaena 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 – Kimberley/Coastal North Lacepede Island, 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 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 offshore 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 and Albany Canyons	Western end of Perth canyon Albany Canyons - Immediately south of the continental shelf edge extending over the continental slope
Indo-Pacific humpback dolphin	*Sousa chinensis*	Breeding, calving, foraging – Kimberley coastal waters and islands Significant habitat – unknown behavior – Admiralty Gulf & Parry Harbour and 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 and Biggee Island Pender bay Port Nelson, York Sound, Prince Frederick Harbour Prince Regent River Roebuck Bay Vansittart Bay, Anjo Peninsula Willie Creek

Species	Scientific name	Aggregation area and use	BIAs within EMBA
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
Irrawaddy dolphin (Australian snubfin dolphin)	*Orcella heinsohni*	Breeding, calving, foraging, resting– Kimberley coastal waters and islands	Admiralty Gulf and Parry Harbour Bougainville Peninsula Camden Sound Area - Walcott Inlet, Doubtful Bay, Deception Bay, Augustus Island (Kuri Bay) Cape Londonderry and King George River Carnot and Beagle bay King Sound North and Yampi Sound and Talbot Bay Fjord area near Horizontal Falls King Sound Southern Sector Maret and Biggee Island Ord River Pender bay Port Nelson, York Sound, Prince Frederick Harbour Prince Regent River Roebuck Bay Vansittart Bay, Anjo Peninsula Willie Creek
Australian sea lion	*Neophoca cinerea*	Foraging – male and female – Houtman Abrolhos Island, mid-west coast (more restricted spatial extent than males) Foraging – males Houtman Abrolhos Island, mid-west coast down to Perth Breeding – Buller Island, North Fisherman Island, Beagle Island, Albrolhos Island Haul Out Sites – North Cervantes Island, Sandland Island, Albrolhos Island	Houtman Abrolhos Islands Mid-west coast, includes Beagle Island, Fisherman Island, Jurien Bay, Cervantes and Buller Colonies From Recherche Archipelago to Doubtful Islands – Key colonies, Kimberly island, Glenny and Wickham Island. Haul-Off rock
Dugong	*Dugong dugon*	Foraging –Dampier Peninsula, Roebuck Bay, Shark Bay, Exmouth and Ningaloo coastline Migration – Roebuck Bay and North East Peron Peninsula, Shark 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 and Faure Island, Shark Bay Dirk Hartog Island, Shark Bay East of Faure Island, Shark Bay Exmouth Gulf

Species	Scientific name	Aggregation area and use	BIAs within EMBA
			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 habitats in the EMBA 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 cristatus*), white-bellied sea eagle (*Haliaeetus leucogaster*), silver gull (*Larus novaehollandiae*) and eastern reef egret (*Egreta sacra*) (DEWHA 2008a).

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 2008a).

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 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**.

8.1 Regional Surveys

8.1.1 Abrolhos Islands

The Abrolhos Islands are one of the most significant seabird nesting areas in the eastern Indian Ocean with over two million birds breed on the islands and small rocky atolls in the Abrolhos (DoF 2012). The mixture of species is unique, as subtropical and tropical species, and littoral and oceanic foragers, share the breeding islands. A total of 95 bird species have been recorded as residents or visitors to the Abrolhos Islands. Of these 35 species are known to breed at the Abrolhos (DoF, 2012):

+ Common noddy (rookery – Pelseart Island): The Abrolhos supports 80%of the Australian breeding population of the common noddy (*Anous stolidus*) with up to 250,000 common noddies breed at Pelsaert Island. These birds lay their eggs in spring, but the actual month can vary, depending on their food supply and the weather conditions existing in offshore waters (DoF 2012);
+ Caspian tern (rookeries – Leo Island, West Wallabi Island and Pelsaert Island): Unlike other more social terns, Caspian terns (*Hydroprogne caspia*) are usually solitary nesters. There are less than 150 of these breeding at the Abrolhos, across 22 islands (DoF 2012);
+ Wedge-tailed shearwaters (rookeries): The Abrolhos are the most important breeding sites in Australia for the wedge tailed shearwater (*Ardenna pacifica*), with between 500,000 and 1,000,000 of these birds breeding there every year, predominantly on West Wallabi Island. The wedge-tailed shearwater breeding colonies at the Abrolhos are the largest in Australia (DoF 2012);
+ Bridled tern (rookeries – Gun Island, Leo Island, Pelsaert Island, Little North Island, Fisherman Islands, Beagle Islands and Penguin Island): Bridled terns (*Onychoprion anaethetus*) breed on 90 islands throughout the Abrolhos. These birds fly north for the winter, through Indonesia to waters around the Phillippines. There are approximately 4,000 bridled terns who return to the Abrolhos around October every

year to lay their eggs. Bridled terns nest on more islands in the Abrolhos than any other bird species (DoF, 2012);

+ Osprey (nesting area – Pelseart Island): Up to 100 eastern ospreys (*Pandion cristatus*) nest at a number of sites throughout all three island groups at the Abrolhos, including nesting platforms made from converted rock lobster pots and stacked fishing equipment on jetties (DoF 2012);
+ White-bellied sea eagle (nesting area – West Wallabi Island): At the Abrolhos, there are up to 50 breeding white-bellied sea eagles (*Haliaeetus leucogaster*), spread across all three island groups (DoF 2012);
+ Australian lesser noddy (feeding area and rookeries Morley Island, Wooded Island and Pelseart Island): In Australia the Australian lesser noddy is only known to breed in this area and is known to forage between the islands and the continental shelf edge; and
+ Other areas rookeries identified for both the wedge-tailed shearwater and bridled tern within the south west area include Lancelin Island, Rottnest Island and Safety Bay.

8.1.2 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).

8.1.3 Muiron Islands and Exmouth Gulf Islands

Muiron Islands and Exmouth Gulf Islands are generally lacking in published bird observations data. Early indications from surveys commissioned by Santos in 2013/14 indicate that South and North Muiron Islands are regionally significant in terms of wedge-tailed shearwater (*Ardenna pacifica*) nesting, whilst Bessiers and Fly islands are also significant (Surman pers comm. 2013). Nine coastal/terrestrial species and 21 shorebirds were identified on the Muiron and Exmouth Gulf Islands during the first of these surveys and seven bird species were recorded nesting (Surman 2013).

8.1.4 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 (*Ardenna pacifica*), Caspian terns (*Sterna caspia*), bridled terns (*Onychoprion 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 2005).

8.1.5 Barrow 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).

8.1.6 Lowendal Island Group and Airlie and Serrurier Islands

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).

Wedge-tailed shearwaters have been identified to nest on Varanus, Airlie, Serrurier and Bridled Islands (Astron 2017a). Breeding participation on the islands appears to be largely influenced by pre-breeding oceanographic conditions (Astron 2017a). Monitoring in 2016/17 was undertaken by Santos and demonstrated the colony sizes for wedge-tailed shearwaters to be within or above previously reported ranges (Astron 2017a). This is informed though monitoring that has been undertaken under the Integrated Shearwater Monitoring Program (ISMP), established in 1994.

In 2016/17, areas of potential wedge-tailed shearwater nesting habitat were recorded on Varanus Island (5.53 ha) and Airlie Island (12.47 ha) and surrounding islands of Bridled (2.94 ha), Serrurier (130.89 ha), Abutilon (2.02 ha) and Parakeelya (1.66 ha) (Astron 2017a). The number of wedge-tailed shearwater breeding pairs was also estimated for each of Varanus (1,492 +/- 702), Airlie (600 +/- 124), Bridled (1,039 +/- 342), Serrurier (23,240 +/- 4,341), Abutilon (317 +/- 210) and Parakeelya (172 +/- 138) islands (Astron 2017a).

Other seabird species utilising Abutilon, Beacon, Bridled and Parakeelya islands for nesting include bridled terns, silver gulls, crested terns and lesser crested terns. Monitoring for these seabirds in 2016/17 was also completed by Santos, with monitoring results concluded to support previous trends for all species. Bridled terns mainly utilise Abutilon, Bridled and Parakeelya islands for breeding, with smaller numbers noted on Beacon and Varanus Islands. The bridled terns have not been recorded on Airlie Island and only in very small numbers on Varanus Island (Astron 2017b).

Silver gull numbers appear to be growing across the region (2010/2011). However, reasons for this are unknown but considered possibly to be due to greater prey availability or immigration from the mainland (Astron 2017b). Silver gulls have been found to utilise Bridled, Parakeelya, Abutilon and Beacon islands longer term for breeding. Silver gulls have not been identified to nest on Varanus island and were only recorded nesting on Airlie island for the first time in 2016/17 since monitoring commencement in 2004/05 (Astron 2017b).

The crested tern and lesser crested tern are noted as nomadic breeders that appear to use a consistent subset of islands for breeding. In 2016/17, Beacon Island was the favourable nesting site for the crested tern and lesser crested tern (Astron 2017b). Surveys in the vicinity of Port Hedland (Bennelongia 2011) recorded 23 species of migratory shorebird between 2002 and 2011. Terrestrial/coastal and seabird species were not targeted. A total of 4,248 migratory shorebirds of 18 species were observed during the field survey in April 2011.

8.2 Threatened Species

A Protected Matters search of the EMBA identified 55 bird species (**Appendix A**) listed as threatened under the EPBC Act.

An examination of the Species Profile and Threats database (DAWE 2020a) 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 EMBA 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. There are an additional 44 migratory species listed under the EPBC Act, with these detailed in **Section 8.3** (**Table 8-3**). BIAs for birds are detailed in **Table 8-6** and depicted in **Figure 8-1** and **Figure 8-2**.

Santos

Table 8-1: Birds listed as threatened under the EPBC Act

Species	Conservation Status			Likelihood of occurrence in EMBA	BIAs in EMBA
	EPBC Act 1999	BC Act 2016	Other WA Conservation Code		
Shorebirds					
Red knot (*Calidris canutus*)	Endangered, Migratory	Endangered	-	Species or species habitat known to occur within area	None - No BIA defined
Curlew sandpiper (*Calidris ferruginea*)	Critically endangered, Migratory	Critically endangered	-	Species or species habitat known to occur within area	None - No BIA defined
Great knot (*Calidris tenuirostris*)	Critically endangered, Migratory	Critically endangered	-	Roosting known to occur within area	None - No BIA defined
Greater sand plover (*Charadrius leschenaultii*)	Vulnerable, Migratory	Vulnerable	-	Roosting known to occur within area	None - No BIA defined
Lesser sand plover (*Charadrius mongolus*)	Endangered, Migratory	Endangered	-	Roosting known to occur within area	None - No BIA defined
Western Alaskan bar-tailed godwit (*Limosa lapponica baueri*)	Vulnerable, Migratory[7]	Vulnerable, Specially protected (migratory)[7]	-	Species or species habitat known to occur within area	None - No BIA defined
Northern Siberian bar-tailed godwit (*Limosa lapponica menzbieri*)	Critically endangered, Migratory[7]	Critically endangered, Specially protected (migratory)[7]	-	Species or species habitat known to occur within area	None - No BIA defined
Eastern curlew (*Numenius madagascariensis*)	Critically endangered, Migratory	Critically endangered	-	Species or species habitat known to occur within area	None - No BIA defined
Australasian bittern (*Botaurus poiciloptilus*)	Endangered	Endangered	-	Species or species habitat known to occur within area	Yes – refer to **Table 8-6**
Australian painted snipe (*Rostratula australis*)	Endangered	Endangered	-	Species or species habitat may occur within area	None - No BIA defined

[7] Listed as migratory at species level

Species	Conservation Status			Likelihood of occurrence in EMBA	BIAs in EMBA
	EPBC Act 1999	BC Act 2016	Other WA Conservation Code		
Seabirds					
Australian lesser noddy (*Anous tenuirostris melanops)*	Vulnerable	Endangered	-	Breeding known to occur within area	Yes – refer to **Table 8-6**
Fairy prion (southern) (*Pachyptila tutur subantarctica)*	Vulnerable	-	-	Species or species habitat known to occur within area	None - No BIA defined
Southern royal albatross (*Diomedea epomophora)*	Vulnerable, Migratory	Vulnerable	-	Foraging, feeding or related behaviour likely to occur within area	None - No BIA defined
Northern royal albatross (*Diomedea sanfordi)*	Endangered, Migratory	Endangered	-	Foraging, feeding or related behaviour likely to occur within area	None - No BIA defined
Amsterdam albatross (*Diomedea amsterdamensis*)	Endangered, Migratory	Critically endangered	-	Species or species habitat may occur within area	None - No BIA defined
Antipodean albatross (*Diomedea antipodensis)*	Vulnerable	-	-	Foraging, feeding or related behaviour likely to occur within area	None - No BIA defined
Sooty Albatross (*Phoebetria fusca)*	Vulnerable, Migratory	Endangered	-	Species or species habitat may occur within area	None - No BIA defined
Tristan albatross (*Diomedea dabbenea)*	Endangered, Migratory	Critically endangered	-	Species or species habitat may occur within area	None - No BIA defined
Wandering albatross (*Diomedea exulans)*	Vulnerable, Migratory	Vulnerable	-	Foraging, feeding or related behaviour likely to occur within area	None - BIA not found in EMBA
Christmas island frigatebird (*Fregata andrewsi)*	Endangered, Migratory	Specially protected (migratory)	-	Foraging, feeding or related behaviour known to occur within area	Yes – refer to **Table 8-6**

Species	Conservation Status			Likelihood of occurrence in EMBA	BIAs in EMBA
	EPBC Act 1999	BC Act 2016	Other WA Conservation Code		
Southern giant petrel (*Macronectes giganteus)*	Endangered, Migratory	Specially protected (migratory)	-	Species or species habitat may occur within area	None - BIA not found in EMBA
Northern giant petrel (*Macronectes halli)*	Vulnerable, Migratory	Specially protected (migratory)	-	Species or species habitat may occur within area	None - BIA not found in EMBA
Abbott's booby (*Papasula abbotti)*	Endangered	-	-	Species or species habitat likely to occur within area	Yes – refer to **Table 8-6**
Soft-plumaged petrel (*Pterodroma mollis)*	Vulnerable	-	-	Foraging, feeding or related behaviour known to occur within area	Yes – refer to **Table 8-6**
Blue petrel (*Halobaena caerulea)*	Vulnerable	-	-	Species or species habitat may occur within area	None - No BIA defined
Australian fairy tern (*Sternula nereis nereis)*	Vulnerable	Vulnerable	-	Breeding known to occur within area	Yes – refer to **Table 8-6**
Indian yellow-nosed albatross (*Thalassarche carteri)*	Vulnerable, Migratory	Endangered	-	Foraging, feeding or related behaviour may occur within area	Yes – refer to **Table 8-6**
Shy albatross (*Thalassarche cauta)*	Endangered, Migratory	Vulnerable	-	Foraging, feeding or related behaviour likely to occur within area	None - BIA not found in EMBA
White-capped albatross (*Thalassarche steadi)*	Vulnerable, Migratory	Vulnerable	-	Foraging, feeding or related behaviour likely to occur within area	None - BIA not found in EMBA
Black-browed albatross (*Thalassarche melanophris)*	Vulnerable, Vulnerable	Endangered	-	Species or species habitat may occur within area	None - BIA not found in EMBA
Campbell albatross (*Thalassarche impavida)*	Vulnerable, Migratory	Vulnerable	-	Species or species habitat may occur within area	None - BIA not found in EMBA

Species	Conservation Status			Likelihood of occurrence in EMBA	BIAs in EMBA
	EPBC Act 1999	BC Act 2016	Other WA Conservation Code		
Christmas Island white-tailed tropicbird (*Phaethon lepturus fulvus)*	Endangered	-	-	Species or species habitat may occur within area	None - No BIA defined

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. During the non-breeding season, the species spends the majority of its time 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 congeners 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 and in the east for the lesser sand plover (DAWE 2020a).

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 (DAWE 2020a).

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).

Australasian Bittern

The Australasian bittern is found in coastal and sub-coastal areas of south-eastern and south-western mainland Australia and the eastern marshes of Tasmania (Birdlife Australia 2017). The Australasian Bittern occurs mainly in freshwater wetlands and, rarely, in estuaries or tidal wetlands (Marchant & Higgins 1990). It favours wetlands with tall dense vegetation, where it forages in still, shallow water up to 0.3 m deep, often at the edges of pools or waterways, or from platforms or mats of vegetation over deep water. It favours permanent and seasonal freshwater habitats, particularly those dominated by sedges, rushes and reeds (e.g. *Phragmites, Cyperus, Eleocharis, Juncus, Typha, Baumea, Bolboschoenus*) or cutting grass (*Gahnia*) growing over a muddy or peaty substrate (Marchant & Higgins 1990). The diet of the Australasian Bittern includes aquatic animals such as small fish, frogs, freshwater crayfish, spiders, insects and small reptiles at night. Breeding occurs during summer from October to January.

All remaining natural habitat (including constructed wetlands) is considered critical habitat for this species. This species is known to occur on the western coastal plain between Lancelin and Busselton and the southern coastal region from Augusta to east of Albany within the EMBA (**Table 8-6**).

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 DAWE 2020a). 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 DAWE 2020a).

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 8-6**). 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 EMBA (**Appendix A**) identified several albatross species that may occur in the area, comprising of the southern royal albatross, northern royal albatross, Amsterdam albatross, Antipodean 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 (DAWE 2020a).

The National Conservation Values Atlas (DAWE 2020b) 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 NT border. However, a BIA for the Indian yellow-nosed albatross is identified for foraging north to Shark bay and extending east into Bass Strait.

Christmas Island Frigatebird

The Christmas Island frigatebird is a very large seabird. Breeding colonies of the Christmas Island frigatebird is currently confined to Christmas Island in the Indian Ocean (Birdlife International 2019) but forages and roosts widely in south-east Asia and Indian Ocean No breeding colonies have ever been found away from Christmas Island. The Christmas Island Frigatebird predominantly nests in forests on shore terraces that are protected from prevailing south-east trade winds (TSSC 2020a). All forest containing nesting and roosting sites, including currently known nesting and roosting colonies and any other smaller groups of nests and roosts on Christmas Island is considered critical habitat (TSSC 2020a).

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 (DAWE 2020a).

The National Conservation Values Atlas (DAWE 2020b) 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 NT 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 (DAWE 2020b) does not identify any BIAs for this species in the area spanning SW WA to the NT 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 DAWE 2020a).

A BIA for this species is identified for foraging in seas north to 21°30’S off WA.

Blue Petrel

The blue petrel is marine species of the Sub Antarctic and Antarctic seas. In summer, it occurs mainly over waters of -2 to 2° C in surface temperature, but it also ranges south to the edge of the pack-ice and north to approximately 30° south, or further north over cool currents (DoE 2014e). In the Antarctic, it generally avoids the pack-ice, and only occasionally approaches the edge of the ice. Given the location of the EMBA, this species is unlikely to occur.

The National Conservation Values Atlas (DAWE 2020b) does not identify any BIAs for this species in the area spanning SW WA to the NT border.

Santos

Abbott's Booby

Currently, Abbott's booby is only known to breed on Christmas Island and to forage in the waters surrounding the island and south-east Asia (TSSC 2020b). 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 2019b) does not identify any BIAs for this species in the area spanning SW WA to the NT border. Critical habitat is considered all known nesting trees and all forest vegetation within a 200m radius of known nesting trees on Christmas Island (TSSC 2020).

Australian Fairy Tern

The Australian 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 WA; occurring as far north as the Dampier Archipelago (DAWE 2020a). 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 DAWE 2020a). 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 (DAWE 2020b) 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 8-6**).

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 (DAWE 2020b) does not identify any BIAs for this species within the EMBA.

Fairy Prion (southern)

The fairy prion is distributed off the cold-water coasts of Antarctica and southern Australia and New Zealand. The southern subspecies is known to breed on Macquarie Island, Langdon Point, Davis Point and Bishop and Clerk islands (Garnett & Crowley 2000). It is estimated that the population of the fairy piron (southern) is a little over 50 pairs (Brothers 1984).

The National Conservation Values Atlas (DAWE 2020b) does not identify any BIAs for this species within the EMBA.

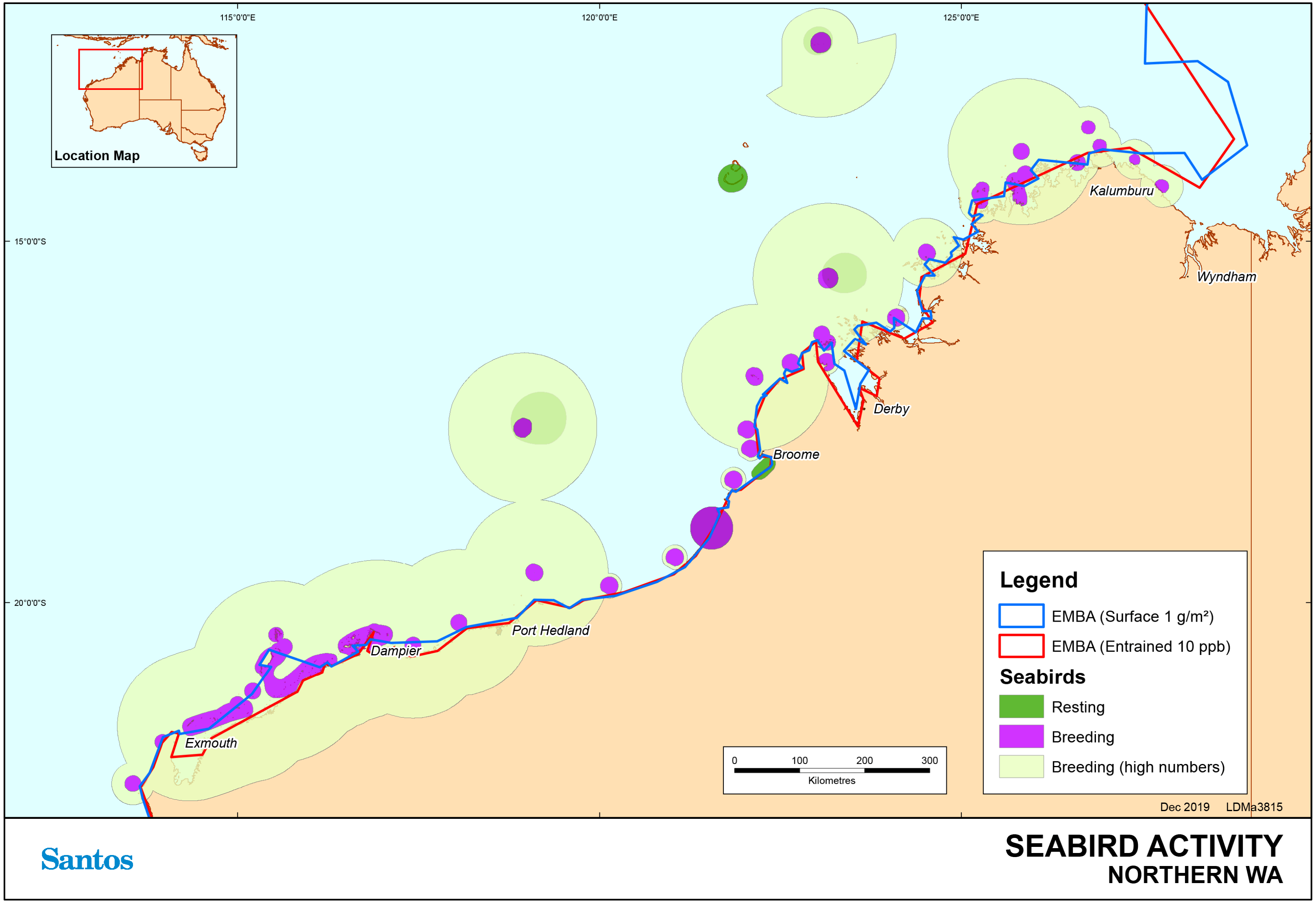

Figure 8-1: Biological important areas – birds – Northern WA

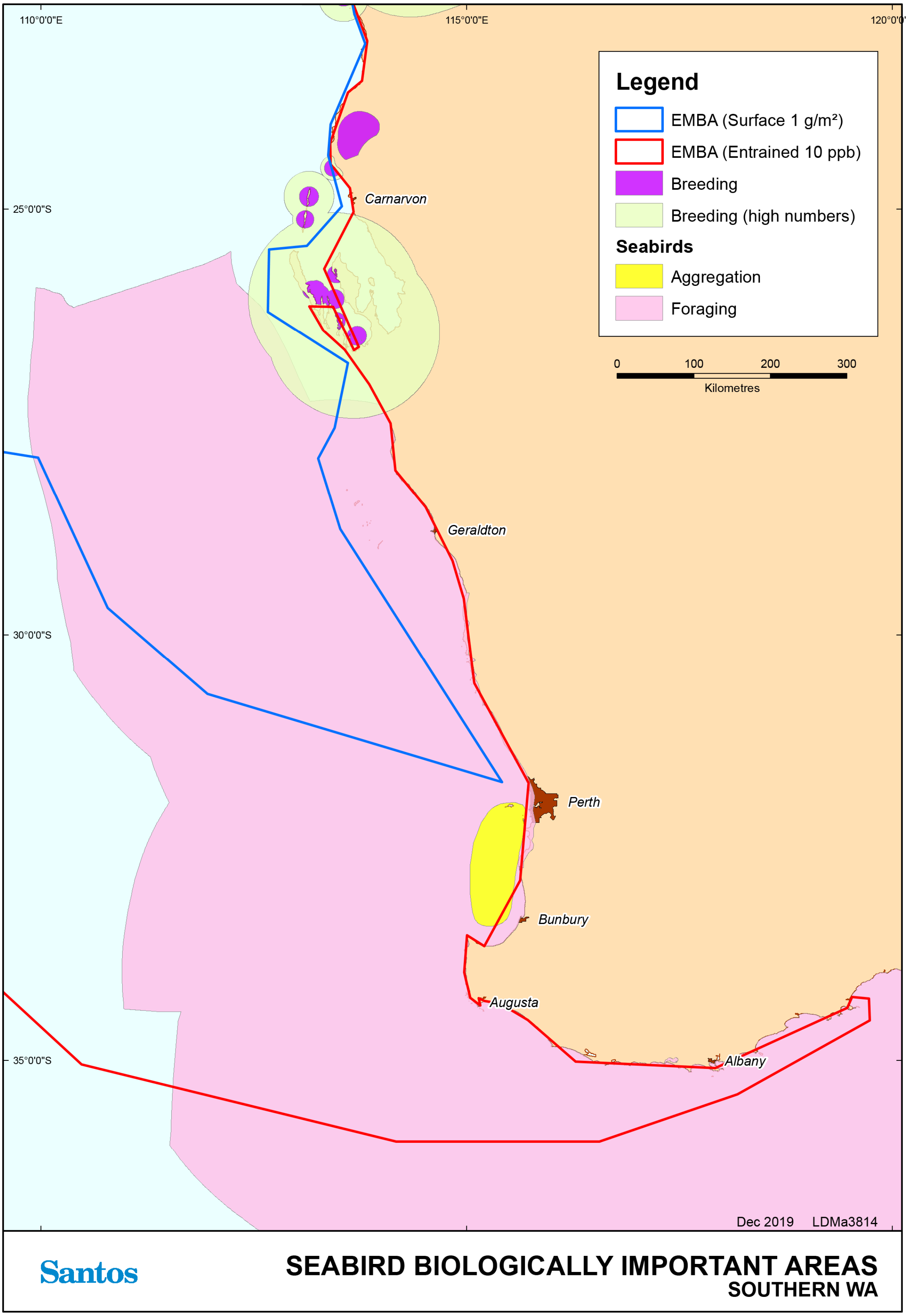

Figure 8-2: Biologically important areas – birds – Southern WA

Table 8-2: Summary of information for birds listed as threatened under the EPBC Act that may be in the EMBA

Species	Species Expected in EMBA	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
Western Alaskan bar-tailed godwit	Yes	No	Worms, molluscs, crustaceans, insects
Northern Siberian bar-tailed godwit	Yes	No	Worms, molluscs, crustaceans, insects and some plant material
Seabirds			
Australian lesser noddy	May forage from Kalbarri to Shark Bay	No	Small fish taken from marine and coastal waters (DoE 2014b)
Amsterdam albatross	Low densities	No	Cephalopods, fish and crustaceans taken from marine and coastal waters.
Antipodean albatross	Low densities	No	Cephalopods, fish and crustaceans taken from marine and coastal waters.
Black-browed albatross	Low densities	No	Cephalopods, fish and crustaceans taken from marine and coastal waters.
Campbell albatross	Low densities	No	Cephalopods, fish, salps, jellyfish and crustaceans taken from marine and coastal waters.
Indian yellow-nosed albatross	Low densities	No	Cephalopods, and fish taken from marine and coastal waters.
Northern royal albatross	Low densities	No	Cephalopods, fish, salps and crustaceans taken from marine and coastal waters.
Shy albatross	Low densities	No	Cephalopods, fish and crustaceans taken from marine and coastal waters.
Sooty Albatross	Low densities	No	Cephalopods, fish, crustaceans, siphonophores and penguin carrion taken from marine waters.

Species	Species Expected in EMBA	Breeding in the Area /Seasonality	Foraging
Southern royal albatross	Low densities	No	Cephalopods, and fish taken from marine and coastal waters.
Tristan albatross	Low densities	No	Cephalopods, fish and crustaceans taken from marine waters.
Wandering albatross	Low densities	No	Cephalopods, fish and crustaceans taken from marine and coastal waters.
White-capped albatross	Low densities	No	Cephalopods and fish 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 prion (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
Christmas Island white-tailed tropicbird	Very low densities	No	Squid and flying fish

8.3 Migratory Species

The EPBC PMST search identified an additional 44 species listed as migratory under the EPBC Act that may occur within the EMBA. These species are listed in **Table 8-3**. All of these species are also listed as migratory under the BC Act, with the exception of the flesh-footed shearwater, which is listed as vulnerable under the BC Act. Those species that are listed as both migratory and threatened under either the EPBC Act and/or BC Act are outlined in **Table 8-1** and are not repeated within **Table 8-3**.

Table 8-3: Summary of migratory birds that may occur within the EMBA

Species	Common Name	Likelihood of occurrence in EMBA
Limnodromus semipalmatus	Asian dowitcher	Roosting known to occur within area
Limosa lapponica	Bar-tailed godwit	Species or species habitat known to occur within area
Limosa limosa	Black-tailed godwit	Roosting known to occur within area
Onychoprion anaethetus	Bridled tern	Breeding known to occur within area
Limicola falcinellus	Broad-billed sandpiper	Roosting known to occur within area
Sula leucogaster	Brown booby	Breeding known to occur within area
Hydroprogne caspia	Caspian tern	Breeding known to occur within area

Species	Common Name	Likelihood of occurrence in EMBA
Tringa nebularia	Common greenshank	Species or species habitat known to occur within area
Anous stolidus	Common noddy	Breeding known to occur within area
Tringa totanus	Common redshank	Roosting known to occur within area
Actitis hypoleucos	Common sandpiper	Species or species habitat known to occur within area
Thalasseus bergii	Crested tern	Breeding known to occur within area
Charadrius bicinctus	Double-banded plover	Roosting known to occur within area
Ardenna carneipes	Flesh-footed shearwater	Breeding known to occur within area
Apus pacificus	Fork-tailed swift	Species or species habitat likely to occur within area
Fregata minor	Greater frigatebird	Breeding known to occur within area
Pluvialis squatarola	Grey plover	Roosting known to occur within area
Tringa brevipes	Grey-tailed tattler	Roosting known to occur within area
Fregata ariel	Lesser frigatebird	Breeding known to occur within area
Tringa stagnatilis	Little greenshank	Roosting known to occur within area
Sternula albifrons	Little tern	Breeding known to occur within area
Calidris subminuta	Long-toed stint	Species or species habitat known to occur within area
Sula dactylatra	Masked booby	Breeding known to occur within area
Charadrius veredus	Oriental plover	Roosting known to occur within area
Glareola maldivarum	Oriental pratincole	Roosting known to occur within area
Pandion haliaetus	Osprey	Breeding known to occur within area
Pluvialis fulva	Pacific golden plover	Roosting known to occur within area
Calidris melanotos	Pectoral sandpiper	Species or species habitat known to occur within area
Sula sula	Red-footed booby	Breeding known to occur within area
Phalaropus lobatus	Red-necked phalarope	Roosting known to occur within area
Calidris ruficollis	Red-necked stint	Roosting known to occur within area
Phaethon rubricauda	Red-tailed tropicbird	Breeding known to occur within area
Sterna dougallii	Roseate tern	Breeding known to occur within area
Arenaria interpres	Ruddy turnstone	Roosting known to occur within area
Philomachus pugnax	Ruff (reeve)	Roosting known to occur within area
Calidris alba	Sanderling	Roosting known to occur within area
Calidris acuminata	Sharp-tailed sandpiper	Roosting known to occur within area
Ardenna grisea	Sooty shearwater	Species or species habitat may occur within area
Calonectris leucomelas	Streaked shearwater	Species or species habitat known to occur within area
Xenus cinereus	Terek sandpiper	Roosting known to occur within area
Ardenna pacifica	Wedge-tailed shearwater	Breeding known to occur within area
Numenius phaeopus	Whimbrel	Roosting known to occur within area
Phaethon lepturus	White-tailed tropicbird	Breeding known to occur within area

Species	Common Name	Likelihood of occurrence in EMBA
Tringa glareola	Wood sandpiper	Roosting known to occur within area

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 BC Act.

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 (Commonwealth of Australia 2017b). 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 (Commonwealth of Australia 2017b). 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 (Commonwealth of Australia 2017b).

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 (Commonwealth of Australia 2017b).

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 8-4**.

Table 8-4: 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
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

Feeding habitat	Feeding guild	Species
Soft mudflats in north-east Roebuck Bay	Visual hunters of fast large prey	Eastern curlew, whimbrel, greenshank, striated heron and black-necked stork
Soft mudflats in north-east 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 for Migratory Shorebirds (DoE 2015) 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.

The following migratory shorebird species are subject to the Wildlife Conservation Plan for Migratory Shorebirds 2015 (DoE 2015).

Table 8-5: Birds subject to the Wildlife Conservation Plan for Migratory Shorebirds 2015

Migratory species	DoEE SPRAT information on distribution within the area of interest
Asian dowitcher	The Asian dowitcher is a regular visitor to the north-west between Port Hedland and Broome. Elsewhere they are sporadic and rare. In the NT, the Asian dowitcher is found in Darwin and Arnhem Land. In WA, the species has been recorded at Albany, Lake McLarty, Lake McLeod, north-east Pilbara and the south-west Kimberley division. It has also been recorded at the Port Hedland Saltworks, Roebuck Bay, Ashmore Reed and Eighty Mile Beach.
Bar-tailed godwit	The bar-tailed godwit has been recorded in the coastal areas of all Australian states. In WA, it is widespread around the coast, from Eyre to Derby, with a few scattered records elsewhere in the Kimberley.
Black-tailed godwit	The black-tailed godwit is found in all states and territories of Australia; however, it prefers coastal regions and the largest populations are found on the north coast between Darwin and Weipa. The population that inhabitats Roebuck Bay is approximately 7,374 (>1% of the species total population).
Broad-billed sandpiper	In WA, few records occur in the south-west, but the broad-billed sandpiper may be regular in small numbers at scattered locations, from Warden Lake Nature Reserve and Coramup Creek to Guraga Lake Nature Reserve and Hurstview Lake. Individuals mostly occur on the coasts of the Pilbara and Kimberley between Onslow and Broome but are also recorded north to the mouth of Lawley River, and inland at Lake Daley.
Common greenshank	The common greenshank occurs around most of the coast from Cape Arid in the south to Carnarvon in the north-west. In the Kimberley region, it is recorded in the south-west and the north-east, with isolated records from the Bonaparte Archipelago. WA has three sites of international importance for the common greenshank which include: + Eighty Mile Beach (2,240 individuals); + Wilson Inlet (568 individuals); and + Roebuck Bay (560 individuals).
Common redshank	In Western Australia (WA), the species is vagrant to the south-west with records at Peel Inlet, Coodanup, the Gascoyne region, Coral Bay and Carnarvon.
Common sandpiper	WA distribution includes: + Roebuck Bay; and + Nuytsland Nature Reserve.
Double-banded plover	The double-banded plover can be found in both coastal and inland areas. There are no nationally significant sites within WA.

Migratory species	DoEE SPRAT information on distribution within the area of interest
Fork-tailed swift	In WA, 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 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).
Great knot	The great knot has been recorded around the entirety of the Australian coast, with a few scattered records inland. The greatest numbers are found in northern Australia; where the species is common on the coasts of the Pilbara and Kimberley, from the Dampier Archipelago to the Northern Territory border. Important sites for great knot in Western Australia include: + Eighty Mile Beach (169,044 individuals); and + Roebuck Bay (22,600 individuals).
Greater sand plover	In Australia, the greater sand plover occurs in coastal areas in all states, though the greatest numbers occur in northern Australia, especially the north-west. In northern Australia, the species is especially widespread between North West Cape and Roebuck Bay in Western Australia and are sparsely scattered records from the largely inaccessible area between Roebuck Bay and Darwin. Internationally important sites within Western Australia include: + Eighty Mile Beach (64,548 individuals); + Roebuck Bay (26,900 individuals); and + Ashmore Reef (1,196 individuals).
Grey plover	In Australia, the grey plover has been recorded in all states, where it is found along the coasts and are recorded frequently between Albany and the northern Kimberley coast. Internationally important sites include: + Eighty Mile Beach (1,650 individuals); + Roebuck Bay (1,300 individuals); + Peel Inlet (600 individuals); and + Nuytsland Nature Reserve (409 individuals).
Grey-tailed tattler	There are a few scattered records for the species along the south coast near the Eyre Bird Observatory, Point Malcolm, Rossiter Bay, Shark Lake Nature Reserve and surrounding swampland. It is found in the south-west between Augusta and Cervantes. The grey-tailed tattler is widespread from Houtman Abrolhos and the mainland adjacent to the Kimberley Division. It has also been recorded inland at Lake Argyle and on islands off the coast.
Lesser sand plover	Within Australia, the lesser sand-plover is widespread in coastal regions and has been recorded in all states. It mainly occurs in northern and eastern Australia, in south-eastern parts of the Gulf of Carpentaria, western Cape York Peninsula and islands in Torres Strait, and along the entire east coast, though it occasionally also occurs inland. In Western Australia, the following are important sites: + Eighty Mile Beach (1,575 individuals); + Roebuck Bay (1,057 individuals); + Broome (745 individuals); and + Port Hedland Saltworks (668 individuals).
Little greenshank	The marsh sandpiper is found on coastal and inland wetlands throughout Australia found mainly on the coast in Western Australia. National sites of importance within Western Australia include:

Migratory species	DoEE SPRAT information on distribution within the area of interest
	+ Port Hedland Saltworks (500 individuals); + Peel inlet (276 individuals); and + Eighty Mile Beach (140 individuals).
Long-toed stint	In Western Australia, the species is found mainly along the coast, with a few scattered inland records. On the south coast the Long-toed Stint is found from Esperance to Albany and inland to Lake Cassencarry and Dumbleyung. On the south-west coast the species is known from the Vasse River estuary, Guraga Lake and the Namming Nature Reserve. The species has occasionally been recorded in the Gascoyne Region, around Lake Wooleen, Meeberrie Station and McNeill Claypan. It is widespread around the Pilbara region and the Kimberley Division between Karratha and Wyndham-Kununurra. Inland records include Lake Brown, Hannan Lake, Lake Biolet, Newman Sewage Farm and Lake Gregory.
Oriental plover	Internationally important marine sites: + Eighty Mile Beach (approximately 60,000 birds); and + Roebuck Bay (Approximately 8,500 birds).
Oriental pratincole	Internationally important site: + Eighty Mile Beach (2.88 million birds). The species occurs at numerous and widespread sites in northern Australia, especially near the Pilbara and Kimberley coasts of northern WA.
Pacific golden plover	In Western Australia, the species is seldom recorded along the southern or south-western coasts but is more widespread along the Pilbara and Kimberley coasts between North-West Cape. Internationally important sites include Eighty Mile Beach with 440 individuals.
Pectoral sandpiper	In Australasia, the pectoral sandpiper prefers shallow fresh to saline wetlands. The species is found at coastal lagoons, estuaries, bays, swamps, lakes, inundated grasslands, saltmarshes, river pools, creeks, floodplains and artificial wetlands. The species is usually found in coastal or near coastal habitat but occasionally found further inland. It prefers wetlands that have open fringing mudflats and low, emergent or fringing vegetation, such as grass or samphire.
Red knot	The red knot large numbers are regularly recorded in north-west Australia, with 80 Mile Beach and Roebuck Bay being particular strongholds.
Red-necked phalarope	The red-necked phalarope is a regular at the Port Hedland Saltworks and Rottnest Island, Western Australia. The species is also found at the ICI Saltworks in South Australia.
Red-necked stint	The red-necked stint has been recorded in all coastal regions and found inland in all states when conditions are suitable. The red-necked stint probably travels in flocks and has been observed to feed in dense flocks. The Australian population was estimated at 353,000. Internationally important sites include: + Eighty Mile Beach (60,000 individuals); + Port Hedland Salt Works (23,000 individuals); + Roebuck Bay (19,800 individuals); + Wilson Inlet (15,252 individuals) + Alfred Cove Nature Reserve (10,000 individuals); + Lake Macleod (8,312 individuals); and + Peel Inlet (8,063 individuals).
Ruddy turnstone	The ruddy turnstone is widespread within Australia during its non-breeding period of the year. Australian sites of international importance include: + Eighty Mile Beach (3,480 individuals); + Ashmore Reef (2,230 individuals); + Roebuck Bay (2,060 individuals);

Migratory species	DoEE SPRAT information on distribution within the area of interest
	+ Barrow Island (1,733 individuals); and + Lacepede Islands (1,050 individuals).
Ruff (reeve)	In Western Australia, the species has been recorded at the lower King River and it is mostly found in the south-west region of the state. It has been sighted at the Vasse River estuary, north to Namming Lake and Lake McLarty. It has been periodically recorded at Port Hedland, Kununurra and the Argyle Diamond Mine. There are unconfirmed reports at Curlewis Camp, Millstream Chichester, Broome and Roebuck Bay.
Sanderling	They occur on most of the coast from Eyre to Derby, and also around Wyndham. They are more often recorded on the south and southwest coasts, north to around southern Shark Bay, with more sparsely scattered records further north in Gascoyne and Pilbara Regions and the Kimberley Division. Important sites include: + Eighty Mile Beach (2,230 individuals); + Ashmore Reef (1,132 individuals); and + Roebuck Bay (1,510 individuals).
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).
Streaked shearwater	Exmouth Gulf to the north.
Terek sandpiper	In Western Australia (WA), the terek sandpiper is rarely seen on the south coast: occasionally around Eyre and several records around Albany. On Swan River plain, it has been recorded between Bunbury and the mouth of the Moore River. The species is widespread in the Pilbara region and Kimberley Division, from Dampier to Wyndham, with occasional records around Shark Bay. Internationally important sites include: + Eighty Mile Beach (8,000 individuals); and + Roebuck Bay (1,840 individuals).
Whimbrel	It is common and widespread from Carnarvon to the north-east Kimberley Division, Western Australia. It is occasionally seen on the south coast of Western Australia and has occasionally been recorded in south-west Western Australia and further north to Shark Bay.
Wood sandpiper	The wood sandpiper has its largest numbers recorded in north-west Australia, with all areas of national importance located in Western-Australia: + Parry Floodplain (Wyndham) (355 individuals) + Camballin (185 individuals) + Lake Argyle (90 individuals) + Shark Bay area, (80 individuals) + Vasse-Wonnerup estuary (61 individuals) + Lake McLarty (64 individuals) + Kogolup Lakes (60 Individuals)

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 do not 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 8-6 below provides an overview of BIAs in the EMBA for birds. The DAWE 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**[8].

In addition, both the EPBC Act and WA BC Act and associated regulations (2018) provide for the listing of critical habitat - habitat 'critical to the survival of the threatened species'.

Table 8-6: Critical habitat/ biologically important areas - birds

Species	Scientific name	Aggregation area and use	Specific geographic locations for species
Abbott's booby	*Papsula abbotti*	All known nesting trees and all forest vegetation within a 200m radius of known nesting trees for Abbott's booby	Christmas Island
Australasian bittern	*Botaurus poiciloptilus*	All natural habitat (including constructed wetlands with suitable habitat)	Western coastal plain between Lancelin and Busselton Southern coastal region from Augusta to east of Albany
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 Island and Houtman Abrolhos. Pilbara and Gascoyne coasts and islands
Australian lesser noddy	*Anous tenuirorstris melanops*	Foraging - Houtman Abrolhos Islands	Houtman Abrolhos Islands
Bridled tern	*Onychoprion anaethetus*	Foraging - West coast of Western Australia and around to Recherche Archipelago	West coast of WA and around to Recherche Archipelago including offshore waters
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.
Caspian tern	*Sterna caspia*	Foraging - mainly islands (as far offshore as Adele, Bedout, Trimouille and the Houtman Abrolhos)	In WA 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.
Common noddy	*Anous stolidus*	Foraging	Around Houtman Abrolhos Around Lancelin Island
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.

[8] Further background information on BIA and identification of critical habitat in recovery plans is provided in Section 5.4.

Species	Scientific name	Aggregation area and use	Specific geographic locations for species
Christmas Island frigatebird	*Fregeta andrewsii*	All forest containing nesting and roosting sites, including currently known nesting and roosting colonies and any other smaller groups of nests and roosts	Christmas Island
Greater frigatebird	*Fregata minor*	Breeding, foraging - Kimberley and Ashmore Reef	Kimberley and 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
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
Lesser frigatebird	*Fregata ariel*	Breeding, foraging – Kimberley and Pilbara coasts and islands also Ashmore Reef.	Kimberley and Pilbara coasts and islands also Ashmore Reef.
Little penguin	*Eudyptula minor*	Foraging - Perth to Bunbury	Perth to Bunbury
Little shearwater	*Puffinus assimilis*	Foraging - From Kalbarri to Eucla	From Kalbarri to Eucla including offshore waters
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
Pacific gull	*Larus pacificus*	Foraging –west coast and islands	West coast and islands from Point Quobba (24º30'S) south to Wedge Island (formerly south to Warnbro Sound and at Cape Naturaliste); casual further north (Point Cloates and Lake MacLeod).
Red-footed Booby	*Sula sula*	Breeding, foraging - north west Kimberley and Ashmore reef	North west Kimberley and Ashmore reef
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 (13º50'S), south to Mandurah (32º32'S) and as far offshore as

Species	Scientific name	Aggregation area and use	Specific geographic locations for species
			Ashmore Reef, Bedout Island and the Houtman Abrolhos.
Soft plumage petrel	*Pterodroma mollis*	Foraging - seas north to 21º30'S	In WA found in seas north to 21º30'S.
Sooty tern	*Sterna fuscata*	Foraging – Timor sea	Timor Sea S to 14º30, off northwest coast from Lacepede I SW to 117ºE including 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
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 Island (32º07'S), and ranging in western seas between 12º00'S and 33º20'S. Kimberley, Pilbara and Gascoyne coasts and islands including Ashmore Reef
White-faced storm petrel	*Pelagodroma marina*	Foraging (in high numbers) - Offshore areas of the south-west marine region and into the adjacent south-east marine region and the north-west marine region to north of Shark Bay	Offshore areas of the south-west marine region and into the adjacent south-east marine region and the north-west marine region to north of Shark Bay
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

9. Protected Areas

A number of areas in the EMBA are protected under state and federal legislation. Protected areas include World Heritage Areas, 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**, **Figure 9-2** and **Figure 9-3**, 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 EMBA (**Appendix A**) identified several protected areas which were deemed to be irrelevant to Santos' petroleum activities due to their terrestrial location (e.g. Forrestdale and Thomsons Lakes – Ramsar wetland).

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 NT 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 EMBA

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 wetlands
	Peel-Yalgorup System
	Vasse-Wonnerup System
	Hosnies Spring
	The Dales
Wetlands of National Importance	Ashmore Reef
	Mermaid Reef
	Vasse-Wonnerup Wetland System
	"The Dales", Christmas Island
	Eighty Mile Beach System
	Exmouth Gulf East
	Hosnies Spring, Christmas Island
	Hutt Lagoon System
	Lake Macleod
	Lake Thetis
	Learmonth Air Weapons Range – Saline Coastal Flats
	Leslie (Port Hedland) Saltfields System
	Prince Regent River System

Area type	Title
	Roebuck Bay
	Rottnest Island Lakes
	Shark Bay East
	Cape Leeuwin System
	Doggerup Creek System
	Cape Range Subterranean Waterways
	Yalgorup System
National Heritage Place	HMAS Sydney II and HSK Kormoran Shipwreck Sites (Historic)
	Batavia Shipwreck Site and Survivor Camps Area 1629- Houtman Abrolhos (Historic)
	Dirk Hartog Landing Site 1616 - Cape Inscription Area (Historic)
	Dampier Archipelago (including Burrup Peninsula) (Indigenous)
	The West Kimberley (Natural)
	The Ningaloo Coast (Natural)
	Shark Bay (Natural)
	Fitzgerald River National Park (Natural)
	Lesueur National Park (Natural)
Commonwealth Heritage Place	Scott Reef and Surrounds – Commonwealth Area
	Ningaloo Marine Area - Commonwealth Waters
	Mermaid Reef - Rowley Shoals
	Ashmore Reef National Nature Reserve
	Garden Island
	Christmas Island Natural Areas
	Yampi Defence Area
	Learnmonth Air Weapons Range Facility
	Lancelin Defence Training Area
Threatened Ecological Communities	Monsoon Vine Thickets on the Ridge on the Coastal Sand Dunes of Dampier Peninsula
	Roebuck Bay mudflats
	Subtropical and Temperate Coastal Saltmarsh
	Trombolite (microbialite) Community of a Coastal Brackish Lake (Lake Clifton)
Terrestrial Conservation Reserves e.g. national parks, nature reserves, and conservation parks.	Numerous bounding marine waters – refer to **Section 9.6.**

9.1 World Heritage Areas

There are two World Heritage Areas located in marine waters of WA, both of which occur in the waters from the South Australian border to the NT 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 2008a). 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 2020):

+ 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 World Heritage Area is protected as a State Marine Reserve and is discussed further in **Section 11.1.3**.

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 2010b):

+ 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 Muiron 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 World Heritage Area is protected as a State Marine Park, a Commonwealth Marine Park, and is discussed further in **Section 11.1.4** and **Section 12.3.4**, 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 NT 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 and is discussed further in **Section 12.3.12.**

9.2.1 Eighty Mile Beach

The Eighty Mile Beach Ramsar site comprises a 220 km beach between Port Hedland and Broome with extensive intertidal mudflats and Mandora Salt Marsh, located 40 km east (Hale & Butcher 2009) totalling 175,487 ha. Eighty Mile Beach is characterised by extensive mudflats supporting an abundance of macroinvertebrates which provide food for large numbers of shorebirds.

Eighty Mile Beach is one of the most important sites for migratory shorebirds in the East Asian Australasian Flyway, with 42 migratory shorebird species recorded at this location. It is estimated that 500,000 shorebirds use Eighty Mile Beach as a migration terminus annually (Hale and Butcher 2009), and more than 472,000 migratory waders have been counted on the mudflats during the September to November period. The location of Eighty Mile Beach makes it a primary staging area for many migratory shorebirds on their way to and from Alaska and eastern Siberia (Hale & Butcher 2009). Although many birds move further on their journey, others remain at the site for the non-breeding period.

Eighty-mile Beach supports more than one per cent of the flyway population (or one per cent of the Australian population for resident species) of 21 waterbirds, including 17 migratory species and four Australian residents. It is one of the most important sites in the world for the migration of Great Knot.

Eighty Mile Beach also supports a high diversity and abundance of wetland birds. A total of 97 wetland bird species have been recorded within the beach portion of the Ramsar site (Hale & Butcher 2009). This includes 42 species that are listed under international migratory agreements CAMBA (38), JAMBA (38) and ROKAMBA (32) as well as an additional 22 Australian species that are listed under the EPBC Act. In addition, there is a single record for Nordmann's Greenshank (*Tringa guttifer*) from the beach, which is listed as endangered under the IUCN Red List (IUCN 2019).

The Mandora Salt Marsh area contains an important and rare group of wetlands (Lake Walyarta and East Lake), including raised peat bogs, a series of small permanent mound springs and the most inland occurrence of mangroves in WA (Hale & Butcher 2009). A small number of tidal creeks dissect the beach, including Salt Creek which is fed partly from groundwater and has permanent surface water. The Mandora Salt Marsh lakes fill predominantly from rainfall and runoff in the wet season then dry back to clay beds. The mound springs likely come from water deep within the Broome sandstone aquifer rising through fractures in the rock, and resulting in permanent mostly freshwater surface water. Flatback turtles (*Natator depressus*), listed as vulnerable under the EPBC Act, regularly nest at scattered locations along Eighty Mile Beach.

Eighty Mile Beach is used for beach based recreation, including four-wheel driving, motorcycling, fishing and shell collecting. Mandora Salt Marsh is mainly used for cattle grazing. The site is traditionally part of Karajarri Country in the north, Nyangumarta Country in the south and Ngarla Country in the southern end of Eighty Mile Beach. The site has artefacts such as middens, pinka (large baler shells used to scoop and carry water for drinking), wilura (used for sharpening spear heads), axes, and flakes, and kurtanyanu and jungari (grinding stones).

9.2.2 Roebuck Bay

The Roebuck Bay Ramsar site is located at Roebuck Bay near Broome in northern WA totalling 34,119 ha. Roebuck Bay has a large tidal range which exposes around 160 km^2 of mudflat, covering most of the Ramsar site (DoE 2014c). Waters more than 6 m deep at low tide are excluded from the site (Bennelongia 2009). The eastern edge of the site is made up of microscale linear tidal creeks (DoE 2014c).

The intertidal mud and sand flats support a high abundance of bottom dwelling invertebrates (between 300—500 benthic invertebrate species), which are a key food source for waterbirds (Bennelongia 2009). The site is one of the most important migration stop-over areas for shorebirds in Australia and globally. For many shorebirds, Roebuck Bay is the first Australian landfall they reach on the East Asian Australasian Flyway. The total numbers of waders using the site each year is estimated at over 300,000 (DoE 2014c). The northern beaches and Bush Point provide important high tide roost sites.

The site receives tidal seawater as well as fresh surface and groundwater, and the balance between the two influences the residual groundwater salinity and the distribution of plants and animals (DoE 2014c). Mangrove swamps line the eastern and southern edges of the site and extend up into the linear tidal creeks (DoE 2014c). They are important nursery areas for marine fishes and crustaceans, particularly prawns.

Extensive seagrass beds occur in the bay, providing an important feeding ground for dugongs and loggerhead and green turtles (Bennelongia 2009). Flatback turtles nest in small numbers, while marine fish (including sawfish) regularly breed in the tidal creeks and mangroves. Dolphins also regularly use the site (DoE 2014c).

The site is used for recreational or tourism activities such as fishing, crabbing, sightseeing and bird watching. Broome Bird Observatory, a small reserve at the northern end of the site, engages in shorebird research and public education.

Roebuck Bay lies in the traditional estate of Indigenous people belonging to both Jukun and Yawuru groups. The site was an important area for seasonal meetings, exchanging gifts, arranging marriages and settling disputes. Numerous shellfish middens, marking former camping places, can still be seen along coastal cliffs and dunes. Indigenous people continue to make extensive use of Roebuck Bay's natural resources for activities such as gathering shellfish, fishing and hunting.

9.2.3 Ashmore Reef National Nature Reserve

In addition to being listed as a National Nature Reserve, Ashmore Reef has been designated a Ramsar Wetland of International Importance due to the importance of the islands in providing a resting place for migratory shorebirds and supporting large breeding colonies of seabirds (Hale and Butcher, 2013). The reserve provides a staging point for many migratory wading birds from October to November and March to April as part of the migration between Australia and the northern hemisphere (Commonwealth of Australia, 2002). Migratory shorebirds use the reserve’s islands and sand cays as feeding and resting areas during their migration.

Ashmore is the largest of the atolls in the Timor Province bioregion. The three islands within the site are also the only vegetated islands in the bioregion. Each of the wetland types present are in near natural condition and the site has the largest seagrass coverage in the bioregion. The reserve supports 64 species of internationally and nationally threatened species. This includes 41 species of hard reef forming coral, eight fish, six reptiles (including endangered and critically endangered sea turtles and seasnakes), five sea cucumbers, two giant clams, one soft coral and the dugong.

Ashmore Reef plays a primary role in the maintenance of biodiversity in reef systems in the region. The Reserve supports 275 species of reef building coral, 13 species of sea cucumbers, and high numbers of mollusc species. There are over 760 fish species, 13 species of sea snake, 99 species of decapod crustacean and 47 species of waterbird listed as migratory under international treaties. It supports breeding of 20 species of waterbirds including the brown booby, lesser frigatebird, crested tern, bridled tern, sooty tern and common noddy. The Ramsar site is also important for feeding for green turtles, hawksbill turtle and loggerhead turtle and critical nesting and inter-nesting habitats for green and hawksbill turtles.

Ashmore Reef regularly supports more than 20,000 waterbirds and has been known to support more than 65,000 waterbirds. The Ramsar site regularly supports more than one per cent of at least six species of waterbird including the sooty tern, bar-tailed godwit, grey-tailed tattler, ruddy turnstone, sanderling and greater sand plover.

9.2.4 Becher Point

The Becher Point Wetlands Ramsar site is a system of about sixty small wetlands located near Rockingham in south-west Western Australia and covers 677 ha. The wetlands are made up of chains of small, linear ovoid or irregular shaped basins arranged in five groups, each roughly parallel to the coast and separated by sand ridges (DoE 2014l). The wetlands are an example of shrub swamps and seasonal marshes that have formed in an extensive sequence of inter-dunal depressions that have arisen from seaward advancement of the coastline over recent millennia.

The wetlands in the site are shallow and fill seasonally. Rainfall in winter and spring recharges the groundwater, which rise up to waterlog the wetland basins. The wetlands then dry out again for summer to autumn. When flooded the wetlands are mainly freshwater (DoE 2014l).

The wetlands support sedgelands, herblands, grasslands, open-shrublands and low open-forests. The sedgelands that occur within the linear wetland depressions of the Ramsar site are a nationally listed threatened ecological community. At least four species of amphibians and 21 species of reptiles have been recorded within the wetlands, as well as the Southern Brown Bandicoot (DoE 2014l).

9.2.5 Peel-Yalgorup System

The Peel-Yalgorup System located adjacent to the city of Mandurah in Western Australia, is a large and diverse system of shallow estuaries, coastal saline lakes and freshwater marshes. The site includes the Peel Inlet, Harvey Estuary, Lake McLarty, Lake Mealup and ten Yalgorup National Park wetlands and covers an area of 26, 530 ha (DoE 2014m). Lake Clifton, which is part of the wetlands is one of the few locations in the word where thrombolites occur in inland, hyposaline waters. Thrombalites are underwater rock-like structures that are formed by the activities of microbial communities.

The Peel-Yalgorup System Ramsar site is the most important area for waterbirds in south-western Australia, supporting in excess of 20,000 waterbirds annually (DoE 2014m). It also supports a wide variety of invertebrates and estuarine and marine fish.

9.2.6 Vasse-Wonnerup System

The Vasse-Wonnerup System Ramsar wetland is situated in the Perth Basin, south-western Western Australia and covers an area of 1,115 ha. It is an extensive, shallow, nutrient-enriched wetland system of highly varied salinities. The site is located on a narrow, flat plain separated from the ocean by a narrow system of low dunes. The system is comprised of two former estuaries – the Vasse and Wonnerup lagoons (DoE 2014n).

The system supports tens of thousands of resident and migrant waterbirds of a wide variety of species. More than 33,000 waterbirds have been counted at the Vasse-Wonnerup System and more than 80 species have been recorded in the System including Red-necked Avocets and Black-winged Stilts, Wood Sandpiper, Sharp tailed Sandpiper, Long-toed Stint, Curlew Sandpiper and Common Greenshank (DoE 2014n).

9.2.7 Hosnies Spring

The Hosnies Spring Ramsar site is located on Christmas Island and is a small area of shallow freshwater streams and seepages, 20–45 metres above sea-level on the shore terrace of the east coast of the island covering an area of approximately 199 ha. The site includes surrounding terrestrial areas with rainforest grading to coastal scrub and includes an area of shoreline and coral reef (DoEE 2019).

The Hosnies Spring Ramsar site supports a unique wetland of Christmas Island with the mangrove forest present at the site unique within the bioregion and possibly worldwide. The two species of mangroves that make up the stand, which normally grow intertidally, grow to a height of 24–37 m above sea level that have been estimated to have persisted for 120,000 years. Additionally, the site is important to blue crabs which rely on the freshwater provided by the spring and as a likely migratory route for the endemic red crab during breeding migrations (DoEE 2019).

9.2.8 The Dales

The Dales Ramsar site is located on Christmas Island and is comprised of a near-pristine system of seven watercourses collectively known as The Dales and covers an area of 585 ha. The Dales includes permanent and perennial streams, permanent springs, and include the majority of surface water on the Island. Most rainfall on Christmas Island filters down through the soil and limestone, and surface runoff only occurs after heavy rain. The Dales contain numerous wetland types including surface and karst features, and inland and coastal wetlands (DoEE 2019a).

The Dales support a number of unique ecological and geomorphic features including anchialine cave communities, surface karst including the unique stepped tufa deposits at Hugh's waterfall, a stand of Tahitian chestnuts, a large number of endemic terrestrial species and a significant number of seabirds including Abbott's booby, red-footed booby and the brown booby, all of which breed at the site, and provide essential habitat for the Christmas Island frigatebird (DoEE 2019a).

9.3 Wetlands of National Importance

9.3.1 Ashmore Reef

See the Ashmore Reef National Nature Reserve (**Section 9.2.3**) and Ashmore Reef Marine Park (**Section 12.3.12**).

9.3.2 Mermaid Reef

See the Mermaid Reef Marine Park (**Section 12.3.9**).

9.3.3 Vasse-Wonnerup Wetland System

See the Vasse-Wonnerup Wetland System (**Section 9.2.6**).

9.3.4 "The Dales", Christmas Island

See The Dales Ramsar site (**Section 9.2.8**).

9.3.5 Eighty Mile Beach System

See Eighty Mile Beach Ramsar site (**Section 9.2.1**).

9.3.6 Exmouth Gulf East

The Exmouth Gulf East wetlands are located in the eastern section of Exmouth Gulf from Giralia Bay to Urala Creek Locker Point. The wetland comprises of numerous tidal creeks, indentations and islands of dry land, mudflats, saline coastal flats and extensive mangroves (DAWE 2020a).

The site is one of the major population centres for dugongs in WA and its seagrass beds and extensive mangroves provide nursery and feeding areas for marine fishes and crustaceans in the Gulf. In addition, there are at least 29 species of birds which utilise the wetland, including 16 migratory shorebirds and several terns (DAWE 2020a).

9.3.7 Hosnies Spring, Christmas Island

See Hosnie's Spring Ramsar site (**Section 9.2.7**).

9.3.8 Hutt Lagoon System

The Hutt Lagoon System wetlands (3,000 ha) are located within the Geraldton Sandplains and comprises of Hutt Lagoon and the lakes and marshes immediately north-west and south-east of the lagoon, notably Utcha Swamp. The system is a coastal brine lake which runs parallel to the coast (DAWE 2020b).

Hutt Lagoon is a migratory stop-over for migratory waders, however numbers using the area vary greatly between years and are likely to be lower when northern and inland waterbodies are extensively flooded. Breeding shorebirds include the Australasian grebe (*Tachybaptus novaehollandiae*), grey teal (*Anas gibberifrons*) and eurasian coot (*Fulica atra*) at Utcha Swamp (DAWE 2020b).

9.3.9 Lake Macleod

The Lake Macleod wetland (150,000 ha) is located in the Carnarvon bioregion and includes distinct "inner wetlands" (sinkholes, channels, lakes, marshes) in the west and "floodout marshes" at river mouths in the north-east. The wetland also includes a lakebed that is infrequently inundated. The lake lies parallel to the Indian Ocean, north of the Gascoyne River and located 30 km away from Shark Bay East wetland (DAWE 2020c).

The Lake Macleod is a major migration stop-over and drought refuge area for shorebirds; it is one of the most important non-tidal stop-over sites in Australia. It also supports Australia's largest inland community of mangroves and associated fauna. Fifty-eight species have been identified within the wetland with 29 being shorebirds and eight gulls and terns, with seven species found breeding (DAWE 2020c).

9.3.10 Lake Thetis

The Lake Thetis wetland (7 ha) is located in the Swan bioregion and comprises of seasonal marshes that form in interdunal areas to the south of the lake. Lake Thetis is distinguished by the presence of both a variety of benthic microbial communities (mats) and stromatolites. No threatened species or migratory species have been observed to utilise this wetland (DAWE 2020d).

9.3.11 Learmonth Air Weapons Range – Saline Coastal Flats

The Learmonth Air Weapons Range – Saline Coastal Flats wetland (300 ha) represents typical saline coastal flats subject to inundation and ponding. The vegetation typically has a low species richness, but its floristic composition and structure is highly distinctive and supports habitat specific fauna (DAWE 2020e).

Species composition of the wetland has little information however it is likely to possess a relatively diverse community (DAWE 2020e).

9.3.12 Leslie (Port Hedland) Saltfields System

The Leslie (Port Hedland) Saltfields System (13,000 ha) comprises a large saltfield, fringing coastal flats, tidal creeks and mudflats between the saltfields and the Indian Ocean.

The wetland is likely a major migration stop-over area for shorebirds in the East Asia-Australasia Flyway. It is possibly the most important stop-over site in the Flyway for the broad-billed sandpiper (*Limicola falcinellus*) and an important site for oriental plover (*Charadrius veredus*). It is also likely to be the most important site in Australia for Asian dowitcher (*Limnodromus semipalmatus*) and red-necked phalarope (*Phalaropus lobatus*) (DAWE 2020f).

9.3.13 Prince Regent River System

The site comprises of the entire Prince Regent River system and large areas of mangrove on either side of the river mouth in Saint George Basin (14,300 ha). The site is a tropical estuary and river system incised in a plateau and is characterised by mangrove-fringed embayments (DAWE 2020g).

The site comprises of a diverse assemblage of flora and fauna, and includes mangroves, riverine vegetation, waterbirds, frogs, reptiles and fish. The site includes some of the most suitable and extensive breeding habitat for the saltwater crocodile in WA, well developed river banks with thick stands of reed and grasses (DAWE 2020g).

9.3.14 Roebuck Bay

See Roebuck Bay Ramsar site (**Section 9.2.2**).

9.3.15 Rottnest Island Lakes

The Rottnest Island Lakes wetland site comprises of a cluster of 18 lakes and swamps on the north-east part of Rottnest Island (180 ha). The site is a breeding area for Australian shelduck (*Tadorna tadornoides*) and major breeding area for Australian fairy tern (*Sterna nereis nereis*). The lakes are also a major migration stop-over area for shorebirds in south-western Australia and provide a significant drought refuge area for shorebirds, notably the banded stilt (*Cladorhynchus leucocephalus*) (DAWE 2020h).

9.3.16 Shark Bay East

The Shark Bay East wetland site extends along 250 km of coastline in the east arm of Shark Bay, from the mouth of the Gascoyne River (Carnarvon) south to latitude 26 S. The site comprises tidal wetlands and marine waters that are less than 6 m deep at low tide (up to approximately 10 km from shore). The wetland is a large, shallow marine embayment that support extensive seagrass beds and substantial areas of intertidal mud/sand-flats and mangrove swamp (DAWE 2020i).

The mangroves, algae and seagrasses present at the side are important for both dugongs and green turtles. A total of 69 species have been identified within the wetland including the threatened little tern (*Sterna albifrons*) and 33 shorebirds. A total of six species have been identified to be breeding within the wetland (Australian pelican, great egret, little egret, unidentified cormorants and striated herons). The site is also a stop-over for 24 species of migratory shorebirds (DAWE 2020i).

9.3.17 Cape Leeuwin System

The Cape Leeuwin System site is a small coastal valley, approximately 20 ha in size. Seepage from a series of freshwater springs feed an elongate swamp on the floor of the valley and moistens areas of the limestone and granite coastline to the west (DAWE 2020j). The site has been identified as the habitat for the largest known population of the rare aquatic gastropod mollusc; the Cape Leeuwin freshwater snail (*Austroassiminea letha* (Sr)) (DAWE 2020j).

9.3.18 Doggerup Creek System

The Doggerup Creek System site (2,500 ha) supports extensive flats subject to inundation in the north and east of its catchment. The site includes lakes (e.g. Doggerup, Samuel and Florence Lakes) and many small unnamed swamps. The site is an example of an `acid peat flat' with small permanent lakes and river (DAWE 2020k).

The wetland plant communities include 32 species at Doggerup Lake, 19 at Lake Samuel and 35 at Lake Florence. The site is a major habitat for two aestivating inland fishes, *Galaxiella nigrostriata* and *Lepidogalaxias salamandroides*, that are endemic to the far south coast of WA. No threatened species have been identified within the site and it is not considered to be an important wetland for migratory shorebirds (DAWE 2020k).

9.3.19 Cape Range Subterranean Waterways

The Cape Range Subterranean Waterways wetland site comprises of the subterranean waterways, sinkholes, general groundwater and artificial wells of the coastal plain and foothills of Cape Range north of a line between Norwegian Bay, at the foot of the peninsula on the west coast, and the Bay of Rest in Exmouth Gulf (DAWE 2020l).

The site is one of the only examples of subterranean karst wetland system (apart from Barrow Island) in arid north-western Australia. Two threatened species have been identified within the wetland and include the blind cave eel and the blind gudgeon (DAWE 2020l).

9.3.20 Yalgorup System

See Peel-Yalgorup System Ramsar site (**Section 9.2.5**).

9.4 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 NT border, with nine of these occurring within the EMBA. Shark Bay and The Ningaloo Coast are listed as both World Heritage Areas and National Heritage Places, and are discussed in **Section 9.1**.

9.4.1 HMAS Sydney II and HSK Kormoran Shipwreck Sites

The naval battle fought in 1941 between the Australian warship HMAS Sydney II and the German commerce raider HSK Kormoran off the Western Australian coast during World War II was a defining event in Australia's cultural history. The loss of HMAS Sydney II, along with its entire crew of 645 following the battle with HSK Kormoran, remains Australia's worst naval disaster (DoE 2014d).

The shipwreck sites are comprised of two areas located approximately 290 km west-southwest of Carnarvon. The shipwrecks of the HMAS Sydney II and HSK Kormoran are located on the seabed approximately 22 km apart (DoE 2014d).

9.4.2 Batavia Shipwreck site and Survivor Camps Area 1629 - Houtman Abrolhos

The Batavia was included on the National Heritage List in 2006. This shipwreck is the oldest of the known Verenigde Oost-Indische Compagnie (VOC) wrecks on the WA coast and has a unique place in Australian shipwrecks. Because of its relatively undisturbed nature the archaeological investigation of the wreck itself has revealed a range of objects of considerable value to the artefact specialist and historian. The recovered sections of the hull of the Batavia that have been reconstructed in the Western Australian Maritime Museum and provides information on 17th century Dutch ship building techniques, while the remains of the cargo carried by the vessel have provided economic, and social evidence of the operation of the Dutch port at Batavia (now Jakarta) in the early 17th century (DoE 2014d).

9.4.3 The West Kimberley

The West Kimberley was included on the National Heritage List in 2011 and has numerous values which contribute to the significance of the property, including indigenous, historic, aesthetic, cultural and natural heritage values (DoE 2014d). Of these values, the most relevant to the marine environment is Roebuck Bay as a migratory hub for shorebirds. These values are discussed in **Section 9.2.2**. The area is characterised by a diversity of landscapes and biological richness found in its cliffs, headlands, sandy beaches, rivers, waterfalls and islands.

9.4.4 The Ningaloo Coast

See the Ningaloo Coast World Heritage Area (**Section 9.1.2**).

9.4.5 Shark Bay

See Shark Bay World Heritage Area (**Section 9.1.1**).

9.4.6 Dirk Hartog Landing Site 1616 - Cape Inscription Area

Cape Inscription is the site of the oldest known landings of Europeans on the Western Australian coastline (from Dirk Hartog of the Dutch East India Company's ship the Eendracht in October 1616), and is associated with a series of landings and surveys by notable explorers over a 250-year period (DoEE 2019b). The landing site forms part of the Dirk Hartog Island and is about 1,110 ha located 100 km south west of Carnarvon (DoEE 2019b).

9.4.7 Dampier Archipelago (including Burrup Peninsula)

The Dampier Archipelago (including the Burrup Peninsula) contains one of the densest concentrations of rock engravings in Australia, with some sites containing thousands or tens of thousands of images. At a national level it has an exceptionally diverse and dynamic range of schematised human figures and provides an unusual and outstanding visual record of the Aboriginal responses to the rise of sea levels at the end of the last Ice Age (DoEE 2019c).

The site is about 36,860 ha at Dampier and comprises of nine distinct areas of the Burrup Peninsula Areas and part of the following surrounding islands: West Intercourse Island, West Mid Intercourse Island, Enderby Island, Goodwin Island, West Lewis Island and East Lewis Island, Rosemary Island, Brigadier Island, Miller Rocks, Lady Nora Island and Elphick Nob, Malus Islands, Angel Island, Gidley Island, Cohen Island, Keast Island and Collier Rocks, Tozer Island, Dolphin Island, and Unnamed Island (DoEE 2019c).

9.4.8 Fitzgerald River National Park

The Fitzgerald River National Park contains an exceptional concentration of plant species richness and endemism. At an international level it is recognised as a biodiversity hotspot of south western Australia and at a national level it has an exceptional endemism and diversity for plant species. The diversity is considered high due to a wide range of landforms, geology and soil types that supports a diverse community of shrublands and heath, often dominated by eucalypt mallee species (DoEE 2019d).

The national park is approximately 297,244 ha located between Bremer Bay and Hopetoun in the south west of Western Australia. The park contains extensive marine plain sediments deeply incised by several rivers, creating valleys and tablelands. The park’s coastline is diverse, consisting of long beaches, quartzite cliffs, extensive sand drifts and inlets. Along the Hamersley and Fitzgerald River valleys are spongolite cliffs that were formed more than 36 million years ago (Eocene period) and consist of sea sponge fossils (DoEE 2019d)

9.4.9 Lesueur National Park

The Lesueur National Park contains an exceptional concentration of plant species richness and endemism. At an international level it is recognised as a biodiversity hotspot of south western Australia and at a national level it has an exceptional endemism and diversity for plant species. The diversity is considered high due to a wide range of landforms, geology and soil types that supports a diverse community of shrublands and heath (DoEE 2019e).

The national park is approximately 27,235 ha located near the towns of Green Head and Jurien Bay. Coastal areas consist of recent (Holocene) sand deposits and mobile dunes extending inland for approximately two kilometres. The dunes are bordered by a series of mainly saline lakes with some freshwater springs and swamps on the eastern margins. Further inland are older (Quaternary) dune systems that have been compacted in places to form limestone. The park supports approximately 122 birds, including a diverse range of honeyeaters, fairy wrens and thornbills (DoEE 2019e).

9.5 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. Nine natural Commonwealth Heritage Places are found in or adjacent to the EMBA. Three of these places (Ashmore Reef, Mermaid Reef and the Ningaloo Marine Area – Commonwealth Waters) are found in Marine Parks and are 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 9.4.1**.

9.5.1 Scott Reef and Surrounds – Commonwealth Area

Scott Reef is a large, emergent shelf atoll located on the edge of the broad continental shelf, about 300 km from mainland north-western Australia. The listing comprises the areas of Scott Reef that are within Commonwealth waters to the 50 m BSL bathymetric contour. This includes North Reef, an annular reef, 16.3 km long and 14.4 km wide and parts of the lagoon of South Reef, a crescent shaped reef 17 km across (DoE 2014d).

The place is regionally significant both because of its high representation of species not found in coastal waters off Western Australia and for the unusual nature of its fauna which has affinities with the oceanic reef habitats of the Indo-West Pacific as well as the reefs of the Indonesian region (DoE 2014d).

9.5.2 Mermaid Reef – Rowley Shoals

See the Mermaid Reef Marine Park (**Section 12.3.9**).

9.5.3 Ningaloo Marine Area – Commonwealth Waters

See the Ningaloo Coast World Heritage Area (**Section 9.1.2**).

9.5.4 Ashmore Reef National Nature Reserve

See the Ashmore Reef Marine Park (**Section 12.3.12**).

9.5.5 Garden Island

Garden Island is located to the south of Perth, 5 km northwest of Rockingham. It was registered in 2004 based on various fauna, geological, European and Aboriginal heritage and vegetation values. It was the original first site occupied by Governors Stirling's Party in 1829, with prior use by Aborigines and the French (being called Ile de Buache by the French in 1801). The island is virtually free from widespread feral animal colonisation, providing important habitat for various species that have reduced on the mainland. The island provides breeding habitat for bridled tern (*Onychoprion anaethetus*), rainbow bee-eaters (*Merops ornatus*) and osprey (*Pandion haliaetus*), which nest on the rocks surrounding the island. Important feeding habitat for the Sanderling (*Calidris alba*) is provided by sandy beaches on the west coast of the island.

The island provides nesting habitat on beaches for the breeding migrant fairy tern (*Sterna nereis*), which requires undisturbed nesting periods. The mature relatively undisturbed heath, scrub and low forest communities unburnt since the 1920's in the northern section of the island are especially important as a reference site for natural history. The least disturbed examples of calcaronite reef structures dune and tamate landscapes in the metropolitan region are present on the western side of the island (DoEE 2016b).

9.5.6 Christmas Island Natural Areas

Christmas Island is located is approximately 1,500 km from Exmouth and is approximately 2,200 ha above Low Water and 3,600 ha below Low Water in the Indian Ocean. The island is an uplifted coral atoll with its characteristic steep series of rainforest-covered terraces and sheer limestone cliffs. It was registered in 2004 based on various fauna, vegetation, geological and cultural heritage values. The evolutionary significance of Christmas Island is demonstrated both by its high level of endemism and by its unique assemblage of plant and animal species. The island hosts seventeen endemic plant species and rich endemic fauna includes three mammal species, ten bird species, five reptile species, one crab species, two insects, three marine fish species and several marine sponge species (DoEE 2019f).

The rainforests of Christmas Island are biogeographically significant; species have evolved from being either shoreline forest or early rainforest succession species to those that fill a tall climax rainforest role. The Island contains unique plant communities of high conservation and scientific interest including a variety of elevated and relict cycad and back-mangrove communities of international significance (DoEE 2019f).

The island is also one of the world's most significant seabird islands, both for the variety and numbers of sea-birds, with over 100 species of bird having been recorded, including eight species that breed on the island. The island rainforest provides significant habitat for two endemics the nationally endangered Abbott's booby and the nationally vulnerable Christmas Island frigate bird (DoEE 2019f).

The fringing simple reefs and adjacent waters of Christmas Island support provides habitat for two nationally vulnerable species of turtle, the green and hawksbill which nest on two of the Island's beaches and two nationally vulnerable shark species (DoEE 2019f).

9.5.7 Yampi Defence Area

The Yampi Defence Area is located at the confluence of the Dampierland, Central and Northern Kimberley biogeographic regions and has a diverse range of ecosystems of landforms, soils and vegetation representative of the transition from the sandstone plateaux of the wetter north-west Kimberley, to the broad plains and pindan scrub of the drier south-west Kimberley (DoEE 2019g).

The diversity of landforms in the place and the resultant high concentration of small refugial habitats support a regionally rich vertebrate fauna. The bird fauna is significant as it represents a suite of species which are at or near the southern edge of their range in the semi-humid zone of the Kimberley. The place is also an important zone of overlap between many northern and southern species and sub-species. The vertebrate fauna shows its closest similarity to those recorded from the wetter areas of the west Kimberley that lie further to the north. The place supports several fauna and flora species that are listed as specially protected, threatened or having priority status in Western Australia in addition to four fauna species that are nationally vulnerable and one nationally endangered (DoEE 2019g).

9.5.8 Learmonth Air Weapons Range Facility

The Learmonth Air Weapons Range Facility is located 30 km south west of Learmonth within Cape Range and Adjacent Coastal Plain, which is listed on the Register of the National Estate. As the Learmonth Air Weapons Range Facility is located within Cape Range it is of considerable importance of showing he sea level and landform changes for the past 1.8 million years (DoEE 2019h).

The area is important to a number of cave fauna of Cape Range and is considered of exceptional biogeographical importance. It hosts a high number of endemic aquatic stygofauna with ecosystems found within this area are considered rare within Western Australia and are considered to be of considerable scientific interest. The area also supports several species of terrestrial fauna that are isolated populations, populations at the extent of their range and a number of fauna and flora species that are endemic to southern WA and restricted to sandy coastal habitats along the western coast (DoEE 2019h).

9.5.9 Lancelin Defence Training Area

The Lancelin Defence Training Area is located approximately 11 k north of Lancelin township situated on the Swan Coastal Plain and consists of three main land systems that include Quindalup and Spearwood Dune Systems (together making up the Coastal Belt), and the Bassendean Dunes (DoEE 2019i).

The area supports a high diversity of vegetation types, flora species, fauna habitat types and a high diversity of terrestrial fauna.

9.6 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, 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; and
+ 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 EMBA. 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 9.6.1** (national parks) and **Section 9.6.2** (nature reserves and conservations parks).

9.6.1 Coastal National Parks

Protected coastal national parks managed under the CALM Act 1984 in the EMBA 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[9]	Management plan	Includes inter-tidal zone	Adjacent Marine Management Park (see Section 11)
Reserves of Northern WA (see Figure 9-4)				
Lawley River	Northern Kimberley	-	No [10]	Kimberley Marine Park
Mitchell River		-		
Prince Regent		-		
Reserves of North-West WA (see Figure 9-5)				
Murujuga	Pilbara	Murujuga National Park management plan 78 (DEC 2013)	Yes [11]	-
Cape Range	Carnarvon	Cape Range National Park Management Plan (DEC 2010a)	No	Ningaloo Marine Park
Reserves of Southern WA – (see Figure 9-6)				
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)	
Houtman Abrolhos Islands	Geraldton Sandplains	-	No - extends to the high water mark only.	Abrolhos Commonwealth Marine Park
Kalbarri	Geraldton Sandplains	Kalbarri National Park Management Plan (DPAW 2015)	Yes [11]	-
Namburg	Geraldton Sandplains	Namburg National Park Management Plan (1998)	Yes	-
Yalgorup	Swan Coastal Plain	Yalgorup National Park Management Plan (CALM 1995)	Yes [11]	-

[9] IBRA classifies Australia's landscapes into large geographically distinct bioregions based on common climate, geology, landform, native vegetation and species information (DoEE 2012).

National Park	IBRA bioregion[9]	Management plan	Includes inter-tidal zone	Adjacent Marine Management Park (see Section 11)
Leeuwin - Naturaliste	Warren	Leeuwin-Naturaliste Capes Area Parks and Reserves Management Plan (DPAW 2015)	No	Ngari Capes Marine Park
Torndirrup	Warren	Albany coast draft management plan 2016 (DPaW 2016b)	Yes[11]	
Walpole-Nornalup	Warren	Walpole Wilderness and Adjacent Parks and Reserves Management Plan (DEC 2008) Walpole and Nornalup Inlets Marine Park Management Plan No 62 (DEC 2009b)	Yes[11]	Walpole and Nornalup Inlets Marine Park
Waychinicup	Southern Jarrah Forest and Fitzgerald	Albany coast draft management plan 2016 (DPAW 2016)	Yes[11]	
West Cape Howe	Warren	Albany coast draft management plan 2016 (DPaW 2016)	Yes[11]	
D'Entrecasteaux	Warren	Shannon and D'Entrecasteaux National Parks Management Plan No. 71 (DEC 2012b)	Yes[11]	
Fitzgerald River	Fitzgerald	Fitzgerald River National Park Management Plan 1991 – 2001 No. 15 (CALM 1991)	Yes[11]	

9.6.2 Coastal Nature Reserves and Conservation Parks

Protected coastal nature reserves and conservation parks managed under the CALM Act 1984 in the EMBA are listed in **Table 9-3** and shown in **Figure 9-4**, **Figure 9-5** and **Figure 9-6** 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 EMBA

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 9-4)					
Ord River NR	-	1a	-	No [10]	North Kimberley Marine Park
Pelican Island NR	-	1a			
Lesueur Island NR	A	1a			
Low Rocks NR	A	1a			
Browse Island NR	A	1a	-	Yes [11]	-
Scott Reef NR	-	1a	-	Yes [11]	-
Adele Island NR	A	1a	-	Yes [11]	-
Tanner Island NR	A	1a	-	Yes [11]	-
Lacepede Islands NR		1a	-	Yes [11]	-
Coulomb Point NR	A	1a	-	Yes [11]	-
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 (DPAW 2016). *Covers 80 Mile Beach coastal reserves*.	No	Eighty Mile Beach Marine Park
Jinmarnkur Kulja NR	A	-			
Kujungurru Warrarn NR	A	1a			
Kujungurru Warrarn CP	C	-			
Unnamed	A	-			
Jarrkunpungu NR	A				
Bedout Island NR	A	1a	-	Yes [11]	-
North Turtle Island NR	A	1a	-	Yes [11]	-
Reserves of North-West WA (see Figure 9-5)					
Unnamed (Dampier Archipelago) NR	A	1a	Dampier Achipelago Management Plan (CALM 1990). *Covers 25 of the islands*	Yes	-
Swan Island NR	A	1a	-	Yes[11]	Kimberly Marine Park
Unnamed NR		1a	-	Yes [11]	-
North Sandy Island NR	A	1a	-	Yes [11]	-

[10] Inferred as adjacent marine park boundary is the high water mark and dual tenure cannot exist.

[11] 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)
Montebello Islands CP	A	2	-	Partially [12]	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 [11]	-
Little Rocky Island NR	A	1a	-	Yes [11]	-
Airlie Island NR	-	1a	-	Yes [11]	-
Thevenard Island Nature	-	1a	-	Yes [11]	-
Bessieres Island NR	A	1a	-	Yes [11]	-
Serrurier Island NR	-	1a	-	Yes [11]	-
Round Island NR	-	1a	-	Yes [11]	-
Locker Island NR	A	1a	-	Yes [11]	-
Rocky Island NR	-	1a	-	Yes [11]	-
Gnandaroo Island NR	A	1a	-	Yes [11]	-
Victor Island NR	-	1a	-	Yes [11]	-
Y Island NR	-	1a	-	Yes [11]	-
Tent Island NR	-	1a	-	Yes [11]	-
Burnside and Simpson Island NR	-	1a	-	Yes [11]	-
Whalebone Island NR		1a	-	Yes [11]	-
Whitmore, Roberts, Doole Islands & Sandalwood Landing NR	-	1a	-	Yes [11]	-
Muiron Islands NR	-	1a	Jarabi and Bundegi Coastal Parks and Muiron Islands (CALM 1999)	No [10]	Muiron Islands Marine Management Area
OneTree Point NR	A	1a	-	Yes [11]	
Reserves of Southern WA – (see Figure 9-6)					
Koks Island NR	A	1a	Shark Bay Terrestrial Reserves and Proposed Reserve Additions	Yes [11]	-
Bernier and Dorre Islands NR	A	4			

[12] 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)
Shell Beach CP	-	3	Management Plan (DPAW 2012)	No	Shark Bay Marine Park
Freycinet, Double Islands etc NR	A	1a			Shark Bay Marine Park
Zuytdorp NR	-	1a		Yes [11]	-
Beekeepers NR	-	1a	-	Yes [11]	-
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			
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 Beekeepers 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 [11]	-
Unnamed CR (R 42469) at Woodman Point	-	-	Woodman Park Regional Park Management Plan (DEC 2010b)	No	-
Unnamed CP at Woodman Point (R 49220)	-	2		No	-
Carnac Island NR	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	

Reserve name and type	Reserve class (WA)	IUCN	Management Plan	Includes inter-tidal zone	Adjacent Marine Park (see Section 11)
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	
St Alouarn Island NR	A	1a		Yes	
Flinders Bay NR	A	1a		Yes	
Quagering NR	A	1a	-	Yes[11]	-
Doubtful Islands NR	A	1a	-	Yes	Bremer Marine Park
Quarram NR	A	1a	-	Yes	South-west corner Marine Park
Chatham Island NR	A	1a	-	Yes	
Two Peoples Bay NR	A	4	Albany coast draft management plan 2016 (DPAW 2016b)	Yes[11]	-
Breaksea Island NR	A	1a		Yes[11]	-
Bald Island NR	A	1a		Yes[11]	-
Eclipse Island NR	A	1a		Yes[11]	-
Michaelmas Island NR	A	1a		Yes[11]	-
Glasse Island NR	A	1a	-	Yes[11]	-
Arpenteur NR	-	1a	-	No	-

Further information is provided below in relation to Varanus Island and Airlie Island Nature Reserves. Santos' 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-tailed Shearwater nesting (see **Section 8.1.6**); 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 8.2.1**.

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 8.1.6**); silver gull nesting (see **Section 8.1.6**) and low levels of green turtle and hawksbill turtle nesting (see **Section 6.1.2** and **6.1.3**).

9.7 Threatened Ecological Communities

An ecological community is a naturally occurring group of plants, animals and other organisms interacting in a unique habitat. Ecological communities are listed under the EPBC Act as threatened if the community is at risk of extinction.

Similarly, ecological communities can be listed under the WA BC Act as threatened if facing a risk of becoming a collapsed ecological community. To date no ecological communities are listed as threatened under the WA Act, however several ecological communities are currently endorsed by the WA Minister of Environment as Threatened Ecological Communities (TECs) through the previous non-statutory process.

TECs of relevance (likely to exist in marine water inter-tidal areas) in the EMBA are listed in **Table 9-1** and further described below.

Table 9-4: Relevant TEC in the marine EMBA

Species	Conservation Status		
	EPBC Act 1999 (Cwth)	BC Act 2016 (WA)	Otherwise endorsed by the WA Minister for Environment
Monsoon Vine Thicket on the Ridge on the Coastal Sand Dunes of Dampier	Endangered	-	Vulnerable
Roebuck Bay mudflats	-	-	Vulnerable
Subtropical and Temperate Coastal Saltmarsh	Vulnerable	-	-

9.7.1 Monsoon Vine Thicket on the Ridge on the Coastal Sand Dunes of Dampier

Monsoon vine thicket occurs as semi - deciduous and evergreen vine thicket communities on and behind landward slopes of coastal sand dunes on the Dampier Peninsula in the Kimberley Region. This community is closely associated with coastal dunes elsewhere on the Dampier Peninsula and is listed as Endangered under the EPBC Act (Government of Western Australia 2010; DoEE 2016b). The community is also endorsed by the WA Minister for Environment as a threatened ecological community (non-statutory process).

9.7.2 Roebuck Bay Mudflats

Roebuck Bay mudflats (Kimberley region) have been endorsed by the WA Minister for Environment as a threatened ecological community (non-statutory process). The TEC is not listed under the EPBC Act.

Roebuck Bay mudflats (Kimberley region) are described as a ‘species rich faunal community of the intertidal mudflats of Roebuck Bay’ in the Kimberley region. Classed as Vulnerable (B). Roebuck Bay is a tropical marine embayment with extensive, biologically diverse, intertidal mudflats.

Roebuck Bay is protected as a designated Ramsar Wetland of International Importance (**Section 9.2.2**) and Marine Park (see **Sections 11.1.17** and **12.3.10**).

9.7.3 Subtropical and Temperate Coastal Saltmarsh

Subtropical and Temperate Coastal Saltmarsh occurs within the subtropical and temperate climatic zones and is present in coastal areas under regular or intermittent tidal influences and occurs over six State jurisdictions (Queensland, New South Wales, Victoria, Tasmania and WA). In WA it occurs from the south coast up to the southern part of Shark Bay. The community is made up of mainly salt tolerant vegetation which include halophytes as well as a number of non-vascular plant species. The community is listed as vulnerable under the EPBC Act (DoE 2014k).

9.7.4 Thrombolite (microbialite) Community of a Coastal Brackish Lake (Lake Clifton)

The Lake Clifton thrombolite community is restricted to Lake Clifton, which occurs on the Swan Coastal Plain region of WA. Lake Clifton is situated within the Yalgorup National Park and is the northernmost lake in the Peel-Yalgorup Lakes System, which consists of several hypersaline and brackish lakes (Moore 1990). The Lake Clifton thrombolite community occurs on a relict foredune plain of Holocene age sands. The main known occurrence of the ecological community is a stretch, approximately 15 km long and up to 15 m wide, along the north-eastern shoreline of Lake Clifton. There are other small clusters of thrombolites within the Lake, also at the northern end. The thrombolites cover a total area of approximately four square kilometres (Moore 1990). This structure is the largest known example of a living, non-marine microbialite reef in the southern hemisphere.

The Thrombolite (microbialite) Community of a Coastal Brackish Lake (Lake Clifton) is listed as critically endangered under the EPBC Act because it has a very restricted distribution and recent investigations indicate that *Scytonema*, a key cyanobacterium for thrombolite formation has gone from being a dominant species to no longer being found in Lake Clifton thrombolites.

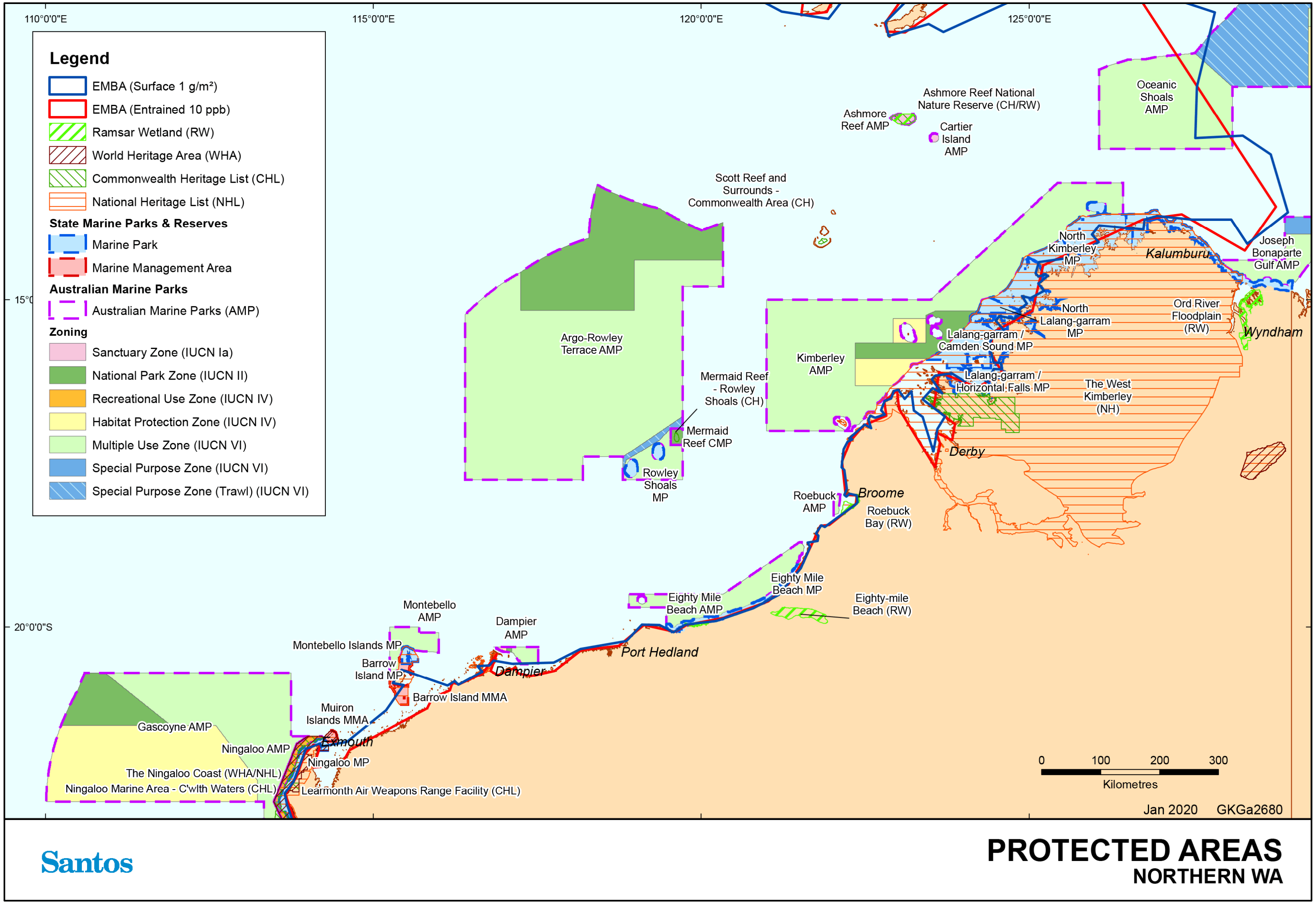

Figure 9-1: Protected areas in Northern WA

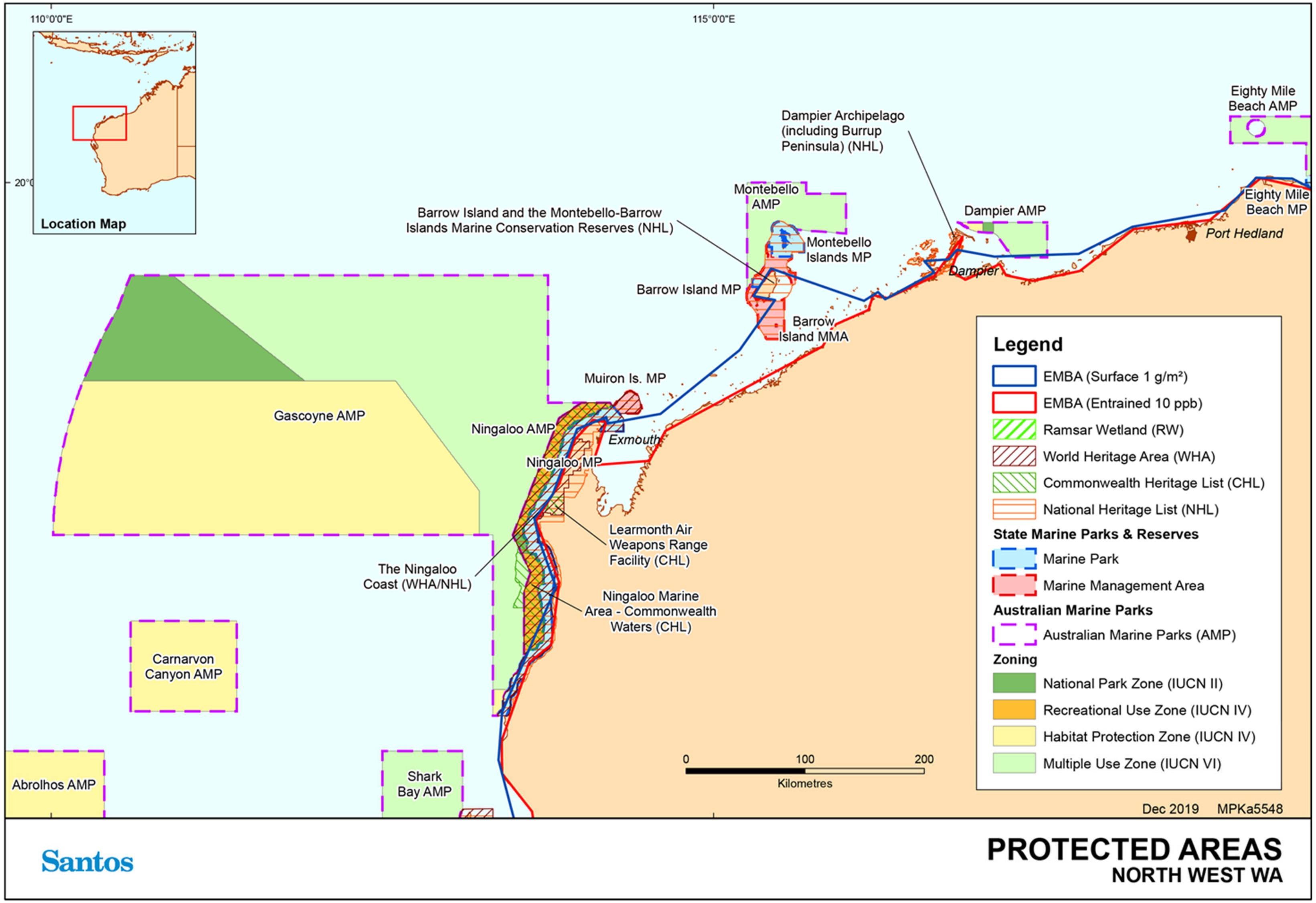

Figure 9-2: Protected areas in North-West WA

Santos

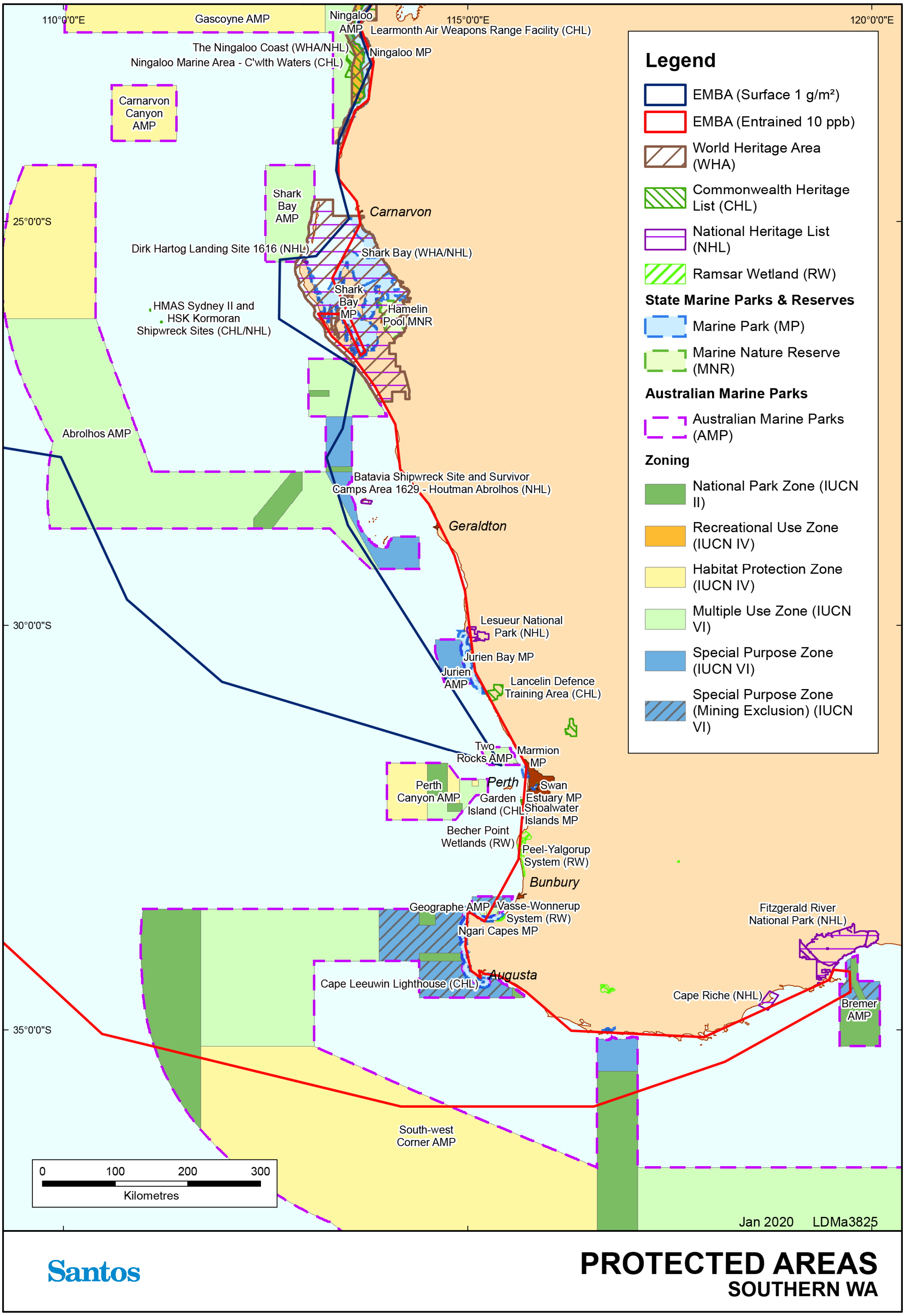

Figure 9-3: Protected areas in Southern WA

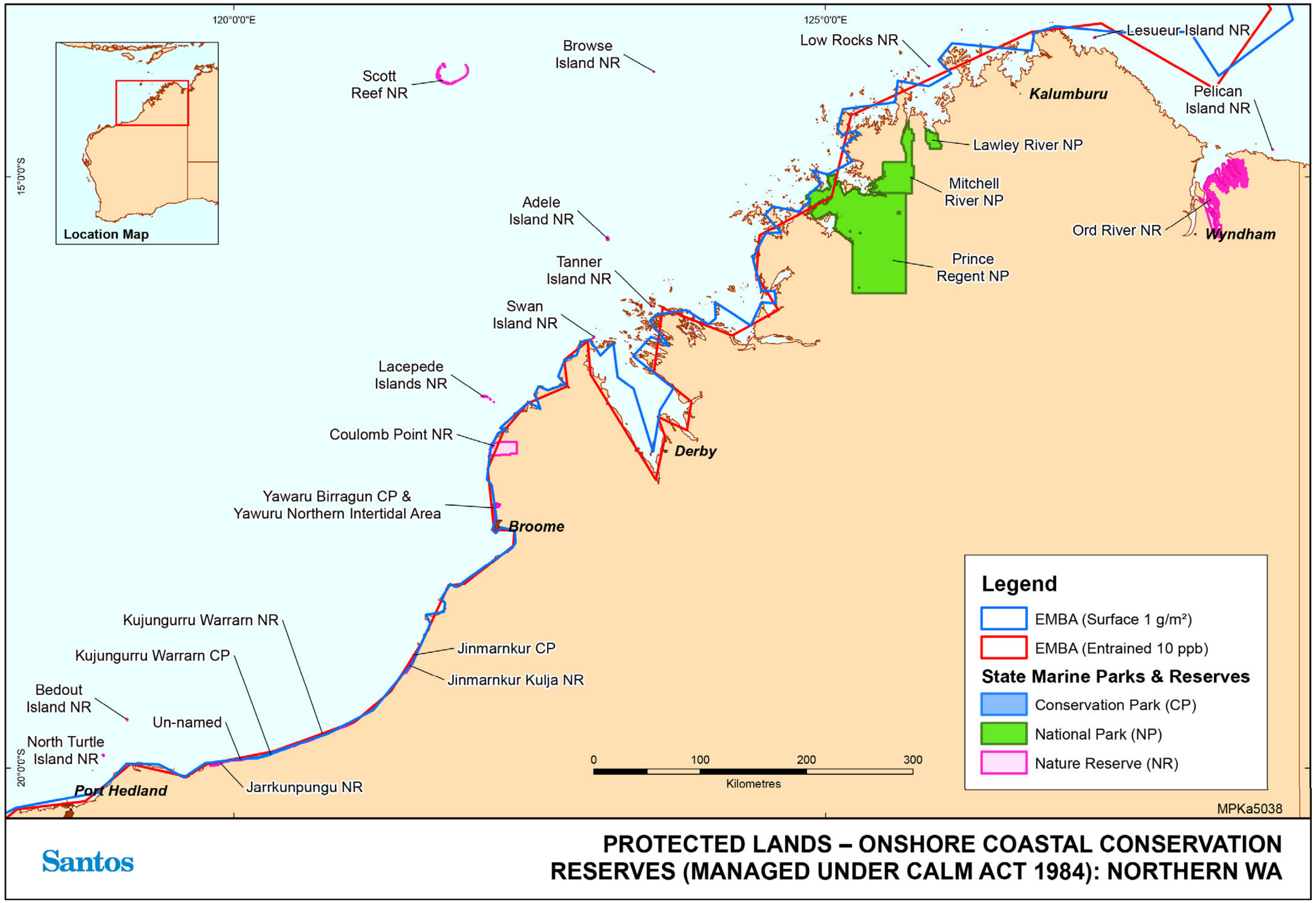

Figure 9-4: Protected Lands (CALM Act 1984) – terrestrial conservation reserves bounding marine waters in northern WA[13]

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[13] 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 (described in **Section 11.1.17**).

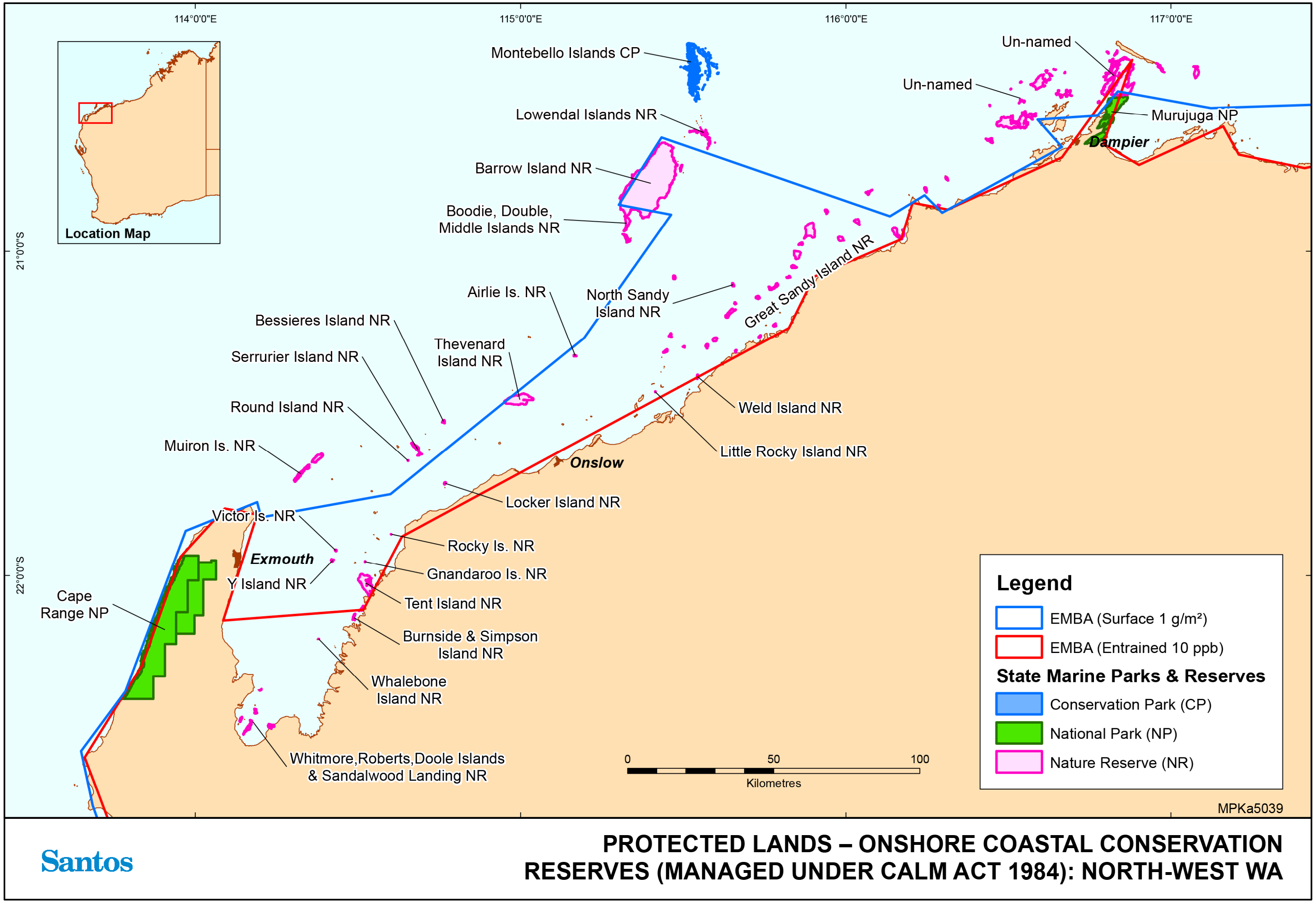

Figure 9-5: Protected Lands (CALM Act 1984) – terrestrial conservation reserves bounding marine waters in North-West WA

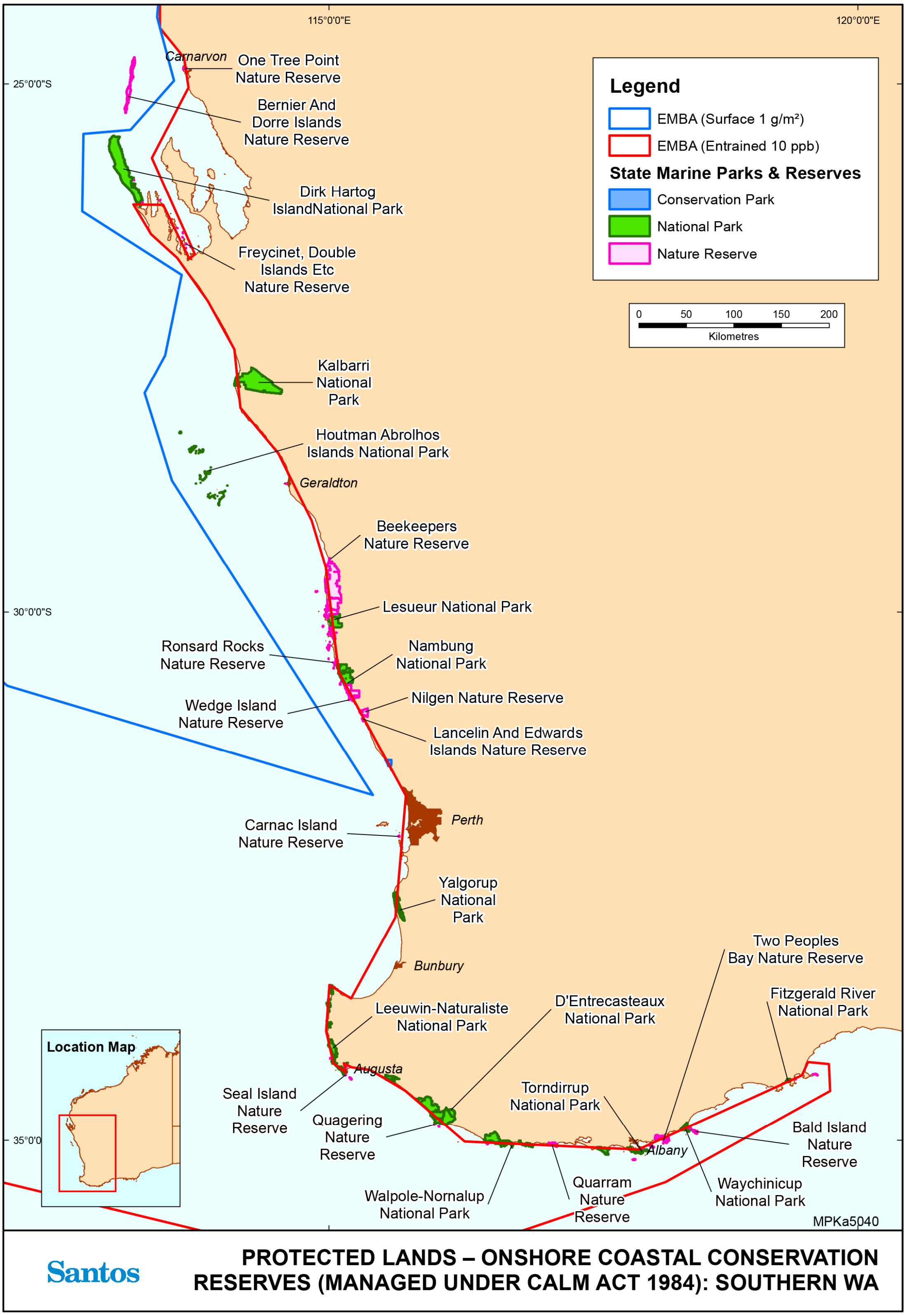

Figure 9-6: Protected Lands (CALM Act 1984) – terrestrial conservation reserves bounding marine waters in Southern WA[14]

[14] Rottnest Islands Conservation Park Conservation Park is not shown (managed under Rottnest Island Authority Act 1987).

9.8 International Protected Areas

There are 53 National Parks in Indonesia, six are World Heritage Sites, nine are part of the World Network of Biosphere Reserves and five are wetlands of international importance under the Ramsar convention. A total of nine parks are largely marine (ADB 2014). Of these protected areas only the Laut Sawu Marine National Park (including the Tirosa Batek Marine Area and the Sumba Strait Marine Area) intersects with the EMBA.

The Laut Sawu Marine National Park located within the Lesser Sunda Ecoregion in the Savu Sea and covers a reported 35,211 km^2 (Protected Planet 2017). It was established in 2009 and has an IUCN Category II status (Protected Planet 2017). The marine park area is a known migration route for several cetacean species, including the blue whale and sperm whale. Other cetacean species such as pygmy killer whales, melon-head whale, short-finned pilot whales and numerous dolphin species (including Risso's dolphin, Fraser's dolphin, common dolphin, bottlenose dolphin and spinner dolphin) are known to frequent the marine park area. Several species of marine turtle, including the green turtle, hawksbill turtle and leatherback turtle have also been recorded in the marine park area.

The marine park area covers a range of habitats and species diversity, including:

+ 532 corals species which include 11 endemic and sub endemic species;
+ 350 reef fish species;
+ fifteen mangrove species are recorded that represented 9 families of mangrove;
+ ten seagrass species;
+ deep-water habitats such as seamounts, deep-water canyons, straits (migratory corridors);
+ large persistent pelagic habitats;
+ main migratory corridors and habitats for 14 whale species, seven dolphin's species, and dugong; and
+ habitats for five sea turtle species (green, leatherback, olive ridley, loggerhead, and flatback) as well as for large marine fauna such as sharks, napoleon, parrotfish and groupers (Savu Sea National Marine Conservation Area undated).

10. Key Ecological Features

10.1 Introduction

Key ecological features (KEFs) 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. KEFs meet one or more of the following criteria (DSEWPaC 2012a):

- 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 four key ecological features of the Commonwealth waters in the EMBA (covering the NMR, the NWMR and the SWMR) have been identified in the protected matters search (**Figure 10-1** and **Figure 10-2**) and are discussed in this section.

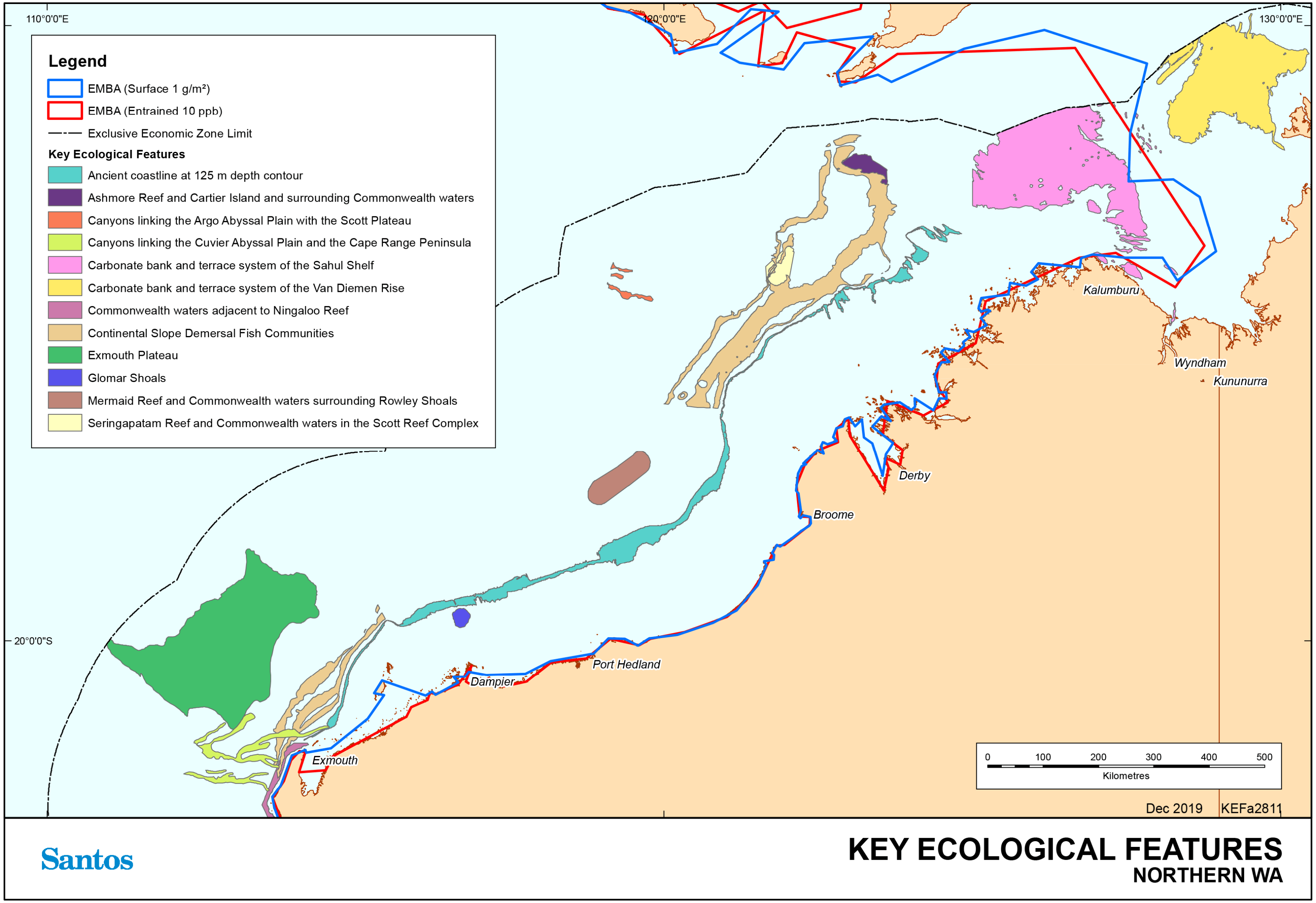

Figure 10-1: Key ecological features of Northern WA

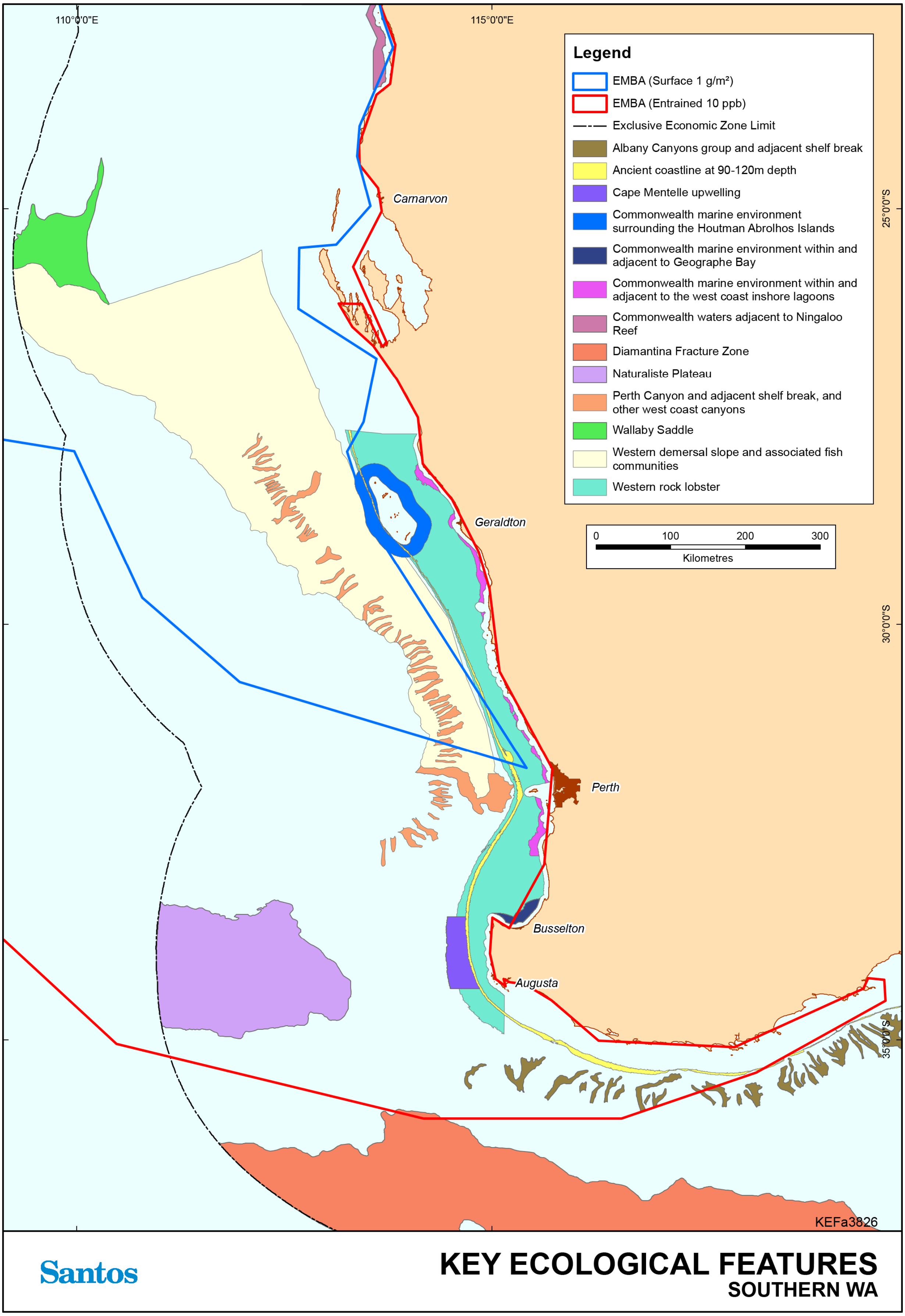

Figure 10-2: Key ecological features of Southern WA

10.1.1 Commonwealth Marine Environment Surrounding the Houtman Abrolhos Islands (and Adjacent Shelf Break)

The Commonwealth marine environment surrounding the Houtman Abrolhos Islands (and adjacent shelf break) is defined as a KEF for its high levels of biodiversity and endemism in benthic and pelagic habitats. The Houtman Abrolhos Islands and surrounding reefs support a unique mix of temperate and tropical species, resulting from the southward transport of species by the Leeuwin Current over thousands of years. The reefs are composed of 184 known species of corals that support about 400 known species of demersal fish, 492 known species of molluscs, 110 known species of sponges, 172 known species of echinoderms and 234 known species of benthic algae (DEWHA 2008b). The Houtman Abrolhos Islands are the largest seabird breeding station in the eastern Indian Ocean (DSEWPaC 2012a). They support more than one million pairs of breeding seabirds. The Houtman Abrolhos Islands and surround waters are also BIAs for Australian sea lions for foraging and breeding (DEWHA 2010b).

10.1.2 Perth Canyon and Adjacent Shelf Break, and other West-Coast Canyons

The Perth Canyon is defined as a KEF for its high biological productivity and aggregations of marine life and unique seafloor features with ecological properties of regional significance. The Perth Canyon is the largest known undersea canyon in Australian waters. In the Perth Canyon, interactions between the Leeuwin Current and the Canyon topography induce clockwise-rotating eddies that transport nutrients upwards in the water column from greater depths (DoEE 2019a). Due to the Canyon's depth and Leeuwin Current's barrier effect, this remains a subsurface upwelling which supports ecological complexity that is typically absent from canyon systems in other areas (Pattiaratchi 2007). This nutrient-rich cold-water habitat attracts feeding aggregations of deep-diving mammals, such as pygmy blue whales and large predatory fish that feed on aggregations of small fish, krill and squid (DSEWPaC 2012a). The Perth Canyon also marks the southern boundary for numerous tropical species groups on the shelf, including sponges, corals, decapods and xanthid crabs (DoEE 2017a).

10.1.3 Commonwealth Marine Environment within and adjacent to the West-Coast Inshore Lagoons

This key ecological feature is composed by a chain of inshore lagoons of limestone reef (as deep as 30 m) extending along the Western Australian coast from south of Mandurah to Kalbarri. The mix of sheltered and exposed seabeds form a complex mosaic of habitats. The lagoons are dominated by seagrass and epiphytic algae (Dambacher et al. 2009). Although macroalgae (principally Ecklonia spp.) and seagrass appear to be the primary source of production, scientists suggest that groundwater enrichment may supplement the supply of nutrients to the lagoons. The lagoons are associated with high biodiversity and endemism, containing a mix of tropical, subtropical and temperate flora and fauna.

The inshore lagoons are important areas for the recruitment of the commercially and recreationally important western rock lobster, dhufish, pink snapper, breaksea cod, baldchin and blue gropers, abalone and many other reef species. The area includes breeding and nursery aggregations for many temperate and tropical marine species (Goldberg & Collings 2006 in McClatchie et al. 2006). Extensive schools of migratory fish visit the area annually, including herring, garfish, tailor and Australian salmon.

10.1.4 Commonwealth Marine Environment within and Adjacent to Geographe Bay

The Commonwealth marine environment within and adjacent to Geographe Bay is defined as a KEF for its high productivity and aggregations of marine life and high levels of biodiversity and endemism. Geographe Bay is known for its extensive beds of tropical and temperate seagrass that account for about 80 % of benthic primary production in the area (DEH 2006). This habitat supports a diversity of species, many of them not found anywhere else (DSEWPaC 2012a). The bay provides important nursery habitat for many species, including juvenile dusky whaler sharks. It is also an important resting area for migrating for humpback whales (McCauley *et al.* 2000).

10.1.5 Cape Mentelle Upwelling

The Cape Mentelle upwelling is defined as a KEF for its high productivity and aggregation soft marine life. The Cape Mentelle upwelling draws relatively nutrient-rich water from the base of the Leeuwin Current, up the continental slope and onto the inner continental shelf, where it results in phytoplankton blooms at the surface. The phytoplankton blooms provide the basis for an extended food chain characterised by feeding aggregations of small pelagic fish, larger predatory fish, seabirds, dolphins and sharks (DSEWPaC 2012a). The Cape Mentelle upwelling has a disproportionate influence on the overall-nutrient poor nature of the region's water.

10.1.6 Naturaliste Plateau

The Naturaliste Plateau is defined as a KEF for its unique seafloor feature with ecological properties of regional significance. The Naturaliste Plateau is Australia's deepest temperate marginal plateau and occurs an area where numerous water bodies and currents converge. It is also the only seafloor feature in the region that interacts with the subtropical convergence front (DoEE 2019b). Although there is very little known about the marine life of the plateau, it is speculated that the combination of its structural complexity, mixed water dynamics and relative isolation indicate that it supports deep-water communities with high species diversity and endemism (DEWHA 2008b; DSEWPaC 2012a). The Plateau acts as an underwater 'biogeographical island' on the edge of the abyssal plain, providing habitat for fauna unique to these depths (Richardson et al. 2005). The Plateau is also within a deep eddy field that is thought to be associated with high productivity and aggregations of marine life (Pattiaratchi 2007). Proximity to the nearby subtropical convergence front is thought to have a significant influence on the biodiversity of the Plateau (DEWHA 2008b).

10.1.7 Western Demersal Slope and associated Fish Communities

The Western Demersal Slope and associated Fish Communities, also known as the Demersal Slope and associated Fish Communities of the Central Western Province, is defined as a key ecological community for its high levels of biodiversity and endemism. It is located on the edge of the shelf to the limit of the exclusive economic zone from Perth to the northern boundary of the SWMR. The western demersal slope provides important habitat for demersal fish communities, with a high level of diversity and endemism. A diverse assemblage of demersal fish species below a depth of 400 m is dominated by relatively small benthic species such as grenadiers, dogfish and cucumber fish. Unlike other slope fish communities in Australia, many of these species display unique physical adaptations to feed on the sea floor (such as a mouth position adapted to bottom feeding), and many do not appear to migrate vertically in their daily feeding habits (DSEWPaC 2012a, Williams *et al.* 2001). A total of 480 fish species have been described that inhabit the slope of this bioregion with 31 considered to be endemic to the bioregion (DoEE 2019a). Demersal fish communities within the area have recorded higher diversity when compared to other oceanic regions which have been more intensively sampled. The increased diversity within the area has been attributed to the overlap of ancient and extensive Indo-west Pacific and temperate Australasian fauna (Williams et al. 2001).

10.1.8 Western Rock Lobster

The Western Rock Lobster KEF is defined due to its presumed ecological role on the West Coast Continental Shelf. This species is the dominant large benthic invertebrate in the region. The lobster plays an important trophic role in many of the inshore ecosystems of the South-west Marine Region. Western rock lobsters are an important part of the food web on the inner shelf, particularly as juveniles as they are preyed upon by octopus, cuttlefish, baldchin groper, dhufish, pink snapper, wirrah cod and breaksea cod (DEWHA 2008b, DSEWPaC 2012a). The high biomass of western rock lobsters and their vulnerability to predation suggest that they are an important trophic pathway for a range of inshore species that prey upon juvenile lobsters (DEWHA 2008b).

10.1.9 Wallaby Saddle

The Wallaby Saddle is defined as a KEF for its high productivity and aggregations of marine life. The Wallaby Saddle is an abyssal geomorphic feature located on the upper continental slope at a depth of 4,000–4,700 m (DSEWPaC 2012a). The feature connects the north-west margin of the Wallaby Plateau with the margin of the Carnarvon Terrace (Falkner *et al*. 2009 in DSEWPaC 2012a). The Wallaby Saddle is situated within the Indian Ocean water mass and is thus differentiated from systems to the north that are dominated by transitional fronts or the Indonesian Throughflow (DSEWPaC 2012a). Little is known about the Wallaby Saddle; however, the area is considered one of enhanced productivity and low habitat diversity (Brewer *et al*. 2007). The Wallaby Saddle is associated with historical aggregations of sperm whales (DEWHA 2008c).

10.1.10 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 2008d, DSEWPaC 2012a). 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 2008c).

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 2008c). 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 2008c). 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 12.3.4**.

10.1.11 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 KEF 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 2012a). 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 2012a). 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 2012a).

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 2008c).

10.1.12 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 2012a). 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 2012a).

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).

10.1.13 Mermaid Reef and Commonwealth Waters surrounding Rowley Shoals

Mermaid Reef and Commonwealth waters surrounding Rowley Shoals is defined as a KEF for its enhanced productivity and high species richness. The Rowley Shoals are a group of three atoll reefs—Clerke, Imperieuse and Mermaid reefs—located about 300 km north-west of Broome. Mermaid Reef lies 29 km north of Clerke and Imperieuse reefs and is totally submerged at high tide. Mermaid Reef and Commonwealth Waters surrounding Rowley Shoals are regionally important in supporting high species richness, higher productivity and aggregations of marine life associated with the adjoining reefs themselves (Done et al. 1994). Rowley shoals contain 214 coral species and approximately 530 species of fishes (Gilmour et al. 2007), 264 species of molluscs and 82 species of echinoderms (Done et al. 1994; Gilmour et al. 2007). Both coral communities and fish assemblages differ from similar habitats in eastern Australia (Done et al. 1994).

Mermaid Reef falls under Commonwealth jurisdiction and forms the Mermaid Reef Commonwealth Marine Park. Clerke and Imperieuse reefs constitute the Rowley Shoals Marine Park, which falls under Western Australian Government jurisdiction (EA 2000). The Rowley Shoals are discussed with the Commonwealth and State Marine Park (**Sections 11.1.9** and **12.3.9**).

10.1.14 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 2012a). 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 2012a). 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 2012a).

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 2012a). 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 2012a).

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 2012a).

10.1.15 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 2012a). 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 2012a). 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 2008c), 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 2008c).

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 2012a). 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 2019a).

10.1.16 Ancient Coastline at 90-120 m Depth

This coastline is found in the South-west Marine Region and contains several terraces and steps reflecting a gradual increase in sea level across the shelf that occurred during the Holocene. Some of these features create escarpments of distinct elevation, creating topographic complexity through the exposure of rocky substrates. The most prominent of these occurs close to the middle of the continental shelf off the Great Australian Bight at a depth of 90-120 m, which provides a complex habitat for a number of species (DSEWPaC 2012c). The area has important conservation value due to its potential for high productivity, biodiversity and aggregations of marine life. Benthic biodiversity and productivity occur where the ancient coastline forms a prominent escarpment of exposed hard substrates, where it is dominated by sponge communities of significant biodiversity and structural complexity (DSEWPaC 2012c). These sponge communities have been recorded to contain sponges up to one metre across, which implies that some of the sponges in this region are likely to be many decades old (DSEWPC 2012c). It has been suggested that in certain places, the area may support some demersal fish species, travelling to the upper continental slope from across the continental shelf. The transportation of fine grained sediments off shelf occurs as a physical process down to depths of approximately 120 m, and influence the benthic invertebrate communities of the Great Australian Bight (DSEWPaC 2012c). Both species richness and biomass in the area, has been associated as declining with increasing depth and percentage of fines in sediment (Ward *et al.* 2006 cited in DSEWPaC 2012c).

10.1.17 Canyons Linking the Argo Abyssal Plain with Scott Plateau

The Scott Plateau connects with the Argo Abyssal Plain via a series of canyons, the largest of which are the Bowers and Oates canyons (DSEWPaC 2012a). The canyons are believed to be up to 50 million years old and excavated during the evolution of the region through sediment and water movements (DEWHA 2008d). The canyons cut deeply into the south-west margin of the Scott Plateau and act as conduits for transport of sediments from an approximate depth of 2,000–3,000 m to depths of more than 5,500 m (DSEWPaC 2012a). The water masses at these depths are deep Indian Ocean water on the Scott Plateau and Antarctic bottom water on the Argo Abyssal Plain. Both water masses are cold, dense and nutrient-rich (Lyne *et al*. 2006 in DSEWPaC 2012a). The high productivity of the region is believed to be led by topographically induced water movements through the canyons and the action of internal waves in these canyons as well as around islands and reefs. The canyons are therefore thought to be linked to small and periodic upwellings that enhance this biological productivity (DEWHA 2008d).

The Canyons linking the Argo Abyssal Plain and Scott Plateau are likely to be important features due to their historical association with sperm whale aggregations (DSEWPaC 2012a). Historical records of whaling in the Timor region indicate that the number of sperm whales was high in the region in the past. Though current numbers are unknown, it is possible that they congregate around the canyon heads adjacent to the Scott Plateau, encouraged by the high biological productivity, supporting stocks of their prey (DEWHA 2008d). There is anecdotal evidence that supports the idea that the Scott Plateau itself may be a breeding ground for sperm and beaked whales. It is also likely that important demersal communities occur in the canyons, as they do in the Scott Plateau supported by the localised upwelling, which in turn attract larger predatory fish, sharks and cetaceans (DEWHA 2008d).

10.1.18 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

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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 2019a). 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 2019a).

10.1.19 Seringapatam Reef and Commonwealth Waters in the Scott Reef Complex

Scott and Seringapatam reefs are part of a series of submerged reef platforms that rise steeply from the sea floor between the 300–700 m contours on the north-west continental slope and lie in the Timor Province (Falkner et al. 2009). Scott Reef consists of two separate reef formations, North Reef and South Reef. The total area of the key ecological feature is approximately 2,418 km². As two of the few offshore reefs in the north-west, they provide an important biophysical environment in the region.

Scott and Seringapatam reefs and the waters surrounding them attract aggregations of marine life including humpback whales on their northerly migration, Bryde’s whales, pygmy blue whales, Antarctic minke whales, dwarf minke whales, minke whales, dwarf sperm whales and spinner dolphins (Jenner et al. 2008; Woodside 2009). Whale sharks and several species of sea snakes have also been recorded in this area (Donovan et al. 2008). Green and hawksbill turtles nest during the summer months on Sandy Islet on South Scott Reef. These species also internest and forage in the surrounding waters (Guinea 2006). Scott Reef is a particularly biologically diverse system and includes more than 300 species of reef-building corals, approximately 400 mollusc species, 118 crustacean species, 117 echinoderm species and around 720 fish species (Woodside 2009). Corals and fish at Scott Reef have higher species diversity than the Rowley Shoals (Done et al. 1994).

Scott Reef is listed as Commonwealth Heritage Places and is discussed in **Section 9.5.1**.

10.1.20 Ashmore Reef and Cartier Island and Surrounding Commonwealth Waters

Ashmore Reef and Cartier Island are situated on the shallow upper slope of the Sahul Shelf, north of Scott and Seringapatam reefs. Rising from a depth of more than 100 m, the reef platform is at the edge of the North West Shelf and covers an area of 239 km². Ashmore Reef Commonwealth Marine Reserve encloses an area of about 583 km² of seabed (EA 2002). Cartier Island lays about 350 km off Australia’s Kimberley coast, 115 km south of the Indonesian island of Roti and 45 km south-east of Ashmore Reef Commonwealth Marine Reserve. Cartier Island Commonwealth Marine Reserve covers 167 km² (EA 2002). Species at Ashmore Reef and Cartier Island include more than 225 reef-building corals, 433 molluscs, 286 crustaceans, 192 echinoderms, and the most diverse variety of fish of any region in Western Australia with 709 species (EA 2002).

Sandy beaches provide important habitat for nesting green and hawksbill turtles throughout the year. Seagrass present at Ashmore Reef provides critical breeding (April–May) and foraging (throughout the year) habitat for a genetically distinct population of dugong with their range probably extending to other submerged shoals within the area (Brown & Skewes 2005; Whiting 1999). The emergent habitat at Ashmore also provides important nesting sites for seabirds, many of which are migratory. Ashmore’s islands are regarded as supporting some of the most important seabird rookeries on the North West Shelf seasonally supporting up to 50,000 seabirds (26 species) and up to 2,000 waders (30 species, representing almost 70% of wader species that regularly migrate to Australia) (Milton 2005). Large colonies of sooty terns, crested terns, bridled terns and common noddies breed on the east and middle islands. Smaller breeding colonies of little egrets, eastern reef egrets, black noddies and possibly lesser noddies also occur. Migratory wading birds include eastern curlews, ruddy turnstones, whimbrels, bar-tailed godwits, common sandpipers, Mongolian plovers, red-necked stints and tattlers, during October–November and March–April as part of the migration between Australia and the Northern Hemisphere (Milton 2005).

10.1.21 Carbonate Bank and Terrace System of the Sahul Shelf

The Carbonate Banks and Terrace System of the Sahul Shelf are located in the western Joseph Bonaparte Gulf and to the north of Cape Bougainville and Cape Londonderry. The banks consist of a hard substrate and flat tops at depths of 150–300 m. Each bank occupies an area generally less than 10 km^2 and is separated from the next bank by narrow sinuous channels with depths up to 150 m. The origin of the banks is uncertain, though the area contains predictably high levels of productivity, in comparison to the generally low productivity of the region (DSEWPaC 2012).

The banks are foraging areas for loggerhead, olive ridley and flatback turtles and provide habitat for humpback whales, and green and freshwater sawfish (Donovan *et al*. 2008 in DSEWPaC 2012). The hard substrate of the banks is thought to support diverse organisms including sessile benthic invertebrates such as sponges, soft and hard corals, gorgonians, bryozoans, ascidians and associated reef fish and elasmobranchs (Brewer *et al*. 2007). Cetaceans, green and fresh sawfish are also likely to occur in the area, as well as possibly the Australian snubfin dolphin, a migratory species occurring mostly on the northern extent of the Sahul Shelf (DSEWPaC 2012).

According to DSEWPaC (2012) the carbonate banks and terrace system of the Sahul Shelf are regionally important because of their role in enhancing productivity relative to their surrounds. Little is known about the banks, terraces and associated channels but they are believed to be areas of enhanced productivity and biodiversity due to the upwellings of cold nutrient-rich water at the heads of the channels and the availability of hard substrate (Brewer *et al*. 2007).

10.1.22 Pinnacles of the Bonaparte Basin

The limestone Pinnacles of the Bonaparte Basin are located in the mid-outer shelf of the western Joseph Bonaparte Gulf and comprise of 61% of the limestone pinnacles in the Northwest Marine Region and 8% of the total limestone pinnacles found within the Australian Exclusive Economic Zone (Baker *et al.* 2008). The pinnacles range from water depths of 30 to 80 m providing hard substrate in a relatively sparse soft sediment habitat for sessile species. The pinnacles are thought to be remnants of the calcareous shelf and coastal features from previous low sea level stands, and have been recorded to be up to 50 m in height and range from 50 to 100 km long (Baker *et al.* 2008, Heyward *et al.* 1997).

Diverse communities of sessile benthic invertebrates including hard and soft corals, sponges, whips, fans, bryozoans and aggregations of demersal fish species such as snappers, emperors and groupers have been recorded (Brewer *et al.* 2007, Nichol *et al.* 2013). Foraging and general use has been recorded within the pinnacles by marine turtles and the area has also been suggested to be used by freshwater and green sawfish as well as humpback whales (Donovan *et al.* 2008). The pinnacles have been recognised as a sponge biodiversity hotspot which has recorded greater diversity and communities than that of the surrounding seafloor (NERP MBH 2014).

According to DSEWPaC (2012) the Pinnacles of the Bonaparte Basin are regionally important because of its biodiversity values (unique sea-floor feature with ecological properties of regional significance), which apply to both the benthic and pelagic habitats. The hard substrate of the pinnacles are likely to support a high number of species, although a better understanding of the species richness and diversity associated with these structures is required.

10.1.23 Diamantina Fracture Zone

The Diamantina Fracture Zone is located south of the Naturaliste Plateau covering a range of more than 100,000 km^2 in water depths greater than 3,000 m. The ridge, troughs and seamounts that form the fracture zone have been recorded to have a relief up to 4,000 m which has resulted in highly variable environmental conditions (Stow 2006, Richardson *et al.* 2005). The Diamantina Fracture Zone encompasses the deepest known points in Australia's exclusive economic zone, reaching depths of more than 6,000 metres.

Limited information is available for the Diamantina Fracture Zone, however it is likely that due to the highly variable environmental conditions within the distinctive community structures and unique habitats have the potential to form. The presence of seamounts and ridges has the potential to increase local primary and secondary productivity, which may in turn promote phytoplankton growth. Increased phytoplankton has been recorded to increase the diversity and abundance of marine life (e.g. whales, dolphins, fish and benthic species) (Rowden *et al.* 2010). The area is expected to sustain similar habitats to that of and around the Tasmanian Seamounts due to similar depths in the South-east Marine Region (Richardson et al. 2005).

According to DSEWPaC (2012) the Diamantina Fracture Zone is regionally important because of to enhance productivity and assist with dispersal and migration of species across the region and wider abyssal plain (Wilson & Kaufman 1987, in Richardson *et al.* 2005). While research on the Diamantina Fracture Zone is limited, its size, physical complexity and isolation indicate that it is likely to support deepwater communities characterised by high species diversity and endemism.

10.1.24 Albany Canyons Group and Adjacent Shelf Break

The Albany Canyons group and adjacent shelf break is located along a 700 km extent ranging from Cape Leeuwin to the east of Esperance and consists of 32 deep canyons which cut into the continental slope. Sonar surveys have indicated that individual canyons can extent up to 90 km long at water depths of 2,000 m. The canyons can start at the uppermost continental slope and reach the lowermost slope and extend onto the abyssal plain (Exon *et al.* 2005).

Due to close spacing of the numerous canyons, a wide range of depth dependent benthic habitats are connected increasing the habitat heterogeneity along the south western Australian continental margin. Offshore transport increases the sediment load and organic material is received from productive shelf waters. The closely spaced canyons have the potential to allow increased amounts of organic matter to reach the abyssal plain which may increase biodiversity in comparison to other areas within the south west Marine Region. (Richardson e*t al.* 2005).

According to DSEWPaC (2012), the Albany Canyons group and adjacent shelf break is regionally important and recognised as a key ecological feature for its high productivity, aggregations of marine life, and as a unique seafloor feature with ecological properties of regional significance (Pattiaratchi 2007). Both benthic and demersal habitats within the feature are of conservation value. The canyons are known to be a feeding area for the sperm whale (Bannister *et al.* 1996) and sites of orange roughy aggregations (Caton & McLoughlin 2004).

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 18 marine parks within the EMBA (refer **Figure 9-1**, **Figure 9-2** and **Figure 9-3**).

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 EMBA (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 Ngari Capes Marine Park

The Ngari Capes Marine Park is gazetted as a Class A Marine Park. The park is located off the southwest coast of Western Australia, approximately 250 km south of Perth, covering approximately 123,790 ha. The seaward boundary of the marine park is congruent with the seaward limit of Western Australian waters (three nautical miles from the territorial baseline). The north-eastern boundary in Geographe Bay is located near the intersection of the Shire of Busselton boundary with the coastline. The Shire of Busselton–Shire of Capel boundary is approximately 30 m north-east of the marine park boundary, while the south-eastern boundary in Flinders Bay is located at 115˚17’00” E. The marine park consists of four areas that are representative of the Leeuwin–Naturaliste marine bioregion: Geographe Bay; Cape Naturaliste to Cape Mentelle coast; the Cape Mentelle to Cape Leeuwin coast; and Flinders Bay. These areas show distinct differences in geomorphology, oceanography, habitats and flora and fauna.

The Ngari Capes Marine Park was identified as one of the most diverse temperate marine environments in Australia. Warm, tropical waters of the Leeuwin Current mix with the cool waters of the Capes Current, resulting in high finfish diversity, including tropical and temperate species (see fish in **Section 5.1.1**) and internationally significant seagrass diversity with seagrasses occurring at depths greater than 40 m (see seagrasses in **Section 3.2**). The marine park also surrounds a number of islands that are important seabird nesting habitat and pinniped haul-outs (places where seals and sea lions leave the water and come onto land), including Hamelin Island, Sugarloaf Rock and the Saint Alouarn Islands which include Flinders Island, Seal Island and Square Rock (DEC 2013). These islands are vested with the Conservation Commission as nature reserve and are managed by DBCA for the purpose of conservation. The marine park is also adjacent to the Leeuwin Naturaliste National Park which extends to the high water mark (DEC 2013).

The Ngari Capes marine park was also created for its high social values. The unique geographical location of this region exposes it to large, uninterrupted ocean swells and results in the South West capes area being recognised as one of the world's premier surfing regions. Many activities occurring in the region are marine based, including commercial and recreational fishing, swimming, surfing, diving, snorkelling, boating, and marine nature-based tourism.

11.1.2 Jurien Bay Marine Park

The Jurien Bay Marine Park is a Class A marine park located on the central west coast of Western Australia about 200 km north of Perth and covers an area of 82,375 ha (CALM 2005b). Its western boundary is the seaward limit of Western Australian coastal waters. Its northern boundary is the northern point of Dynamite Bay at Green Head (30° 4' 7.9" South), and its southern boundary is located just south of Wedge (30° 50' 20" South) and is contiguous with the southern boundary of the Wanagarren Nature Reserve.

Jurien Bay Marine Park is considered to be broadly representative of the Central West Coast limestone reef system, which is a major marine ecosystem within this bioregion. The marine biota of the area consists of an unusual mix of tropical and temperate species as well as many endemic species (Larkum & Hartog, 1989). The Marine Park is dominated by five major marine habitat types: seagrass meadows; bare or sparsely vegetated mobile sand; shoreline and offshore intertidal reef platforms; subtidal limestone reefs; and reef pavement (CALM 2005b). Marine wildlife includes 14 species of cetaceans, a variety of sea and shorebirds which nest on the islands and the Australian sea lion (North Fisherman Island to the north of Jurien Bay is one of the main breeding sites for sea lions in the Central West Coast region and it is believed this breeding population is genetically distinct from the southern coast population – Gales et al. 1992). Commercial fishing for western rock lobster as well commercial wetlining, abalone, shark netting, beach seining for mullet and collecting of specimen shells and aquarium fish are carried out within the marine park.

11.1.3 Shark Bay Marine Park and Hamelin Pool Marine Nature Reserve

The Shark Bay Marine Reserves comprise the Shark Bay Marine Park and the Hamelin Pool Marine Nature Reserve. The Shark Bay Marine Park was gazetted on 30 November 1990 as A Class Marine Park Reserve No. 7 and vested in the National Park and Nature Conservation Authority (NPNCA) under the CALM Act. The marine park encompasses an area of 748,725 ha (CALM 1996).

The Bay is located near the northern limit of a transition region between temperate and tropical marine fauna. Of the 323 fish species recorded from Shark Bay, 83% are tropical species with 11% warm temperate and 6% cool temperate species. Similarly, of the 218 species of bivalves recorded in Shark Bay, 75% have a tropical range and 10% a southern Australian range, with 15% being endemic to the west coast (CALM 1996).

Key features of Shark Bay Marine Park include (CALM 1996, DSEWPaC 2013b):

+ 12 species of seagrass making it one of the most diverse seagrass assemblages in the world;
+ Seagrass that covers over 4,000 km^2 of the bay. The 1,030 km^2 Wooramel Seagrass Bank is the largest structure of its type in the world;
+ An estimated population of about 11,000 dugongs, one of the largest populations in the world;
+ Humpback and southern right whales use the bay as a migratory staging post;
+ Bottlenose dolphins occur in the bay, and green turtle and loggerhead turtle nest on the beaches;
+ Large numbers of sharks including whaler, tiger shark and hammerhead are present as well as an abundant population of rays, including the manta ray;
+ Hamelin Pool in Shark Bay contains the most diverse and abundant examples of stromatolite forms in the world, representative of life-forms which lived some 3,500 million years ago; and
+ Shark Bay Marine Park does not cover Bernier and Dorre Islands and only coastal waters inshore of Dirk Hartog Island (east of eastern shoreline).

Shark Bay was included on the World Heritage List in 1991 primarily on the basis of three natural features: vast seagrass beds; dugong population; and stromatolites (microbial colonies that form hard, dome-shaped deposits and are among the oldest forms of life on Earth) (DSEWPaC 2013b; see **Section 9.1**).

There is no zoning within the Hamelin Pool Marine Nature Reserve. This area is a ‘look but don’t take’ area managed solely for the conservation of globally outstanding marine life. Hamelin Pool is one of only two known places in the world with living examples of marine stromatolites (DEC 2010). The shores of Hamelin Pool are also important for the formation of extensive marine algal mats formed by microbial algae. If damaged, the mats and stromatolites can take many hundreds of years to recover (DEC 2010).

11.1.4 Ningaloo Marine Park

The Ningaloo Marine Park was declared in May 1987 under the National Parks and Wildlife Conservation Act 1975 (Commonwealth). 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.

11.1.5 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).

11.1.6 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.

11.1.7 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.

11.1.8 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.

11.1.9 Rowley Shoals Marine Park

The Rowley Shoals (including the Commonwealth-managed Mermaid Reef Marine National Nature Reserve) are located approximately 300 km west-northwest of Broome, lying between 17°07'S, 119°36'E and 17°35'S, 118°56'E and encompassing approximately 87,674 ha (DEC 2007b).

The Rowley Shoals is ecologically significant in that the reefs form part of a series of important ecological "stepping stones" for a range of reef biota originating in Indonesian/west Pacific waters. Their position off the north-west Australian coast, an area of few offshore reef systems, provides an important upstream source for recruitment to reefs further south (DEC 2007b). Marine wildlife includes 184 species of corals, primarily Indo-West Pacific species, indicating the strong affinity of the Rowley Shoals communities with Indonesia. In terms of other species, at least 264 species of molluscs, 82 species of echinoderms and 389 species of finfish were also identified (DEC 2007b). The faunal assemblages of the Rowley Shoals Marine Park are regionally significant as they contain large numbers of species not found in the more turbid coastal environments of tropical Western Australia (DEC 2007b). There is a relatively low level of recreational and commercial activity, mostly atribuated to the remoteness of the Shoals with access difficult from both Indonesia and mainland Australia (DEC 2007b).

11.1.10 Lalang-garram/Camden Sound Marine Parks

The Lalang-garram/Camden Sound Marine Park was created on 19 June 2012 under Section 13 of the Conservation and Land Management Act 1984 (CALM Act). It is a multiple zone marine park that includes; Sanctuary, Special Purpose, and General Use zones (DPaW 2013). The marine park falls within the west Kimberley, which was recently added to the Australian National Heritage List because of its natural, indigenous and historic values to the nation.

The marine park is located about 150 km north of Derby (or 300 km north of Broome) and lies within the traditional country of three Aboriginal native title groups. The Dambimangari people's determination overlies the majority of the marine park. A section of the Wunambal Gaambera people's Uunguu determination includes a small portion of St George Basin, while a small section of the Mayala people's claim (native title not determined at the time of writing of Management Plan) overlies the southwest corner of the marine park (DPaW 2013).

The marine park covers an area of approximately 705,000 ha. It recognises and provides special management arrangements for this area of the Kimberley, which is a principal calving habitat of the humpback whale (*Megaptera novaeangliae*) population that migrates annually along Western Australia's coast. The marine park also conserves a range of species listed as having special conservation status including marine turtles, snubfin and Indo-Pacific humpback dolphins, dugong, saltwater crocodiles, and several species of sawfish. The park also includes a wide range of marine habitats and associated marine life, such as coral reef communities, rocky shoals, and the extensive mangrove forests and marine life of the St George Basin and Prince Regent River (DPaW 2013).

11.1.11 Marmion Marine Park

Marmion Marine Park was Western Australia's first marine park, declared in 1987 and is a multi-use reserve (CALM 2002). Marmion Marine Park is located offshore from Perth's northern suburbs, between Trigg Island and Burns Beach.

Habitats in the area include intertidal reef platforms, coastal sand beaches, a high limestone reef about 1 km from shore, Little Island and the Three Mile Reef system. Of note are complex assemblages of sea floor communities, including seagrass meadows, algal limestone pavement communities and crevice animal associations (CALM 2002).

The marine park provides an important habitat for marine mammals, such as sea lions, dolphins and whales. The island nature reserves within Marmion Marine Park provide an important habitat for several species of seabirds and haul-out areas for Australian sea lions, especially at Little Island and Burns Rocks (CALM 2002).

11.1.12 Swan Estuary Marine Park

The Swan Estuary Marine Park (A Class marine reserve number 4) was gazetted on 25 May 1990. The Swan Estuary Marine Park and Adjacent Nature Reserves Management Plan 1999-2009 was gazetted 7 April 2000 (CALM 1999).

The Swan Estuary Marine Park encompasses Alfred Cove, 200 ha adjacent to the suburbs of Attadale and Applecross; Pelican Point, a 45 ha area in Crawley; and Milyu, 95 ha adjacent to the Como foreshore (CALM 1999). All three localities are within 20 minutes of the Perth CBD.

These areas encompass mudflats, seagrass beds and intertidal vegetation such as sedges and saltmarsh, which provide many different habitats for a host of animals. The most important of these, due to their international significance, are the migratory wading birds. They come from as far afield as Asia, Mongolia and Siberia. About 33 of these species are protected, including the red-necked stint (CALM 1999).

11.1.13 Shoalwater Islands Marine Park

The Shoalwater Islands Marine Park is located within the Perth metropolitan area, adjacent to the city of Rockingham and was gazetted in 1990 (DEC 2007). There are three sanctuary zones, two special purpose zones and a large general use zone in the park.

The Shoalwater Island region is dominated by beach and rocky shore shoreline habitats. The many jagged edged islands and rocky islets of the marine park provide important roosting and nesting areas for numerous bird species. The marine park has some of the healthiest seagrass meadows in the Perth metropolitan area, consisting of long lived species such as *Posidonia* spp. and *Amphibolis* spp. Seagrass meadows provide an important habitat and nursery area for a large number of marine species such as fish, rock lobsters, worms, shellfish, crustaceans, fish sharks and rays (DEC 2007).

The habitats of the marine park are important for the feeding, resting and breeding of little penguins and other sea and shore birds. Penguin Island which is found within the marine park has the largest breeding colony of little penguin on the west coast of Australia (DEC 2007). The bottlenose dolphin is the most common marine mammal, and Australian sea lions are commonly seen throughout the park.

11.1.14 Eighty Mile Beach Marine Park

The Eighty Mile Beach Marine Park, located between Port Hedland and Broome, was gazetted on 29 January 2013. It covers an area of approximately 200,000 ha stretching for some 220 km from Cape Missiessy to Cape Keraudren, and includes sanctuary, recreation, general use and special purpose zones. The park is managed under the Eighty Mile Beach Marine Park Management Plan 2014-20124 (DPaW, 2014).

The listed ecological values of the Eighty Mile Beach Marine Park include the high sediment and water quality, the juxtaposition of the beach, coastal topography and seabed and the diverse and ecologically important habitats and marine/coastal flora and fauna. The listed habitat values of the marine park are as follows:

- The intertidal sand and mudflat communities supporting a high abundance and diversity of invertebrate life and providing a valuable food source for shorebirds (including migratory species) and other fauna;
- The diverse subtidal filter-feeding communities;
- Macroalgal and seagrass communities providing habitat and feeding opportunities for fish, invertebrates and dugongs;
- High diversity intertidal and subtidal coral reef communities; and
- Mangrove communities and adjacent saltmarshes provide nutrients to the surrounding waters and habitat for fish and invertebrates.

The listed marine and coastal fauna values are as follows:

+ A high diversity and abundance of nationally and internationally important shorebirds and waders (including migratory species) are found in the marine park;
+ Flatback turtles are endemic to northern Australia and nest at Eighty Mile Beach;
+ Dugongs and several whale and dolphin species inhabit or migrate through the marine park;
+ A highly diverse marine invertebrate fauna provides an important food source for a variety of animals, including birds, fish and turtles, along with recreational and commercial fishing opportunities;
+ A diversity of fish species provides recreational and commercial fishing opportunities; and
+ A diversity of sharks and rays, including several protected species, are found in the park.

In addition to these natural values, the marine park contains land and sea important to traditional Indigenous owners through identity and place, family networks, spiritual practice and resource gathering. The marine park also has a history of European activity including exploration, pastoralism and commercial fishing (e.g. the pearl oyster fishery). The park contains a historical WWII plane wreck (*Dornier Do-24 X-36*) and shipwrecks (two pearl luggers). The marine park provides tourism opportunity and recreational value through its remoteness, diversity and abundance of habitats and marine fauna and the pristine nature of the marine and coastal environment.

The marine park contains vast intertidal sand and mudflats that extend up to 4 km wide at low tide and provide a rich source of food for many species. Eighty Mile Beach Marine Park is one of the world's most important feeding grounds for small wading birds that migrate to the area each summer, travelling from countries thousands of kilometres away (DPaW 2014) (see **Section 9.2.1**).

11.1.15 Lalang-garram/ Horizontal Falls and North Lalang-garram Marine Parks

The Lalang-garram/ Horizontal Falls and North Lalang-garram Marine Parks were established in 2016 under the State Government's *Kimberley Science and Conservation Strategy* and are jointly managed by Dambimangari Traditional Owners and the Department of Parks and Wildlife (DPaW 2016). The marine parks fall within the west Kimberly region, included in the Australian National Heritage List for its nationally significant natural, indigenous and historic values (DoEE 2019c).

The Lalang-garram/ Horizontal Falls Marine Park extends from Talbot Bay (*Ganbadba*) in the west to Walcott Inlet (*Iledda*) and Glenelg River (*Molor Moloiyn*) in the east and covers approximately 353,000 ha (DPaW 2016). The marine park protects the internationally recognised Horizontal Falls and is important for the region's tourism. The North Lalang-garram Marine Park lies between the Lalang-garram / Camden Sound and North Kimberley Marine Parks and covers approximately 110,000 ha (DPaW 2016).

The area's large tidal range results in extensive intertidal areas with diverse ecosystems such as fringing coral reefs, mangroves and mudflat communities. Subtidal habitats and communities common to the marine parks include filter feeding communities of sponges and hard and soft corals. These intertidal and subtidal habitats provide critical foraging and nursery areas for dugong, marine turtles, estuarine crocodiles, snubfin and Indo-Pacific humpback dolphins, several species of sawfish and migratory seabirds. The marine parks are also a principal calving habitat for humpback whales (DPaW 2016).

11.1.16 North Kimberley Marine Park

The North Kimberley Marine Park was established in December 2016 as a Class A marine park under the CPC (DPaW 2016a). The marine park comprises four separate management areas including, Uunguu, Balanggarra, Miriuwung Gajerrong, and Wilinggin. It is a multiple zone marine park that includes: eight sanctuary zones, nine special purpose zones (recreation and conservation), two special use zone (cultural heritage), and general use areas (DPaW 2016a). The marine park is managed in accordance with the provisions of the CALM Act with joint management between the Department of Parks and Wildlife and Traditional Owners of the area.

The area within the marine park is recognised for its Aboriginal cultural and heritage values, natural values including coral reefs, marine turtle species, dugongs, seagrass and macroalgal communities, mangroves and saltmarshes, finfish, and water and sediment quality, as well as for its social values (i.e. recreation, tourism and community values) and commercial values and resource use (e.g. commercial fishing). The marine park lies within the Indian Ocean and Timor Sea of Western Australia's Kimberley region, covering an area of approximately 1,845,000 hectares (DPaW 2016a). The south-western boundary is approximately 270 km northeast of Derby.

11.1.17 Yawuru Nagulagun/ Roebuck Bay Marine Park

The Yawuru Nagulagun/Roebuck Bay Marine Park was approved by the State Minister for Environment in October 2016 and declared as a Class A reserve over the subtidal and intertidal areas of Roebuck Bay (excluding the Kimberley Ports Authority waters), (DBCA, 2017a). The Marine Park is managed with a joint management framework between Parks and Wildlife and Yawuru Registered Native Title Body Corporation (RNTBC). The intent is to manage the areas from the offshore waters around Roebuck and Broome, collectively referred to as the Yawuru conservation estate, as one ecological system (DPaW 2016b). The development of the joint management plan is in accordance with the Conservation and Land Management Act 1984 (Yawuru Organisation 2017) as well as contributes to the State Governments commitment under the Kimberly Science and Conservation Strategy, released in June 2011.

The Yawuru people have lived along the foreshores of Roebuck Bay for thousands of years, the Bay is part of the Yawuru traditional estate (DPaW 2016b). Roebuck Bay is an internationally significant Ramsar wetland, declared in 1990, and an important feeding ground for many species of migratory shorebirds. It hosts possibly the greatest diversity of shorebird species at any site across the globe (DBCA 2017b). The Bay has some of the most productive tropical intertidal flats in the world, and is consequently an important ground for Yawuru fishing, hunting and gathering of sea food. The Bay hosts communities of seagrass and macroalgae, providing food for protected species such as the dugong and flatback turtle. Marine mammals also pass through the waters of the Bay such as the Australian snubfin dolphin and the humpback dolphin, the humpback whale can also be found during annual migration (DPaW 2016b).

12. Australian Marine Parks

12.1 Introduction

In agreement with the States and NT governments, the Australian Commonwealth government was committed to establish Commonwealth marine parks as a component of the National Representative System of Marine Protected Areas (DoE 2014) (See **Figure 9-1, Figure** 9-2 and **Figure 9-3**). 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 EMBA include:

+ The South-West Marine Parks Network;
+ The North-West Marine Parks Network; and
+ The North Marine Parks Network.

The South-West Marine Parks Network comprises 14 marine parks. Seven of these occur in West Australian waters in the EMBA, including:

+ Abrolhos Commonwealth Marine Park;
+ Jurien Marine Park;
+ Two Rocks Marine Park;
+ Perth Canyon Marine Park;
+ Geographe Marine Park;
+ South-west Corner Marine Park; and
+ Bremer Marine Park

The North-West Marine Parks Network comprises 13 marine parks which all occur in West Australian waters pertinent to the EMBA:

+ Carnarvon Canyon Marine Park;
+ Shark Bay Marine Park;
+ Gascoyne Marine Park;
+ Ningaloo Marine Park;
+ Montebello Marine Park;
+ Dampier Marine Park;
+ Eighty Mile Beach Marine Park;
+ Argo-Rowley Terrace Marine Park;
+ Mermaid Reef Marine Park;
+ Roebuck Marine Park;

+ Kimberley Marine Park;
+ Ashmore Reef Marine Park; and
+ Cartier Island Marine Park.

The Northern Marine Parks Network comprises eight marine parks. However, only the Oceanic Shoals Marine Park extends across the boundary with the North-West Marine Parks Network, into the EMBA.

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 considers 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.

Five types of zone are represented within the North Marine Parks Network. However, it is only the Multiple Use Zone (IUCN Category VI) of the Oceanic Shoals Marine Park which extends into the EMBA.

The North-West Marine Parks Network includes six different types of zoning:

+ Sanctuary Zone (IUCN Category Ia);
+ National Park Zone (IUCN Category II);
+ Recreational Use Zone (IUCN Category IV);
+ Habitat Protection Zone (IUCN Category IV);
+ Multiple Use Zone (IUCN Category VI); and
+ Special Purpose Zone (Trawl) (VI).

The South-west Marin Parks Network includes six different types of zoning:

+ National Park Zone (IUCN Category II);
+ Habitat Protection Zone (IUCN Category IV);
+ Multiple Use Zone (IUCN Category VI);
+ Special Purpose Zone (Mining Exclusion) (IUCN Category VI);
+ Special Purpose Zone (IUCN Category VI); and
+ Special Purpose Zone (Trawl) (IUCN Category VI).

A summary of the South-West and North-West Marine Parks Networks is provided in **Table 12-1**.

12.2 South-West Marine Parks Network

The South-West Commonwealth Marine Parks Network is aligned to the South-West Marine Region. The network covers 508,371 km^2 and includes 14 marine parks (Director of National Parks, 2018a). Broad values of the South-west Australian Marine Parks include:

+ Natural values;
+ Cultural values;
+ Heritage values; and
+ Socio-economic values.

Further detail on each of the relevant marine parks those that fall within the EMBA is provided below.

12.2.1 Abrolhos Marine Park

The Abrolhos Marine Park (including zones within the EMBA: Marine National Park Zone – IUCN Category II-2,548 km^2; Habitat Protection Zone – IUCN Category VI-23,239 km^2; Multiple Use Zone – IUCN Category VI-56,545 km^2; Special Purpose Zone – IUCN Category VI-5,729 km^2) covers an area of approximately 88,060 km^2 and protects the following conservation values (Director of National Parks, 2018a):

+ Important foraging areas for the:
  - Threatened Australian lesser noddy;
  - Northernmost breeding colony of the threatened Australian sea lion;
  - Great white sharks; and
  - Migratory common noddy, wedge-tailed shearwater, bridled tern, Caspian tern and roseate tern.
+ Important migration habitat for the protected humpback whale and pygmy blue whales;
+ The second largest canyon on the west coast, the Houtman Canyon;
+ Examples of the northernmost ecosystems of the Central Western Province and South-west Shelf Transition (including the Central West Coast meso-scale bioregion);
+ Examples of the deeper ecosystems of the Abrolhos Islands meso-scale bioregion;
+ Examples of the shallower, southernmost ecosystems of the Central Western Shelf Province provincial bioregion including the Zuytdorp meso-scale bioregion;
+ Examples of the deeper ecosystems of the Central Western Transition provincial bioregion;
+ Examples of diversity of seafloor features including: southern most banks and shoals of the North-west region; deep holes and valleys; slope habitats; terrace and shelf environments; and
+ Seven KEFs.

The Abrolhos Marine Park is adjacent to the Shark Bay World Heritage Property. The marine park does not contain any Commonwealth or National Heritage listings (Director of National Parks 2018a). The marine park contains 11 known shipwrecks listed under the *Underwater Culture Heritage Act 2018*. Commercial tourism, fishing, recreation and mining are important supported socio-economic activities in the park.

12.2.2 Jurien Marine Park

The Jurien Marine Park (including zones within the EMBA): Marine National Park Zone -IUCN Category II – 31 km^2 Special Purpose Zone -IUCN Category VI – 1,820 km^2) covers an area of approximately 1,851 km^2 and protects the following conservation values (Director of National Parks 2018a):

+ Important foraging areas for the:
  - Threatened soft-plumaged petrel;
  - Threatened Australian sea lion;
  - Threatened white shark; and
  - Migratory roseate tern, bridled tern, wedge-tailed shearwater, and common noddy.
+ Important migration habitat for the protected humpback whale;
+ Examples of the ecosystems of two provincial bioregions: the central part of the South-west Shelf Transition (which includes the Central West Coast meso-scale bioregion) and small parts of the Central Western Province;
+ Three KEFs; and
+ Heritage values represented by the SS Cambewarra and Oleander historic shipwreck.

The Jurien Marine Park does not contain any international, Commonwealth or National Heritage listings (Director of National Parks 2018a). Commercial tourism, fishing, recreation and mining are important supported socio-economic activities in the park.

12.2.3 Two Rocks Marine Park

The Two Rocks Marine Park (including zones within the EMBA): Multiple Use Zone - IUCN Category VI – 867 km^2; Marine National Park Zone - IUCN Category II – 15 km^2) covers an area of approximately 882 km^2 and protects the following conservation values (Director of National Parks 2018a):

+ Important foraging areas for the:
  - Threatened soft-plumaged petrel;
  - Threatened Australian sea lion; and
  - Migratory roseate tern, bridled tern, Caspian tern, wedge-tailed shearwater, and common noddy.
+ Important migratory areas for protected humpback whales and pygmy blue whales;
+ Seasonal calving habitat for the threatened southern right whale;
+ Examples of the ecosystem of the southernmost parts of the South-west Shelf Transition (including the Central West Coast meso-scale bioregion); and
+ Three KEFs.

The Two Rocks Marine Park does not contain any international, Commonwealth or National Heritage listings (Director of National Parks 2018a). Commercial tourism, fishing, recreation and scientific research are important supported socio-economic activities in the park.

12.2.4 Perth Canyon Marine Park

Perth Canyon Marine Park (including zones within the EMBA): Marine National Park Zone – IUCN Category II – 1,241 km^2; Habitat Protection Zone – IUCN Category IV –4,352 km^2; Multiple Use Zone – IUCN Category VI – 1,816 km^2) covers an area of approximately 7,409 km^2 and protects the following conservation values (Director of National Parks 2018a):

+ Globally important seasonal feeding aggregation for the threatened blue whale;
+ Important foraging areas for the:
  - Threatened soft-plumaged petrel;
  - Migratory sperm whale; and
  - Migratory wedge-tailed shearwater.
+ Important migratory areas for protected humpback whales and blue whales;
+ Seasonal calving habitat for the threatened southern right whale;
+ Examples of the ecosystems of the southernmost parts of the Central Western Province and South-west Shelf Transition (including the Central West Coast meso-scale bioregion), and the northernmost parts of the South-west Transition and Southwest Shelf Province (including the Leeuwin-Naturaliste meso-scale bioregion); and
+ Four KEFs.

The Perth Canyon Marine Park does not contain any international, Commonwealth or National Heritage listings (Director of National Parks 2018a). Commercial tourism, fishing, shipping, recreation and defence training are important supported socio-economic activities in the park.

12.2.5 Geographe Marine Park

Geographe Marine Park (including zones within the EMBA): Marine National Park Zone - IUCN Category II – 15 km^2; Special Purpose Zone - IUCN VI – 650 km^2; Multiple Use Zone - IUCN Category VI – 291 km^2; Habitat Protection Zone (IV) 21 km^2) covers an area of approximately 977 km^2 and protects the following conservation values (Director of National Parks 2018a):

+ Important foraging areas for the:
  – Threatened soft-plumaged petrel; and
  – Migratory wedge-tailed shearwater.
+ Important pre-migration aggregation area for the migratory flesh-footed shearwater;
+ Important migratory habitat for the protected humpback whale and blue whale;
+ Seasonal calving habitat for the threatened southern right whale.
+ Seasonal calving habitat for the threatened southern right whale.
+ Representation of the South-west Shelf Province on the continental shelf as well as the Leeuwin-Naturaliste meso-scale bioregion;
+ Two KEFs; and
+ Representation of the seagrass habitats of the Geographe Bay key ecological feature, which in this location extend the furthest into Commonwealth waters.

The Geographe Marine Park does not contain any international, Commonwealth or National Heritage listings (Director of National Parks 2018a). The marine park contains eight known shipwrecks listed under the *Underwater Culture Heritage Act 2018.* Commercial tourism, fishing and recreation are important supported socio-economic activities in the park.

12.2.6 South-west Corner Marine Park

The South-west Corner Marine Park (including zones within the EMBA: Marine National Park Zone - IUCN II – 54,841 km^2; Multiple Use Zone - IUCN VI –106,602 km^2; Special Purpose Zone (Mining exclusion) - IUCN VI – 9,550 km^2, Special Purpose Zone – IUCN VI – 5753 km^2; Habitat Protection Zone - IUCN IV – 95,088 km2) covers an area of approximately 271,833 km2 within the EMBA and protects the following conservation values (Director of National Parks 2018a):

+ Important migratory area for protected humpback whales and blue whales;
+ Important foraging areas for the:
  – Threatened white shark;
  – Threatened Australian sea lion;
  – Threatened Indian yellow-nosed albatross and soft-plumaged petrel;
  – Sperm whale;
  – Migratory flesh-footed shearwater, short-tailed shearwater and Caspian tern; and
  – Seasonal calving habitat for the threatened southern right whale.
+ Representation of three provincial bioregions (the South-west Transition and Southern Province in the off-shelf area, and the South-west Shelf Province on the continental shelf) and two meso-scale bioregions (southern end of the Leeuwin-Naturaliste meso-scale bioregion and western and central parts of the Western Australia South Coast meso-scale bioregion);
+ Representation of the Donnelly Banks, east of Augusta, characterised by higher productivity and including nursery habitats; and

- Six KEFs.

The South-west Corner Marine Park does not contain any international, Commonwealth or National Heritage listings (Director of National Parks 2018a). The marine park contains ten known shipwrecks listed under the *Underwater Culture Heritage Act 2018*. Commercial tourism, fishing, shipping and recreation are important supported socio-economic activities in the park.

12.2.7 Bremer Marine Park

The Bremer Marine Park: National Park Zone – IUCN II – 3,172 km^2; Special Purpose Zone (Mining exclusion) - IUCN VI – 1,300 km^2, which covers an area of approximately 4,472 km^2 and protects the following conservation values (Director of National Parks 2018a):

- Contains habitats, species and ecological communities associated with two bioregions: Southern Province and South-west Shelf Province;
- Two key ecological features (Albany Canyon group and adjacent shelf break and ancient coastline between 90 m and 120 m depth);
- Important foraging areas for:
- Threatened white shark;
- Threatened Australian sea lion;
- Threatened Indian yellow-nosed albatross, Australian fairy tern and soft-plumaged petrel; and
- Migratory flesh-footed shearwater, short-tailed shearwater, bridled tern and Caspian tern.
- Important migratory pathway for humpback whales;
- Significant calving habitat for the threatened southern right whale; and
- Important aggregation area for killer whales

The marine park does not contain any international, Commonwealth or National Heritage listings (Director of National Parks 2018a). Commercial tourism, fishing, shipping and recreation are important supported socio-economic activities in the park.

12.3 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 North-west Commonwealth Marine Reserves Network include:

- Natural values;
- Cultural values;
- Heritage values; and
- Socio-economic values.

Further detail on each of the relevant marine parks within the EMBA is provided below.

12.3.1 Carnarvon Canyon Marine Park

The Carnarvon Canyon Marine Park (Habitat Protection Zone – IUCN Category IV) covers an area of approximately 6,177 km^2 and protects the following conservation values (Director of National Parks 2018b):

- The Carnarvon Canyon a single channel canyon with seabed features that include slope, continental rise and deep holes and valleys;

- The Carnarvon Canyon ranges in depth from 1500 m to over 5,000 m, thereby providing habitat diversity for benthic and demersal species; and
- Central Western Transition provincial bioregion ecosystem examples are found here, which are characteristic of the biogeographic faunal transition between tropical and temperate species.

There is limited information about species' use of this Marine Park (Director of National Parks 2018b). The marine park does not contain any international, Commonwealth or National Heritage listings (Director of National Parks 2018b). Commercial fishing, tourism, shipping and mining are important supported socio-economic activities in the marine park.

12.3.2 Shark Bay Marine Park

The Shark Bay Marine Park (Multiple Use Zone – IUCN Category VI) covers an area of approximately 7,443 km^2 and protects the following conservation values (Director of National Parks 2018b):

- Foraging areas adjacent to important breeding areas for several species of migratory seabirds;
- Part of the migratory pathway of protected humpback whales;
- Internesting habitat for marine turtles;
- Waters that are adjacent to the largest nesting area for loggerhead turtles in Australia;
- Marine park and adjacent coastal areas important for shallow-water snapper;
- Protection to shelf and slope habitats as well as a terrace feature;
- Examples of the shallower ecosystems of the Central Western Shelf Province and Central Western Transition provincial bioregions including the Zuytdorp meso-scale bioregion; and
- Connectivity between the inshore waters of the Shark Bay World Heritage Area and the deeper waters of the area.

Whilst no listed international, Commonwealth or National Heritage places are within the marine park, the park is adjacent to Shark Bay World Heritage Area (Director of National Parks 2018b). Commercial tourism, fishing, mining and recreation are important socio-economic values of the park.

12.3.3 Gascoyne Marine Park

The Gascoyne Marine Park (Multiple Use Zone – IUCN Category VI-33,652 km^2; Habitat Protection Zone – IUCN Category IV-38,982 km^2; Marine National Park Zone – IUCN Category II-9,132 km^2) covers an area of approximately 81,766 km^2 and protects the following conservation values (Director of National Parks 2018a):

- Important foraging areas for: migratory seabirds threatened and migratory hawksbills and flatback turtles; and vulnerable and migratory whale shark;
- A continuous connectivity corridor from shallow depths around 15 m out to deep offshore waters on the abyssal plain at over 5,000 m in depth;
- Seafloor features including canyon, terrace, ridge, knolls, deep hole/valley and continental rise. It also provides protection for sponge gardens in the south of the reserve adjacent to Western Australian coastal waters;
- Ecosystems examples from the Central Western Shelf Transition, the Central Western Transition and the Northwest province provincial bioregions as well as the Ningaloo meso-scale bioregion;
- Four KEFs for the region:
  - Canyons on the slope between the Cuvier Abyssal Plain and the Cape Range Peninsula (enhanced productivity, aggregations of marine life and unique sea-floor feature);
  - Exmouth Plateau (unique sea-floor feature associated with internal wave generation);

  - Continental slope demersal fish communities (high species diversity and endemism – the most diverse slope bioregion in Australia with over 500 species found with over 64 of those species occurring nowhere else); and
  - Commonwealth waters adjacent to Ningaloo Reef.
+ The canyons in this reserve are believed to be associated with the movement of nutrients from deep water over the Cuvier Abyssal Plain onto the slope where mixing with overlying water layers occurs at the canyon heads. These canyon heads, including that of Cloates Canyon, are sites of species aggregation and are thought to play a significant role in maintaining the ecosystems and biodiversity associated with the adjacent Ningaloo Reef; and
+ The reserve therefore provides connectivity between the inshore waters of the existing Ningaloo Commonwealth marine park and the deeper waters of the area.

The park is also adjacent to World Heritage listings associated with the Ningaloo Coast. Commercial tourism, commercial fishing, mining and recreation are important socio-economic values of the park (Director of National Parks 2018b).

12.3.4 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 KEFs; 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).

12.3.5 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 KEF 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.

12.3.6 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.

12.3.7 Eighty Mile Beach Marine Park

The Eighty Mile Beach Marine Park (Multiple Use Zone – IUCN Category VI) is adjacent to the Western Australia Eighty Mile Beach Marine Park, 74 km north-east of Port Hedland and covers an area of approximately 10,785 km^2 and protects the following conservation values (Director of National Parks 2018b):

- Breeding, foraging and resting habitat for seabirds (one of the world's most important feeding grounds for migratory shorebirds and waders and is listed under the Ramsar Convention);
- Internesting and nesting habitat for marine turtles (it supports a significant nesting population of flatback turtles, which are endemic to northern Australia);
- Foraging, nursing and pupping habitat for sawfish;
- Migratory pathway for humpback whales;
- Coastal waters provide critical habitat for several shark and ray species at varying life stages;
- The Nyangumarta, Karajarri and Ngarla people's sea country extends into Eighty Mile Beach Marine Park. Access to sea country by families is important for cultural traditions, livelihoods and future socio-economic development opportunities; and
- Three known shipwrecks listed under the *Underwater Cultural Heritage Act 2018*: Lorna Doone (wrecked in 1923), Nellie (wrecked in 1908), and Tifera (wrecked in 1923).

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

12.3.8 Argo-Rowley Terrace Marine Park

The Argo-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 KEFs 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.

12.3.9 Mermaid Reef Marine Park

The Mermaid Reef Marine Park (Multiple Use Zone – IUCN Category VI) lays approximately 280 km north-west of Broome, Western Australia, adjacent to the Argo–Rowley Terrace Marine Park and approximately 13 km from the Western Australian Rowley Shoals Marige Park. It covers an area of 540 km^2 and protects the following conservation values (Director of National Parks 2018b):

+ Mermaid Reef and Commonwealth waters surrounding Rowley Shoals are valued for its high productivity, aggregations of marine life and high species richness;
+ Mermaid Reef, Clerke Reef and Imperieuse Reef are biodiversity hotspot and key topographic feature of the Argo Abyssal Plain;
+ Rowley Shoals present some of the best geological examples of shelf atolls in Australian waters, and are ecologically significant in that they are considered ecological steppingstones for reef species originating in Indonesian/Western Pacific waters, are one of a few offshore reef systems on the north-west shelf, and may also provide an upstream source for recruitment to reefs further south;
+ Breeding habitat for seabirds;
+ Migratory pathway for the pygmy blue whale; and
+ One known shipwreck listed under the *Underwater Cultural Heritage Act 2018*: Lively (wrecked in 1810).

Tourism, recreation, and scientific research are important activities in the Marine Park (Director of National Parks 2018b).

12.3.10 Roebuck Marine Park

The Roebuck Marine Park (Multiple Use Zone – IUCN Category VI) covers an area of approximately 304 km^2 and protects the following conservation values (Director of National Parks 2018b):

- Foraging habitat area for migratory seabirds adjacent to important breeding areas;
- Foraging area adjacent to important nesting sites for flatback turtles;
- Parts of the migratory pathway of the protected humpback whale;
- Habitat adjacent to important foraging, nursing and pupping areas for freshwater, green and dwarf sawfish;
- Foraging and calving areas for Australian snubfin, Indo-Pacific humpback and Indo-Pacific bottlenose dolphins;
- Foraging habitat for dugong;
- Protection for shallow shelf habitats ranging in depth from 15–70 m;
- Ecosystems example of the Northwest Shelf Province provincial bioregion and the Canning meso-scale bioregion; and
- Sea country valued for indigenous cultural identity, health and well-being for the Yawuru people (Director of National Parks 2018b).

No heritage listings apply to the marine park. Commercial tourism, fishing, pearling and recreation are important socio-economic values of the marine park (Director of National Parks 2018b).

12.3.11 Kimberley Marine Park

The Kimberley Marine Park (Multiple Use Zone – IUCN Category VI) is located approximately 100 km north of Broome, Western Australia, and extends from the Western Australian state water boundary north from the Lacepede Islands to the Holothuria Banks offshore from Cape Bougainville. It is adjacent to the Western Australian Lalanggarram / Camden Sound Marine Park and the North Kimberley Marine Park. It covers an area of 74,469 km^2, and protects the following conservation values (Director of National Parks 2018b):

- Northwest Shelf Province;
  - Diverse benthic and pelagic fish communities
  - Ancient coastline thought to be an important seafloor feature
  - Migratory pathway for humpback whales
- Northwest Shelf Transition;
  - High levels of species diversity
  - Endemism occur among demersal fish communities on the continental slope
- Timor Province;
  - Reefs and islands of the bioregion are regarded as biodiversity hotspots
  - Endemism in demersal fish communities of the continental slope is high (two distinct communities have been identified on the upper and mid slopes)
  - Ancient coastline at the 125 m depth contour where rocky escarpments are thought to provide biologically important habitats in areas otherwise dominated by soft sediments;
  - Continental slope demersal fish communities characterised by high diversity of demersal fish assemblages;
  - breeding and foraging habitat for seabirds;

  - Internesting and nesting habitat for marine turtles;
  - Breeding, calving and foraging habitat for inshore dolphins;
  - Calving, migratory pathway and nursing habitat for humpback whales;
  - Migratory pathway for pygmy blue whales;
  - Foraging habitat for dugong and whale sharks;
  - The Wunambal Gaambera, Dambimangari, Mayala, Bardi Jawi and the Nyul Nyul people's sea country extends into the Kimberley Marine Park. Access to sea country by families is important for cultural traditions, livelihoods and future socio-economic development opportunities; and
  - More than 40 known shipwrecks listed under the *Underwater Cultural Heritage Act 2018*.

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

12.3.12 Ashmore Reef Marine Park

The Ashmore Reef Marine Park (Sanctuary Zone – IUCN Category Ia; Recreational Use Zone – IUCN Category II) covers an area of approximately 583 km^2 (Director of National Parks 2018b). It forms part of the North-west Park Network. As the only oceanic reef in the north-east Indian Ocean with vegetated islands (East, Middle and West Islands), Ashmore is also the largest of three emergent, oceanic reefs in the region (DSEWPaC 2012). Both the Ashmore and Cartier Islands fall under the legal memorandum of understanding between Indonesia and Australia, as both areas are located within Australia's external territory (DSEWPaC 2012).

Ashmore Reef Marine Park is located on Australia's North West Shelf in the Indian Ocean, about 450 nautical miles (840 km) west of Darwin and 330 nautical miles (610 km) north of Broome. The reserve covers 583 km^2 and includes two extensive lagoons, shifting sand flats and cays, seagrass meadows, a large reef flat covering an area of 239 km^2. Within the reserve are three small islands known as East, Middle and West Islands (DoE, 2002).

Ashmore was designated a Ramsar Wetland of International Importance in 2003 due to the importance of its islands providing a resting place for migratory shorebirds and supporting large seabird breeding colonies.

The proclaimed marine park will protect the following conservation values (DoE 2014):

+ Ecosystems, habitats and communities associated with; the North West Shelf; Timor Province; and emergent oceanic reefs;
+ The island and reef habitats:
  - Contains critical nesting and internesting habitat for green turtles (including one of three genetically distinct breeding populations in the North-west Marine Region). Low level nesting activity by loggerhead turtles has also been recorded;
  - Large and significant feeding populations of green, hawksbill and loggerhead turtles occur around the reefs (it is estimated that approximately 11,000 marine turtles feed in the area throughout the year);
  - Supports a small dugong population of less than 50 individuals that breed and feed around the reef. This population is thought to be genetically distinct from other Australian populations;
  - Migratory pathway for pygmy blue whales (Director of National Parks 2018b);
  - Support some of the most important seabird rookeries on the North West Shelf including colonies of bridled terns, common noddies, brown boobies, eastern reef egrets, frigatebirds, tropicbirds, red-footed boobies, roseate terns, crested terns and lesser crested terns;
  - Is an important staging points/feeding areas for many migratory seabirds; and
  - Is internationally significant for its abundance and diversity of sea snakes.

- Two KEFs:
- Ashmore Reef and Cartier Island and surrounding Commonwealth waters; and
- Continental slope demersal fish communities (Director of National Parks 2018b);
- Cultural and heritage sites, including;
    - Ashmore lagoon as a rest/staging area for traditional Indonesian fishers
    - Indonesian artefacts; and
    - Grave sites.
    - Commonwealth heritage listing – Ashmore Reef

Ashmore Reef and nearby islands and reefs are associated with benthic communities consisting predominantly of sand and coral rubble, with noteworthy hard coral, soft coral, algae and seagrasses (Heyward *et al.* 2012; Skewes et al., 1999a, 1999b). The reefs host similar benthic communities, with areas of relatively high live coral cover, although episodes of coral bleaching have been recorded (Heyward *et al.* 2012). Benthic organisms that depend on photosynthesis such as seagrasses, macroalgae and zooxanthellate corals are typically restricted to shallower waters around the reefs, although in the clear tropical waters may be found at considerable depths. Given the shallowest sampling location is greater than 60 m, and that most sampling locations are greater than 100 m deep, diverse benthic communities driven by primary producers such as seagrasses, algae and zooxanthellate corals are not expected to occur at the sampling locations. Data collected in the vicinity of Ashmore Reef indicates that corals are likely to spawn during March and April (Heyward *et al.* 2010).

Soft sediments are widespread in the region, with sediment infauna communities in the region dominated by polychaetes and crustaceans. These taxa accounted for over 80% of benthic infauna sampled, both in terms of numbers of species and individual organisms (Smith *et al.* 1997).

Commercial tourism, recreation and scientific research are important socio-economic values of the marine park (Director of National Parks 2018b).

12.3.13 Cartier Island Marine Park

The Cartier Island Marine Park (Sanctuary Zone – IUCN Category Ia) is located approximately 45 km south-east of Ashmore Reef Marine Park and 610 km north of Broome, Western Australia. Both Marine Parks are in Australia's External Territory of Ashmore and Cartier Islands and are also within an area subject to a Memorandum of Understanding (MoU) between Indonesia and Australia, known as the MoU Box. The Marine Park covers an area of 172 km² and protects the following conservation values (Director of National Parks 2018b):

- Ashmore Reef and Cartier Island and surrounding Commonwealth waters;
- Areas of enhanced productivity in an otherwise low-nutrient environment;
- Regional importance for feeding and breeding aggregations of birds and marine life;
- Continental slope demersal fish communities;
- Area of high diversity in demersal fish assemblages;
- Area of high diversity and abundance of hard and soft corals, gorgonians (sea fans), sponges and a range of encrusting organisms;
- Breeding and foraging habitat for seabirds;
- Internesting, nesting and foraging habitat for marine turtles;
- Foraging habitat for whale sharks;
- Internationally significant for its abundance and diversity of sea snakes;

- One known shipwreck listed under the *Underwater Cultural Heritage Act 2018*: the Ann Millicent (wrecked in 1888).

Scientific research is an important activity in the Marine Park (Director of National Parks 2018b).

12.4 North Marine Park Network

The North Park Network is aligned to the North Marine Region. The network covers 157,480 km^2 (Director of National Parks 2018c). Broad values of the North Network include:

- Natural values;
- Cultural values;
- Heritage values; and
- Socio-economic values.

Further detail on the applicable Oceanic Shoals Marine Park is provided below.

12.4.1 Oceanic Shoals Marine Park

The Oceanic Shoals Marine Park (zones within EMBA: Multiple Use Zone - IUCN Category VI- 32,488 km^2; Special Purpose Zone – IUCN VI-24,443 km^2) covers an area of approximately 56,931 km^2 within the EMBA.

The marine park protects the following conservation values (DoE 2014):

- Important resting area for turtles between egg laying (internesting area) for the threatened flatback turtle and olive ridley turtle;
- Important foraging area for the threatened loggerhead turtle and olive ridley turtle;
- Examples of the ecosystems of two provincial bioregions: the Northwest Shelf Transition Province (which includes the Bonaparte, Oceanic Shoals, and Tiwi meso-scale bioregions) and the Timor Transition Province;
- KEFs represented in the park are (Director of National Parks 2018c):
  - Carbonate bank and terrace system of the Van Diemen Rise (unique sea-floor feature);
  - Carbonate banks and terrace system of the Sahul Shelf (unique sea-floor feature);
  - Pinnacles of the Bonaparte Basin (enhanced productivity, unique sea-floor feature); and
  - Shelf break and slope of the Arafura Shelf (unique sea-floor feature).

No heritage listings apply to the marine park. Commercial fishing and mining are important socio-economic values for the park (Director of National Parks 2018c).

A spatial predictive benthic habitat model of the Oceanic Shoals Marine Park has been developed by AIMS, as part of the Australian National Environmental Science Programme, to determine the spatial heterogeneity of the benthic environment and key classes of organisms within the reserve. The benthic habitat model maps the 10 broad classes of benthic organisms; alcyons, gorgonians, soft corals, hard corals, halimeda, macroalgae, seagrass, filterers (e.g. sponges), burrowers (e.g. sea urchins) and no biota detected (Radford and Puotinen 2016).

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Table 12-1 Summary of marine network values, pressures, management programs and actions applicable to the EMBA

Marine network	Values	Pressures	Management programs and actions
SOUTH WEST	+ Nine bioregions + Key ecological features + EPBC listed species + Biologically important areas + Sea country indigenous values + Historic shipwrecks + Adjacent to Shark Bay World Heritage Area + Shipping and port activities + Commercial fishing + Marine tourism	+ Climate change + Hydrological changes from coastal development and agriculture (increase sediment loads and pollutants) + Illegal/unregulated/unreported fishing + Bycatch of non-target species + Habitat modification from mining + Human presence + Invasive species + Marine pollution	+ Communication, education and awareness programs + Promote suitable tourism experience + Facilitate partnerships between tourism operators and Indigenous operators + Indigenous engagement program + Marine monitoring programs + Park management via assessments / authorisation program for marine park activities + Marine park management and development of suitable infrastructure + Compliance planning and surveillance

Marine network	Values	Pressures	Management programs and actions
NORTH WEST	+ Eight bioregions + Key ecological features + EPBC listed species + Biologically important areas + Sea country indigenous values + Native title determinations + Traditional Indonesian fishers + World Heritage Properties (Ningaloo Coast, Shark Bay) + Ashmore Reef Marine Park and Eighty-Mile Beach Ramsar sites + Shipping and port activities + Commercial fishing, pearling, aquaculture + Marine tourism + Scientific research	+ Climate change + Hydrological changes from coastal development and agriculture (increase sediment loads and pollutants) + Illegal/unregulated/unreported fishing + Bycatch of non-target species + Habitat modification from mining + Human presence + Invasive species + Marine pollution	+ Communication, education and awareness programs + Promote suitable tourism experience + Facilitate partnerships between tourism operators and Indigenous operators + Indigenous engagement program + Marine monitoring programs + Park management via assessments / authorisation program for marine park activities + Marine park management and development of suitable infrastructure + Compliance planning and surveillance
NORTH	+ One bioregion + Key ecological features + EPBC listed species + Biologically important areas + Historic shipwrecks	+ Climate change + Hydrological changes reliance upon the large number of estuaries and waterways that feed into the Gulf of Carpentaria and the waters adjacent to the Northern Territory coastline + Illegal/unregulated/unreported fishing + Bycatch of non-target species + Physical Habitat modification + Marine pollution	+ Communication, education and awareness programs + Promote suitable tourism experience + Facilitate partnerships between tourism operators and Indigenous operators + Indigenous engagement program + Marine monitoring programs + Park management via assessments / authorisation program for marine park activities + Marine park management and development of suitable infrastructure + Compliance planning and surveillance

13. Conservation Management Plans

In order to protect, maintain and enhance recovery of certain threatened species and ecological communities the DAWE 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.

Table 13-1: Summary of EPBC Act recovery plans applicable to the EMBA

Taxa	Common name	Recovery Plan / Conservation Advice	Threats
Bird	Australian lesser noddy	Approved Conservation Advice for *Anous tenuirostris melanops* (Australian lesser noddy) (2015)	Habitat modification by pied cormorants (Houtman Abrolhos) Catastrophic destruction of habitat by cyclones
	Migratory species within the EMBA: + Asian dowitcher; + Bar-tailed godwit; + Black-tailed godwit; + Broad-billed sandpiper; + Common greenshank; + Common redshank; + Common sandpiper; + Double-banded plover; + Fork-tailed swift; + Grey plover; + Grey-tailed tattler; + Long-toed stint; + Little greenshank + Oriental plover; + Oriental pratincole; + Pacific golden plover; + Pectoral sandpiper; + Red-necked phalarope; + Red-necked stint; + Ruddy turnstone;	Wildlife Conservation Plan for Migratory Shorebirds (2015)	Habitat loss and degradation Pollution and Contaminants Invasive species Anthropogenic disturbance Climate change and variability Overharvesting of shorebird prey Fisheries bycatch Direct mortality (hunting)

Taxa	Common name	Recovery Plan / Conservation Advice	Threats
	+ Ruff (reeve); + Sanderling; + Sharp-tailed sandpiper; + Streaked shearwater; + Terek sandpiper; + Whimbrel; and + Wood sandpiper.		
	Christmas Island frigatebird	Conservation Advice for the Christmas Island frigatebird *Fregata andrewsi* (2020a) Recovery Plan for the Christmas Island Frigatebird (*Fregeta andrewsi*) (2004)	Introduction of a new disease
			Disturbance of habitat
			Fisheries – prey depletion
			Illegal killing and hunting in south-east Asia
			Invasive weeds
			Fisheries - bycatch
			Drowning in artificial water bodies
			Heavy metal contamination
			Marine debris - plastics
	Australasian bittern	Conservation Advice for *Botaurus poiciloptilus* (Australasian Bittern) (2019)	habitat loss through water reductions and transition from ponded rice to other farming systems
			habitat degradation through increased salinity, siltation and pollution; grazing by livestock and feral animalsan d changes in abundance of plant species
			Climate change through changes in water availability; changes in fire regimes and salinisation of coastal wetlands
			Infrastructure through urban development
			Predation by introduced vertebrate pests such as foxes and cats
	Red knot		Habitat loss and habitat degradation

Taxa	Common name	Recovery Plan / Conservation Advice	Threats
		Approved Conservation Advice for *Calidris canutus* (Red knot) (2016) Wildlife Conservation Plan for Migratory Shorebirds (2015)	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
	Great knot	Approved Conservation Advice for *Calidris tenuirostriss* (Great knot) (2016) Wildlife Conservation Plan for Migratory Shorebirds (2015).	Habitat loss and habitat degradation
			Pollution/contaminants
			Disturbance
			Diseases
			Direct mortality (hunting)
			Climate change impacts
	Greater sand plover	Approved Conservation Advice for *Charadrius leschenaultii* (Greater sand plover) (2016) Wildlife Conservation Plan for Migratory Shorebirds (2015)	Habitat loss and habitat degradation
			Pollution/contamination impacts
			Disturbance
			Direct mortality (hunting)
			Diseases
			Climate change impacts

Taxa	Common name	Recovery Plan / Conservation Advice	Threats
	Lesser sand plover	Approved Conservation Advice for *Charadrius mongolus* (Lesser sand plover) (2016) Wildlife Conservation Plan for Migratory Shorebirds (2015)	Habitat loss and habitat degradation
			Pollution/contamination impacts
			Disturbance
			Direct mortality (hunting)
			Diseases
			Climate change impacts
	Antipodean 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
	Amsterdam 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

Taxa	Common name	Recovery Plan / Conservation Advice	Threats
			Feral pest species
			Human disturbance at the nest
			Parasites and diseases
			Loss of nesting habitat
			Competition for nest space
	Tristan 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
	Southern royal 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

Taxa	Common name	Recovery Plan / Conservation Advice	Threats
			Human disturbance at the nest
			Parasites and diseases
			Loss of nesting habitat
			Competition for nest space
	Wandering 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
	Northern royal 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

Taxa	Common name	Recovery Plan / Conservation Advice	Threats
			Parasites and diseases
			Loss of nesting habitat
			Competition for nest space
	Blue petrel	Approved Conservation Advice for *Halobaena caerulea* (blue petrel) (2015)	Habitat loss, disturbance and modification
			Predation
	Western Alaskan bar-tailed godwit	Wildlife Conservation Plan for Migratory Shorebirds (2015) 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
	Northern Siberian bar-tailed godwit	Approved Conservation Advice for *Limosa lapponica menzbieri* (Bar-tailed godwit (northern Siberian)) (2016)	Habitat loss and habitat degradation
			Over-exploitation of shellfish
			Pollution/contamination impacts
			Disturbance
			Direct mortality (hunting)
			Diseases
			Extreme weather events
			Climate change impacts
	Southern giant petrel		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
	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
			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

Taxa	Common name	Recovery Plan / Conservation Advice	Threats
			Invasive plants
	Fairy prion (southern)	Approved Conservation Advice for *Pachyptila turtur subantarctica* (fairy prion (southern)) (2015)	Competition with blue petrels
			Soil erosion
			Fire
	Abbott's booby	Conservation Advice for the Abbott's booby *Papasula abbotti* (2020b)	Vegetation clearing – edge effects from previous clearing and new vegetation clearing
			Climate change – severe storm events and prey depletion
			Introduction of a new disease
			Invasive weeds
			Yellow crazy ants – habitat modification
			Fisheries – prey depletion
			Marine debris - plastics
	Christmas Island white-tailed tropicbird	Conservation Advice for *Phaethon lepturus fulvus* white-tailed tropicbird (Christmas Island) (2014)	Introduced predators on Christmas Island
			Crazy ants
	Sooty 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

Taxa	Common name	Recovery Plan / Conservation Advice	Threats
			Competition for nest space
	Soft-plumaged petrel	Approved Conservation Advice for *Pterodroma mollis* (soft-plumaged petrel) (2015)	Accidental introduction of predators (relevant only to Maatsuyker Island, located offshore of Tasmania)
	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
			Grazing and associated trampling of wetland vegetation/nests, nutrient enrichment and disturbance to substrate by livestock
			Climate change
			Predation by feral animals
			Introduction of weeds
	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
			Increasing salinity in waters adjacent to Fairy Tern colonies
			Irregular water management
			Weed encroachment
			Oil spills, particularly in Victoria (potential threat)
	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

Taxa	Common name	Recovery Plan / Conservation Advice	Threats
			Parasites and diseases
			Loss of nesting habitat
			Competition for nest space
	Shy albatross	Conservation Advice *Thalassarche cauta* Shy Albatross (2020c) National recovery plan for threatened albatrosses and giant petrels 2011-2016 (2011)	Fisheries bycatch
			Disease
			Competition for nesting habitat
			Marine plastics
			Human disturbance
			Previous harvesting for feathers and eggs
			Climate change
	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
			Habitat degradation including pollution (increasing port expansion and coastal development)

Taxa	Common name	Recovery Plan / Conservation Advice	Threats
			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	Conservation Management Plan for the Southern Right Whale 2011 – 2021 (2012)	Entanglement
			Vessel disturbance
			Whaling
			Climate variability and change
			Noise interference

Taxa	Common name	Recovery Plan / Conservation Advice	Threats
			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
			Vessel disturbance and strike
	Australian sea-lion	Recovery Plan for the Australian Sea Lion (*Neophoca cinerea*) (2013)	Fishery bycatch (primary threat)
			Entanglement in marine debris (primary threat)
			Marine aquaculture
			Habitat degradation
			Human disturbance
			Direct killing (primary threat)
			Disease
			Pollution and oil spills
			Noise
			Competition and prey depletion
			Climate change
Reptiles	Short-nosed seasnake		Degradation of reef habitat, primarily as a result of coral bleaching (primary threat)
			Oil and gas exploration

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Taxa	Common name	Recovery Plan / Conservation Advice	Threats
		Approved Conservation Advice on *Aipysurus apraefrontalis* (Short-nosed seasnake) (2011)	Incidental catch and death in commercial prawn trawling fisheries
	Leaf-scaled seasnake	Approved Conservation Advice on *Aipysurus foliosquama* (Leaf-scaled seasnake) (2011)	Degradation of reef habitat, primarily as a result of coral bleaching (primary threat)
			Oil and gas exploration
			Incidental catch and death in commercial prawn trawling fisheries (north-west marine area)
			Unsustainable and illegal fishing practices (currently the most significant threat in the Ashmore region)
	Loggerhead turtle	Recovery plan for marine turtles in Australia 2017 – 2027 (2017) Loggerhead turtle – WA genetic stock	Fisheries bycatch – international (moderate), domestic (high)
			Indigenous take (moderate)
			Terrestrial predation (moderate)
			Habitat modification – infrastructure/coastal development (moderate), dredging/trawling (moderate)
			Chemical and terrestrial discharge – acute (high), chronic (low)
			Marine debris – entanglement and ingestion (moderate; unknown)
			Climate change and variability (high)
			International take – outside Australia's jurisdiction (moderate), within Australia's jurisdiction (low)
			Light pollution (moderate)
			Vessel disturbance (moderate)
			Noise interference – acute (moderate), chronic (moderate; unknown)
			Recreational activities (low)
			Diseases and pathogens (low; unknown)
			Fisheries bycatch – international (moderate), domestic (high)
			Cumulative impacts of threats

Taxa	Common name	Recovery Plan / Conservation Advice	Threats
	Green turtle	Recovery plan for marine turtles in Australia 2017 – 2027 (2017) Green turtle – NWS genetic stock (NWS), Scott-Browse genetic stock (ScBr), Ashmore genetic stock (AR)	Fisheries bycatch – international (moderate), domestic (moderate)
			Indigenous take (moderate)
			Terrestrial predation NWS – moderate, AR –high; unknown, ScBr – moderate; unknown)
			Habitat modification – infrastructure/coastal development (NWS – moderate, AR – low, ScBr – high), dredging/trawling (NWS – moderate, AR – low, ScBr – low)
			Chemical and terrestrial discharge – acute (NWS, AR, ScBr –high), chronic (NWS – moderate, AR – high, ScBr – high)
			Marine debris – entanglement (NWS – moderate, AR – very high, ScBr – moderate; unknown) and ingestion (NWS – low; unknown, AR – moderate, ScBr – moderate)
			Climate change and variability (NWS – moderate, AR – very high, ScBr – high)
			International take – outside Australia's jurisdiction (moderate; unknown for NWS and ScBr), within Australia's jurisdiction (moderate; unknown for NWS and ScBr)
			Light pollution (NWS – high, AR – moderate, ScBr – moderate)
			Vessel disturbance (moderate)
			Noise interference – acute (NWS – moderate; unknown, AR – low, ScBr – moderate), chronic (NWS – moderate; unknown, AR – low, ScBr – moderate; unknown)
			Recreational activities
			Diseases and pathogens (low; unknown for AR and ScBr)
			Cumulative impacts of threats
	Leatherback turtle	Approved 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

Taxa	Common name	Recovery Plan / Conservation Advice	Threats
			Changes to breeding sites
		Recovery plan for marine turtles in Australia 2017 – 2027 (2017)	Fisheries bycatch – international (high), domestic (high)
			Indigenous take (low)
			Terrestrial predation (moderate; unknown)
			Habitat modification – infrastructure/coastal development (moderate), dredging/trawling (low)
			Chemical and terrestrial discharge – acute (low), chronic (low; unknown)
			Marine debris – entanglement (moderate) and ingestion (high)
			Climate change and variability (high)
			International take – outside Australia's jurisdiction (high), within Australia's jurisdiction (low)
			Light pollution (low)
			Vessel disturbance (moderate)
			Noise interference – acute (low; unknown), chronic (low; unknown)
			Recreational activities (low)
			Diseases and pathogens (low; unknown)
			Fisheries bycatch – international (high), domestic (high)
			Cumulative impacts of threats
	Hawksbill turtle	Recovery plan for marine turtles in Australia 2017 – 2027 (2017) Hawksbill turtle – WA genetic stock	Fisheries bycatch – international (moderate), domestic (moderate)
			Indigenous take (moderate)
			Terrestrial predation (moderate)
			Habitat modification – infrastructure/coastal development (moderate), dredging/trawling (moderate)
			Chemical and terrestrial discharge – acute (moderate), chronic (moderate)

Taxa	Common name	Recovery Plan / Conservation Advice	Threats
			Marine debris – entanglement (moderate) and ingestion (low; unknown)
			Climate change and variability (high)
			International take – outside Australia's jurisdiction (very high), within Australia's jurisdiction (moderate)
			Light pollution (high)
			Vessel disturbance (moderate)
			Noise interference – acute (moderate), chronic (moderate; unknown)
			Recreational activities (low)
			Diseases and pathogens (low; unknown)
			Cumulative impacts of threats
	Olive ridley turtle	Recovery plan for marine turtles in Australia 2017 – 2027 (2017) Olive ridley turtle – Northern Territory genetic stock	Fisheries bycatch – international (moderate), domestic (high)
			Indigenous take (moderate)
			Terrestrial predation (moderate; unknown)
			Habitat modification – infrastructure/coastal development (low), dredging/trawling (low)
			Chemical and terrestrial discharge – acute (high), chronic (moderate)
			Marine debris – entanglement (very high) and ingestion (moderate; unknown)
			Climate change and variability (very high)
			International take – outside Australia's jurisdiction (moderate), within Australia's jurisdiction (moderate)
			Light pollution (moderate)
			Vessel disturbance (moderate)
			Noise interference – acute (low), chronic (low; unknown)
			Recreational activities (low)
			Diseases and pathogens (low; unknown)

Taxa	Common name	Recovery Plan / Conservation Advice	Threats
			Cumulative impacts of threats
	Flatback turtle	Recovery plan for marine turtles in Australia 2017 – 2027 (2017) Flatback turtle – Pilbara coast genetic stock (Pil), South-west Kimberley coast genetic stock (swKim) and Cape Domett (CD)	Fisheries bycatch – international (low), domestic (moderate)
			Indigenous take (moderate)
			Terrestrial predation (moderate)
			Habitat modification – infrastructure/coastal development (Pil – high, swKim – moderate), dredging/trawling (moderate)
			Chemical and terrestrial discharge – acute (high), chronic (moderate)
			Marine debris – entanglement (moderate) and ingestion (low)
			Climate change and variability (Pil – high, swKim – moderate)
			International take – outside Australia's jurisdiction (low), within Australia's jurisdiction (low)
			Light pollution (Pil – high, swKim – moderate)
			Vessel disturbance (moderate)
			Noise interference – acute (moderate), chronic (moderate; unknown)
			Recreational activities (Pil – low, swKim – moderate)
			Diseases and pathogens (low; unknown)
			Cumulative impacts of threats
Sharks and fish	Grey nurse shark	Recovery Plan for the Grey Nurse Shark (*Carcharias taurus*) (2014)	Mortality due to incidental capture by commercial and recreational fisheries
			Mortality die to shark control programs
			Ecotourism
			Public aquarium trade
			Pollution and disease
			Ecosystem effects - habitat modification and climate change

Taxa	Common name	Recovery Plan / Conservation Advice	Threats
	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
	Northern river shark	Approved Conservation Advice for *Glyphis garricki* (northern river shark) (2014)	Commercial fishing activities
			Recreational fishing
			Indigenous fishing
			Illegal, unreported and unregulated fishing
			Habitat degradation and modification
			Marine debris
			Collection of animals for display in public aquaria (no known occurrences to date)
		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
	Dwarf sawfish	Approved Conservation Advice on *Pristis clavata* (dwarf sawfish) (2009)	Being caught as bycatch in commercial and recreational net fishing
			Illegal, unreported and unregulated fishing
			Habitat degradation due to increasing human 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
	Freshwater sawfish	Approved Conservation Advice for *Pristis pristis* (largetooth sawfish) (2014)	Commercial fishing activities
			Recreational fishing

Taxa	Common name	Recovery Plan / Conservation Advice	Threats
			Indigenous fishing
			Illegal, unreported and unregulated fishing
			Habitat degradation and modification
			Marine debris
			Collection of animals for display in public aquaria
		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
	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
	Blind gudgeon	Approved Conservation Advice for *Milyeringa veritas* (blind gudgeon) (2008)	Habitat degradation and modification associated with sedimentation from mining/construction, canal development, water abstraction, point source pollution from sewage, landfill, dumping and mining; and diffuse pollution from urban development/ petroleum infrastructure

Taxa	Common name	Recovery Plan / Conservation Advice	Threats
	Blind cave eel	Approved Conservation Advice for *Ophisternon candidum* (blind cave eel) (2008)	Habitat degradation and modification associated with sedimentation from mining/construction, canal development, water abstraction, point source pollution from sewage, landfill, dumping and mining; and diffuse pollution from urban development
	Balston's pygmy perch	Approved Conservation Advice for *Nannatherina balstoni* (Balston's pygmy perch) (2008)	Habitat degradation and modification associated with flow and increased salinisation, siltation and eutrophication that occur through changes to flow regimes (regulation and abstraction), road maintenance, mineral sand exploration and mining, ground water extraction and agricultural and forestry practices in the uppermost catchment
	Black-stripe minnow	Approved Conservation Advice for *Galaxiella nigrostriatal* (Black-striped minnow) (2018)	Climate change – increased air and water temperatures, decreased rainfall, increased evaporation, lowering groundwater table.
			Invasive species (*Gambusia holbrooki*), aggressive interactions and competition

14. Social, Economic and Cultural Features

14.1 Industry

In 2018/19, Western Australia's petroleum industry was worth $38.4 billion per annum. The petroleum sector accounted for 26% of the total value of WA's mineral and petroleum sales in 2018/19, with 20 per cent of all mineral and petroleum sales coming from Liquefied Natural Gas (LNG). Currently Western Australia has four operating LNG projects; the North West Shelf, Gorgon, Pluto and Wheatstone. There are 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** to **Figure 14-3**. 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 WA and Commonwealth waters in the EMBA. Existing petroleum infrastructure, permits and licences are shown in **Figure 14-1** to **Figure 14-3**.

14.2 Other Infrastructure

The Jasuraus submarine communication cable links Australia with Indonesia. The cable was installed as a link from Australia to provide telephone services connection to the world in 1995-1996. Travelling north out of Port Hedland for approximately 210 km the cable then heads north-west toward Jakarta, Indonesia. The cable runs up through Permit Areas WA-435-P and WA437-P. Its capacity and major role was overtaken in 2000 by other subsea cables out of Australia. However, Telstra continues to manage the cable as it remains an emergency backup link out of Australia. The cable includes two submerged repeaters in the wider region.

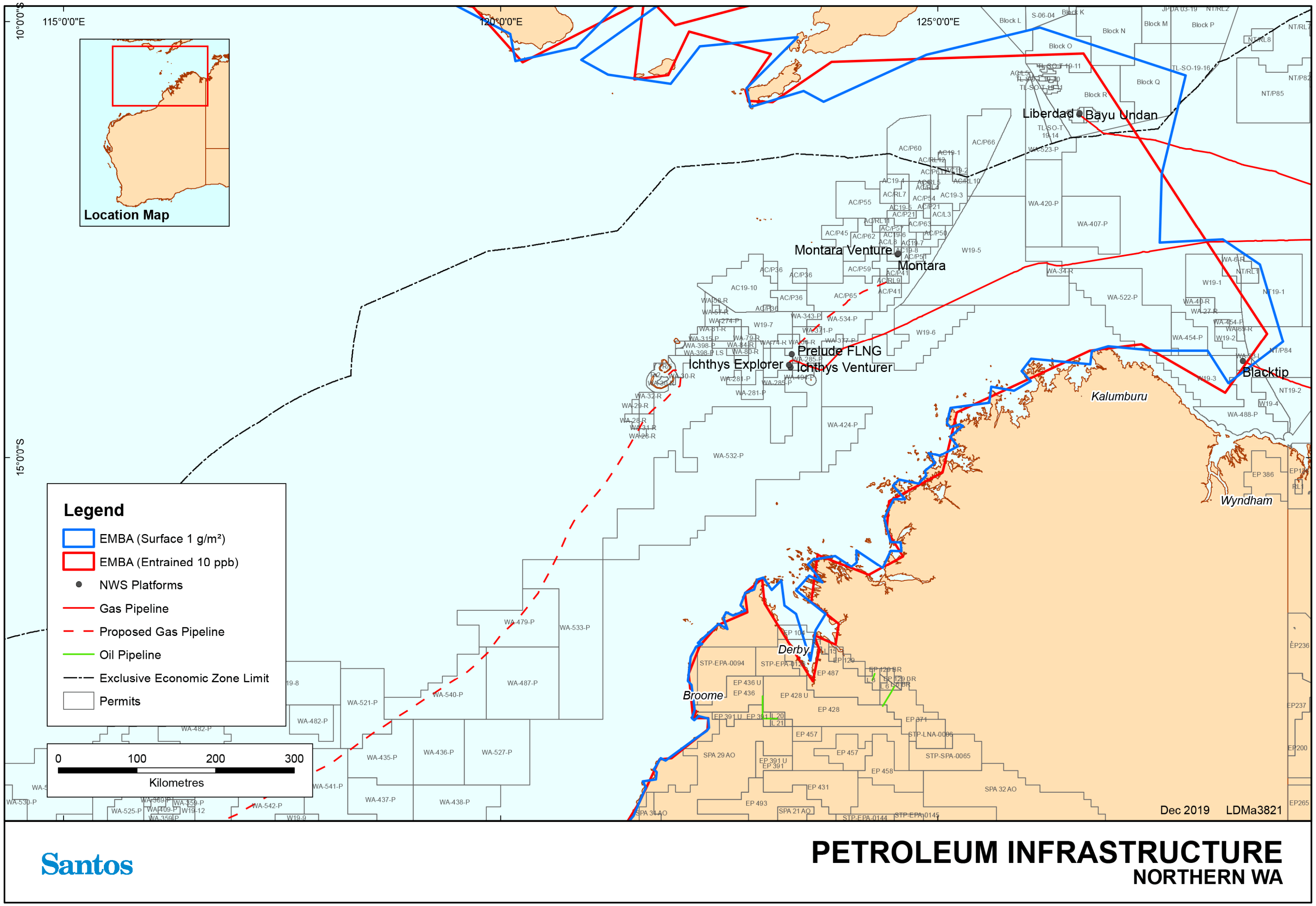


Figure 14-1: Existing petroleum infrastructure, permits and licences – Northern WA

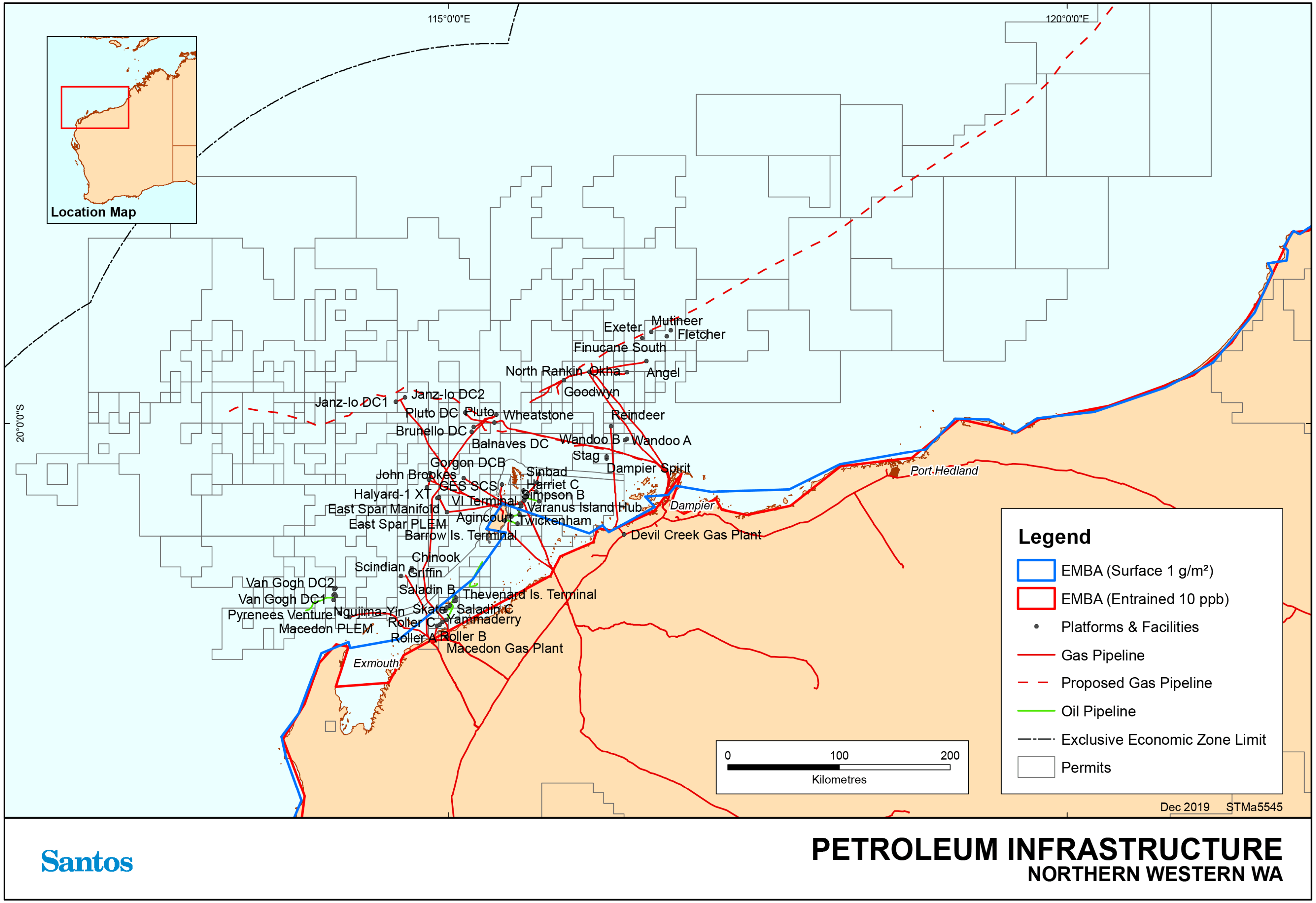
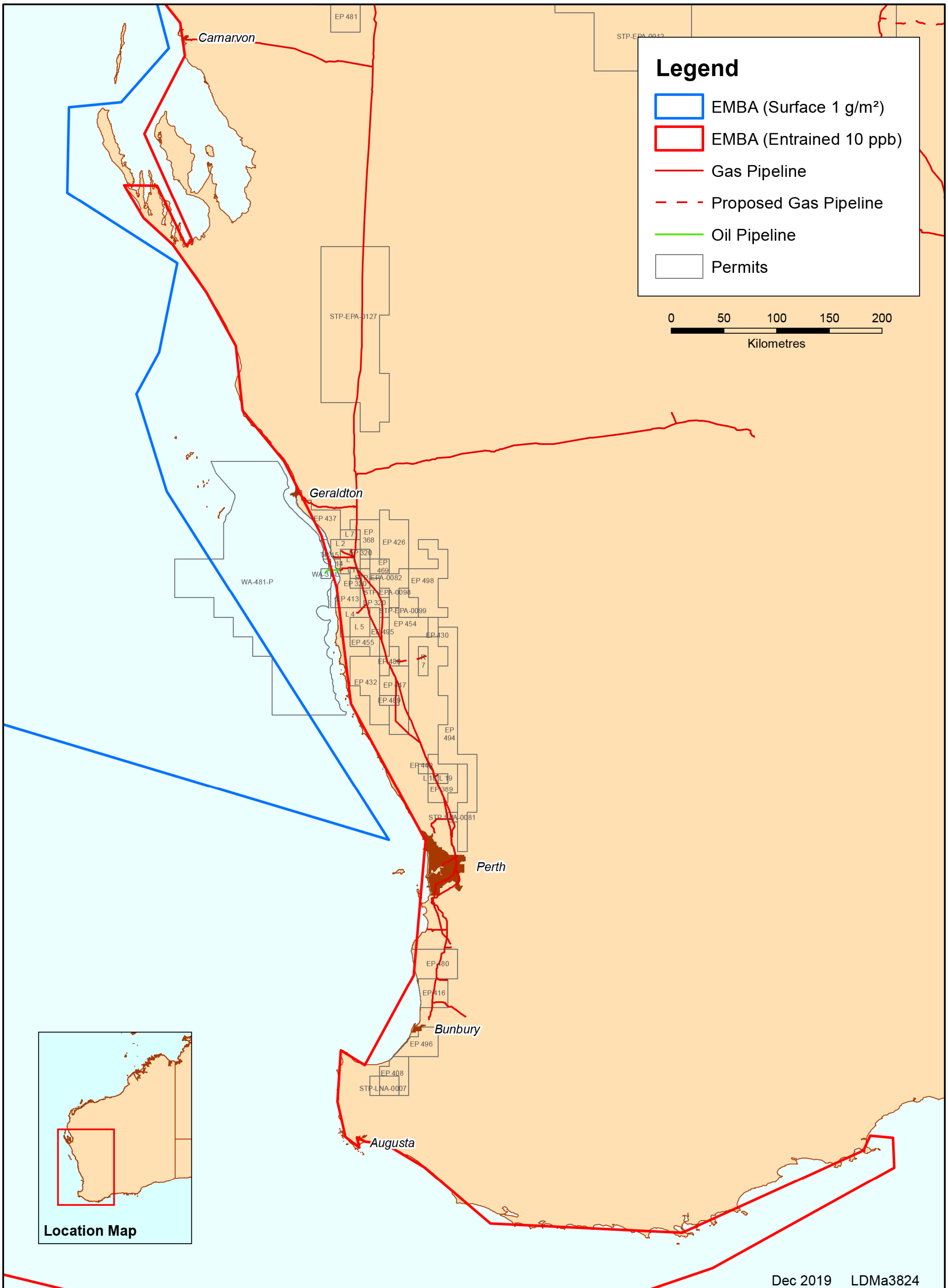


Figure 14-2: Existing petroleum infrastructure, permits and licences – Northern Western Australia



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PETROLEUM INFRASTRUCTURE
SOUTHERN WA

Figure 14-3: Existing petroleum infrastructure, permits and licences –Southern WA

14.3 Shipping

The Western Australian coastline 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).

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 AMSA through the RCC. Vessels recorded in waters in the EMBA through the AUSREP system in 2019 are shown in **Figure 14-4**.

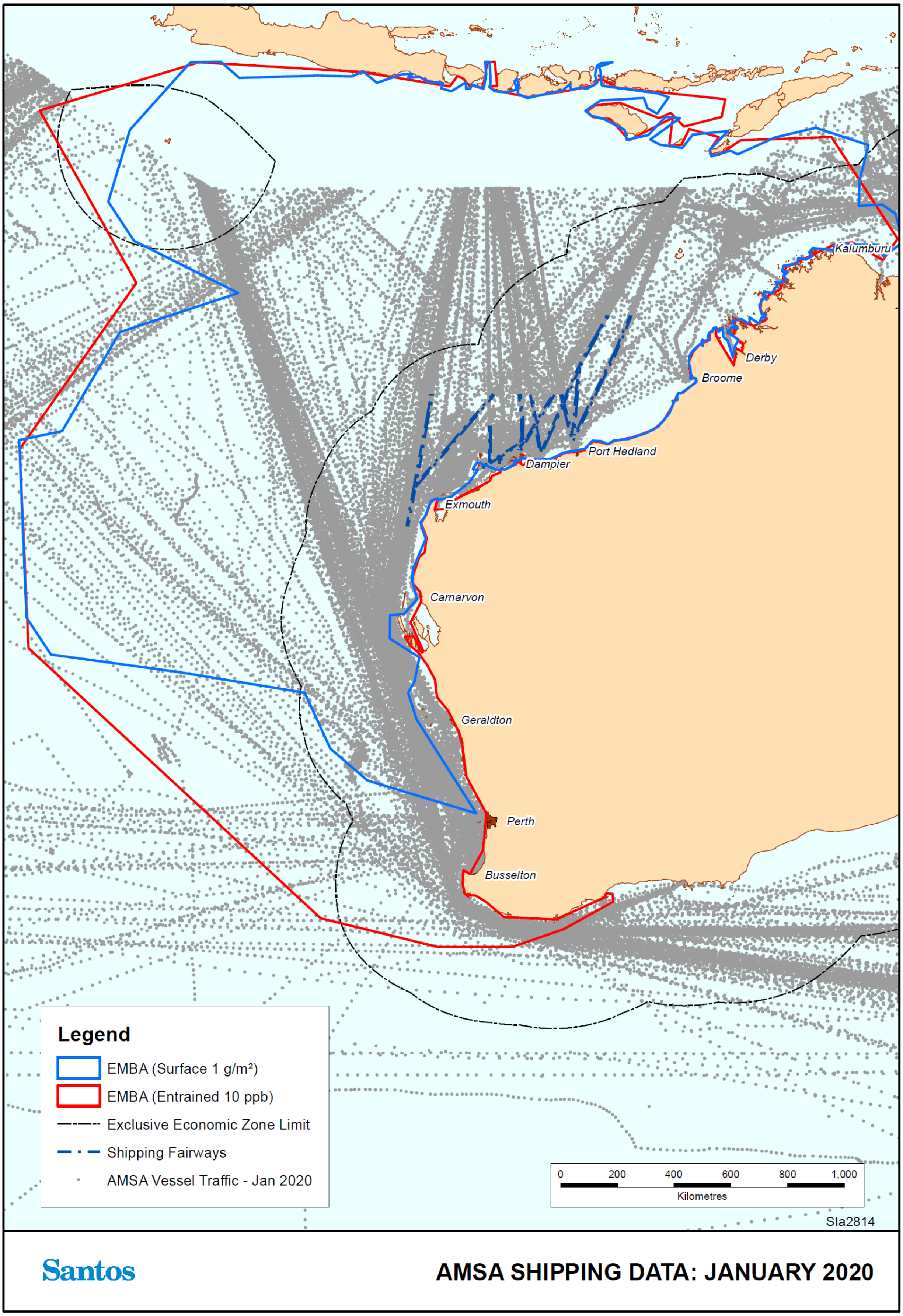

Figure 14-4: AMSA ship locations and shipping routes

14.4 Defence Activities

Key defence bases and facilities are illustrated in **Figure** 14-5.

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 2018, DoE 2014).

The station provides very low frequency 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 2018, DoE 2014).

Two Royal Australian Airforce (RAAF) bases are located in the northwest of WA; 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 WA and may be activated following the required notifications.

Additional defence activities that occur within the EMBA include:

+ Broome training depot;
+ Exmouth admin and high frequency transmitting;
+ Exmouth Very Low Frequency transmitting station;
+ Geraldton training depot “A” Company 16th Battalion;
+ HMAS Stirling-Rockingham;
+ HMAS Stirling-Garden Island;
+ Karratha training depot;
+ Learmonth – air weapons range;
+ Learmonth radar site – Vlaming Head Exmouth; and
+ Yampi Sound training area.

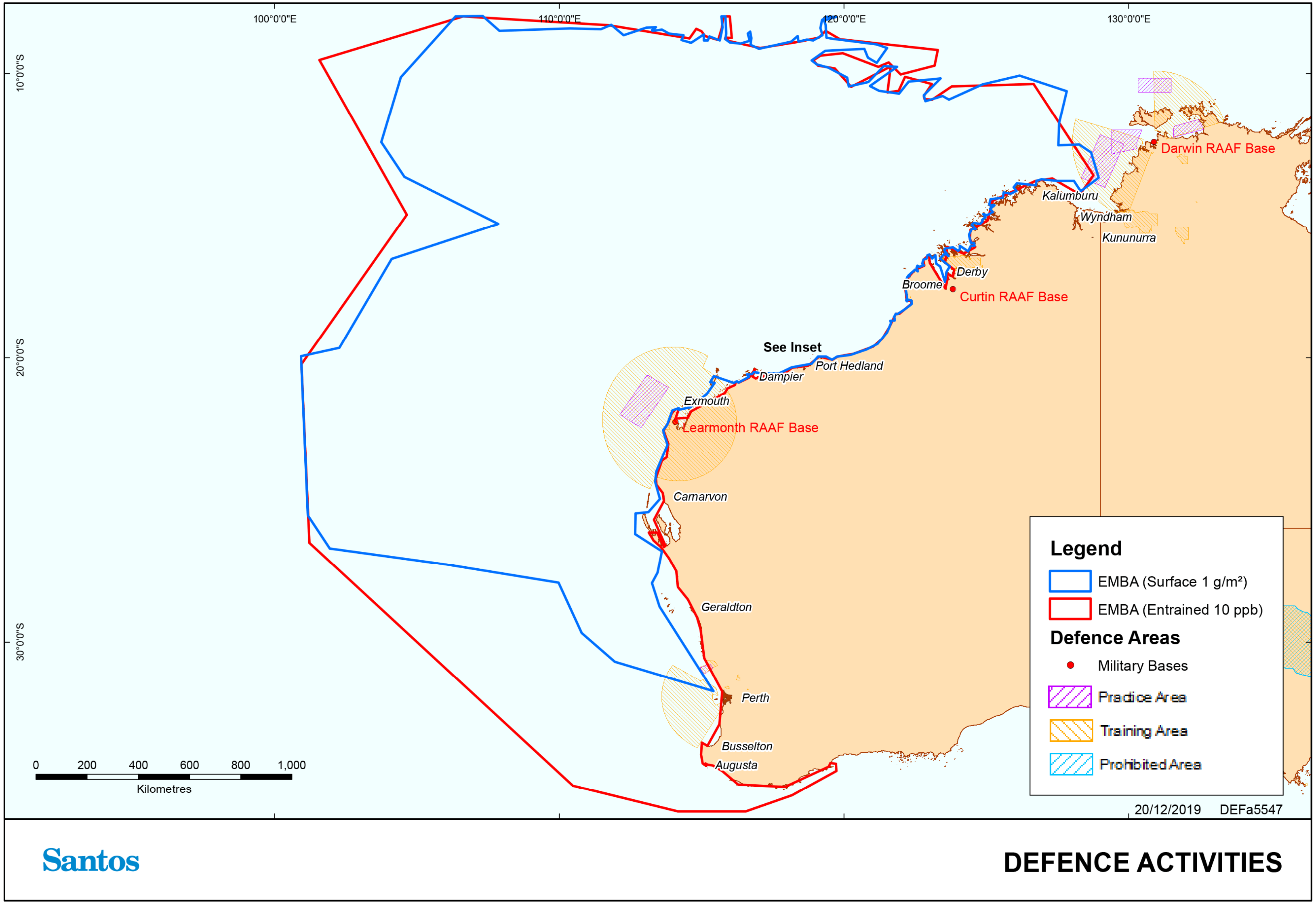

Figure 14-5: Defence activities in WA

14.5 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 WA 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 2014). 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).

14.6 Cultural Heritage

Four places of cultural significance are protected as National Heritage Places in the waters from Busselton to the NT 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 EMBA are listed in **Appendix A**.

14.6.1 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 2008a). With the EMBA, Barrow Island, Montebello Islands, Exmouth, Ningaloo Reef, Kimberly Coast, 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 coastline, 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 2008a).

14.6.2 Maritime Heritage

Details of recorded shipwreck sites are available on the Australian National Shipwreck Database are managed by the DAWE although precise locations of the wrecks are sometimes unknown. A search of the Australian National Shipwreck Database in the EMBA identified 942 shipwrecks. Key shipwrecks in the North West Marine Region are listed in **Table 14-1** and shown in **Figure 14-6** to **Figure 14-9**, in addition to the Ann Millicent (DEWHA 2008a). Under the Commonwealth *Underwater Culture Heritage Act 2018* all shipwrecks older than 75 years are protected, while those dated pre-1900 are protected by WA law under the *Maritime Archaeology Act 1973*. Within the EMBA, there are 697 shipwrecks in excess of 75 years old.

Table 14-1: Shipwrecks

Name	Description	Location
Ann Millicent	Iron hulled barque, wrecked c. 1888	Cartier Island
Batavia	Wood sailing vessel, wrecked 1629	Morning Reef, Houtman Abrolhos Islands
Crown of England	1,847 t sailing ship, wrecked c. 1912	Wreck Point, Depuch Island
Eddystone	2,040 t brigantine rigged iron steamship	Cossack Roads, Depuch Island Passage
Perentie	Barge	Barrow Island
Fin	Early iron whaler	Frazer Island, Point Cloates
Karrakatta	1,271 t, schooner rigged, coastal steamship	King Sound, 140 km north-northwest of Derby
Manfred	587 t barque	3 km north west of West Island in the Lacepede Islands
Perth	499 t, iron coastal steamship	Ningaloo Reef
Rowley Shoals unconfirmed wreck	Armed whaler of 200–250 t, possibly the Lively, wrecked c 1800	Mermaid Reef
Zvir	Iron steamer	Frazer Island, Point Cloates
Browse Island (East) unconfirmed wreck	Late nineteenth century iron sailing vessel of approximately 1,000 t	Browse Island
Fairy Queen	115 t Singapore built brigantine	Point Murat, North West Cape
Gudrun	Iron frames and fastenings	Cape Peron Flats in Shark Bay
SS Sunbeam	Iron hulled, single screw steamer	Middle Osborne Island, Admiralty Gulf
Trial	English East Indiaman of about 500 t, wrecked c 1622	Trial (or Tryal) Rocks, 20 km northwest of the Montebello Islands
Zuytdorp	Seventeenth century Dutch East Indiaman	Zuytdorp Cliffs, 75 km north of Kalbarri

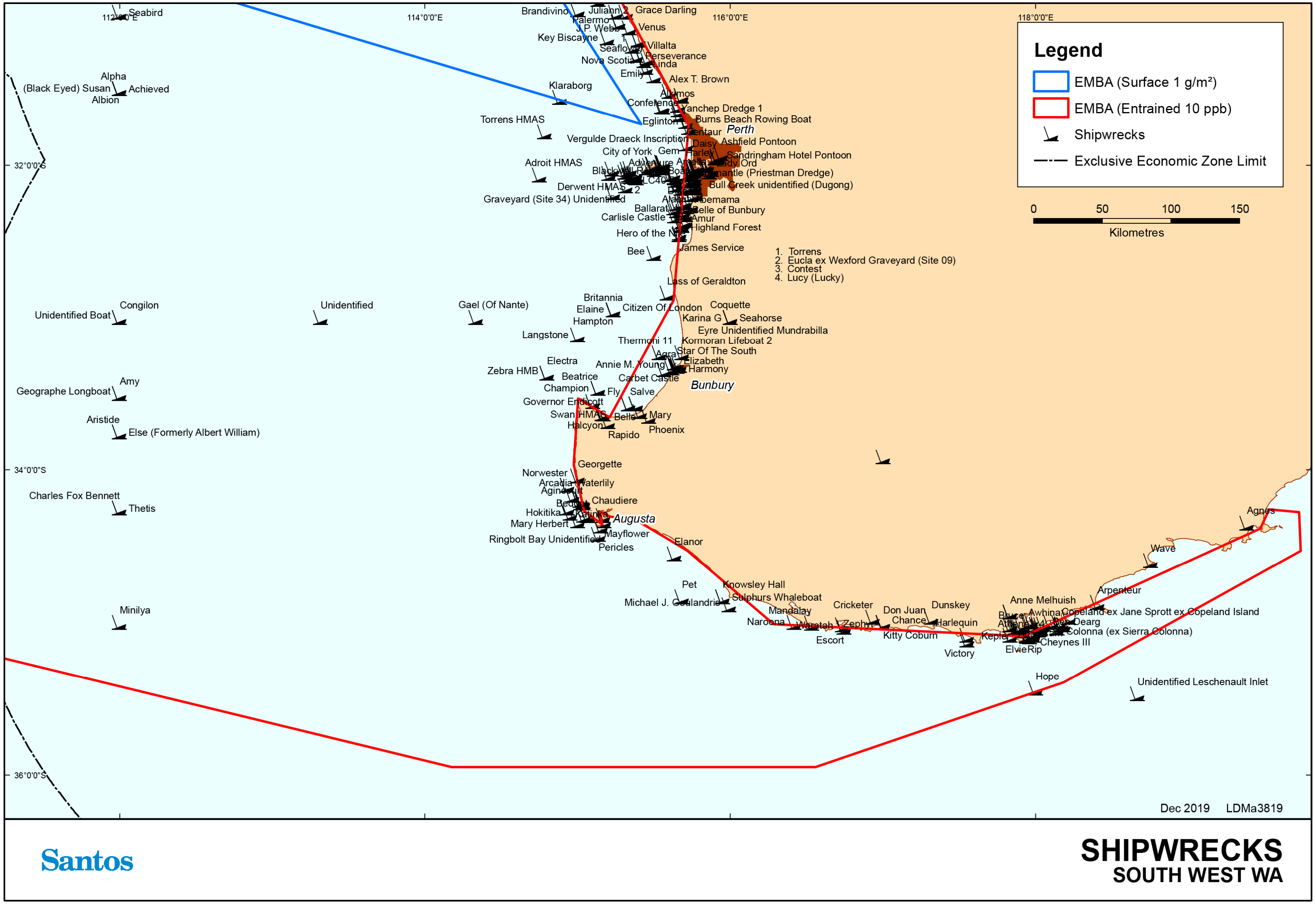

Figure 14-6: Shipwrecks – South West WA

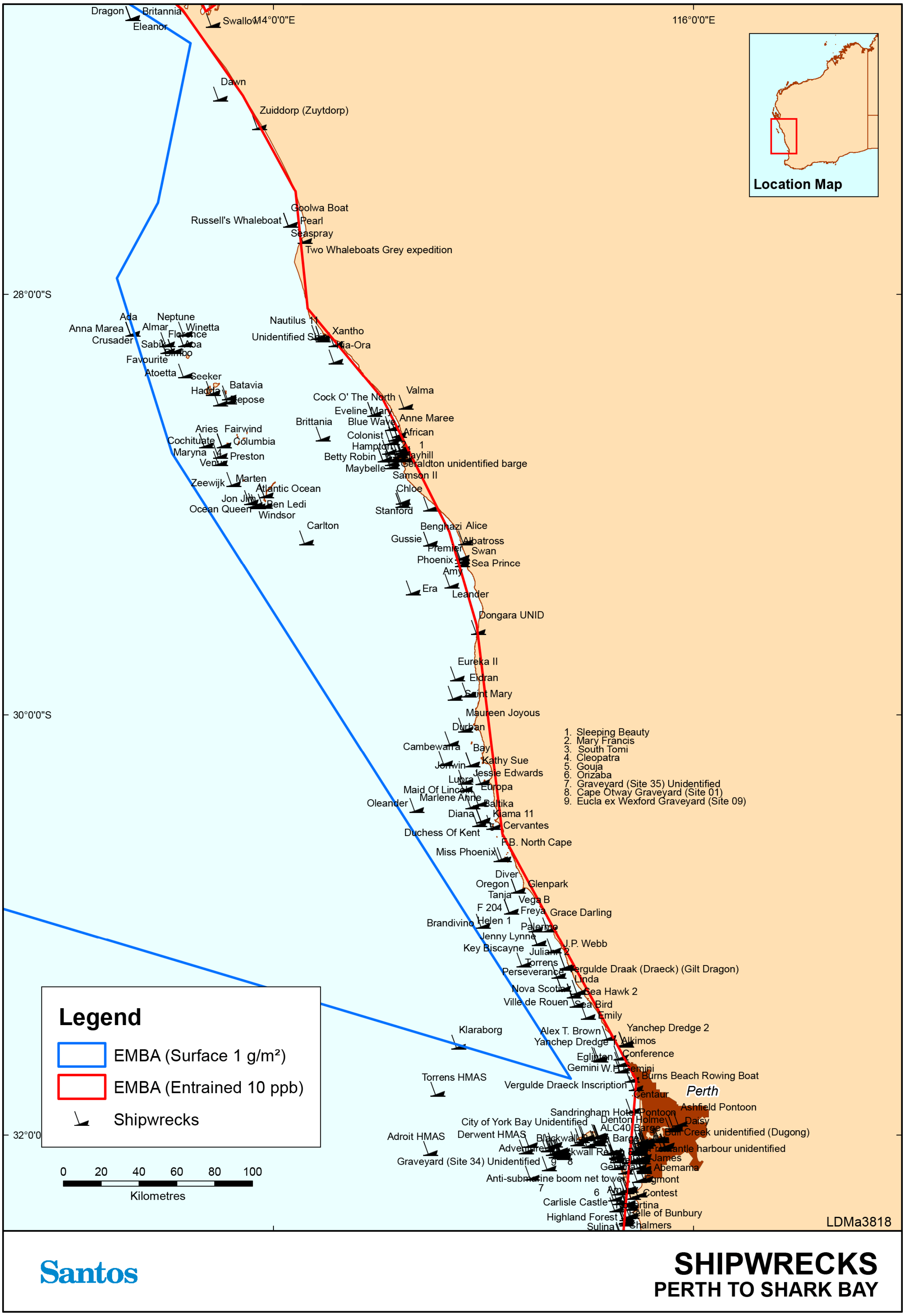

Figure 14-7: Shipwrecks – Perth – Shark Bay

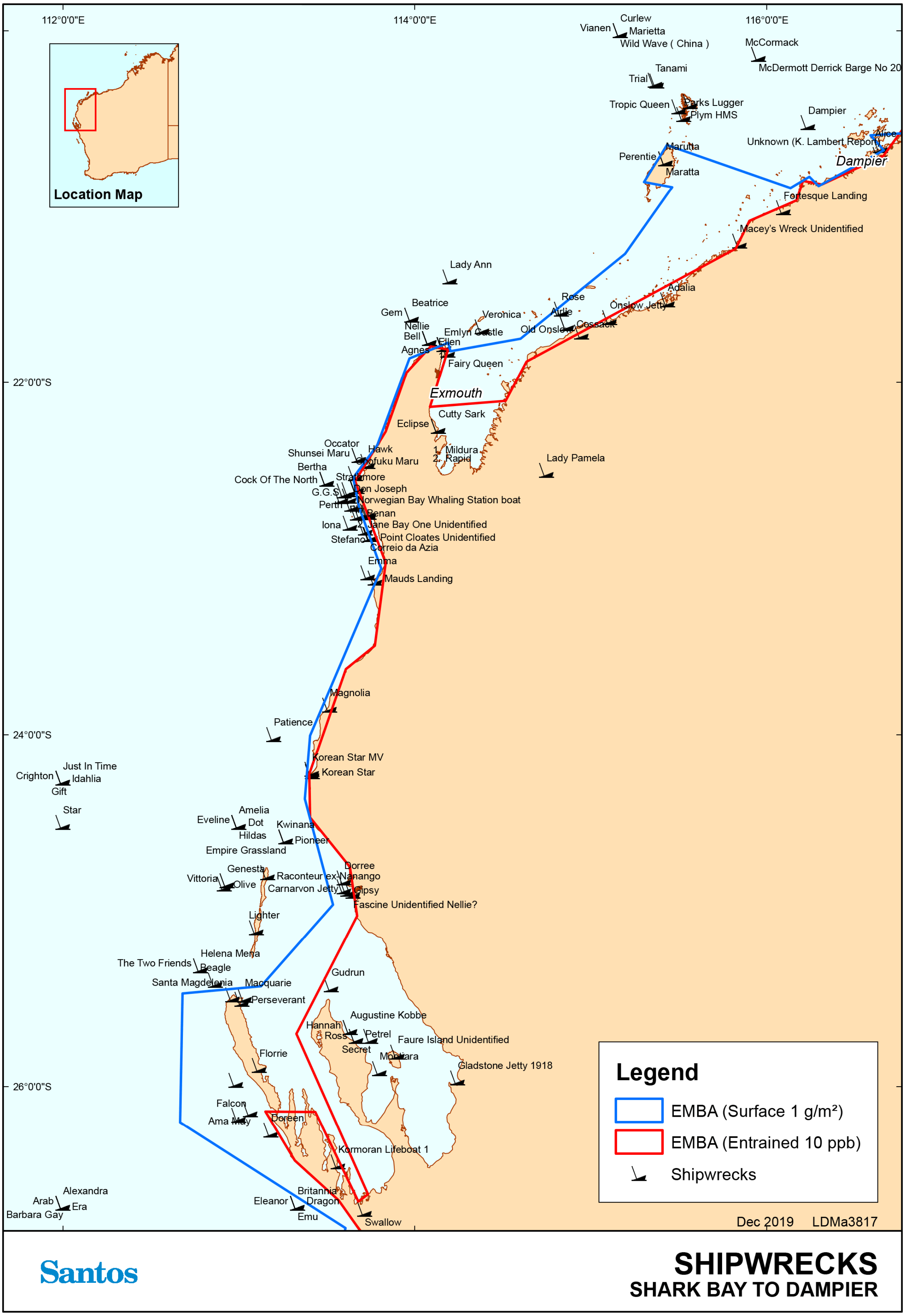

Figure 14-8: Shipwrecks – Shark Bay – Dampier

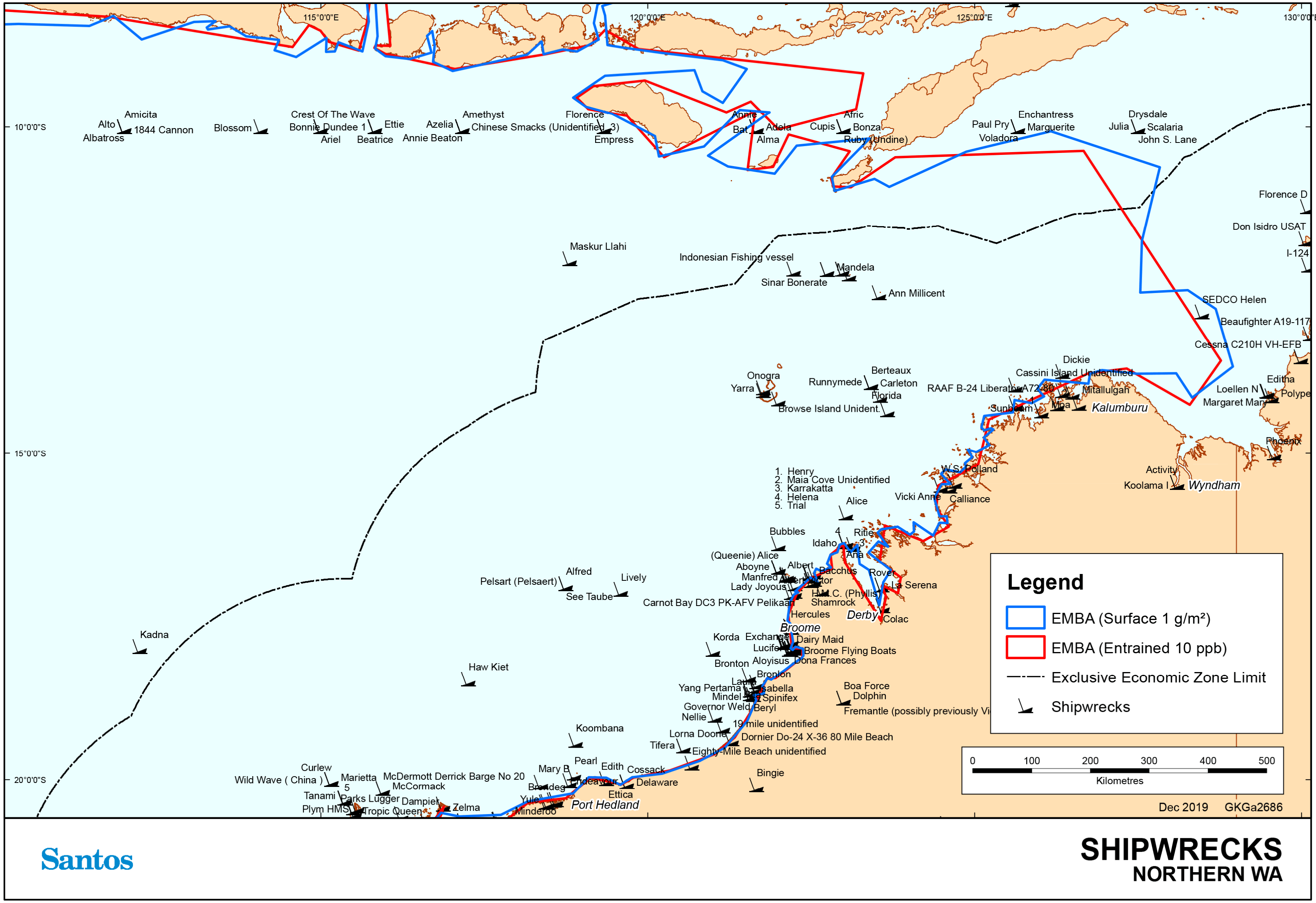

Figure 14-9: Shipwrecks – Northern WA

14.7 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 WA and NT and South Australian 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.

14.7.1 State Fisheries

State fisheries are managed by the WA Department of Primary Industries and Regional Development (DPIRD) (formerly 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 2018/2019 (Gaughan *et al.* 2020) and direct consultation with DPIRD. Santos consults regularly with State fisheries relevant to activity operational areas, mainly by distribution of an Annual Consultation Update by post.

State commercial fisheries that exist between Kalbarri (WA) and the NT border are shown in **Figure** 14-10. A summary of all commercial fisheries in the area is also summarised **Table 14-2**. These are:

North Coast Bioregion

- Onslow Prawn Managed Fishery (OPMF);
- Nickol Bay Prawn Managed Fishery (NBPMF) – referred to as Nickol Bay Prawn Limited Entry Fishery in **Figure** 14-10;
- Broome Prawn Managed Fishery (BPMF);
- Kimberley Prawn Managed Fishery (KPMF);
- Kimberley Gillnet & Barramundi Managed Fishery (KGBF);
- Kimberley Developing Mud Crab Fishery – not shown in **Figure** 14-10;
- Northern Demersal Scalefish Managed Fishery (NDSF);
- North Coast Traditional Trochus Fishery – not shown in **Figure** 14-10;
- Pilbara Demersal Scalefish Fisheries – not shown in **Figure** 14-10;
- Pilbara Developing Crab Fishery – not shown in **Figure** 14-10;
- Pilbara Fish Trawl (Interim) Managed Fishery (PFTIMF);
- Pilbara Trap Managed Fishery (PTMF);
- Pilbara Line Fishery;
- Western Australian Sea Cucumber Fishery (referred to as Beche-de-mer Fishery in **Figure** 14-10);
- Mackerel Managed Fishery (Area 1 – Kimberley and Area 2 – Pilbara);
- Western Australian Pearl Oyster Fishery – referred to as Pearl Oyster Managed Fishery in **Figure** 14-10;
- Northern Shark Fisheries (closed, not shown in **Figure** 14-10) including:
    - Western Australian North Coast Shark Fishery - not shown in **Figure** 14-10; and
    - Joint Authority Northern Shark Fishery - not shown in **Figure** 14-10;
    - North Coast Trochus Fishery – not shown in **Figure** 14-10; and
    - Pilbara Developing Crab Fishery – not shown in **Figure** 14-10.

Gascoyne Bioregion

- Exmouth Gulf Prawn Managed Fishery;
- Gascoyne Demersal Scalefish Managed Fishery;
- Shark Bay Scallop Managed Fishery – referred to as Shark Bay Scallop Limited Entry Fishery on **Figure** 14-10;
- Shark Bay Prawn Managed Fishery – referred to as Shark Bay Prawn Limited Entry Fishery on **Figure** 14-10;
- Shark Bay Beach Seine and Mesh Net Managed Fishery – not shown in **Figure** 14-10**;**
- Shark Bay Crab Interim Managed Fishery; and
- Mackerel Fishery (Area 3 – Gascoyne/West Coast).

West Coast Bioregion

- Roe's Abalone – not shown in **Figure** 14-10;
- Abrolhos Islands and Mid-West Trawl Managed Fishery (AIMWRMF) (Closed) – referred to as Abrolhos Islands and Mid-West Trawl Limited Entry Fishery in **Figure** 14-10;
- West Coast Demersal Scalefish Interim Managed Fishery (WCDSIMF);
- South West Trawl Managed Fishery – referred to as South West Trawl Limited Entry Fishery in **Figure** 14-10;
- Mandurah to Bunbury Developing Crab Fishery – not shown in **Figure** 14-10;
- Cockburn Sound Crab Managed Fishery – not shown in **Figure** 14-10**;**
- Cockburn Sound Line and Pot Managed Fishery – not shown in **Figure** 14-10;
- Cockburn Sound Mussel Managed Fishery – not shown in **Figure** 14-10;
- Warnbro Sound Crab Managed Fishery (closed) – not shown in **Figure** 14-10;
- West Coast Nearshore and Estuarine Finfish Fisheries, including:
- Cockburn Sound Fish Net Managed Fishery – not shown in **Figure** 14-10;
- West Coast Beach Baited Managed Fishery – not shown in **Figure** 14-10;
- South West Beach Seine Fishery – not shown in **Figure** 14-10; and
- West Coast Estuarine Managed Fishery – not shown in **Figure** 14-10;
- Temperate Demersal Gillnet and Demersal Longline Fisheries, including:
    - West Coast Demersal Gillnet and Demersal Longline (Interim) Managed Fishery (West Coast Bioregion) – not shown in **Figure** 14-10;
- West Coast Deep Sea Crab (Interim) Managed Fishery – referred to as West Coast Deep Sea Crustacean Managed Fishery in **Figure** 14-10;
- West Coast Nearshore Net Managed Fishery – not shown in **Figure** 14-10;
- Octopus Interim Managed Fishery – not shown in **Figure** 14-10;
- West Coast Rock Lobster Managed Fishery; and
- West Coast Purse Seine Fishery – not shown in **Figure** 14-10.

South Coast Bioregion

- Greenlip/Brownlip Abalone Fishery – not shown in **Figure** 14-10;

- South Coast Crustacean Managed Fishery – not shown in **Figure** 14-10**;**
- South Coast Deep-Sea Crab Fishery – not shown in **Figure** 14-10;
- South Coast Estuarine Managed Fishery – not shown in **Figure** 14-10**;**
- South Coast Open Access Netting Fishery – not shown in **Figure** 14-10; and
- South West Coast Beach Net – not shown in **Figure** 14-10.
- South Coast Salmon Managed Fishery;
- South West Coast Salmon Managed Fishery – not shown in **Figure** 14-10;
- Temperate Demersal Gillnet and Demersal Longline Fisheries including:
    - Joint Authority Southern Demersal Gillnet and Demersal Longline Managed Fishery (South Coast Bioregion)
    - South West Trawl Managed Fishery (SWTMF) – referred to as South West Trawl Limited Entry Fishery in **Figure** 14-10; and
    - Windy Harbour/Augusta Rock Lobster Managed Fishery – not shown in **Figure** 14-10.

Whole of State Fisheries

- Marine Aquarium Fish Managed Fishery (MAFMF);
- Specimen Shell Managed Fishery; and
- Hermit Crab Fishery (HCF) – not shown in **Figure** 14-10.

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 have been significantly affected by the initial heat wave event of 2010/11 (Caputi *et al*. 2014).

14.7.2 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 2019 (Department of Agriculture 2019)

Commonwealth fisheries who have permits to operate in the EMBA include:

- North West Slope Trawl (NWST);
- Northern Prawn Fishery (NPF);
- Southern Bluefin Tuna Fishery (SBFTF);
- Western Tuna and Billfish Fishery (WTBF) (including Southern Tuna and Billfish Fishery shown in **Figure** 14-11);
- Small Pelagic Fishery (SPF);
- Southern and Eastern Scalefish and Shark Fishery (SESSF) – not shown in **Figure** 14-11;
- Skipjack Tuna Fishery (STF) (referred to as Western Skipjack Tuna Fishery in **Figure** 14-11); and
- Western Deepwater Trawl (WDTF) (referred to as Western Deepwater Trawl Fishery in **Figure** 14-11).

Commonwealth commercial fisheries between Kalbarri (WA) and the NT Border are shown in **Figure** 14-11 and summarised in **Table 14-2**.

14.7.3 Indonesian Commercial and Subsistence Fishing

Within the northern and north-western extent of the EMBA is a defined area where a Memorandum of Understanding (MoU) exists between the Australian and Indonesian Governments. The Agreement between the Government of Australia and the Government of the Republic of Indonesia Relating to Cooperation in Fisheries (1992 Fisheries Cooperation Agreement) provides the framework for fisheries and marine cooperation between Australia and Indonesia, and facilitates information exchange on research, management and technological developments, complementary management of shared stocks, training and technical exchanges, aquaculture development, trade promotion and cooperation to deter illegal fishing.

Cooperation under the Agreement today takes place under the auspices of the Working Group on Marine Affairs and Fisheries. Established in 2001, the Working Group on Marine Affairs and Fisheries is the primary bilateral forum to enhance collaboration across the spectrum of marine and fisheries issues relevant to the areas of the Arafura and Timor seas. The Working Group brings together the fisheries, environment and scientific research portfolios and agencies from both countries.

The MoU Box (shown on **Figure** 14-10 and **Figure** 14-11) is an area of Australian water in the Timor Sea where Indonesian traditional fishers, using traditional fishing methods only, are permitted to operate. Officially it is known as the Australia-Indonesia Memorandum of Understanding regarding the Operations of Indonesian Traditional Fishermen in Areas of the Australian Fishing Zone and Continental Shelf – 1974.

As part of negotiations to delineate seabed boundaries, Australia and Indonesia entered into the MoU which recognises the rights of access for traditional Indonesian fishers in shared waters to the north of Australia. This access was granted in recognition of the long history of traditional Indonesian fishing in the area. The MoU provides Australia with a tool to manage access to its waters while for Indonesia, it enables Indonesian traditional fishers to continue their customary practices and target species such as trepang, trochus, abalone and sponges. Guidelines under the MoU were agreed in 1989 in order to clarify access boundaries for traditional fishers and take into account the declaration of the 200 nautical mile fishing zones. Because of its approximate shape the MoU area became known as the MoU Box.

Between 2006 and 2008, a series of surveys were undertaken to understand the traditional practice of Indonesian fishers that journey to Scott Reef within the MoU boundary (ERM 2008, 2009). The majority of perahu (vessels) that travel to Scott Reef originate from the islands of Rote (near West Timor) and Tonduk and Raas (in East Java). Some crew from the Rote perahus are recruited from the region of Alor (one of the Lesser Sundas chain, located north of East Timor and east of Bali). In 2007, an estimated 800 fishers (approximately 80 vessels) travelled from these home islands to Scott Reef, mainly to collect trepang. Similar vessel numbers sailed to Scott Reef in 2008.

Journeys to Scott Reef are generally restricted to drier months when wind speeds and directions are more desirable. Most Indonesian fishers travel to Scott Reef during July to October, although a few Rotenese make the journey to Scott Reef in the early season between April and June. Other fishers plan to go after Aidil Fitri, a religious holiday widely celebrated on Tonduk Island that celebrates the end of Ramadan.

The fishers focus their activities in and around the shallow water lagoons of Scott Reef primarily targeting trepang; and opportunistically gather trochus shells. They also catch fish largely for subsistence purposes although the average fish catch per lete-lete (traditional Indonesian fishing vessel) in 2008 increased to commercial volumes. Although deeper waters are more plentiful in trepang, deep diving is generally not undertaken by the fishers due to the MoU stipulation on the exclusive use of traditional equipment only (Woodside Energy Limited 2011).

14.8 Aquaculture

14.8.1 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 barramundi.

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 in this region mainly focuses on barramundi farming within Cone Bay, with two aquaculture licences granted in this area located about 200 km north-east of Broome (Gaughan and Santoro 2020).

Further aquaculture operations have expanded in the region with the establishment of the Kimberley Aquaculture Development zone, which encompasses almost 2,000 ha of coastal waters within Cone Bay supporting the production of up to 20,000 t of finfish annually (Gaughan and Santoro 2020).

14.8.2 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 black-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.

14.8.3 West Coast Bioregion

The principal aquaculture development activities in this region are the production of blue mussels (*Mytilus galloprovincialis*) and marine algae (*Dunaliella salina*) and the emerging black pearl industry based on the production of *Pinctada margaritifera* at the Abrolhos Islands. The main mussel farming area is in southern Cockburn Sound, where conditions are sheltered and the nutrient and planktonic food levels are sufficient to promote good growth rates fishing (Fletcher and Santoro 2015).

Further aquaculture operations are expected following the establishment of the Mid-West Aquaculture Development Zone by DPIRD, which aims to provide a platform to stimulate aquaculture investment and development in the bioregion (Gaughan and Santoro 2020).

14.8.4 South West Bioregion

The predominant aquaculture activity undertaken in this region is the production of mussels and oysters from Oyster Harbour at Albany. This activity is restricted to this area where there are sufficient nutrient levels related to terrestrial run-off to provide the planktonic food necessary to promote growth of filter-feeding bivalves fishing (Fletcher and Santoro 2015). The high-energy environment and limited protected deep waters limits other forms of aquaculture such as sea cage farming.

Further invertebrate aquaculture operations are expected after recent funding to establish a South Coast Aquaculture Development Zone by DPIRD. An initial south coast aquaculture project aims to identify suitable areas for artificial farm structures to be constructed supporting shellfish production including abalone and edible oysters (Gaughan and Santoro 2020).

14.8.5 Indonesian Aquaculture

An analysis by WorldFish has indicated that aquaculture will overtake capture fisheries as the major source of fish in Indonesia before 2030 (Phillips *et al.* 2015). By volume, Indonesian aquatic production is dominated by seaweeds, but by value, domestically consumed species such tilapia and milkfish, together with export-orientated commodities such as shrimp and tuna, are of greater importance (Phillips *et al*. 2015).

Carrageenan seaweed farming based primarily on the cultivation of *Kappaphycus* and *Eucheuma* species has grown significantly in Indonesia. Due to the simple farming techniques required, low requirements of capital and material inputs, and short production cycles it has become a favourable livelihood for smallholder farmers and fishers (Valderrama *et al*. 2013). Indonesia's coastline provides ideal conditions for fish farming in "brackish waters". Aquaculture in Indonesia is predominantly used for seaweed production, whilst offshore fish cultivation remains relatively undeveloped (Global Business Guide 2014).

14.9 Recreational Fisheries

14.9.1 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 saddletail snapper and red emperor, cods, coral and coronation trout, sharks, trevally, tuskfish, mackerels and billfish (WAFIC 2016).

14.9.2 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, mackerels, 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).

14.9.3 West Coast Bioregion

The marine environment of the West Coast Bioregion which lies between Kalbarri and Augusta is predominantly a temperate oceanic zone, but it is heavily influenced by the Leeuwin current, which transports warm tropical water southward along the edge of the continental shelf. This region contains the state's major population centres and is the most heavily used bioregion for recreational fishing (Fletcher and Santoro 2015). The range of recreational fishing opportunities includes estuarine fishing, beach fishing and boat fishing either in embayments or offshore for demersal and pelagic game species often around the islands and out to the continental shelf (WAFIC 2016).

14.9.4 South West Bioregion

The South West Bioregion includes the water from Augusta to Eucla on the Western Australia/South Australia border. The continental shelf waters of this region are generally temperate but low in nutrients due to the seasonal presence of the tail of the tropical Leeuwin current and limited terrestrial run-off. As much of the south coast is remote or difficult to access, recreational beach and boat fishing tends to be concentrated around the main population and holiday centres. The major target species for beach and rock anglers are salmon, herring, whiting and trevally, while boat anglers target pink snapper, queen snapper, Bight redfish, a number of shark species, salmon fish and King George whiting. Another component of the recreational fishery is dinghy and shoreline fishing off estuaries and rivers where the main angling targets are black bream and whiting. Recreational netting primarily targeting mullet also occurs in these estuaries (WAFIC 2016).

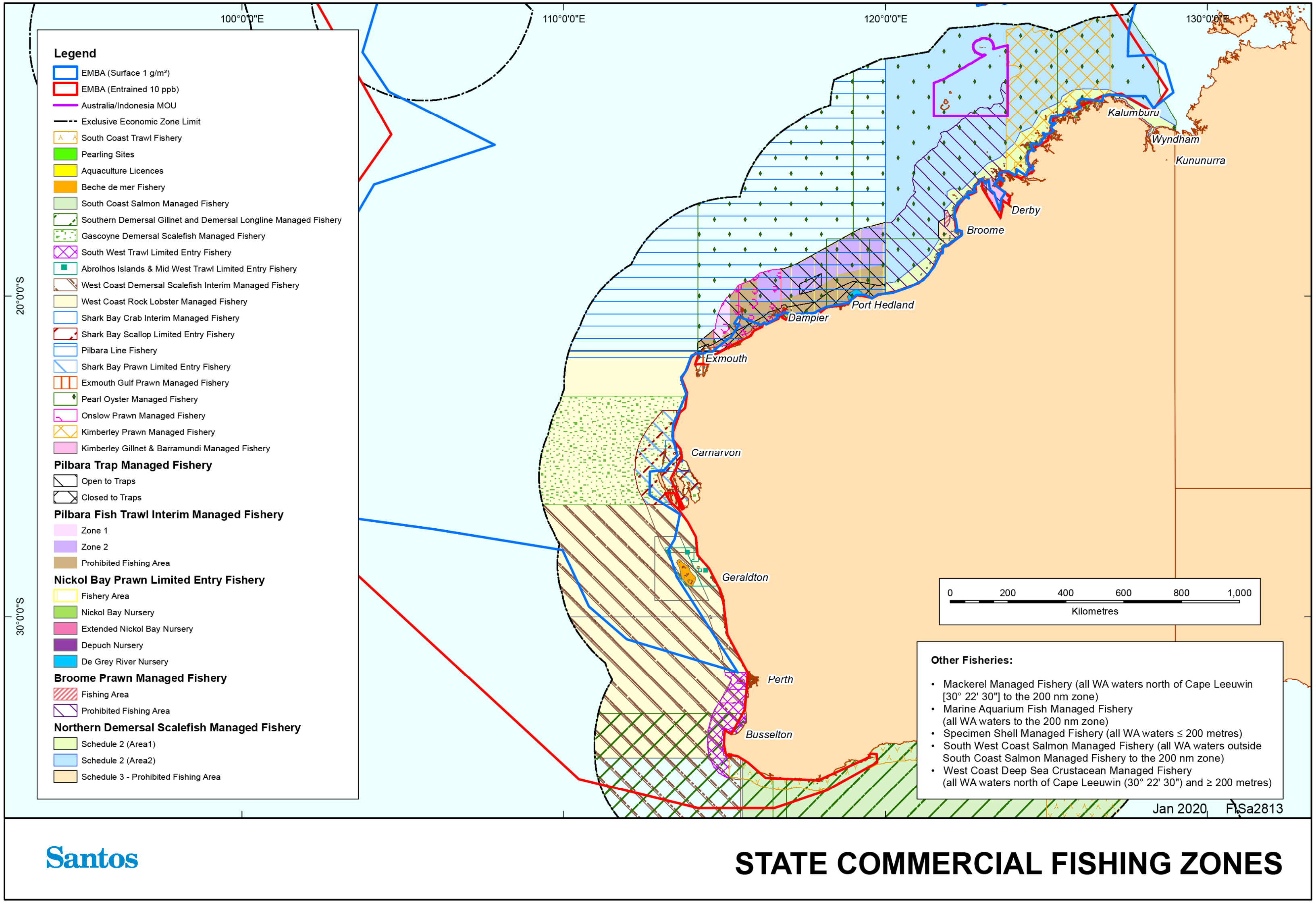

Figure 14-10: State commercial fishing zones

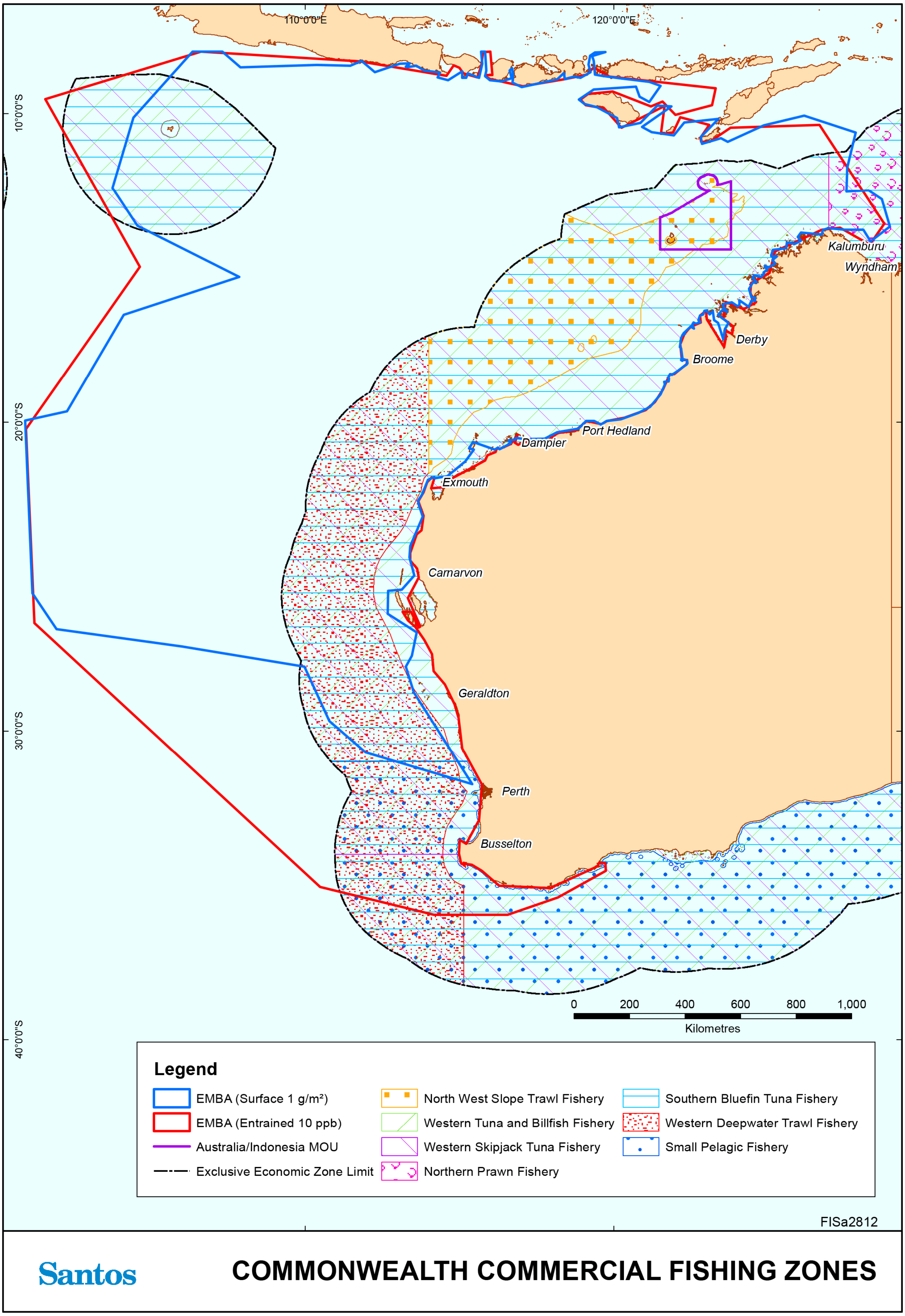

Figure 14-11: Commonwealth commercial fishing zones

Table 14-2: Commercial fisheries with permits to operate within the EMBA

Fishery	Target Species	Catch[1]	Fishing Method	Area Description
State Managed Fisheries				
Abrolhos Islands and Mid-West Trawl Managed Fishery (AIMWTMF)	Saucer scallops (*Ylistrum balloti*), with a small component targeting the western king prawn (*Penaeus latisulcatus*)	2017/2018: 651 tonnes	Operates using low opening otter trawl systems.	All the waters of the Indian Ocean adjacent to Western Australia between 27°51´ south latitude and 29°03´ south latitude on the landward side of the 200 m isobath'.
Broome Prawn Managed Fishery (BPMF)	Western king prawns (*Penaeus latisulcatus*) and coral prawns (a combined category of small penaeid species).	Extremely low fishing effort occurred as only a single boat undertook trial fishing to investigate whether catch rates were sufficient for commercial fishing. This resulted in negligible landings of western king prawns with no byproduct recorded.	Otter trawl	The BPMF operates in a designated trawl zone off Broome. The boundaries of the BPMF are 'all Western Australian waters of the Indian Ocean lying east of 120° east longitude and west of 123°45' east longitude on the landward side of the 200 m isobath'. The actual trawl area is contained within a delineated small area north west of Broome.
Cockburn Sound Mussel Managed Fishery	Blue mussels (*Mytilus edulis*)	2015: Unspecified	Agriculture	Main mussel farming occurs in southern Cockburn Sound.
Cockburn Sound Crab Managed Fishery	Blue Swimmer (*Portunus armatus)* Blue swimmer crab (*Portunus armartus)*	2017/2018: 5: closed to commercial and recreational fishing since April 2014	Drop nets, scoop nets, diving	Encompasses the inner waters of Cockburn Sound, from South Mole at Fremantle to Stragglers Rocks, through Mewstone to Carnac Island and Garden Island, along the eastern shore of Garden Island and back to John Point on the mainland.
Cockburn Sound Line and Pot Managed Fishery	Southern garfish (*Hyporhamphus melanochir*), Australian herring (*Arripis geogianus*)	2017/2018: 257 tonnes	Line (fish) Shelter and trigger pots (octopus)	Encompasses the inner waters of Cockburn Sound, from South Mole at Fremantle to Stragglers Rocks, through Mewstone to Carnac Island and Garden Island, along the eastern shore of Garden Island and back to John Point on the mainland.

Fishery	Target Species	Catch[1]	Fishing Method	Area Description
Exmouth Gulf Prawn Managed Fishery	Western king prawns (*Penaeus latisulcatus*), brown tiger prawns (*Penaeus esculentus*), endeavour prawns (*Metapenaeus* spp.) and banana prawns (*Penaeus merguiensis*).	2017/2018: 713 tonnes	Low opening otter trawls.	Sheltered waters of Exmouth Gulf Essentially the western half of the Exmouth Gulf (eastern part is a nursery ground). The Muiron Islands and Point Murat provide the western boundary; Serrurier Island provides the northern limit
Gascoyne Demersal Scalefish Managed Fishery (GDSMF)	Targets pink snapper (*Pagrus auratus*) and goldband snapper (*Pristipomoides multidens*). Other demersal species caught include the rosy snapper (*P. filamentosus*), ruby snapper (*Etelis carbunculus*), red emperor (*Lutjanus sebae*), emperors (Lethrinidae, including spangled emperor, *Lethrinus nebulosus*, and redthroat emperor, *L. miniatus*), cods (Epinephelidae, including Rankin cod, *Epinephelus multinotatus* and goldspotted rockcod, *E. coioides*), pearl perch (*Glaucosoma burgeri*), mulloway (*Argyrosomus japonicas*), amberjack (*Seriola dumerili*) and trevallies (Carangidae).	2017/2018: Snapper: 133 tonnes Other demersals: 144 tonnes	Mechanised handlines	The GDSF operates in the waters of the Indian Ocean and Shark Bay between latitudes 23°07'30"S and 26°30'S. Vessels are not permitted to fish in inner Shark Bay.
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.

Fishery	Target Species	Catch[1]	Fishing Method	Area Description
Hermit Crab Fishery (HCF)	Australian land hermit crab (*Coenobita variabilis*)	2017/2018: 58,643 (lowest reported in the last 10 years (2008-2017; catch range 58,643-118,203).	Land based hand collection typically using four-wheel drives to access remote beaches	Operates in Western Australian waters north of the Exmouth Gulf (22°30'S)
Kimberley Developing Mud Crab Managed Fishery	Mud crab (*Scylla serrata*)	2017/2018: 60 tonnes (also includes catch data from Pilbara Developmental crab fishery)	Mud Crab traps	This fishery operates between Broome and Cambridge Gulf. Three commercial operators are permitted to fish from King Sound to the Northern Territory border, with closed areas around communities and fishing camps. One Aboriginal Corporation is permitted to fish in King Sound, with the other Aboriginal Corporation permitted to fish in a small area on the western side of the Dampier peninsula, north of Broome. Notices issued under the *Fish Resources Management Act 1994* prohibit all commercial fishing for mud crabs in Roebuck Bay and an area of King Sound near Derby.
Kimberley Gillnet and Barramundi Managed Fishery (KGBF)	Barramundi *(Lates calcarifer),* King threadfin *(Polydactylus macrochir),* Blue threadfin *(Eleutheronema tetradactylum)*	2017/2018: 79.9 tonnes	Gill net in inshore waters	Nearshore and estuarine zones of the North Coast Bioregion from the WA/NT border (129ºE) to the top end of Eighty Mile Beach, south of Broome (19ºS). The waters of the KGBF are defined as 'all Western Australian waters north of 19° south latitude and west of 129° east longitude and within three nautical miles of the high water mark of the mainland of Western Australia and the waters of King Sound south of 16°21.47´ south latitude.
Kimberley Prawn Managed Fishery (KPMF)	Banana prawns (*Penaeus merguiensis*) Tiger prawns (*Penaeus esculentus*)	2017/2018: 269 tonnes	Otter trawl	The KPMF operates off the north of the state between Koolan Island and Cape Londonderry.

Fishery	Target Species	Catch[1]	Fishing Method	Area Description
	Endeavour prawns (*Metapenaeus endeavouri*) Western king prawns (*Penaeus latisulcatus*)			The boundaries of the KPMF are 'all Western Australian waters of the Indian Ocean lying east of 123°45´ east longitude and west of 126°58´ east longitude'. It abuts the western boundary of the Commonwealth Northern Prawn Fishery (NPF).
Mandurah to Bunbury Developing Crab Fishery	Blue swimmer crab (*Portunus armartus)*	2017/2018: 5.2 tonnes	Drop nets, scoop nets, diving	Fishery extends from south of the Shoalwater Islands Marine Park (32°22'40''S) to Point McKenna near Bunbury (33°16'S) and offshore to 115°30'E. The fishery is divided into two zones with crab fishing historically being permitted within Area 1, Comet Bay between 32°22''40''S and 32°30'S, and Area 2, Cape Bouvard to the southern boundary of the fishery. In 2015 crab fishing within Area 2 ceased.
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.	2017/2018: Total catch of 150,544 fishes, 21.9 t of coral, live rock & living sand and 322 L of marine plants.	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).
Nickol Bay Prawn Managed Fishery (NBPMF)	Primarily targets banana prawns (*Penaeus merguiensis*)	2017/2018: 227 tonnes	Otter trawl	Operates along the western part of the North-West Shelf in coastal shallow waters

Fishery	Target Species	Catch[1]	Fishing Method	Area Description
				The boundaries of the NBPMF are 'all the waters of the Indian Ocean and Nickol Bay between 116°45' east longitude and 120° east longitude on the landward side of the 200 m isobath'. The NBPMF incorporates the Nickol Bay, Extended Nickol Bay, Depuch and De Grey size managed fish grounds (State of the Fisheries 2014-15).
North Coast Trochus Fishery	Trochus (*Tectus niloticus*)	2017/2018: Unspecified	Harvested by with handheld levers or chisels	Indigenous fishery operating within King Sound
Northern Demersal Scalefish Managed Fishery (NDSF)	Red emperor (*Lutjanus sebae*) Goldband snapper (*Pristipomoides multidens*)	2017/2018:1317 tonnes (total) Goldband snapper (not including other jobfish): 473 tonnes Red emperor: 34 – 47 tonnes	The permitted means of operation within the fishery include handline, dropline and fish traps, but since 2002 it has essentially been a trap-based fishery which uses gear time access and spatial zones as the primary management measures (State of the Fisheries 2014-15).	The Northern Demersal Scalefish Managed Fishery (NDSF) operates off the northwest coast of Western Australia in the waters east of 120° E longitude. These waters extend out to the edge of the Australian Fishing Zone (200 nautical miles). The Fishery consists of three zones; Zone A is an inshore area, Zone B comprises the area with most historical fishing activity and Zone C is an offshore deep slope developmental area. The fishery is further divided into two fishing areas; an inshore sector and an offshore sector. The inshore waters in the vicinity of Broome are closed to commercial fishing.
WA North Coast Shark Fisheries	Sandbar (*Carcharhinus plumbeus*), hammer head (*Sphyrnidae*), blacktip (*Carcharhinus melanopterus*) and lemmon sharks (*Negaprion brevirostris*).	2017/2018: closed since 2008/2009	Gill net, longline	Comprised of the State-managed WA North Coast Shark Fishery in the Pilbara and western Kimberley, and the Joint Authority Northern Shark Fishery in the eastern Kimberley.
Octopus Interim Managed Fishery	*Octopus cf. tetricus*, with occasional bycatch of *O. ornatus* and *O. cyanea* in the northern parts of the fishery,	2017/2018: Commercial: 257 tonnes Recreational: 1 tonne	Line and pots Trawl and trap (land Octopus as byproduct)	Fishery in development phase. Four main categories in WA waters. Octopus are primarily caught in the Developing Octopus Interim Managed Fishery (largest fishery) are

Fishery	Target Species	Catch[1]	Fishing Method	Area Description
	and *O.maorum* in the southern and deeper sectors.			limited to the boundaries of the developmental fishery, which is an area bounded by the Kalbarri Cliffs (26°30'S) in the north and Esperance in the south. Passive and by-product harvests of octopus occur in both the Cockburn Sound (Line and Pot) Managed Fishery and the West Coast Rock Lobster Managed Fishery.
Onslow Prawn Managed Fishery (OPMF)	Western king prawns (*Penaeus latisulcatus*), brown tiger prawns (*Penaeus esculentus*), endeavour prawns (*Metapenaeus* spp.)	2017/2018: Negligible (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 mainland. 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)	2017/2018: 60 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.
Pilbara Fish Trawl (Interim) Managed Fishery (PFTIMF)	Variety of demersal scalefish including goldband snapper (*Pristipomoides multidens*), red emperor (*Lutjanus sebae*), bluespotted emperor	2017/2018: 1,780 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

Fishery	Target Species	Catch[1]	Fishing Method	Area Description
	(*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 nebulosus*) and frypan Moses' snapper (*Argyrops Lutjanusspinifer russelli*).			longitudes 114°9'36"E and 120°E. The Fishery is seaward of the 50 m isobath and landward of the 200 m isobath. 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 nebulosus*) and frypan snapper (*Argyrops spinifer*), Ruby	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
	snapper (*Etelis carbunculus*) and eightbar grouper (*Hyporthodus octofasciatus)*			
Roe's Abalone	Western Australian Roe's abalone (*Haliotis roei*)	2017/2018: Commercial: 49 tonnes Recreational: 23 tonnes	Dive and wade fishery. 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. Abalone divers operate from small fishery vessels (generally less than 9 metres in length).	Operating in shallow coastal waters along WA's western and southern coasts from Shark Bay to the SA border. Divided into 8 management areas. Commercial fishing for Roe's abalone is managed in 6 separate regions from the South Australian border to Busselton Jetty – Areas 1, 2, 5, 6, 7 and 8. Area 8 of the fishery was not fished in 2013.
Shark Bay Crab Interim Managed Fishery	Blue swimmer crab (*Portunus armatus*)	2017/2018: 443 tonnes total Crab: 153 tonnes	Trawl and trap	Waters of Shark Bay north of Cape Inscription, to Bernier and Dorre Islands and Quobba Point. In addition, two fishers with long-standing histories of trapping crabs in Shark Bay are permitted to fish in the waters of Shark Bay south of Cape Inscription.
Shark Bay Prawn Managed Fishery	Western king prawn (*Penaeus latisulcatus*), brown tiger prawn (*Penaeus esculentus*), Variety of smaller prawn species including endeavour prawns (*Metapenaeus* spp.) and coral prawns (various species).	2017/2018: 1,608 tonnes	Low opening otter trawls	The boundaries of the Shark Bay Prawn Managed Fishery are located in and near the waters of Shark Bay
Shark Bay Scallop Managed Fishery	Saucer Scallop (*Ylistrum balloti*)	2017/2018: 1,632 tonnes	Low opening otter trawls	The boundaries of the Shark Bay Scallop Managed Fishery are located in and near the waters of Shark Bay

Fishery	Target Species	Catch[1]	Fishing Method	Area Description
South Coast Open Access Netting Fishery	Insufficient information	Insufficient information	Insufficient information	Bunbury to the South Australian Border
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.	2017/2018: 7,806 shells	Hand harvest while diving or wading along coastal beaches below the high water mark An 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 WA 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.
South Coast Salmon Managed Fishery	WA salmon (*Arripis truttaceus*)	2017: 50 tonnes	Beach seine net, rod and line	Licensees operate from 18 designated beaches within the South Coast Bioregion, many of which have huts that are referred to as salmon camps.
South West Coast Salmon Managed Fishery	WA salmon (*Arripis truttaceus*)	Insufficient information	Insufficient information	Insufficient information
South West Coast Beach Net	Insufficient information	Insufficient information	Insufficient information	Insufficient information
South West Trawl Managed Fishery (SWTMF)	Saucer scallops (*Ylistrum balloti*)	2017/2018: 460 t meat weight (2,301 t whole weight)	Otter trawls	Waters between 31°34’27’’S and 115°8’8’’E where it intersects with the high water mark at Cape Leeuwin and on the landward side of the 200 m isobath.
Temperate Demersal Gillnet and Demersal	Gummy shark (*Mustelus antarcticus*), dusky shark (*Carcharhinus obscurus*), whiskery shark (*Furgaleus macki*) and	2017/2018: 2016-17Sharks and rays: 936 tonnes Scalefish: 133 tonnes	Demersal gillnets and power-hauled reels (to target sharks) Demersal longline	The Temperate Demersal Gillnet and Demersal Longline fisheries consists of Zone 1 of the Joint Authority Southern Demersal Gillnet and Demersal Longline Managed Fishery and the West Coast Demersal Gillnet

Fishery	Target Species	Catch[1]	Fishing Method	Area Description
Longline Fisheries (TDGDLF)	sandbar shark (*Carcharhinus plumbeus*).			and Demersal Longline (Interim) Managed Fishery. The Joint Authority Southern Demersal Gillnet and Demersal Longline Managed Fishery (JASDGDLF) spans the waters from 33° S latitude to the WA/SA border and comprises three management zones Zone 1 extends southwards from 33° S to 116° 30’ E longitude off the south coast. Zone 2 extends from 116°30’ E to the WA/SA border (129° E). A small number of Zone 3 units permit fishing throughout Zone 1 and eastwards to 116° 55’40” E. The West Coast Demersal Gillnet and Demersal Longline (Interim) Managed Fishery (WCDGDLF) technically extends northwards from 33° S latitude to 26° S longitude. However, the use of shark fishing gear has been prohibited north of 26° 30’ S (Steep Point) since 1993. Demersal gillnet and longline fishing inside the 250 metre depth contour has been prohibited off the Metropolitan coast (between latitudes 31° S and 33° S) since November 2007.
Warnbro Sound Crab Managed Fishery	Blue Swimmer (*Portunus armatus)* Blue swimmer crab (*Portunus armartus)*	2017/2018: closed to commercial and recreational fishing	Drop nets, scoop nets, diving	Includes Warnbro sound and adjacent water, extending from Becher Point to John Point.
West Coast Deep Sea Crustacean (Interim) Managed Fishery	Crystal (Snow) crabs (*Chaceon albus*), Giant (King) crabs (*Pseudocarcinus gigas*) and Champagne (Spiny) crabs (*Hypothalassia acerba*).	2017/2018: 164.4 tonnes	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.
West Coast Demersal Scalefish	West Coast Inshore Demersals:	2017/2018: 248 tonnes	Handline and drop line	The WCDSIMF encompasses the waters of the Indian Ocean just south of Shark Bay (at

Fishery	Target Species	Catch[1]	Fishing Method	Area Description
(Interim) Managed Fishery	West Australian Dhufish (*Glaucosoma hebraicum*), Pink snapper (*Pagrus auratus*) with other species captured including Redthroat Emperor (*Lethrinus miniatus*), Bight Redfish (*Centroberyx gerrardi*) and Baldchin Groper (*Choerodon rubescens*). West Coast Offshore Demersals: Eightbar Grouper *Hyporthodus octofasciatus*, Hapuku *Polyprion oxygeneios*, Blue-eye Trevalla *Hyperoglyphe antarctica* and Ruby Snapper *Etelis carbunculus*.			26°30'S) to just east of Augusta (at 115°30'E) and extends seaward to the 200 nm boundary of the Australian Fishing Zone (AFZ). The commercial fishery is divided into five management areas comprising four inshore areas and one offshore area. The inshore areas, i.e. Kalbarri, Mid-West, Metropolitan and South-West, extend outwards to the 250 m depth contour, while the Offshore Area extends the entire length of the fishery from the 250 m depth contour to the boundary of the AFZ.
West Coast Estuarine Managed Fishery	Blue swimmer crab (*Portunus armartus)*	2017/2018: 353 tonnes (blue swimmer crab) commercial and 58-77 tonnes recreational	Drop nets, scoop nets, diving (crabs)	Includes the waters of the Swan and Canning Rivers (Area 1), the waters of the Peel Inlet and Harvey Estuary, together with the Murray Serpentine, Harvey and Dandalup Rivers (Area 2) and waters of the Hardy Inlet (Area 3). Of these areas only Areas 1-2 are permitted for crab fishing.
West Coast Nearshore and Estuarine Finfish Fisheries	Nearshore: whitebait (*Hyperlophus vittatus*), western Australian salmon (*Arripis truttaceus*), Australian herring (*Arripis georgianus*), sourthern school whiting (*Sillago bassensis*), yellowfin whiting (*Sillago schomburgkii*), yelloweye mullet (*Aldrichetta forsteri*), tailor (*Pomatomus saltarix*), southern garfish (*Hyporhamphus melanochir*), silver trevally (*Pseudocaranx georgianus*) and King George whtiting (*Sillaginodes punctate*). Estuarine: sea mullet (*Mugil cephalus*), estuary cobbler	2017/2018: 353 tonnes	Haul, beach seine and gill netting (commercial). Line fishing (recreational)	Five commercial fisheries target nearshore and/or estuarine finfish in the West Coast Bioregion. Nearshore: Cockburn Sound Fish Net Managed Fishery operating within in Cockburn sound, South West Coast Salmon Managed Fishery operating on various beaches south of the Perth Metropolitan area, West Coast Beach Bait Managed Fishery operating on beaches spanning from Moore River to Tim's Thicket and the South West Beach Seine Fishery operating on

Fishery	Target Species	Catch[1]	Fishing Method	Area Description
	(*Cnidoglanis macrocephalus*) and black bream (*Acanthopagrus butcheri*).			various beaches from Tim's Thicket southwards to Port Geographe Bay Marina. Estuarine*:* West Coast Estuarine Managed Fishery operating in the Swan/Canning and Peel Harvey estuaries, and in the Hardy Inlet
West Coast Nearshore Net Managed Fishery	Southern garfish (Hyporhamphus melanochir), Australian herring (Arripis georgianus),	Insufficient information	Insufficient information	Insufficient information
West Coast Purse Seine Fishery	Scaly mackerel (*Sardinella lemuru*), pilchard (*S. sagax*), Australian anchovy (*Engraulis australis*), yellowtail scad (*Trachurus novaezelandiae*) and maray (*Etrumeus teres*).	2017/2018: 1,095 tonnes	Purse seine gear	Waters between Ningaloo and Cape Leeuwin including three separate zones: Northern Development (22°00'S to 31°00'S), Perth Metropolitan (31°00'S to 33°00'S) and Southern Development Zone (33°00'S to Cape Leeuwin).
West Coast Rock Lobster Managed Fishery (WCRLMF)	Western rock lobster (*Panulirus cygnus*)	2016: 272 – 400 tonnes (346-481 tonnes based on updated average weight)	Baited traps (pots). Pots and diving (recreational catch)	The fishery is situated along the west coast of Australia between Latitudes 21°44′ to 34°24′ S. The fishery is managed in three zones: Zone A – Abrolhos Islands, north of latitude 30° S excluding the Abrolhos Islands (Zone B) and south of latitude 30° S (Zone C).
West Coast Demersal Gillnet and Demersal Longline (WCDGDLF)*	Gummy shark (*Mustelus antarcticus*), dusky shark (*Carcharhinus obscurus*), whiskery shark (*Furgaleus macki*) and sandbar shark (*C. plumbeus*)	2016/2018: 936 tonnes of sharks and rays	Demersal gillnets and demersal longline (not widely used)	Operates between 26° and 33° S.
Mackerel Fishery	Spanish mackerel *(Scomberomorus commerson)*, grey mackerel *(S.semifasciatus)*, with other species from the genera *Scomberomorus*, *Grammatorcynus* and *Acanthocybium* also contributing to commercial catches.	2016: Commercial: The commercial catch of spanish mackerel was 276 tonnes in 2016 (Gaughan & Santoro, 2018)	Trolling or handline Near-surface trolling gear from vessels in coastal areas around reefs, shoals and headlands. Jig fishing is also used to capture grey mackerel *(S.semifasciatus)*	The Fishery 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. Restricted to coastal and shallower waters.

Fishery	Target Species	Catch[1]	Fishing Method	Area Description
				Catches are reported separately for three Areas: Area 1 - Kimberley (121º E to WA/NT border); Area 2 -Pilbara (114º E to 121º E); Area 3 - Gascoyne (27º S to 114º E) and West Coast (Cape Leeuwin to 27º S).
Western Australian Pearl Oyster Managed Fishery	Indo- Pacific silver-lipped pearl oyster (*Pinctada maxima*).	2018: 468,573 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.
Western Australian Sea Cucumber Fishery (formerly known as Beche-de-mer)	Sandfish (*Holothuria scabra*) and deepwater redfish (*Actinopyga echinites*).	2016: 93 tonnes	Hand-harvest fishery, with animals caught principally by diving, and a smaller amount by wading.	The Western Australian Sea Cucumber Fishery is permitted to operate throughout WA waters with the exception of a number of specific closures around the Dampier Archipelago, Cape Keraudren, Cape Preston

Fishery	Target Species	Catch[1]	Fishing Method	Area Description
				and Cape Lambert, the Rowley Shoals and the Abrolhos Islands. The fishery is primarily based in the northern half of the State, from Exmouth Gulf to the Northern Territory border.
Commonwealth Managed Fisheries				
North West Slope Trawl	Scampi (crayfish): velvet scampi (*Metanephrops velutinus*) and boschmai scampi (*Metanephrops boschmai*). Deepwater prawns (penaeid and carid): pink prawn (*Parapenaeus longirostris*), red prawn (*Aristaeomorpha foliacea*), striped prawn (*Aristeus virilis*), giant scarlet prawn (*Aristaeopsis edwardsiana*), red carid prawn (*Heterocarpus woodmasoni*) and white carid prawn (*Heterocarpus sibogae*). Snapper.	2017-18: 79.7 total tonnes.	Demersal crustacean trawl seaward of the 200 m isobath.	Extends from 114° E to approximately 125° E off the WA coast between the 200 m isobath and the outer limit of the Australian Fishing Zone (AFZ).
Western Skipjack Tuna Fishery	Skipjack tuna (*Katsuwonus pelamis*)	2017-18: 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 Australia waters west of 142° 30’ 00°E, out to 200 nm from the coast. There has been no fishing effort in the Skipjack Tuna Fishery since the 2008-09 season, and in that season activity concentrated off South Australia (Department of Agriculture 2019).
Small Pelagic Fishery	Australian sardine (*Sardinops sagax*), blue mackerel (*Scomber australasicus*), jack mackerel	2018-19: 9,424 tonnes	Purse-seine and midwater trawling	Extends from Queensland to southern Western Australia.

Fishery	Target Species	Catch[1]	Fishing Method	Area Description
	(*Trachurus declivis*) and redbait (*Emmelichthys nitidus*).			
Southern Bluefin Tuna Fishery	Southern bluefin tuna (*Thunnus maccoyii*).	2017-18: 6,159 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 the North West Shelf, fishing activity is concentrated in the Great Australian Bight and off South-east Australia (Department of Agriculture 2019).
Western Deepwater Trawl Fishery	A diverse range of species are caught, ranging from tropical and ruby snappers on the shelf edge to orange roughy (*Hoplostethus atlanticus*), oreo dories and bugs (*Ibacus* spp.) in the deeper temperate waters.	2017-18: 101.9 tonnes	Demersal fish trawl seaward of the 200 m isobath.	Its northernmost point is from the boundary of the AFZ to longitude 114° E, and its southernmost point is from the boundary of the AFZ to longitude 115°08' E. Deep water off WA, from the 200 m isobath to the edge of the AFZ.
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*).	2018: 278 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 the North West Shelf (Department of Agriculture 2019).

Source: Apache (2008); Australian Fisheries Management Authority (2011); Department of Fisheries (2013), Stakeholder consultation.

[1]Sources for catch data: Department of Agriculture 2019; Gaughan *et al*, 2019; DPIRD 2018.

15. Document review

This document is to be reviewed annually at a minimum. The review and revision will consider any changes to the spatial scope of the document, i.e. the Environment that May be Affected (EMBA), as well as any changes to EPBC Act Matters of National Environmental Significance (MNES) from one review year to the next, regardless of any changes to the spatial extent of the EMBA. A review of changes to MNES shall consider at a minimum any changes to EPBC Act species lists, species management/recovery plans and MNES spatial layers. Changes are to be recorded within the MNES review register (**Appendix B**).

16. References

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Appendix A: EPBC Act Protected Matters Report

Australian Government

Department of Agriculture, Water and the Environment

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.

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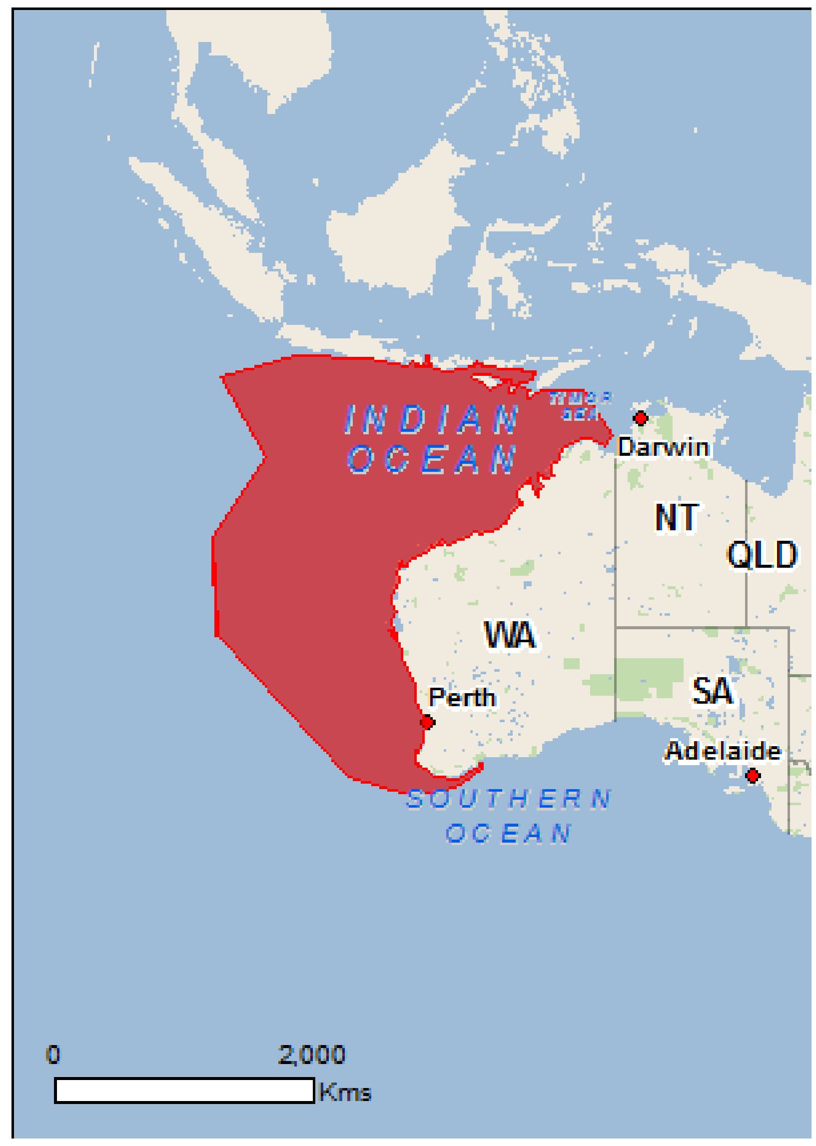

Coordinates

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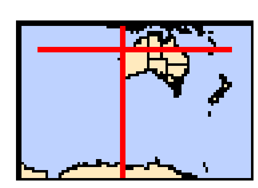

Summary

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:	2
National Heritage Places:	9
Wetlands of International Importance:	7
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	2
Listed Threatened Ecological Communities:	6
Listed Threatened Species:	196
Listed Migratory Species:	109

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:	9
Commonwealth Heritage Places:	24
Listed Marine Species:	216
Whales and Other Cetaceans:	44
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	1
Australian Marine Parks:	45

Extra Information

This part of the report provides information that may also be relevant to the area you have nominated.

State and Territory Reserves:	140
Regional Forest Agreements:	1
Invasive Species:	64
Nationally Important Wetlands:	19
Key Ecological Features (Marine)	24

Details

Matters of National Environmental Significance

World Heritage Properties [Resource Information]

Name	State	Status
Shark Bay, Western Australia	WA	Declared property
The Ningaloo Coast	WA	Declared property

National Heritage Properties [Resource Information]

Name	State	Status
Natural		
Fitzgerald River National Park	WA	Listed place
Lesueur National Park	WA	Listed place
Shark Bay, Western Australia	WA	Listed place
The Ningaloo Coast	WA	Listed place
The West Kimberley	WA	Listed place
Indigenous		
Dampier Archipelago (including Burrup Peninsula)	WA	Listed place
Historic		
Batavia Shipwreck Site and Survivor Camps Area 1629 - Houtman Abrolhos	WA	Listed place
Dirk Hartog Landing Site 1616 - Cape Inscription Area	WA	Listed place
HMAS Sydney II and HSK Kormoran Shipwreck Sites	EXT	Listed place

Wetlands of International Importance (Ramsar) [Resource Information]

Name	Proximity
Ashmore reef national nature reserve	Within Ramsar site
Becher point wetlands	Within 10km of Ramsar
Eighty-mile beach	Within Ramsar site
Hosnies spring	Within Ramsar site
Peel-yalgorup system	Within Ramsar site
Roebuck bay	Within Ramsar site
The dales	Within Ramsar site

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
Extended Continental Shelf

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
North-west
South-west

Listed Threatened Ecological Communities [Resource Information]

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.

Name	Status	Type of Presence
Banksia Woodlands of the Swan Coastal Plain ecological community	Endangered	Community likely to occur within area
Monsoon vine thickets on the coastal sand dunes	Endangered	Community likely to

Name	Status	Type of Presence
of Dampier Peninsula		occur within area
Proteaceae Dominated Kwongkan Shrublands of the Southeast Coastal Floristic Province of Western Australia	Endangered	Community likely to occur within area
Subtropical and Temperate Coastal Saltmarsh	Vulnerable	Community likely to occur within area
Thrombolite (microbialite) Community of a Coastal Brackish Lake (Lake Clifton)	Critically Endangered	Community known to occur within area
Tuart (Eucalyptus gomphocephala) Woodlands and Forests of the Swan Coastal Plain ecological community	Critically Endangered	Community likely to occur within area

Listed Threatened Species

[Resource Information]

Name	Status	Type of Presence
Birds		
Accipiter hiogaster natalis Christmas Island Goshawk [82408]	Endangered	Species or species habitat known to occur within area
Anous tenuirostris melanops Australian Lesser Noddy [26000]	Vulnerable	Breeding known to occur within area
Atrichornis clamosus Noisy Scrub-bird, Tjimiluk [654]	Endangered	Species or species habitat known to occur within area
Botaurus poiciloptilus Australasian Bittern [1001]	Endangered	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 tenuirostris Great Knot [862]	Critically Endangered	Roosting known to occur within area
Calyptorhynchus banksii naso Forest Red-tailed Black-Cockatoo, Karrak [67034]	Vulnerable	Species or species habitat known to occur within area
Calyptorhynchus baudinii Baudin's Cockatoo, Long-billed Black-Cockatoo [769]	Endangered	Breeding known to occur within area
Calyptorhynchus latirostris Carnaby's Cockatoo, Short-billed Black-Cockatoo [59523]	Endangered	Species or species habitat known to occur within area
Cereopsis novaehollandiae grisea Cape Barren Goose (south-western), Recherche Cape Barren Goose [25978]	Vulnerable	Species or species habitat known to occur within area
Chalcophaps indica natalis Christmas Island Emerald Dove, Emerald Dove (Christmas Island) [67030]	Endangered	Species or species habitat known to occur within area
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Roosting known to occur within area
Charadrius mongolus Lesser Sand Plover, Mongolian Plover [879]	Endangered	Roosting known to occur within area
Dasyornis longirostris Western Bristlebird [515]	Endangered	Species or species habitat known to occur within area
Diomedea amsterdamensis Amsterdam Albatross [64405]	Endangered	Species or species habitat likely to occur

Name	Status	Type of Presence
		within area
Diomedea antipodensis Antipodean Albatross [64458]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea dabbenena Tristan Albatross [66471]	Endangered	Species or species habitat likely to occur within area
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Erythrotriorchis radiatus Red Goshawk [942]	Vulnerable	Species or species habitat likely to occur within area
Erythrura gouldiae Gouldian Finch [413]	Endangered	Species or species habitat known to occur within area
Falco hypoleucos Grey Falcon [929]	Vulnerable	Species or species habitat known to occur within area
Falcunculus frontatus whitei Crested Shrike-tit (northern), Northern Shrike-tit [26013]	Vulnerable	Species or species habitat likely to occur within area
Fregata andrewsi Christmas Island Frigatebird, Andrew's Frigatebird [1011]	Endangered	Breeding known to occur within area
Geophaps smithii blaauwi Partridge Pigeon (western) [66501]	Vulnerable	Species or species habitat likely to occur within area
Halobaena caerulea Blue Petrel [1059]	Vulnerable	Species or species habitat may occur within area
Leipoa ocellata Malleefowl [934]	Vulnerable	Species or species habitat likely to occur within area
Limosa lapponica baueri Bar-tailed Godwit (baueri), Western Alaskan Bar-tailed Godwit [86380]	Vulnerable	Species or species habitat known to occur within area
Limosa lapponica menzbieri Northern Siberian Bar-tailed Godwit, Bar-tailed Godwit (menzbieri) [86432]	Critically Endangered	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
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 within area

Name	Status	Type of Presence
Malurus leucopterus leucopterus White-winged Fairy-wren (Dirk Hartog Island), Dirk Hartog Black-and-White Fairy-wren [26004]	Vulnerable	Species or species habitat likely to occur within area
Ninox natalis Christmas Island Hawk-Owl, Christmas Boobook [66671]	Vulnerable	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
Pachyptila turtur subantarctica Fairy Prion (southern) [64445]	Vulnerable	Species or species habitat known to occur within area
Papasula abbotti Abbott's Booby [59297]	Endangered	Species or species habitat known to occur within area
Pezoporus flaviventris Western Ground Parrot, Kyloring [84650]	Critically Endangered	Species or species habitat may occur within area
Pezoporus occidentalis Night Parrot [59350]	Endangered	Species or species habitat may occur within area
Phaethon lepturus fulvus Christmas Island White-tailed Tropicbird, Golden Bosunbird [26021]	Endangered	Breeding likely to occur within area
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat likely to occur within area
Polytelis alexandrae Princess Parrot, Alexandra's Parrot [758]	Vulnerable	Species or species habitat known to occur within area
Psophodes nigrogularis nigrogularis Western Heath Whipbird [64449]	Endangered	Species or species habitat known to occur within area
Pterodroma mollis Soft-plumaged Petrel [1036]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Rostratula australis Australian Painted Snipe [77037]	Endangered	Species or species habitat known to 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 Shy Albatross [89224]	Endangered	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
Thalassarche steadi White-capped Albatross [64462]	Vulnerable	Foraging, feeding or related behaviour likely

Name	Status	Type of Presence
		to occur within area
Turdus poliocephalus erythropleurus		
Christmas Island Thrush [67122]	Endangered	Species or species habitat likely to occur within area
Turnix varius scintillans		
Painted Button-quail (Houtman Abrolhos) [82451]	Vulnerable	Species or species habitat likely to occur within area
Tyto novaehollandiae kimberli		
Masked Owl (northern) [26048]	Vulnerable	Species or species habitat likely to occur within area
Fish		
Galaxiella nigrostriata		
Blackstriped Dwarf Galaxias, Black-stripe Minnow [88677]	Endangered	Species or species habitat known to occur within area
Milyeringa veritas		
Blind Gudgeon [66676]	Vulnerable	Species or species habitat known to occur within area
Nannatherina balstoni		
Balston's Pygmy Perch [66698]	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
Insects		
Hesperocolletes douglasi		
Douglas' Broad-headed Bee, Rottnest Bee [66734]	Critically Endangered	Species or species habitat may occur within area
Trioza barrettae		
Banksia brownii plant louse [87805]	Endangered	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	Foraging, feeding or related behaviour 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
Bettongia lesueur lesueur		
Burrowing Bettong (Shark Bay), Boodie [66659]	Vulnerable	Species or species habitat known to occur within area
Bettongia penicillata ogilbyi		
Woylie [66844]	Endangered	Species or species habitat known to occur within area
Conilurus penicillatus		
Brush-tailed Rabbit-rat, Brush-tailed Tree-rat, Pakooma [132]	Vulnerable	Species or species habitat likely to occur within area
Crocidura trichura		
Christmas Island Shrew [86568]	Critically Endangered	Species or species habitat likely to occur within area

Name	Status	Type of Presence
Dasyurus geoffroii Chuditch, Western Quoll [330]	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 known to occur within area
Eubalaena australis Southern Right Whale [40]	Endangered	Breeding known to occur within area
Isoodon auratus auratus Golden Bandicoot (mainland) [66665]	Vulnerable	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
Lagorchestes hirsutus bernieri Rufous Hare-wallaby (Bernier Island) [66662]	Vulnerable	Species or species habitat known to occur within area
Lagorchestes hirsutus dorreae Rufous Hare-wallaby (Dorre Island) [66663]	Vulnerable	Species or species habitat known to occur within area
Lagostrophus fasciatus fasciatus Banded Hare-wallaby, Merrnine, Marnine, Munning [66664]	Vulnerable	Species or species habitat known to occur within area
Leporillus conditor Wopilkara, Greater Stick-nest Rat [137]	Vulnerable	Translocated population known to occur within area
Macroderma gigas Ghost Bat [174]	Vulnerable	Species or species habitat known to occur within area
Macrotis lagotis Greater Bilby [282]	Vulnerable	Species or species habitat known to occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Breeding known to occur within area
Mesembriomys gouldii gouldii Black-footed Tree-rat (Kimberley and mainland Northern Territory), Djintamoonga, Manbul [87618]	Endangered	Species or species habitat may occur within area
Neophoca cinerea Australian Sea-lion, Australian Sea Lion [22]	Vulnerable	Breeding 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
Parantechinus apicalis Dibbler [313]	Endangered	Species or species habitat known to occur within area
Perameles bougainville bougainville Western Barred Bandicoot (Shark Bay) [66631]	Endangered	Species or species habitat known to occur within area

Name	Status	Type of Presence
Petrogale concinna monastria Nabarlek (Kimberley) [87607]	Endangered	Species or species habitat known 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
Phascogale calura Red-tailed Phascogale, Red-tailed Wambenger, Kenngoor [316]	Vulnerable	Species or species habitat may occur within area
Phascogale tapoatafa kimberleyensis Kimberley brush-tailed phascogale, Brush-tailed Phascogale (Kimberley) [88453]	Vulnerable	Species or species habitat likely to occur within area
Pipistrellus murrayi Christmas Island Pipistrelle [64383]	Critically Endangered	Species or species habitat known to occur within area
Potorous gilbertii Gilbert's Potoroo, Ngilkat [66642]	Critically Endangered	Species or species habitat known to occur within area
Pseudocheirus occidentalis Western Ringtail Possum, Ngwayir, Womp, Woder, Ngoor, Ngoolangit [25911]	Critically Endangered	Breeding known to occur within area
Pseudomys fieldi Shark Bay Mouse, Djoongari, Alice Springs Mouse [113]	Vulnerable	Species or species habitat likely to occur within area
Pseudomys shortridgei Heath Mouse, Dayang, Heath Rat [77]	Endangered	Species or species habitat may occur within area
Pteropus natalis Christmas Island Flying-fox, Christmas Island Fruit-bat [87611]	Critically Endangered	Roosting known to occur within area
Rhinonicteris aurantia (Pilbara form) Pilbara Leaf-nosed Bat [82790]	Vulnerable	Species or species habitat known to occur within area
Saccolaimus saccolaimus nudicluniatus Bare-rumped Sheath-tailed Bat, Bare-rumped Sheathtail Bat [66889]	Vulnerable	Species or species habitat likely to occur within area
Setonix brachyurus Quokka [229]	Vulnerable	Species or species habitat known to occur within area
Xeromys myoides Water Mouse, False Water Rat, Yirrkoo [66]	Vulnerable	Species or species habitat may occur within area
Other		
Idiosoma nigrum Shield-backed Trapdoor Spider, Black Rugose Trapdoor Spider [66798]	Vulnerable	Species or species habitat may occur within area
Kumonga exleyi Cape Range Remipede [86875]	Vulnerable	Species or species habitat likely to occur within area
Westralunio carteri Carter's Freshwater Mussel, Freshwater Mussel [86266]	Vulnerable	Species or species habitat known to occur within area
Plants		
Adenanthos dobagii Fitzgerald Woollybush [21253]	Endangered	Species or species habitat likely to occur within area

Name	Status	Type of Presence
Andersonia gracilis Slender Andersonia [14470]	Endangered	Species or species habitat may occur within area
Androcalva bivillosa Straggling Androcalva [87807]	Critically Endangered	Species or species habitat may occur within area
Asplenium listeri Christmas Island Spleenwort [65865]	Critically Endangered	Species or species habitat known to occur within area
Banksia brownii Brown's Banksia, Feather-leaved Banksia [8277]	Endangered	Species or species habitat known to occur within area
Banksia nivea subsp. uliginosa Swamp Honeypot [82766]	Endangered	Species or species habitat likely to occur within area
Banksia pseudoplumosa False Plumed-Banksia [82760]	Endangered	Species or species habitat may occur within area
Banksia squarrosa subsp. argillacea Whicher Range Dryandra [82769]	Vulnerable	Species or species habitat may occur within area
Banksia verticillata Granite Banksia, Albany Banksia, River Banksia [8333]	Vulnerable	Species or species habitat likely to occur within area
Beyeria lepidopetala Small-petalled Beyeria, Short-petalled Beyeria [18362]	Endangered	Species or species habitat likely to occur within area
Boronia clavata Bremer Boronia [5538]	Endangered	Species or species habitat likely to occur within area
Caladenia barbarella Small Dragon Orchid, Common Dragon Orchid [68686]	Endangered	Species or species habitat may occur within area
Caladenia bryceana subsp. cracens Northern Dwarf Spider-orchid [64556]	Vulnerable	Species or species habitat known to occur within area
Caladenia busselliana Bussell's Spider-orchid [24369]	Endangered	Species or species habitat likely to occur within area
Caladenia caesarea subsp. maritima Cape Spider-orchid [64856]	Endangered	Species or species habitat known to occur within area
Caladenia elegans Elegant Spider-orchid [56775]	Endangered	Species or species habitat likely to occur within area
Caladenia excelsa Giant Spider-orchid [56717]	Endangered	Species or species habitat likely to occur within area
Caladenia granitora [65292]	Endangered	Species or species habitat known to occur within area
Caladenia hoffmanii Hoffman's Spider-orchid [56719]	Endangered	Species or species habitat known to occur within area

Name	Status	Type of Presence
Caladenia huegelii King Spider-orchid, Grand Spider-orchid, Rusty Spider-orchid [7309]	Endangered	Species or species habitat likely to occur within area
Caladenia lodgeana Lodge's Spider-orchid [68664]	Critically Endangered	Species or species habitat known to occur within area
Caladenia procera Carbunup King Spider Orchid [68679]	Critically Endangered	Species or species habitat may occur within area
Caladenia viridescens Dunsborough Spider-orchid [56776]	Endangered	Species or species habitat known to occur within area
Calectasia cyanea Blue Tinsel Lily [7669]	Critically Endangered	Species or species habitat known to occur within area
Chamelaucium sp. S coastal plain (R.D.Royce 4872) Royce's Waxflower [87814]	Vulnerable	Species or species habitat may occur within area
Chordifex abortivus Manypeaks Rush [64868]	Endangered	Species or species habitat known to occur within area
Chorizema varium Limestone Pea [16981]	Endangered	Species or species habitat known to occur within area
Conostylis micrantha Small-flowered Conostylis [17635]	Endangered	Species or species habitat may occur within area
Conostylis misera Grass Conostylis [21320]	Endangered	Species or species habitat may occur within area
Diuris drummondii Tall Donkey Orchid [4365]	Vulnerable	Species or species habitat known to occur within area
Diuris micrantha Dwarf Bee-orchid [55082]	Vulnerable	Species or species habitat likely to occur within area
Diuris purdiei Purdie's Donkey-orchid [12950]	Endangered	Species or species habitat may occur within area
Drakaea elastica Glossy-leafed Hammer Orchid, Glossy-leaved Hammer Orchid, Warty Hammer Orchid [16753]	Endangered	Species or species habitat likely to occur within area
Drakaea micrantha Dwarf Hammer-orchid [56755]	Vulnerable	Species or species habitat likely to occur within area
Drummondita ericoides Morseby Range Drummondita [9193]	Endangered	Species or species habitat known to occur within area
Eucalyptus argutifolia Yanchep Mallee, Wabling Hill Mallee [24263]	Vulnerable	Species or species habitat known to occur within area
Eucalyptus cuprea Mallee Box [56773]	Endangered	Species or species habitat may occur within area

Name	Status	Type of Presence
Eucalyptus x phylacis Meelup Mallee [87817]	Endangered	Species or species habitat known to occur within area
Gastrolobium papilio Butterfly-leaved Gastrolobium [78415]	Endangered	Species or species habitat may occur within area
Grevillea batrachioides Mt Lesueur Grevillea [21735]	Endangered	Species or species habitat may occur within area
Grevillea brachystylis subsp. australis [55525]	Vulnerable	Species or species habitat may occur within area
Grevillea humifusa Spreading Grevillea [61182]	Endangered	Species or species habitat may occur within area
Hemiandra gardneri Red Snakebush [7945]	Endangered	Species or species habitat likely to occur within area
Isopogon uncinatus Albany Cone Bush, Hook-leaf Isopogon [20871]	Endangered	Species or species habitat known to occur within area
Kennedia glabrata Northcliffe Kennedia [16452]	Vulnerable	Species or species habitat likely to occur within area
Kennedia lateritia Augusta Kennedia [45985]	Endangered	Species or species habitat likely to occur within area
Lambertia echinata subsp. occidentalis Western Prickly Honeysuckle [64528]	Endangered	Species or species habitat may occur within area
Lambertia orbifolia Roundleaf Honeysuckle [15725]	Endangered	Species or species habitat likely to occur within area
Lechenaultia chlorantha Kalbarri Leschenaultia [16763]	Vulnerable	Species or species habitat likely to occur within area
Leptomeria dielsiana Diels' Currant Bush [5146]	Vulnerable	Species or species habitat known to occur within area
Leucopogon obtectus Hidden Beard-heath [19614]	Endangered	Species or species habitat may occur within area
Marianthus paralius [83925]	Endangered	Species or species habitat known to occur within area
Pityrodia augustensis Mt Augustus Foxglove [4962]	Vulnerable	Species or species habitat likely to occur within area
Pneumatopteris truncata fern [68812]	Critically Endangered	Species or species habitat known to occur within area
Reedia spathacea Reedia [2995]	Critically Endangered	Species or species habitat likely to occur within area

Name	Status	Type of Presence
Seringia exastia Fringed Fire-bush [88920]	Critically Endangered	Species or species habitat known to occur within area
Sphenotoma drummondii Mountain Paper-heath [21160]	Endangered	Species or species habitat likely to occur within area
Stachystemon nematophorus Three-flowered Stachystemon [81447]	Vulnerable	Species or species habitat known to occur within area
Tectaria devexa [14767]	Endangered	Species or species habitat likely to occur within area
Thelymitra stellata Star Sun-orchid [7060]	Endangered	Species or species habitat may occur within area
Verticordia apecta Hay River Featherflower, Scruffy Verticordia [65545]	Critically Endangered	Species or species habitat may occur within area
Verticordia plumosa var. vassensis Vasse Featherflower [55804]	Endangered	Species or species habitat may occur within area
Wurmbea calcicola Naturaliste Nancy [64691]	Endangered	Species or species habitat known to occur within area
Wurmbea tubulosa Long-flowered Nancy [12739]	Endangered	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
Aipysurus foliosquama Leaf-scaled Seasnake [1118]	Critically Endangered	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
Cryptoblepharus egeriae Christmas Island Blue-tailed Skink, Blue-tailed Snake-eyed Skink [1526]	Critically Endangered	Species or species habitat likely to occur within area
Ctenotus lancelini Lancelin Island Skink [1482]	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
Cyrtodactylus sadleiri Christmas Island Giant Gecko [86865]	Endangered	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
Egernia stokesii badia Western Spiny-tailed Skink, Baudin Island Spiny-	Endangered	Species or species

Name	Status	Type of Presence
tailed Skink [64483]		habitat known to occur within area
Emoia nativitatis Christmas Island Forest Skink, Christmas Island Whiptail-skink [1400]	Critically Endangered	Species or species habitat known to occur within area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Breeding known to occur within area
Lepidochelys olivacea Olive Ridley Turtle, Pacific Ridley Turtle [1767]	Endangered	Foraging, feeding or related behaviour known to occur within area
Lepidodactylus listeri Christmas Island Gecko, Lister's Gecko [1711]	Critically Endangered	Species or species habitat known to occur within area
Lerista nevinae Nevin's Slider [85296]	Endangered	Species or species habitat known to occur within area
Liasis olivaceus barroni Olive Python (Pilbara subspecies) [66699]	Vulnerable	Species or species habitat known to occur within area
Liopholis pulchra longicauda Jurien Bay Skink, Jurien Bay Rock-skink [83162]	Vulnerable	Species or species habitat known to occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Breeding known to occur within area
Ramphotyphlops exocoeti Christmas Island Blind Snake, Christmas Island Pink Blind Snake [1262]	Vulnerable	Species or species habitat likely 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	Foraging, feeding or related behaviour known to occur within area
Glyphis garricki Northern River Shark, New Guinea River Shark [82454]	Endangered	Breeding likely to occur within area
Pristis clavata Dwarf Sawfish, Queensland Sawfish [68447]	Vulnerable	Breeding known to occur within area
Pristis pristis Freshwater Sawfish, Largetooth Sawfish, River Sawfish, Leichhardt's Sawfish, Northern Sawfish [60756]	Vulnerable	Species or species habitat known to occur within area
Pristis zijsron Green Sawfish, Dindagubba, Narrowsnout Sawfish [68442]	Vulnerable	Breeding 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]		Breeding known to occur within area
Apus pacificus Fork-tailed Swift [678]		Species or species

Name	Threatened	Type of Presence
		habitat likely to occur within area
Ardenna carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [82404]		Breeding known to occur within area
Ardenna grisea Sooty Shearwater [82651]		Species or species habitat may occur within area
Ardenna pacifica Wedge-tailed Shearwater [84292]		Breeding known to occur within area
Calonectris leucomelas Streaked Shearwater [1077]		Species or species habitat known to occur within area
Diomedea amsterdamensis Amsterdam Albatross [64405]	Endangered	Species or species habitat likely to occur within area
Diomedea antipodensis Antipodean Albatross [64458]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea dabbenena Tristan Albatross [66471]	Endangered	Species or species habitat likely to occur within area
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Fregata andrewsi Christmas Island Frigatebird, Andrew's Frigatebird [1011]	Endangered	Breeding known to occur within area
Fregata ariel Lesser Frigatebird, Least Frigatebird [1012]		Breeding known to occur within area
Fregata minor Great Frigatebird, Greater Frigatebird [1013]		Breeding known to 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
Phaethon lepturus White-tailed Tropicbird [1014]		Breeding known to occur within area
Phaethon rubricauda Red-tailed Tropicbird [994]		Breeding known to occur within area
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat likely to occur within area

Name	Threatened	Type of Presence
Sterna dougallii Roseate Tern [817]		Breeding known to occur within area
Sternula albifrons Little Tern [82849]		Breeding known to occur within area
Sula dactylatra Masked Booby [1021]		Breeding known to occur within area
Sula leucogaster Brown Booby [1022]		Breeding known to occur within area
Sula sula Red-footed Booby [1023]		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 Shy Albatross [89224]	Endangered	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
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*	Breeding known 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	Foraging, feeding or related behaviour known to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Caperea marginata Pygmy Right Whale [39]		Foraging, feeding or related behaviour likely to occur within area
Carcharhinus longimanus Oceanic Whitetip Shark [84108]		Species or species habitat likely to occur within area
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Foraging, feeding or

Name	Threatened	Type of Presence
		related behaviour 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
Crocodylus porosus Salt-water Crocodile, Estuarine Crocodile [1774]		Species or species habitat likely 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
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
Lagenorhynchus obscurus Dusky Dolphin [43]		Species or species habitat likely to occur within area
Lamna nasus Porbeagle, Mackerel Shark [83288]		Species or species habitat likely to occur within area
Lepidochelys olivacea Olive Ridley Turtle, Pacific Ridley Turtle [1767]	Endangered	Foraging, feeding or related behaviour known 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 known to occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Breeding known to occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Breeding known to occur within area
Orcaella heinsohni Australian Snubfin Dolphin [81322]		Species or species habitat known to occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat may occur within area
Physeter macrocephalus Sperm Whale [59]		Foraging, feeding or related behaviour known to occur within area
Pristis clavata Dwarf Sawfish, Queensland Sawfish [68447]	Vulnerable	Breeding known to occur within area
Pristis pristis Freshwater Sawfish, Largetooth Sawfish, River	Vulnerable	Species or species

Name	Threatened	Type of Presence
Sawfish, Leichhardt's Sawfish, Northern Sawfish [60756]		habitat known to occur within area
Pristis zijsron		
Green Sawfish, Dindagubba, Narrowsnout Sawfish [68442]	Vulnerable	Breeding 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]		Breeding 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		
Cecropis daurica		
Red-rumped Swallow [80610]		Species or species habitat known to occur within area
Cuculus optatus		
Oriental Cuckoo, Horsfield's Cuckoo [86651]		Species or species habitat known to occur within area
Hirundo rustica		
Barn Swallow [662]		Species or species habitat known to occur within area
Motacilla cinerea		
Grey Wagtail [642]		Species or species habitat known to occur within area
Motacilla flava		
Yellow Wagtail [644]		Species or species habitat known to occur within area
Rhipidura rufifrons		
Rufous Fantail [592]		Species or species habitat known to occur within area
Migratory Wetlands Species		
Acrocephalus orientalis		
Oriental Reed-Warbler [59570]		Species or species habitat known to occur within area
Actitis hypoleucos		
Common Sandpiper [59309]		Species or species habitat known to occur within area
Arenaria interpres		
Ruddy Turnstone [872]		Roosting known to occur within area
Calidris acuminata		
Sharp-tailed Sandpiper [874]		Roosting known to occur within area
Calidris alba		
Sanderling [875]		Roosting 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 known to occur within area
Calidris ruficollis		
Red-necked Stint [860]		Roosting known to occur

Name	Threatened	Type of Presence
		within area
Calidris subminuta Long-toed Stint [861]		Species or species habitat known to occur within area
Calidris tenuirostris Great Knot [862]	Critically Endangered	Roosting known to occur within area
Charadrius bicinctus Double-banded Plover [895]		Roosting known to occur within area
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Roosting known to occur within area
Charadrius mongolus Lesser Sand Plover, Mongolian Plover [879]	Endangered	Roosting known to occur within area
Charadrius veredus Oriental Plover, Oriental Dotterel [882]		Roosting known to occur within area
Gallinago megala Swinhoe's Snipe [864]		Roosting likely to occur within area
Gallinago stenura Pin-tailed Snipe [841]		Roosting likely to occur within area
Glareola maldivarum Oriental Pratincole [840]		Roosting known to occur within area
Limicola falcinellus Broad-billed Sandpiper [842]		Roosting known to occur within area
Limnodromus semipalmatus Asian Dowitcher [843]		Roosting known to occur within area
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat known to occur within area
Limosa limosa Black-tailed Godwit [845]		Roosting known to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area
Numenius minutus Little Curlew, Little Whimbrel [848]		Roosting known to occur within area
Numenius phaeopus Whimbrel [849]		Roosting known to occur within area
Pandion haliaetus Osprey [952]		Breeding known to occur within area
Phalaropus lobatus Red-necked Phalarope [838]		Roosting known to occur within area
Philomachus pugnax Ruff (Reeve) [850]		Roosting known to occur within area
Pluvialis fulva Pacific Golden Plover [25545]		Roosting known to occur within area
Pluvialis squatarola Grey Plover [865]		Roosting known to occur within area
Thalasseus bergii Crested Tern [83000]		Breeding known to occur within area
Tringa brevipes Grey-tailed Tattler [851]		Roosting known to occur

Name	Threatened	Type of Presence
		within area
Tringa glareola Wood Sandpiper [829]		Roosting known to occur within area
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat known to occur within area
Tringa stagnatilis Marsh Sandpiper, Little Greenshank [833]		Roosting known to occur within area
Tringa totanus Common Redshank, Redshank [835]		Roosting known to occur within area
Xenus cinereus Terek Sandpiper [59300]		Roosting known 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
Commonwealth Land -
Commonwealth Land - Christmas Island National Park
Defence - EXMOUTH VLF TRANSMITTER STATION
Defence - GERALDTON TRAINING DEPOT "A" Company 16th Battalion
Defence - GREENOUGH RIFLE RANGE
Defence - HMAS STIRLING-ROCKINGHAM ;HMAS STIRLING - GARDEN ISLAND
Defence - LANCELIN TRAINING AREA
Defence - LEARMONTH - AIR WEAPONS RANGE
Defence - YAMPI SOUND TRAINING AREA

Commonwealth Heritage Places [Resource Information]

Name	State	Status
Natural		
Ashmore Reef National Nature Reserve	EXT	Listed place
Christmas Island Natural Areas	EXT	Listed place
Garden Island	WA	Listed place
Lancelin Defence Training Area	WA	Listed place
Learmonth Air Weapons Range Facility	WA	Listed place
Mermaid Reef - Rowley Shoals	WA	Listed place
Ningaloo Marine Area - Commonwealth Waters	WA	Listed place
Scott Reef and Surrounds - Commonwealth Area	EXT	Listed place
Yampi Defence Area	WA	Listed place
Historic		
Administrators House Precinct	EXT	Listed place
Bungalow 702	EXT	Listed place
Cape Leeuwin Lighthouse	WA	Listed place
Cliff Point Historic Site	WA	Listed place
Drumsite Industrial Area	EXT	Listed place
Geraldton Drill Hall Complex	WA	Listed place
HMAS Sydney II and HSK Kormoran Shipwreck Sites	EXT	Listed place
Industrial and Administrative Group	EXT	Listed place
J Gun Battery	WA	Listed place
Malay Kampong Group	EXT	Listed place
Malay Kampong Precinct	EXT	Listed place
Phosphate Hill Historic Area	EXT	Listed place
Poon Saan Group	EXT	Listed place
Settlement Christmas Island	EXT	Listed place
South Point Settlement Remains	EXT	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		
Acrocephalus orientalis Oriental Reed-Warbler [59570]		Species or species habitat known to occur within area
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat known to occur within area
Anous minutus Black Noddy [824]		Breeding known to occur within area
Anous stolidus Common Noddy [825]		Breeding known to occur within area
Anous tenuirostris melanops Australian Lesser Noddy [26000]	Vulnerable	Breeding known to occur within area
Anseranas semipalmata Magpie Goose [978]		Species or species habitat may 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]		Breeding known to occur within area
Ardea ibis Cattle Egret [59542]		Species or species habitat may occur within area
Arenaria interpres Ruddy Turnstone [872]		Roosting known to occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Roosting known to occur within area
Calidris alba Sanderling [875]		Roosting 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 known to occur within area
Calidris ruficollis Red-necked Stint [860]		Roosting known to occur within area
Calidris subminuta Long-toed Stint [861]		Species or species habitat known to occur within area
Calidris tenuirostris Great Knot [862]	Critically Endangered	Roosting known to occur within area
Calonectris leucomelas Streaked Shearwater [1077]		Species or species habitat known to occur within area
Catharacta skua Great Skua [59472]		Species or species

Name	Threatened	Type of Presence
		habitat may occur within area
Cereopsis novaehollandiae grisea Cape Barren Goose (south-western), Recherche Cape Barren Goose [25978]	Vulnerable	Species or species habitat known to occur within area
Charadrius bicinctus Double-banded Plover [895]		Roosting known to occur within area
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Roosting known to occur within area
Charadrius mongolus Lesser Sand Plover, Mongolian Plover [879]	Endangered	Roosting known to occur within area
Charadrius ruficapillus Red-capped Plover [881]		Roosting known to occur within area
Charadrius veredus Oriental Plover, Oriental Dotterel [882]		Roosting known to occur within area
Chrysococcyx osculans Black-eared Cuckoo [705]		Species or species habitat known to occur within area
Diomedea amsterdamensis Amsterdam Albatross [64405]	Endangered	Species or species habitat likely to occur within area
Diomedea antipodensis Antipodean Albatross [64458]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea dabbenena Tristan Albatross [66471]	Endangered	Species or species habitat likely to occur within area
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Eudyptula minor Little Penguin [1085]		Breeding known to occur within area
Fregata andrewsi Christmas Island Frigatebird, Andrew's Frigatebird [1011]	Endangered	Breeding known to occur within area
Fregata ariel Lesser Frigatebird, Least Frigatebird [1012]		Breeding known to occur within area
Fregata minor Great Frigatebird, Greater Frigatebird [1013]		Breeding known to occur within area
Gallinago megala Swinhoe's Snipe [864]		Roosting likely to occur within area
Gallinago stenura Pin-tailed Snipe [841]		Roosting likely to occur within area
Glareola maldivarum Oriental Pratincole [840]		Roosting known to occur within area
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species

Name	Threatened	Type of Presence
		habitat known to occur within area
Halobaena caerulea Blue Petrel [1059]	Vulnerable	Species or species habitat may occur within area
Heteroscelus brevipes Grey-tailed Tattler [59311]		Roosting known to occur within area
Himantopus himantopus Pied Stilt, Black-winged Stilt [870]		Roosting known to occur within area
Hirundo daurica Red-rumped Swallow [59480]		Species or species habitat known to occur within area
Hirundo rustica Barn Swallow [662]		Species or species habitat known to occur within area
Larus dominicanus Kelp Gull [809]		Breeding known to occur within area
Larus novaehollandiae Silver Gull [810]		Breeding known to occur within area
Larus pacificus Pacific Gull [811]		Breeding known to occur within area
Limicola falcinellus Broad-billed Sandpiper [842]		Roosting known to occur within area
Limnodromus semipalmatus Asian Dowitcher [843]		Roosting known to occur within area
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat known to occur within area
Limosa limosa Black-tailed Godwit [845]		Roosting 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 known to occur within area
Motacilla flava Yellow Wagtail [644]		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
Numenius minutus Little Curlew, Little Whimbrel [848]		Roosting known to occur within area
Numenius phaeopus Whimbrel [849]		Roosting known to occur within area

Name	Threatened	Type of Presence
Pachyptila turtur Fairy Prion [1066]		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 known to occur within area
Pelagodroma marina White-faced Storm-Petrel [1016]		Breeding known to occur within area
Phaethon lepturus White-tailed Tropicbird [1014]		Breeding known to occur within area
Phaethon lepturus fulvus Christmas Island White-tailed Tropicbird, Golden Bosunbird [26021]	Endangered	Breeding likely to occur within area
Phaethon rubricauda Red-tailed Tropicbird [994]		Breeding known to occur within area
Phalacrocorax fuscescens Black-faced Cormorant [59660]		Breeding likely to occur within area
Phalaropus lobatus Red-necked Phalarope [838]		Roosting known to occur within area
Philomachus pugnax Ruff (Reeve) [850]		Roosting known to occur within area
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat likely to occur within area
Pluvialis fulva Pacific Golden Plover [25545]		Roosting known to occur within area
Pluvialis squatarola Grey Plover [865]		Roosting known to occur within area
Pterodroma macroptera Great-winged Petrel [1035]		Breeding known to occur within area
Pterodroma mollis Soft-plumaged Petrel [1036]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Puffinus assimilis Little Shearwater [59363]		Breeding known to occur within area
Puffinus carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [1043]		Breeding known to occur within area
Puffinus griseus Sooty Shearwater [1024]		Species or species habitat may occur within area
Puffinus huttoni Hutton's Shearwater [1025]		Foraging, feeding or related behaviour known to occur within area
Puffinus pacificus Wedge-tailed Shearwater [1027]		Breeding known to occur within area
Recurvirostra novaehollandiae Red-necked Avocet [871]		Roosting known to occur within area
Rhipidura rufifrons Rufous Fantail [592]		Species or species habitat known to occur

Name	Threatened	Type of Presence
		within area
Rostratula benghalensis (sensu lato) Painted Snipe [889]	Endangered*	Species or species habitat known to occur within area
Sterna albifrons Little Tern [813]		Breeding known to 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
Sterna nereis Fairy Tern [796]		Breeding known to occur within area
Stiltia isabella Australian Pratincole [818]		Roosting known to occur within area
Sula dactylatra Masked Booby [1021]		Breeding known to occur within area
Sula leucogaster Brown Booby [1022]		Breeding known to occur within area
Sula sula Red-footed Booby [1023]		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 Shy Albatross [89224]	Endangered	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
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 glareola Wood Sandpiper [829]		Roosting known to occur within area
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat known to occur within area

Name	Threatened	Type of Presence
Tringa stagnatilis Marsh Sandpiper, Little Greenshank [833]		Roosting known to occur within area
Tringa totanus Common Redshank, Redshank [835]		Roosting known to occur within area
Xenus cinereus Terek Sandpiper [59300]		Roosting known to occur within area
Fish		
Acentronura australe Southern Pygmy Pipehorse [66185]		Species or species habitat may occur within area
Acentronura larsonae Helen's Pygmy Pipehorse [66186]		Species or species habitat may occur within area
Bhanotia fasciolata Corrugated Pipefish, Barbed Pipefish [66188]		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 sculptus Sculptured Pipefish [66197]		Species or species habitat may occur within area
Choeroichthys suillus Pig-snouted Pipefish [66198]		Species or species habitat may occur within area
Corythoichthys amplexus Fijian Banded Pipefish, Brown-banded Pipefish [66199]		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
Corythoichthys haematopterus Reef-top Pipefish [66201]		Species or species habitat may occur within area
Corythoichthys intestinalis Australian Messmate Pipefish, Banded Pipefish [66202]		Species or species habitat may occur within area
Corythoichthys schultzi Schultz's Pipefish [66205]		Species or species habitat may occur within area
Cosmocampus banneri Roughridge Pipefish [66206]		Species or species habitat may occur within

Name	Threatened	Type of Presence
		area
Cosmocampus maxweberi Maxweber's Pipefish [66209]		Species or species habitat may occur within area
Doryrhamphus baldwini Redstripe Pipefish [66718]		Species or species habitat may occur within area
Doryrhamphus dactyliophorus Banded Pipefish, Ringed Pipefish [66210]		Species or species habitat may occur within area
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 dunckeri Red-hair Pipefish, Duncker's Pipefish [66220]		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 macrorhynchus Whiskered Pipefish, Ornate Pipefish [66222]		Species or species habitat may occur within area
Halicampus mataafae Samoan Pipefish [66223]		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
Heraldia nocturna Upside-down Pipefish, Eastern Upside-down Pipefish, Eastern Upside-down Pipefish [66227]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
Hippichthys cyanospilos Blue-speckled Pipefish, Blue-spotted Pipefish [66228]		Species or species habitat may occur within area
Hippichthys heptagonus Madura Pipefish, Reticulated Freshwater Pipefish [66229]		Species or species habitat may occur within area
Hippichthys penicillus Beady Pipefish, Steep-nosed Pipefish [66231]		Species or species habitat may occur within area
Hippichthys spicifer Belly-barred Pipefish, Banded Freshwater Pipefish [66232]		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 breviceps Short-head Seahorse, Short-snouted Seahorse [66235]		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 subelongatus West Australian Seahorse [66722]		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
Histiogamphelus cristatus Rhino Pipefish, Macleay's Crested Pipefish, Ring-back Pipefish [66243]		Species or species habitat may occur within area
Leptoichthys fistularius Brushtail Pipefish [66248]		Species or species habitat may occur within area
Lissocampus caudalis Australian Smooth Pipefish, Smooth Pipefish [66249]		Species or species habitat may occur within area
Lissocampus fatiloquus Prophet's Pipefish [66250]		Species or species habitat may occur within area
Lissocampus runa Javelin Pipefish [66251]		Species or species habitat may occur within area
Maroubra perserrata Sawtooth Pipefish [66252]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
Micrognathus brevirostris thorntail Pipefish, Thorn-tailed Pipefish [66254]		Species or species habitat may occur within area
Micrognathus micronotopterus Tidepool Pipefish [66255]		Species or species habitat may occur within area
Mitotichthys meraculus Western Crested Pipefish [66259]		Species or species habitat may occur within area
Nannocampus subosseus Bonyhead Pipefish, Bony-headed Pipefish [66264]		Species or species habitat may occur within area
Notiocampus ruber Red Pipefish [66265]		Species or species habitat may occur within area
Phoxocampus belcheri Black Rock Pipefish [66719]		Species or species habitat may occur within area
Phycodurus eques Leafy Seadragon [66267]		Species or species habitat may occur within area
Phyllopteryx taeniolatus Common Seadragon, Weedy Seadragon [66268]		Species or species habitat may occur within area
Pugnaso curtirostris Pugnose Pipefish, Pug-nosed Pipefish [66269]		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
Stigmatopora nigra Widebody Pipefish, Wide-bodied Pipefish, Black Pipefish [66277]		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
Urocampus carinirostris Hairy Pipefish [66282]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
Vanacampus margaritifer Mother-of-pearl Pipefish [66283]		Species or species habitat may occur within area
Vanacampus phillipi Port Phillip Pipefish [66284]		Species or species habitat may occur within area
Vanacampus poecilolaemus Longsnout Pipefish, Australian Long-snout Pipefish, Long-snouted Pipefish [66285]		Species or species habitat may occur within area
Mammals		
Arctocephalus forsteri Long-nosed Fur-seal, New Zealand Fur-seal [20]		Breeding known to occur within area
Dugong dugon Dugong [28]		Breeding known to occur within area
Neophoca cinerea Australian Sea-lion, Australian Sea Lion [22]	Vulnerable	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 foliosquama Leaf-scaled Seasnake [1118]	Critically Endangered	Species or species habitat known to occur within area
Aipysurus fuscus Dusky Seasnake [1119]		Species or species habitat known to 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
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
Crocodylus johnstoni Freshwater Crocodile, Johnston's Crocodile, Johnston's River Crocodile [1773]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
Crocodylus porosus Salt-water Crocodile, Estuarine Crocodile [1774]		Species or species habitat likely 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
Enhydrina schistosa Beaked Seasnake [1126]		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 atriceps Black-headed Seasnake [1101]		Species or species habitat may occur within area
Hydrophis coggeri Slender-necked Seasnake [25925]		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 inornatus Plain Seasnake [1107]		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
Lapemis hardwickii Spine-bellied Seasnake [1113]		Species or species habitat may occur within area
Lepidochelys olivacea Olive Ridley Turtle, Pacific Ridley Turtle [1767]	Endangered	Foraging, feeding or related behaviour known to occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Breeding known to occur

Name	Threatened	Type of Presence
		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 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	Foraging, feeding or related behaviour known to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Berardius arnuxii Arnoux's Beaked Whale [70]		Species or species habitat may occur within area
Caperea marginata Pygmy Right Whale [39]		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	Breeding known 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
Globicephala melas Long-finned Pilot Whale [59282]		Species or species habitat may occur within area
Grampus griseus Risso's Dolphin, Grampus [64]		Species or species habitat may occur within area
Hyperoodon planifrons Southern Bottlenose Whale [71]		Species or species habitat may occur within area
Indopacetus pacificus Longman's Beaked Whale [72]		Species or species habitat may occur within area

Name	Status	Type of Presence
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
Lagenorhynchus obscurus Dusky Dolphin [43]		Species or species habitat likely to occur within area
Lissodelphis peronii Southern Right Whale Dolphin [44]		Species or species habitat may occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Breeding known to occur within area
Mesoplodon bowdoini Andrew's Beaked Whale [73]		Species or species habitat may 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
Mesoplodon grayi Gray's Beaked Whale, Scamperdown Whale [75]		Species or species habitat may occur within area
Mesoplodon hectori Hector's Beaked Whale [76]		Species or species habitat may occur within area
Mesoplodon layardii Strap-toothed Beaked Whale, Strap-toothed Whale, Layard's Beaked Whale [25556]		Species or species habitat may occur within area
Mesoplodon mirus True's Beaked Whale [54]		Species or species habitat may occur within area
Orcaella brevirostris Irrawaddy Dolphin [45]		Species or species habitat known to 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 habitat may occur within area
Physeter macrocephalus Sperm Whale [59]		Foraging, feeding or related behaviour known to 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]		Breeding known to occur

Name	Status	Type of Presence
		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
[Tasmacetus shepherdi](#) Shepherd's Beaked Whale, Tasman Beaked Whale [55]		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

Commonwealth ReservesTerrestrial [Resource Information]

Name	State	Type
Christmas Island	EXT	National Park (Commonwealth)

Australian Marine Parks [Resource Information]

Name	Label
Abrolhos	Habitat Protection Zone (IUCN IV)
Abrolhos	Multiple Use Zone (IUCN VI)
Abrolhos	National Park Zone (IUCN II)
Abrolhos	Special Purpose Zone (IUCN VI)
Argo-Rowley Terrace	Multiple Use Zone (IUCN VI)
Argo-Rowley Terrace	National Park Zone (IUCN II)
Argo-Rowley Terrace	Special Purpose Zone (Trawl) (IUCN VI)
Ashmore Reef	Recreational Use Zone (IUCN IV)
Ashmore Reef	Sanctuary Zone (IUCN Ia)
Bremer	National Park Zone (IUCN II)
Bremer	Special Purpose Zone (Mining
Carnarvon Canyon	Habitat Protection Zone (IUCN IV)
Cartier Island	Sanctuary Zone (IUCN Ia)
Dampier	Habitat Protection Zone (IUCN IV)
Dampier	Multiple Use Zone (IUCN VI)
Dampier	National Park Zone (IUCN II)
Eighty Mile Beach	Multiple Use Zone (IUCN VI)
Gascoyne	Habitat Protection Zone (IUCN IV)
Gascoyne	Multiple Use Zone (IUCN VI)
Gascoyne	National Park Zone (IUCN II)
Geographe	Habitat Protection Zone (IUCN IV)
Geographe	Multiple Use Zone (IUCN VI)
Geographe	Special Purpose Zone (Mining
Jurien	National Park Zone (IUCN II)

Name	Label
Jurien	Special Purpose Zone (IUCN VI)
Kimberley	Habitat Protection Zone (IUCN IV)
Kimberley	Multiple Use Zone (IUCN VI)
Kimberley	National Park Zone (IUCN II)
Mermaid Reef	National Park Zone (IUCN II)
Montebello	Multiple Use Zone (IUCN VI)
Ningaloo	National Park Zone (IUCN II)
Ningaloo	Recreational Use Zone (IUCN IV)
Oceanic Shoals	Multiple Use Zone (IUCN VI)
Perth Canyon	Habitat Protection Zone (IUCN IV)
Perth Canyon	Multiple Use Zone (IUCN VI)
Perth Canyon	National Park Zone (IUCN II)
Roebuck	Multiple Use Zone (IUCN VI)
Shark Bay	Multiple Use Zone (IUCN VI)
South-west Corner	Habitat Protection Zone (IUCN IV)
South-west Corner	Multiple Use Zone (IUCN VI)
South-west Corner	National Park Zone (IUCN II)
South-west Corner	Special Purpose Zone (IUCN VI)
South-west Corner	Special Purpose Zone (Mining
Two Rocks	Multiple Use Zone (IUCN VI)
Two Rocks	National Park Zone (IUCN II)

Extra Information

State and Territory Reserves [Resource Information]

Name	State
Adele Island	WA
Airlie Island	WA
Arpenteur	WA
Bald Island	WA
Bardi Jawi	WA
Barrow Island	WA
Bedout Island	WA
Beekeepers	WA
Bernier And Dorre Islands	WA
Bessieres Island	WA
Boodie, Double Middle Islands	WA
Boullanger, Whitlock, Favourite, Tern And Osprey Islands	WA
Breaksea Island	WA
Browse Island	WA
Burnside And Simpson Island	WA
Cape Range	WA
Carnac Island	WA
Chatham Island	WA
Coulomb Point	WA
D'Entrecasteaux	WA
Dambimangari	WA
Dambimangari	WA
Dirk Hartog Island	WA
Doubtful Islands	WA
Eclipse Island	WA
Escape Island	WA
Fitzgerald River	WA
Flinders Bay	WA
Freycinet, Double Islands etc	WA
Glasse Island	WA
Gnandaroo Island	WA
Hamelin Island	WA
Jarrkunpungu	WA
Jinmarnkur	WA
Jinmarnkur Kulja	WA
Jurabi Coastal Park	WA
Kalbarri	WA
Karajarri	WA
Koks Island	WA
Kujungurru Warrarn	WA

Name	State
Lacepede Islands	WA
Lancelin And Edwards Islands	WA
Leeuwin-Naturaliste	WA
Lesueur	WA
Little Rocky Island	WA
Locker Island	WA
Low Rocks	WA
Lowendal Islands	WA
Michaelmas Island	WA
Montebello Islands	WA
Mount Manypeaks	WA
Muiron Islands	WA
Murujuga	WA
NTWA Bushland covenant (0005)	WA
NTWA Bushland covenant (0013)	WA
NTWA Bushland covenant (0090)	WA
Nambung	WA
Nilgen	WA
North Sandy Island	WA
North Turtle Island	WA
Nyangumarta Warrarn	WA
One Tree Point	WA
Prince Regent	WA
Quagering	WA
Quarram	WA
Rottnest Island	WA
Round Island	WA
Scott	WA
Seal Island (WA25645)	WA
Seal Island (WA32199)	WA
Serrurier Island	WA
Southern Beekeepers	WA
St Alouarn Island	WA
Sugar Loaf Rock	WA
Swan Island	WA
Tamala Pastoral Lease (Part)	WA
Tanner Island	WA
Tent Island	WA
Torndirrup	WA
Two Peoples Bay	WA
Unnamed WA11883	WA
Unnamed WA11962	WA
Unnamed WA15185	WA
Unnamed WA26400	WA
Unnamed WA28968	WA
Unnamed WA32478	WA
Unnamed WA33799	WA
Unnamed WA34039	WA
Unnamed WA36907	WA
Unnamed WA36909	WA
Unnamed WA36910	WA
Unnamed WA36913	WA
Unnamed WA36915	WA
Unnamed WA37168	WA
Unnamed WA37338	WA
Unnamed WA37383	WA
Unnamed WA37500	WA
Unnamed WA40322	WA
Unnamed WA40828	WA
Unnamed WA40877	WA
Unnamed WA41080	WA
Unnamed WA41775	WA
Unnamed WA42030	WA
Unnamed WA44665	WA
Unnamed WA44667	WA
Unnamed WA44669	WA

Name	State
Unnamed WA44672	WA
Unnamed WA44673	WA
Unnamed WA44676	WA
Unnamed WA44682	WA
Unnamed WA44685	WA
Unnamed WA44688	WA
Unnamed WA44690	WA
Unnamed WA44709	WA
Unnamed WA46982	WA
Unnamed WA46983	WA
Unnamed WA46984	WA
Unnamed WA48205	WA
Unnamed WA48858	WA
Unnamed WA48968	WA
Unnamed WA49994	WA
Unnamed WA51105	WA
Unnamed WA51162	WA
Unnamed WA51617	WA
Unnamed WA51932	WA
Unnamed WA53015	WA
Utcha Well	WA
Uunguu	WA
Victor Island	WA
Walpole-Nornalup	WA
Wanagarren	WA
Waychinicup	WA
Wedge Island	WA
Weld Island	WA
West Cape Howe	WA
Y Island	WA
Yalgorup	WA
Yampi	WA
Yawuru	WA
Zuytdorp	WA

Regional Forest Agreements [Resource Information]

Note that all areas with completed RFAs have been included.

Name	State
South West WA RFA	Western Australia

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		
Acridotheres tristis		
Common Myna, Indian Myna [387]		Species or species habitat likely to occur within area
Anas platyrhynchos		
Mallard [974]		Species or species habitat likely to occur within area
Carduelis carduelis		
European Goldfinch [403]		Species or species habitat likely to occur within area
Columba livia		
Rock Pigeon, Rock Dove, Domestic Pigeon [803]		Species or species habitat likely to occur within area
Gallus gallus		
Red Junglefowl, Feral Chicken, Domestic Fowl [917]		Species or species habitat likely to occur within area

Name	Status	Type of Presence
Lonchura oryzivora Java Sparrow [59586]		Species or species habitat likely to occur within area
Meleagris gallopavo Wild Turkey [64380]		Species or species habitat likely to occur within area
Passer domesticus House Sparrow [405]		Species or species habitat likely to occur within area
Passer montanus Eurasian Tree Sparrow [406]		Species or species habitat likely to occur within area
Pavo cristatus Indian Peafowl, Peacock [919]		Species or species habitat likely to occur within area
Phasianus colchicus Common Pheasant [920]		Species or species habitat likely to occur within area
Streptopelia chinensis Spotted Turtle-Dove [780]		Species or species habitat likely to occur within area
Streptopelia senegalensis Laughing Turtle-dove, Laughing Dove [781]		Species or species habitat likely to occur within area
Sturnus vulgaris Common Starling [389]		Species or species habitat likely to occur within area
Turdus merula Common Blackbird, Eurasian Blackbird [596]		Species or species habitat likely to occur within area
Frogs		
Rhinella marina Cane Toad [83218]		Species or species habitat likely to occur within area
Mammals		
Bos taurus Domestic Cattle [16]		Species or species habitat likely to occur within area
Camelus dromedarius Dromedary, Camel [7]		Species or species habitat likely to occur within area
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 asinus Donkey, Ass [4]		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

Name	Status	Type of Presence
		within area
Feral deer		
Feral deer species in Australia [85733]		Species or species habitat likely to occur within area
Funambulus pennantii		
Northern Palm Squirrel, Five-striped Palm Squirrel [129]		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 exulans		
Pacific Rat, Polynesian Rat [79]		Species or species habitat likely to occur within area
Rattus norvegicus		
Brown Rat, Norway Rat [83]		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
Sus scrofa		
Pig [6]		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		
Andropogon gayanus		
Gamba Grass [66895]		Species or species habitat likely to occur within area
Asparagus aethiopicus		
Asparagus Fern, Ground Asparagus, Basket Fern, Sprengi's Fern, Bushy Asparagus, Emerald Asparagus [62425]		Species or species habitat likely to occur within area
Asparagus asparagoides		
Bridal Creeper, Bridal Veil Creeper, Smilax, Florist's Smilax, Smilax Asparagus [22473]		Species or species habitat likely to occur within area
Asparagus declinatus		
Bridal Veil, Bridal Veil Creeper, Pale Berry Asparagus Fern, Asparagus Fern, South African Creeper [66908]		Species or species habitat likely to occur within area
Asparagus scandens		
Asparagus Fern, Climbing Asparagus Fern [23255]		Species or species habitat likely to occur within area
Brachiaria mutica		
Para Grass [5879]		Species or species habitat may occur within area
Cenchrus ciliaris		
Buffel-grass, Black Buffel-grass [20213]		Species or species habitat likely to occur within area
Chrysanthemoides monilifera		
Bitou Bush, Boneseed [18983]		Species or species habitat may occur within area
Chrysanthemoides monilifera subsp. monilifera		
Boneseed [16905]		Species or species habitat likely to occur

Name	Status	Type of Presence
		within area
Cryptostegia grandiflora		
Rubber Vine, Rubbervine, India Rubber Vine, India Rubbervine, Palay Rubbervine, Purple Allamanda [18913]		Species or species habitat likely to occur within area
Cylindropuntia spp.		
Prickly Pears [85131]		Species or species habitat likely to occur within area
Dolichandra unguis-cati		
Cat's Claw Vine, Yellow Trumpet Vine, Cat's Claw Creeper, Funnel Creeper [85119]		Species or species habitat likely to occur within area
Genista linifolia		
Flax-leaved Broom, Mediterranean Broom, Flax Broom [2800]		Species or species habitat likely to occur within area
Genista monspessulana		
Montpellier Broom, Cape Broom, Canary Broom, Common Broom, French Broom, Soft Broom [20126]		Species or species habitat likely to occur within area
Genista sp. X Genista monspessulana		
Broom [67538]		Species or species habitat may 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
Lantana camara		
Lantana, Common Lantana, Kamara Lantana, Large-leaf Lantana, Pink Flowered Lantana, Red Flowered Lantana, Red-Flowered Sage, White Sage, Wild Sage [10892]		Species or species habitat likely to occur within area
Lycium ferocissimum		
African Boxthorn, Boxthorn [19235]		Species or species habitat likely to occur within area
Olea europaea		
Olive, Common Olive [9160]		Species or species habitat may occur within area
Opuntia spp.		
Prickly Pears [82753]		Species or species habitat likely to occur within area
Parkinsonia aculeata		
Parkinsonia, Jerusalem Thorn, Jelly Bean Tree, Horse Bean [12301]		Species or species habitat likely to occur within area
Pinus radiata		
Radiata Pine Monterey Pine, Insignis Pine, Wilding Pine [20780]		Species or species habitat may occur within area
Prosopis spp.		
Mesquite, Algaroba [68407]		Species or species habitat likely to occur within area
Rubus fruticosus aggregate		
Blackberry, European Blackberry [68406]		Species or species habitat likely to occur within area
Salix spp. except S.babylonica, S.x calodendron & S.x reichardtii		
Willows except Weeping Willow, Pussy Willow and Sterile Pussy Willow [68497]		Species or species habitat likely to occur within area
Salvinia molesta		
Salvinia, Giant Salvinia, Aquarium Watermoss, Kariba Weed [13665]		Species or species habitat likely to occur within area
Tamarix aphylla		
Athel Pine, Athel Tree, Tamarisk, Athel Tamarisk, Athel Tamarix, Desert Tamarisk, Flowering		Species or species habitat likely to occur

Name	Status	Type of Presence
Cypress, Salt Cedar [16018]		within area
Ulex europaeus		
Gorse, Furze [7693]		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
Lycodon aulicus		
Wolf Snake, Common Wolf Snake, Asian Wolf Snake [83178]		Species or species habitat likely to occur within area
Lygosoma bowringii		
Christmas Island Grass-skink [1312]		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
"The Dales", Christmas Island	EXT
Ashmore Reef	EXT
Cape Leeuwin System	WA
Cape Range Subterranean Waterways	WA
Doggerup Creek System	WA
Eighty Mile Beach System	WA
Exmouth Gulf East	WA
Hosine's Spring, Christmas Island	EXT
Hutt Lagoon System	WA
Lake MacLeod	WA
Lake Thetis	WA
Learmonth Air Weapons Range - Saline Coastal Flats	WA
Leslie (Port Hedland) Saltfields System	WA
Mermaid Reef	EXT
Prince Regent River System	WA
Roebuck Bay	WA
Rottnest Island Lakes	WA
Shark Bay East	WA
Yalgorup Lakes System	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
Ashmore Reef and Cartier Island and surrounding	North-west
Canyons linking the Argo Abyssal Plain with the	North-west
Canyons linking the Cuvier Abyssal Plain and the	North-west
Carbonate bank and terrace system of the Sahul	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
Mermaid Reef and Commonwealth waters	North-west
Pinnacles of the Bonaparte Basin	North-west
Seringapatam Reef and Commonwealth waters in	North-west
Wallaby Saddle	North-west
Albany Canyons group and adjacent shelf break	South-west
Ancient coastline at 90-120m depth	South-west
Cape Mentelle upwelling	South-west
Commonwealth marine environment surrounding	South-west

Name	Region
Commonwealth marine environment within and	South-west
Commonwealth marine environment within and	South-west
Diamantina Fracture Zone	South-west
Naturaliste Plateau	South-west
Perth Canyon and adjacent shelf break, and other	South-west
Western demersal slope and associated fish	South-west
Western rock lobster	South-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

-9.178 123.297452,-9.727655 123.186807,-10.039286 121.994911,-9.610169 121.577399,-9.773757 121.205608,-9.285968 119.959365,-9.369249 119.171169,-9.547708 118.915377,-9.726168 119.093836,-9.828816 119.685285,-10.463801 120.250849,-9.758885 121.63986,-10.660106 121.526835,-10.612517 121.916472,-10.115162 122.152333,-10.371597 123.091331,-10.788002 122.799847,-10.90995 122.835539,-10.921847 123.106202,-10.461818 123.784349,-10.366639 126.663497,-13.579298 128.763491,-14.253489 128.287479,-13.700264 127.326771,-13.774622 126.737855,-14.479538 125.217974,-15.169581 125.051412,-15.496699 124.4434,-15.829882 124.414906,-16.12434 124.602289,-16.341466 124.209677,-16.1063 123.6265,-16.650796 123.549377,-16.900639 123.86763,-17.14156 123.828964,-17.028535 123.585069,-17.195098 123.644555,-17.563914 123.567223,-16.668642 123.016973,-16.389055 122.990204,-16.549669 122.793898,-16.769769 122.820667,-16.915511 122.481594,-17.153454 122.277908,-17.47171 122.148469,-17.983294 122.202007,-17.986268 122.371544,-18.117139 122.362621,-18.44134 121.952164,-18.453238 121.818319,-18.944002 121.589296,-19.34851 121.33053,-19.610251 121.024174,-19.858977 120.337626,-19.96717 119.780906,-20.071271 119.596497,-19.96717 119.129528,-20.283799 118.7463,-20.350858 118.171795,-20.669111 117.764312,-20.743469 117.410368,-20.701828 117.208113,-20.615573 117.160524,-20.734546 116.901758,-20.669111 116.791708,-20.410344 116.880938,-20.710751 116.663812,-20.871365 116.312841,-20.850545 116.205765,-20.963569 116.170074,-21.079568 115.902384,-21.237207 115.825052,-21.879662 114.635321,-22.10571 114.516348,-22.138152 114.085576,-21.812128 114.189649,-21.793406 114.09102,-21.942122 113.954201,-22.278221 113.835227,-22.560782 113.659742,-23.024777 113.835227,-23.494721 113.772767,-23.628565 113.609179,-24.223431 113.400976,-24.4703 113.40395,-24.752861 113.629999,-25.032447 113.67164,-25.701671 113.326618,-26.614789 113.7341,-26.654997 113.678699,-26.144845 113.433693,-26.141871 113.151132,-26.421458 113.317695,-26.647507 113.567538,-27.054989 113.856048,-27.513035 114.105891,-28.067424 114.163805,-28.497537 114.519322,-29.131069 114.837575,-29.574244 114.968446,-30.567669 115.090393,-31.739553 115.726899,-32.887643 115.628746,-33.655019 115.209366,-33.530097 115.004138,-33.964349 114.974394,-34.26773 115.042804,-34.35696 115.161777,-34.270705 115.140957,-34.306397 115.212341,-34.333166 115.393774,-34.526497 115.717976,-35.011312 116.283098,-35.088644 117.921952,-34.383729 119.471576,-34.258807 119.528088,-34.276653 119.724393,-34.530152 119.736291,-35.393778 118.181763,-35.946499 116.558145,-35.946499 114.174535,-35.048328 110.478213,-26.515697 101.220136,-20.228495 100.943775,-14.976211 104.641889,-9.532837 101.579516,-7.998084 106.619215,-8.309853 111.745828,-8.771169 114.570899,-8.438285 114.816755,-8.521566 114.998189,-8.694077 115.126085,-8.827921 115.584131,-8.408541 115.706079,-8.004033 115.759617,-7.99511 115.991614,-8.753563 116.065972,-8.747615 115.839923,-8.783306 115.822077,-8.875511 115.985665,-9.110482 117.053448,-8.884434 118.439484,-8.741666 119.12358,-8.509668 119.349628,-8.804127 119.858238,-9.178 123.297452

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-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

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Please feel free to provide feedback via the Contact Us page.

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Appendix B: MNES Register

Santos

Table B-1: MNES Review Register

Taxon	2019 Version (Rev6 19/03/2020)	2020 Review (Rev 7 30/11/2020)	Reason for Change	Sections Updated within this Document
Threatened Species				
Birds	Not listed	Addition of Grey Falcon (*Falco hypoleucos*) listed as Vulnerable species	Was newly listed as Vulnerable under EPBC Act 9 July 2020	No change required as species is not expected to occur in significant numbers in marine and coastal environments in the EMBA due to their terrestrial distribution
Birds	Shy Albatross (*Thalassarche cauta cauta*)	Shy Albatross (*Thalassarche cauta*)	Upgraded from subspecies to species	Table 8-1, Section 8.2
Birds	White-capped Albatross (*Thalassarche cauta steadi*)	White-capped Albatross (*Thalassarche steadi*)	Upgraded from subspecies to species	Table 8-1, Section 8.2
Birds	Shy Albatross (Thalassarche cauta) listed as Vulnerable	Shy Albatross (*Thalassarche cauta*) now listed as Endangered	Upgraded to Endangered under EPBC Act 3 July 2020	Table 8-1, Section 8.2
Birds	Conservation advice for Christmas Island Frigatebird (2016)	Updated conservation advice for Christmas Island Frigatebird (2020)	New published conservation advice	Section 8.2, Table 8.6, Table 13.1
Birds	Conservation advice for Australasian Bittern (2011)	Updated conservation advice for Australasian Bittern (2019)	New published conservation advice	Section 8.2, Table 8.6, Table 13.1
Birds	Conservation advice for Abbott's Booby (2015)	Updated conservation advice for Abbott's Booby (2020)	New published conservation advice	Section 8.2, Table 8.6, Table 13.1
Birds	No conservation advice for Shy Albatross	New conservation advice for Shy Albatross (2020)	New published conservation advice	Section 8.2, Table 8.6, Table 13.1
Plants	*Darwinia oxylepis*	Not listed	Species or species habitat considered not to occur within area	No change required as it is a plant species not expected to occur in marine and coastal environments in the EMBA due to their terrestrial distribution
Plants	*Darwinia wittwerorum*	Not listed	Species or species habitat considered not to occur within area	No change required as it is a plant species not expected to occur in marine and coastal environments in the EMBA due to their terrestrial distribution

Taxon	2019 Version (Rev6 19/03/2020)	2020 Review (Rev 7 30/11/2020)	Reason for Change	Sections Updated within this Document
Plants	*Daviesia obovata*	Not listed	Species or species habitat considered not to occur within area	No change required as it is a plant species not expected to occur in marine and coastal environments in the EMBA due to their terrestrial distribution
Plants	*Keraudrenia exastia*	*Seringia exastia*	Genus name change	No change required as it is a plant species not expected to occur in marine and coastal environments in the EMBA due to their terrestrial distribution
Plants	*Lepidosperma rostratum*	Not listed	Species or species habitat considered not to occur within area	No change required as it is a plant species not expected to occur in marine and coastal environments in the EMBA due to their terrestrial distribution
Migratory Species				
Sharks	Not listed	Addition of oceanic whitetip shark (*Carcharhinus longimanus*) listed as Migratory Marine species	Amendment to list of migratory species under EPBC Act 21 October 2020	Table 5-5-1, Section 5.3, Section 5.3.9
Other Specially Protected Species under WA *Biodiversity Conservation Act 2016*				
Birds	Greater sand plover (*Charadrius leschenaultii*) listed as specially protected under BC Act 2016	Greater sand plover (*Charadrius leschenaultii*) listed as Vulnerable under BC Act 2016	Listing upgraded to be consistent with EPBC Act listing	Table 8-1
National Reserves				
Coastal National Park	Not included	Addition of Houtman Abrolhos Islands National Park	Houtman Abrolhos Islands National Park was created in July 2019	Table 9-2
Biologically Important Areas (BIAs)				
Various	National Conservation Values Atlas	Spatial data layers were last updated in 2016	No change	No change
Threatened Ecological COmmunities				
TEC	Lake Clifton included in Wetlands of National Importance and Ramsar wetland but the associated TEC was not listed	Addition of Thrombolite (microbialite) Community of a Coastal Brackish Lake (Lake Clifton)	This TEC is associated with the wetland system listed as a Nationally Important Wetland and Ramsar wetland and may be	Section 9.7.4

Taxon	2019 Version (Rev6 19/03/2020)	2020 Review (Rev 7 30/11/2020)	Reason for Change	Sections Updated within this Document
			influence from inflows from a potential hydrocarbon spill	

Appendix D: EPBC PMST Reports

Australian Government

Department of Agriculture, Water and the Environment

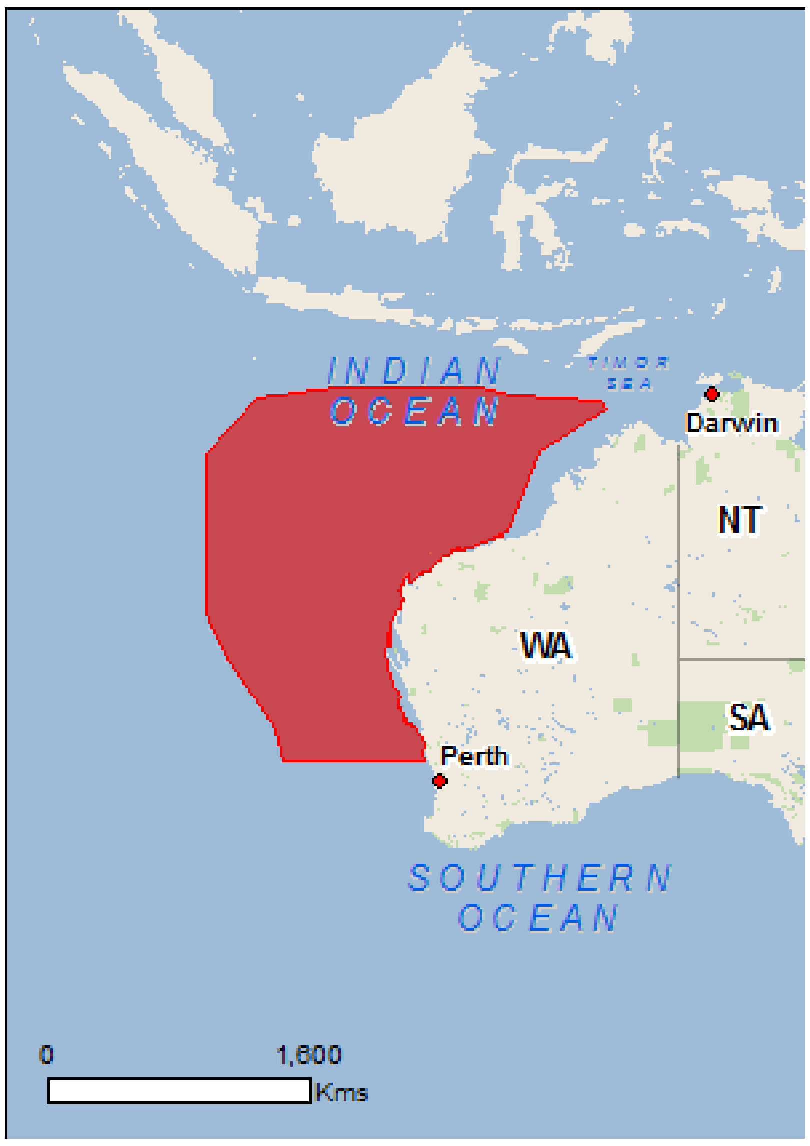
EPBC Act Protected Matters Report

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.

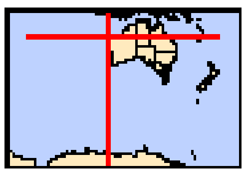
Information is available about Environment Assessments and the EPBC Act including significance guidelines, forms and application process details.

Report created: 30/09/21 13:29:53



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:	2
National Heritage Places:	5
Wetlands of International Importance:	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	2
Listed Threatened Ecological Communities:	2
Listed Threatened Species:	78
Listed Migratory Species:	79

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:	4
Commonwealth Heritage Places:	5
Listed Marine Species:	157
Whales and Other Cetaceans:	40
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	24

Extra Information

This part of the report provides information that may also be relevant to the area you have nominated.

State and Territory Reserves:	33
Regional Forest Agreements:	None
Invasive Species:	28
Nationally Important Wetlands:	3
Key Ecological Features (Marine)	17

Details

Matters of National Environmental Significance

World Heritage Properties [Resource Information]

Name	State	Status
Shark Bay, Western Australia	WA	Declared property
The Ningaloo Coast	WA	Declared property

National Heritage Properties [Resource Information]

Name	State	Status
Natural		
Shark Bay, Western Australia	WA	Listed place
The Ningaloo Coast	WA	Listed place
Indigenous		
Dampier Archipelago (including Burrup Peninsula)	WA	Listed place
Historic		
Dirk Hartog Landing Site 1616 - Cape Inscription Area	WA	Listed place
HMAS Sydney II and HSK Kormoran Shipwreck Sites	EXT	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
Extended Continental Shelf

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
South-west

Listed Threatened Ecological Communities [Resource Information]

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.

Name	Status	Type of Presence
Banksia Woodlands of the Swan Coastal Plain ecological community	Endangered	Community may occur within area
Tuart (Eucalyptus gomphocephala) Woodlands and Forests of the Swan Coastal Plain ecological community	Critically Endangered	Community may occur within area

Listed Threatened Species [Resource Information]

Name	Status	Type of Presence
Birds		
Anous tenuirostris melanops		
Australian Lesser Noddy [26000]	Vulnerable	Breeding 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

Name	Status	Type of Presence
		habitat known to occur within area
Calyptorhynchus latirostris Carnaby's Cockatoo, Short-billed Black-Cockatoo [59523]	Endangered	Species or species habitat likely to occur within area
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Species or species habitat known to occur within area
Diomedea amsterdamensis Amsterdam Albatross [64405]	Endangered	Species or species habitat likely to occur within area
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Falco hypoleucos Grey Falcon [929]	Vulnerable	Species or species habitat known to occur within area
Fregata andrewsi Christmas Island Frigatebird, Andrew's Frigatebird [1011]	Endangered	Foraging, feeding or related behaviour known to occur within area
Halobaena caerulea Blue Petrel [1059]	Vulnerable	Species or species habitat may occur within area
Leipoa ocellata Malleefowl [934]	Vulnerable	Species or species habitat likely to occur within area
Limosa lapponica menzbieri Northern Siberian Bar-tailed Godwit, Russkoye Bar-tailed Godwit [86432]	Critically Endangered	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
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 within area
Malurus leucopterus leucopterus White-winged Fairy-wren (Dirk Hartog Island), Dirk Hartog Black-and-White Fairy-wren [26004]	Vulnerable	Species or species habitat likely to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area
Pachyptila turtur subantarctica Fairy Prion (southern) [64445]	Vulnerable	Species or species habitat may occur within area
Papasula abbotti Abbott's Booby [59297]	Endangered	Species or species habitat may occur within

Name	Status	Type of Presence
		area
Pezoporus occidentalis Night Parrot [59350]	Endangered	Species or species habitat may occur within area
Phaethon lepturus fulvus Christmas Island White-tailed Tropicbird, Golden Bosunbird [26021]	Endangered	Species or species habitat may occur within area
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat may occur within area
Pterodroma mollis Soft-plumaged Petrel [1036]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Rostratula australis Australian Painted Snipe [77037]	Endangered	Species or species habitat likely to 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 Shy Albatross [89224]	Endangered	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
Turnix varius scintillans Painted Button-quail (Houtman Abrolhos) [82451]	Vulnerable	Species or species habitat likely to 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	Foraging, feeding or related behaviour 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

Name	Status	Type of Presence
		within area
Bettongia lesueur lesueur Burrowing Bettong (Shark Bay), Boodie [66659]	Vulnerable	Species or species habitat likely to occur within area
Bettongia penicillata ogilbyi Woylie [66844]	Endangered	Species or species habitat likely to occur within area
Dasyurus geoffroii Chuditch, Western Quoll [330]	Vulnerable	Species or species habitat likely 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
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
Lagorchestes hirsutus dorreae Rufous Hare-wallaby (Dorre Island) [66663]	Vulnerable	Species or species habitat known to occur within area
Lagostrophus fasciatus fasciatus Banded Hare-wallaby, Merrnine, Marnine, Munning [66664]	Vulnerable	Species or species habitat known to occur within area
Macroderma gigas Ghost Bat [174]	Vulnerable	Species or species habitat likely to occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Breeding known to occur within area
Neophoca cinerea Australian Sea-lion, Australian Sea Lion [22]	Endangered	Breeding 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
Parantechinus apicalis Dibbler [313]	Endangered	Species or species habitat may occur within area
Perameles bougainville bougainville Western Barred Bandicoot (Shark Bay) [66631]	Endangered	Species or species habitat known 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
Other		

Name	Status	Type of Presence
Kumonga exleyi Cape Range Remipede [86875]	Vulnerable	Species or species habitat likely to occur within area
Plants		
Andersonia gracilis Slender Andersonia [14470]	Endangered	Species or species habitat may occur within area
Hemiandra gardneri Red Snakebush [7945]	Endangered	Species or species habitat likely to occur within area
Reptiles		
Aipysurus apraefrontalis Short-nosed Seasnake [1115]	Critically Endangered	Species or species habitat known to occur within area
Aipysurus foliosquama Leaf-scaled Seasnake [1118]	Critically Endangered	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 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
Egernia stokesii badia Western Spiny-tailed Skink, Baudin Island Spiny-tailed Skink [64483]	Endangered	Species or species habitat likely to occur within area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Breeding known to occur within area
Lepidochelys olivacea Olive Ridley Turtle, Pacific Ridley Turtle [1767]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Liasis olivaceus barroni Olive Python (Pilbara subspecies) [66699]	Vulnerable	Species or species habitat likely to occur 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	Foraging, feeding or related behaviour known to occur within area
Glyphis garricki Northern River Shark, New Guinea River Shark [82454]	Endangered	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

Name	Status	Type of Presence
Pristis pristis		
Freshwater Sawfish, Largetooth Sawfish, River Sawfish, Leichhardt's Sawfish, Northern Sawfish [60756]	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]		Foraging, feeding or related behaviour known 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]		Foraging, feeding or related behaviour 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 known to occur within area
Diomedea amsterdamensis		
Amsterdam Albatross [64405]	Endangered	Species or species habitat likely to occur within area
Diomedea epomophora		
Southern Royal Albatross [89221]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea exulans		
Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea sanfordi		
Northern Royal Albatross [64456]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Fregata andrewsi		
Christmas Island Frigatebird, Andrew's Frigatebird [1011]	Endangered	Foraging, feeding or related behaviour known to occur within area
Fregata ariel		
Lesser Frigatebird, Least Frigatebird [1012]		Breeding known to occur within area
Fregata minor		
Great Frigatebird, Greater Frigatebird [1013]		Foraging, feeding or related behaviour likely to 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

Name	Threatened	Type of Presence
		habitat may occur within area
Onychoprion anaethetus Bridled Tern [82845]		Breeding known to occur within area
Phaethon lepturus White-tailed Tropicbird [1014]		Breeding likely to occur within area
Phaethon rubricauda Red-tailed Tropicbird [994]		Breeding known to occur within area
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat may occur within area
Sterna dougallii Roseate Tern [817]		Breeding known to occur within area
Sternula albifrons Little Tern [82849]		Congregation or aggregation known to occur within area
Sula dactylatra Masked Booby [1021]		Breeding known to occur within area
Sula leucogaster Brown Booby [1022]		Breeding known to occur within area
Sula sula Red-footed Booby [1023]		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 Shy Albatross [89224]	Endangered	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

Name	Threatened	Type of Presence
Balaenoptera musculus Blue Whale [36]	Endangered	Foraging, feeding or related behaviour known to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Caperea marginata Pygmy Right Whale [39]		Species or species habitat may occur within area
Carcharhinus longimanus Oceanic Whitetip Shark [84108]		Species or species habitat likely to occur within area
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Foraging, feeding or related behaviour 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
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
Lepidochelys olivacea Olive Ridley Turtle, Pacific Ridley Turtle [1767]	Endangered	Foraging, feeding or related behaviour 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 known to occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Breeding known to occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Breeding known to occur within area
Orcaella heinsohni Australian Snubfin Dolphin [81322]		Species or species habitat may occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat may occur within

Name	Threatened	Type of Presence
		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 pristis Freshwater Sawfish, Largetooth Sawfish, River Sawfish, Leichhardt's Sawfish, Northern Sawfish [60756]	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		
Cecropis daurica Red-rumped Swallow [80610]		Species or species habitat may occur within area
Hirundo rustica Barn Swallow [662]		Species or species habitat known to 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		
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 likely to occur within area
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Species or species habitat known to occur within area
Charadrius veredus Oriental Plover, Oriental Dotterel [882]		Species or species

Name	Threatened	Type of Presence
		habitat may occur within area
Glareola maldivarum Oriental Pratincole [840]		Species or species habitat may occur within area
Limnodromus semipalmatus Asian Dowitcher [843]		Species or species habitat known to 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 Greater 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
Commonwealth Land -
Defence - EXMOUTH ADMIN & HF TRANSMITTING
Defence - EXMOUTH VLF TRANSMITTER STATION
Defence - LEARMONTH - AIR WEAPONS RANGE

Commonwealth Heritage Places [Resource Information]

Name	State	Status
Natural		
Learmonth Air Weapons Range Facility	WA	Listed place
Mermaid Reef - Rowley Shoals	WA	Listed place
Ningaloo Marine Area - Commonwealth Waters	WA	Listed place
Scott Reef and Surrounds - Commonwealth Area	EXT	Listed place
Historic		
HMAS Sydney II and HSK Kormoran Shipwreck Sites	EXT	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 within area
Anous stolidus Common Noddy [825]		Foraging, feeding or related behaviour known to occur within area
Anous tenuirostris melanops Australian Lesser Noddy [26000]	Vulnerable	Breeding known to occur within area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur

Name	Threatened	Type of Presence
		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 likely to occur within area
Calonectris leucomelas Streaked Shearwater [1077]		Species or species habitat known to occur within area
Catharacta skua Great Skua [59472]		Species or species habitat may occur within area
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Species or species habitat known 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
Diomedea amsterdamensis Amsterdam Albatross [64405]	Endangered	Species or species habitat likely to occur within area
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Fregata andrewsi Christmas Island Frigatebird, Andrew's Frigatebird [1011]	Endangered	Foraging, feeding or related behaviour known to occur within area
Fregata ariel Lesser Frigatebird, Least Frigatebird [1012]		Breeding known to occur within area
Fregata minor Great Frigatebird, Greater Frigatebird [1013]		Foraging, feeding or related behaviour likely to occur within area
Glareola maldivarum Oriental Pratincole [840]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat known to occur within area
Halobaena caerulea Blue Petrel [1059]	Vulnerable	Species or species habitat may occur within area
Hirundo daurica Red-rumped Swallow [59480]		Species or species habitat may occur within area
Hirundo rustica Barn Swallow [662]		Species or species habitat known to occur within area
Larus novaehollandiae Silver Gull [810]		Breeding known to occur within area
Larus pacificus Pacific Gull [811]		Breeding known to occur within area
Limnodromus semipalmatus Asian Dowitcher [843]		Species or species habitat known to occur within area
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
Pachyptila turtur Fairy Prion [1066]		Species or species habitat may 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
Pelagodroma marina White-faced Storm-Petrel [1016]		Breeding known to occur within area
Phaethon lepturus White-tailed Tropicbird [1014]		Breeding likely to occur within area
Phaethon lepturus fulvus Christmas Island White-tailed Tropicbird, Golden	Endangered	Species or species

Name	Threatened	Type of Presence
Bosunbird [26021]		habitat may occur within area
Phaethon rubricauda Red-tailed Tropicbird [994]		Breeding known to occur within area
Phalacrocorax fuscescens Black-faced Cormorant [59660]		Breeding likely to occur within area
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat may occur within area
Pterodroma macroptera Great-winged Petrel [1035]		Foraging, feeding or related behaviour known to occur within area
Pterodroma mollis Soft-plumaged Petrel [1036]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Puffinus assimilis Little Shearwater [59363]		Breeding known to occur within area
Puffinus carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [1043]		Foraging, feeding or related behaviour likely to occur within area
Puffinus huttoni Hutton's Shearwater [1025]		Foraging, feeding or related behaviour known 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 likely to occur within area
Sterna albifrons Little Tern [813]		Congregation or aggregation known to 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
Sterna nereis Fairy Tern [796]		Breeding known to occur within area
Sula dactylatra Masked Booby [1021]		Breeding known to occur within area
Sula leucogaster Brown Booby [1022]		Breeding known to occur within area
Sula sula Red-footed Booby [1023]		Breeding known to occur within area

Name	Threatened	Type of Presence
Thalassarche carteri Indian Yellow-nosed Albatross [64464]	Vulnerable	Foraging, feeding or related behaviour may occur within area
Thalassarche cauta Shy Albatross [89224]	Endangered	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 likely to occur within area
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat likely to occur within area
Fish		
Acentronura australe Southern Pygmy Pipehorse [66185]		Species or species habitat may occur within area
Acentronura larsonae Helen's Pygmy Pipehorse [66186]		Species or species habitat may occur within area
Bhanotia fasciolata Corrugated Pipefish, Barbed Pipefish [66188]		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 amplexus Fijian Banded Pipefish, Brown-banded Pipefish [66199]		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

Name	Threatened	Type of Presence
Corythoichthys intestinalis Australian Messmate Pipefish, Banded Pipefish [66202]		Species or species habitat may occur within area
Corythoichthys schultzi Schultz's Pipefish [66205]		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
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 dunckeri Red-hair Pipefish, Duncker's Pipefish [66220]		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

Name	Threatened	Type of Presence
Hippocampus breviceps Short-head Seahorse, Short-snouted Seahorse [66235]		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 subelongatus West Australian Seahorse [66722]		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
Lissocampus fatiloquus Prophet's Pipefish [66250]		Species or species habitat may occur within area
Maroubra perserrata Sawtooth Pipefish [66252]		Species or species habitat may occur within area
Micrognathus micronotopterus Tidepool Pipefish [66255]		Species or species habitat may occur within area
Mitotichthys meraculus Western Crested Pipefish [66259]		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
Phycodurus eques Leafy Seadragon [66267]		Species or species habitat may occur within area
Phyllopteryx taeniolatus Common Seadragon, Weedy Seadragon [66268]		Species or species habitat may occur within area
Pugnaso curtirostris Pugnose Pipefish, Pug-nosed Pipefish [66269]		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

Name	Threatened	Type of Presence
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
Stigmatopora nigra Widebody Pipefish, Wide-bodied Pipefish, Black Pipefish [66277]		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
Urocampus carinirostris Hairy Pipefish [66282]		Species or species habitat may occur within area
Vanacampus margaritifer Mother-of-pearl Pipefish [66283]		Species or species habitat may occur within area
Mammals		
Arctocephalus forsteri Long-nosed Fur-seal, New Zealand Fur-seal [20]		Species or species habitat may occur within area
Dugong dugon Dugong [28]		Breeding known to occur within area
Neophoca cinerea Australian Sea-lion, Australian Sea Lion [22]	Endangered	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 foliosquama Leaf-scaled Seasnake [1118]	Critically Endangered	Species or species habitat known to occur within area
Aipysurus fuscus Dusky Seasnake [1119]		Species or species habitat known to occur within area
Aipysurus laevis Olive Seasnake [1120]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
Aipysurus pooleorum Shark Bay Seasnake [66061]		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	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
Enhydrina schistosa Beaked Seasnake [1126]		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 coggeri Slender-necked Seasnake [25925]		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
Lapemis hardwickii Spine-bellied Seasnake [1113]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
Lepidochelys olivacea Olive Ridley Turtle, Pacific Ridley Turtle [1767]	Endangered	Foraging, feeding or related behaviour likely to 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
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	Foraging, feeding or related behaviour known to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Caperea marginata Pygmy Right Whale [39]		Species or species habitat may occur within area
Delphinus delphis Common Dolphin, 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
Globicephala melas Long-finned Pilot Whale [59282]		Species or species habitat may occur within area
Grampus griseus Risso's Dolphin, Grampus [64]		Species or species habitat may occur within area
Hyperoodon planifrons Southern Bottlenose Whale [71]		Species or species habitat may occur within area
Indopacetus pacificus Longman's Beaked Whale [72]		Species or species

Name	Status	Type of Presence
		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
Lissodelphis peronii Southern Right Whale Dolphin [44]		Species or species habitat may occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Breeding known to occur within area
Mesoplodon bowdoini Andrew's Beaked Whale [73]		Species or species habitat may 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
Mesoplodon grayi Gray's Beaked Whale, Scamperdown Whale [75]		Species or species habitat may occur within area
Mesoplodon layardii Strap-toothed Beaked Whale, Strap-toothed Whale, Layard's Beaked Whale [25556]		Species or species habitat may occur within area
Mesoplodon mirus True's Beaked Whale [54]		Species or species habitat may occur within area
Orcaella brevirostris Irrawaddy Dolphin [45]		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 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

Name	Status	Type of Presence
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
Abrolhos	Habitat Protection Zone (IUCN IV)
Abrolhos	Multiple Use Zone (IUCN VI)
Abrolhos	National Park Zone (IUCN II)
Abrolhos	Special Purpose Zone (IUCN VI)
Argo-Rowley Terrace	Multiple Use Zone (IUCN VI)
Argo-Rowley Terrace	National Park Zone (IUCN II)
Argo-Rowley Terrace	Special Purpose Zone (Trawl) (IUCN VI)
Carnarvon Canyon	Habitat Protection Zone (IUCN IV)
Cartier Island	Sanctuary Zone (IUCN Ia)
Dampier	Habitat Protection Zone (IUCN IV)
Dampier	Multiple Use Zone (IUCN VI)
Dampier	National Park Zone (IUCN II)
Eighty Mile Beach	Multiple Use Zone (IUCN VI)
Gascoyne	Habitat Protection Zone (IUCN IV)
Gascoyne	Multiple Use Zone (IUCN VI)
Gascoyne	National Park Zone (IUCN II)
Jurien	National Park Zone (IUCN II)
Jurien	Special Purpose Zone (IUCN VI)
Kimberley	Multiple Use Zone (IUCN VI)
Mermaid Reef	National Park Zone (IUCN II)
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
Bedout Island	WA
Bernier And Dorre Islands	WA
Bessieres Island	WA
Boodie, Double Middle Islands	WA
Bundegi Coastal Park	WA
Cape Range	WA
Dirk Hartog Island	WA
Houtman Abrolhos Islands	WA
Jurabi Coastal Park	WA
Little Rocky Island	WA
Locker Island	WA
Lowendal Islands	WA
Montebello Islands	WA
Muiron Islands	WA
North Sandy Island	WA
North Turtle Island	WA
Round Island	WA
Serrurier Island	WA
Unnamed WA36913	WA
Unnamed WA36915	WA
Unnamed WA37338	WA
Unnamed WA37500	WA
Unnamed WA40322	WA
Unnamed WA40828	WA
Unnamed WA40877	WA
Unnamed WA41080	WA
Unnamed WA44665	WA
Unnamed WA44667	WA
Unnamed WA44672	WA
Victor Island	WA
Y Island	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
Streptopelia senegalensis Laughing Turtle-dove, Laughing Dove [781]		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 asinus Donkey, Ass [4]		Species or species habitat likely to occur within area

Name	Status	Type of Presence
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
Feral deer Feral deer species in Australia [85733]		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
Sus scrofa Pig [6]		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		
Asparagus asparagoides Bridal Creeper, Bridal Veil Creeper, Smilax, Florist's Smilax, Smilax Asparagus [22473]		Species or species habitat likely to occur within area
Brachiaria mutica Para Grass [5879]		Species or species habitat may occur within area
Cenchrus ciliaris Buffel-grass, Black Buffel-grass [20213]		Species or species habitat likely to occur within area
Chrysanthemoides monilifera Bitou Bush, Boneseed [18983]		Species or species habitat may occur within area
Genista sp. X Genista monspessulana Broom [67538]		Species or species habitat may 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
Lycium ferocissimum African Boxthorn, Boxthorn [19235]		Species or species habitat likely to occur within area
Olea europaea Olive, Common Olive [9160]		Species or species habitat may occur within area
Opuntia spp. Prickly Pears [82753]		Species or species habitat likely to occur within area
Parkinsonia aculeata Parkinsonia, Jerusalem Thorn, Jelly Bean Tree, Horse Bean [12301]		Species or species habitat likely to occur within area

Name	Status	Type of Presence
Pinus radiata		
Radiata Pine Monterey Pine, Insignis Pine, Wilding Pine [20780]		Species or species habitat may occur within area
Prosopis spp.		
Mesquite, Algaroba [68407]		Species or species habitat likely to occur within area
Tamarix aphylla		
Athel Pine, Athel Tree, Tamarisk, Athel Tamarisk, Athel Tamarix, Desert Tamarisk, Flowering Cypress, Salt Cedar [16018]		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 may occur within area

Nationally Important Wetlands [Resource Information]

Name	State
Cape Range Subterranean Waterways	WA
Exmouth Gulf East	WA
Mermaid Reef	EXT

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
Ashmore Reef and Cartier Island and surrounding	North-west
Canyons linking the Argo Abyssal Plain with the	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
Mermaid Reef and Commonwealth waters	North-west
Seringapatam Reef and Commonwealth waters in	North-west
Wallaby Saddle	North-west
Ancient coastline at 90-120m depth	South-west
Commonwealth marine environment surrounding	South-west
Commonwealth marine environment within and	South-west
Perth Canyon and adjacent shelf break, and other	South-west
Western demersal slope and associated fish	South-west
Western rock lobster	South-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

-31.001075 107.287395,-29.380422 106.805058,-26.218893 104.272535,-24.15233 103.213594,-23.588241 103.007524,-15.480352 103.018297,-12.488954 105.734949,-11.93057 110.247671,-11.89019 118.117664,-12.334617 119.855859,-12.586371 124.743745,-13.017053 125.042367,-15.358453 121.419889,-19.556435 119.557496,-19.762258 119.31717,-19.934769 118.696131,-20.132265 118.484359,-20.219115 117.876407,-20.352365 117.64322,-20.518927 117.029319,-20.429697 116.973401,-20.354744 116.837772,-20.468958 116.746163,-20.498702 116.67121,-20.541685 116.616117,-20.59388 116.467766,-20.642659 116.482043,-20.775909 116.402331,-20.810411 116.347603,-20.790186 116.22863,-20.861569 116.045412,-21.011475 115.861003,-21.274406 115.65399,-21.550423 115.326814,-21.573028 115.224498,-21.692001 114.922306,-21.769334 114.808092,-21.835959 114.645099,-22.126253 114.258436,-22.132202 114.203709,-21.987054 114.182294,-21.968019 114.138274,-21.865702 114.148981,-21.816923 114.191811,-21.78599 114.164448,-21.802646 114.102582,-21.87522 113.999075,-21.970398 113.939589,-22.116735 113.878912,-22.2714 113.834892,-22.355871 113.794441,-22.380855 113.762319,-22.467706 113.739714,-22.5379 113.692125,-22.549797 113.662381,-22.57954 113.652864,-22.595007 113.670709,-22.62594 113.66952,-22.679478 113.676658,-22.722308 113.673089,-22.716359 113.706401,-22.742533 113.744473,-22.831763 113.784924,-22.980479 113.824185,-23.090973 113.807725,-23.118488 113.763508,-23.212477 113.769457,-23.28624 113.789683,-23.380229 113.784924,-23.489684 113.763508,-23.50872 113.596946,-23.834706 113.461317,-24.34629 113.130572,-25.195758 113.063947,-25.340905 113.082983,-25.528882 112.909282,-26.490184 113.033014,-26.908969 113.192438,-27.277786 113.220991,-27.425313 113.318549,-27.620428 113.646915,-27.870272 113.699263,-28.115356 113.599326,-28.446101 113.654053,-28.557936 113.71116,-28.624561 113.822995,-29.021931 113.949106,-29.297948 114.529695,-29.804774 114.90327,-30.2081 114.99301,-30.55314 114.841894,-30.897472 115.056676,-30.98877 115.047629,-31.001075 107.287395

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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Appendix E: Environment Plan Consultation

Stakeholder Consultation

Copy of Notification Advice

From: [redacted]
Subject: QE Consultation | Varanus Island Hub Operations EPs
Date: Friday, 15 June 2018 3:39:00 PM
Attachments: QE Varanus Island Consultation Package.pdf

Good afternoon stakeholders,

On behalf of Quadrant Energy, please find attached a Consultation Package for the operations of onshore and offshore facilities at the Varanus Island Hub.

This Consultation Package relates to the five-yearly regulatory revision of the two Environment Plans which govern activities at the Varanus Island Hub. More details on relevant regulators are included in the Consultation Package.

If you wish to receive additional information on the Varanus Island please be in contact by email or phone at your earliest convenience.

Kind regards

[redacted]

[redacted]

[redacted]

[redacted]

From: [redacted]
To: [redacted]
Cc: [redacted]
Subject: QE Consultation | Varanus Island Hub Operations EPs
Date: Friday, 15 June 2018 3:34:00 PM
Attachments: QE Varanus Island Consultation Package.pdf

Good afternoon stakeholders,

On behalf of Quadrant Energy, please find attached a Consultation Package for the operations of onshore and offshore facilities at the Varanus Island Hub.

This Consultation Package relates to the five-yearly regulatory revision of the two Environment Plans which govern activities at the Varanus Island Hub. More details on relevant regulators are included in the Consultation Package.

Additional information which may be of value to you is included in this table below.

Key proximities to protected areas		
Infrastructure Name	**Protected Area**	**Distance**
Varanus Island Onshore Gas Plant	Montebello State Marine Park	10 km
Halyard Subsea Completion	Montebello Commonwealth Marine Reserve	35 km
	Barrow Island State Marine Park	42 km
Harriet Bravo Monopod	Montebello State Marine Park	5 km
	Barrow Island State Marine Park	5 km
John Brookes Wellhead Platform	Montebello Commonwealth Marine Reserve	35 km
	Montebello State Marine Park	31 km
Linda Platform	Montebello State Marine Park	4 km
	Barrow Island State Marine Management Area	13 km

If you wish to receive additional information on the Varanus Island Hub and this Consultation Package please be in contact by email or phone at your earliest convenience.

Kind regards

[redacted]

From: [redacted]
[redacted]
Subject: QE Consultation | Varanus Island Hub Operations EPs
Date: Friday, 15 June 2018 3:33:00 PM
Attachments: QE Varanus Island Consultation Package.pdf

Good afternoon [redacted]

On behalf of Quadrant Energy, please find attached a Consultation Package for the operations of onshore and offshore facilities at the Varanus Island Hub. As discussed earlier in the week, Quadrant will continue to engage with DBCA throughout the development of the Environment Plans which are undergoing their five-yearly regulatory revision.

Additional information which may be of value to DBCA is included in this table.

Key proximities to protected areas		
Infrastructure Name	**Protected Area**	**Distance**
Varanus Island Onshore Gas Plant	Montebello State Marine Park	10 km
Halyard Subsea Completion	Montebello Commonwealth Marine Reserve	35 km
	Barrow Island State Marine Park	42 km
Harriet Bravo Monopod	Montebello State Marine Park	5 km
	Barrow Island State Marine Park	5 km
John Brookes Wellhead Platform	Montebello Commonwealth Marine Reserve	35 km
	Montebello State Marine Park	31 km
Linda Platform	Montebello State Marine Park	4 km
	Barrow Island State Marine Management Area	13 km

If you have any immediate enquiries, don't hesitate to be in touch.

Kind regards

[redacted]

Stakeholder Consultation

Copy of Consultation Pack

STAKEHOLDER CONSULTATION PACKAGE

VARANUS ISLAND HUB

Environment Plans for Commonwealth and State waters

Quadrant Energy is the operator of the Varanus Island Hub, which encompasses onshore facilities at Varanus Island as well as offshore platforms, associated pipelines and other subsea infrastructure.

Varanus Island has been in operation since 1986.

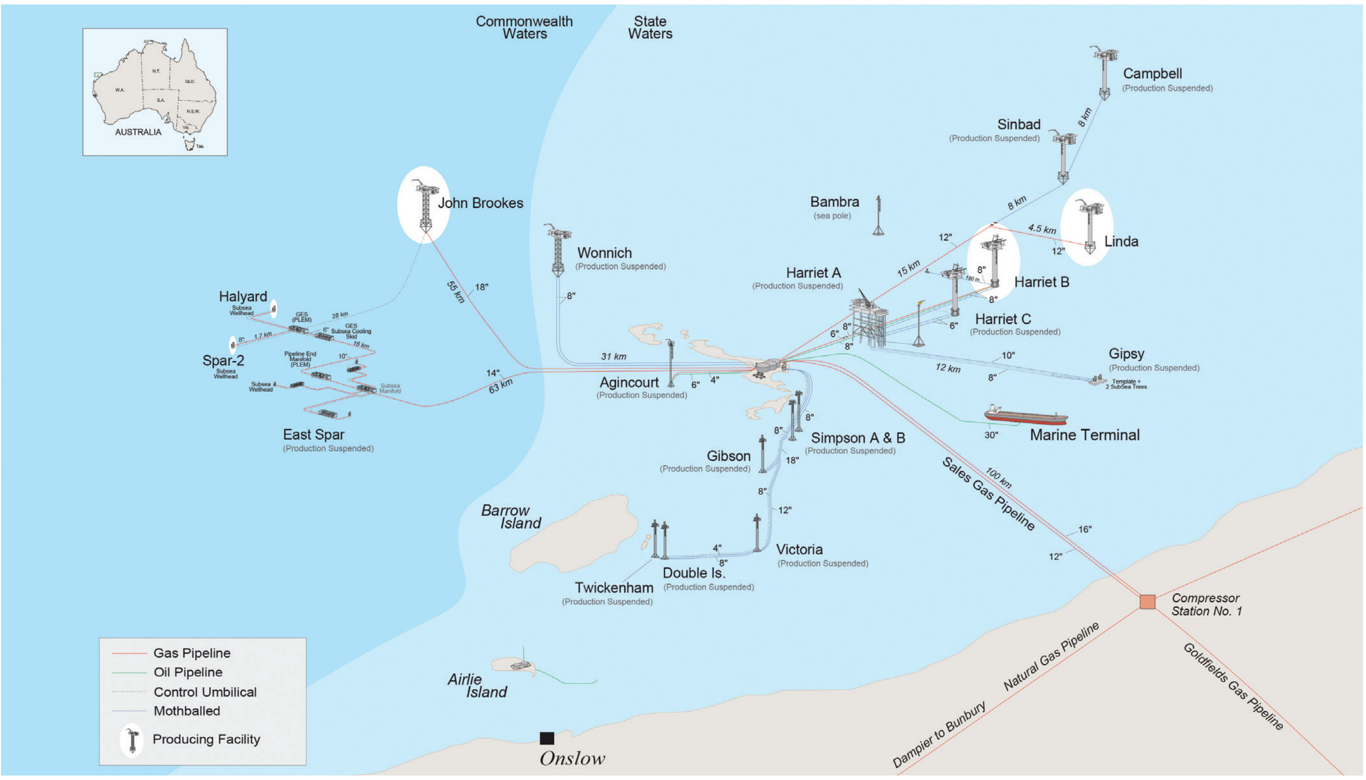
This consultation package relates to the five-yearly regulatory revision of the two Environment Plans (EPs) which govern activities at the Varanus Island Hub:

- Varanus Island Hub Operations EP for activities in State Waters (previously approved by the Department of Mines, Industry Regulation and Safety in September 2014); and
- Varanus Island Hub Operations EP for Commonwealth Waters (previously accepted by the National Offshore Petroleum Safety and Environment Management Authority in September 2014).

Varanus Island is a Class C Nature Reserve located 95 km from the Port of Dampier, and 11 km northeast of Barrow Island. Varanus Island infrastructure extends to Airlie Island, situated approximately 35km north-northeast of Onslow.

Quadrant operates under CALM lease agreements for both Varanus and Airlie Islands, these are administered by the Department of Biodiversity, Conservation and Attractions.

Varanus Island Hub and Airlie Island facilities



Quadrant Energy

Varanus Island and facilities location and current operating status

Asset type	Name	Status	Permit Number	Latitude	Longitude	Commonwealth/ State waters
Platform	Agincourt	Suspended	TL/6	-20° 40' 07.70"	115° 30' 51.56"	State
Platform	Campbell	Suspended	TP/5	-20° 32' 50.46"	115° 36' 16.88"	State
Platform	Double Island	Suspended	TL/9	-20° 24' 50.60"	115° 43' 48.90"	State
Platform	Gibson-South Plato	Suspended	TL/6	-20° 45' 21.19"	115° 30' 19.86"	State
Platform	Harriet A	Suspended	TL/1	-20° 41' 57.54"	115° 33' 51.86"	State
Platform	Harriet B	Producing Oil	TL/1	-20° 38' 07.09"	115° 43' 43.39"	State
Platform	Harriet C	Suspended	TL/1	-20° 36' 07.40"	115° 36' 50.34"	State
Platform	John Brookes	Producing Gas	WA-29-L	-20° 34' 30.80"	115° 38' 15.26"	Commonwealth
Platform	Linda	Producing Gas	TL/1	-20° 35' 20.40"	115° 37' 37.76"	State
Platform	Simpson A	Suspended	TL/6	-20° 26' 50.45"	115° 07' 12.62"	State
Platform	Simpson B	Suspended	TL/6	-20° 33' 18.58"	115° 42' 31.86"	State
Platform	Sinbad	Suspended	TP/5	-20° 40' 20.00"	115° 35' 07.76"	State
Platform	Twickenham	Suspended	TL/9	-20° 40' 24.27"	115° 35' 05.66"	State
Platform	Victoria	Suspended	TL/6	-20° 29' 00.22"	115° 42' 43.98"	State
Platform	Wonnich	Suspended	TL/8	-20° 45' 21.26"	115° 30' 17.81"	State
Manifold	East Spar	Producing Gas	WA-13-L	-20° 44' 22.24"	115° 34' 18.18"	Commonwealth
Wellhead	Halyard	Producing Gas	WA-45-L	-20° 29' 58.48"	115° 25' 44.64"	Commonwealth
Wellhead	Greater East Spar	Producing Gas	WA-45-L	-20° 43' 19.87"	114° 59' 04.31"	Commonwealth
Facility	Airlie Island	Suspended	Onshore	-21° 19' 21.33"	115° 10' 13.41"	State
Pipeline	Sales Gas Pipeline	Gas supply	Shore crossing	-21° 11' 40.73"	115° 50' 50.10"	Onshore
Compressor Station	CS1 metering station	Gas supply	Onshore	-21° 26' 49.26"	115° 57' 13.07"	Onshore

ACTIVITY DESCRIPTION

Varanus Island

Varanus Island forms the central gathering and processing hub for Quadrant's oil and gas production facilities in the area. Gas and liquids from the offshore facilities are processed on the island and transported to shore via a sales gas pipeline. Onshore facilities include a control centre and systems to remotely control and monitor the normally unmanned offshore facilities.

The accommodation, administration and operating centre for the various production facilities are also located on the island. Personnel reside on the island and travel to and from the offshore facilities on a regular basis via helicopter or field support vessel.

Airlie Island

At Airlie Island Quadrant currently undertakes environmental monitoring, equipment inspection and maintenance (including subsea pipeline inspection) and personnel transfer by vessel to/from the Island.

Quadrant has undertaken a significant program of infrastructure and equipment removal on Airlie Island, and the nearby Chervil platform was removed in 2017.

Inspection, maintenance and repair

To support the Varanus Island Hub's ongoing operations, inspection, maintenance and repair activities are regularly conducted both onshore and offshore 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.

Well suspension and decommissioning activities

There are a number of wells associated with the Varanus Island Hub that are no longer producing. Well intervention or suspension activities requiring a rig, will be covered under an activity specific regulatory approval. Decommissioning activities are not included in these EPs.

ENVIRONMENTAL MANAGEMENT

Quadrant 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 Quadrant's activities at the Varanus Island Hub, this consultation material includes information on potential planned and unplanned environmental risks and impacts. 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	Mitigation and/or management controls
Light emissions	• Lighting is minimised to that required for safety and navigational purposes. • Artificial light from onshore operations are managed in accordance with Quadrant's Lighting Management Plan.
Underwater noise impacts	• Quadrant has measures in place for interacting with protected marine fauna as per the EPBC Regulations (Part 8). • Quadrant will maintain equipment to minimise underwater noise
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 each platform.
Disturbance to seabed	• All offshore activities will be managed in accordance with Quadrant's lifting and transfer procedure, Offshore Clearing Permit for State waters 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 Quadrant's Chemical Selection Procedure • All visitors to Varanus Island will undergo relevant inductions and training. • Procedures are in place for the management of stormwater.
Invasive marine species	• Vessels and equipment will be assessed and managed to reduce the risk of invasive marine species. • Quadrant contracted vessels comply with Australian ballast water requirements.
Marine fauna interaction	• Quadrant has measures in place for interacting with protected marine fauna as per the EPBC Regulations (Part 8).
Unplanned releases including hydrocarbons	• Quadrant's 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 Quadrant's lifting and transfer procedure. • All visitors to Varanus Island will undergo relevant inductions and training. • Quadrant 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 operational and recreational activities (introduced species, disturbance to flora and fauna)	• The risk of the introduction of terrestrial non-indigenous species as a result of Quadrant operations is managed in accordance with Quadrant's Quarantine Procedure. • Quadrant undertakes routine environmental monitoring, including turtle and shearwater nesting, coral monitoring. • Permit to work system in place • All visitors to Varanus Island will undergo relevant inductions and training. • Passive Recreation Plan to manage non-petroleum activities in off lease habitats on Varanus Island
Fire	• Environmental impacts associated with any potential fire or petroleum spillage emergencies are managed in accordance with Quadrant's Fire Management Plan. • Firewater is distributed as per the requirements in Quadrant's Firewater System Performance Standard. • All visitors to Varanus Island will undergo relevant inductions and training.

REGULATORS

Varanus Island facilities are located in both State and Commonwealth waters and subject to the jurisdiction of seven regulators as shown below.

	Onshore				Offshore State Waters			Offshore Commonwealth Waters
					Mean Low Water Mark (MLWM) to 3 nm (5.556 km)			3 to 12 nm (5.556 - 22.224 km)
	Lease	VI Compression Project	Licence	Wharfs	EP / OPEP / Pipelines / Operations		Simpson Development	EP / OPEP John Brookes, Halyard, East Spar
Regulator	DBCA	DoEE	DWER	DoT	DMIRs	DWER	DoEE	NOPSEMA
Key Acts	Conservation and Land Management Act 1984 (CALM Act) Wildlife Conservation Act 1950	Environment Protection and Biodiversity Conservation Act 1999 (EPBC)	Environmental Protection Act 1986 *(Part V – Environmental Regulation)* Contaminated Sites Act 2003 Waste Avoidance and Resource Recovery Act 2007	Jetties Act 1926	Petroleum Pipelines Act 1969 Petroleum (Submerged Lands) Act 1982 Environmental Protection Act 1986 Emergency Management Act 2005	Environmental Protection Act 1986 *(Part II – Environmental Protection Policies)* *(Part IV – Environmental Impact Assessment)* Contaminated Sites Act 2003	Environment Protection and Biodiversity Conservation Act 1999 (EPBC)	Offshore Petroleum and Greenhouse Gas Storage Act 2006 (OPGGS Act) Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)

STAKEHOLDER ENGAGEMENT

Quadrant encourages open, two way communication with stakeholders throughout the lifecycle of all operating facilities.

Quadrant communicates regularly with interested stakeholders through documentation including Quarterly Consultation Updates and annual updates to fishing license holders. Activity specific consultation may also be provided for particular projects or where there is a change in operations.

If you wish to discuss this consultation material further please provide comment by August 1, 2018. Quadrant commits to providing all stakeholder feedback to both State and Commonwealth regulators within the revised Varanus Island Hub Environment Plans.

[redacted]
Consultation Coordinator
consultation@quadrantenergy.com.au
Phone: 08 6218 4972

Quadrant Energy

Stakeholder Consultation

Copy of Quarterly Consultation Update

Quarterly Consultation Update

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.

[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

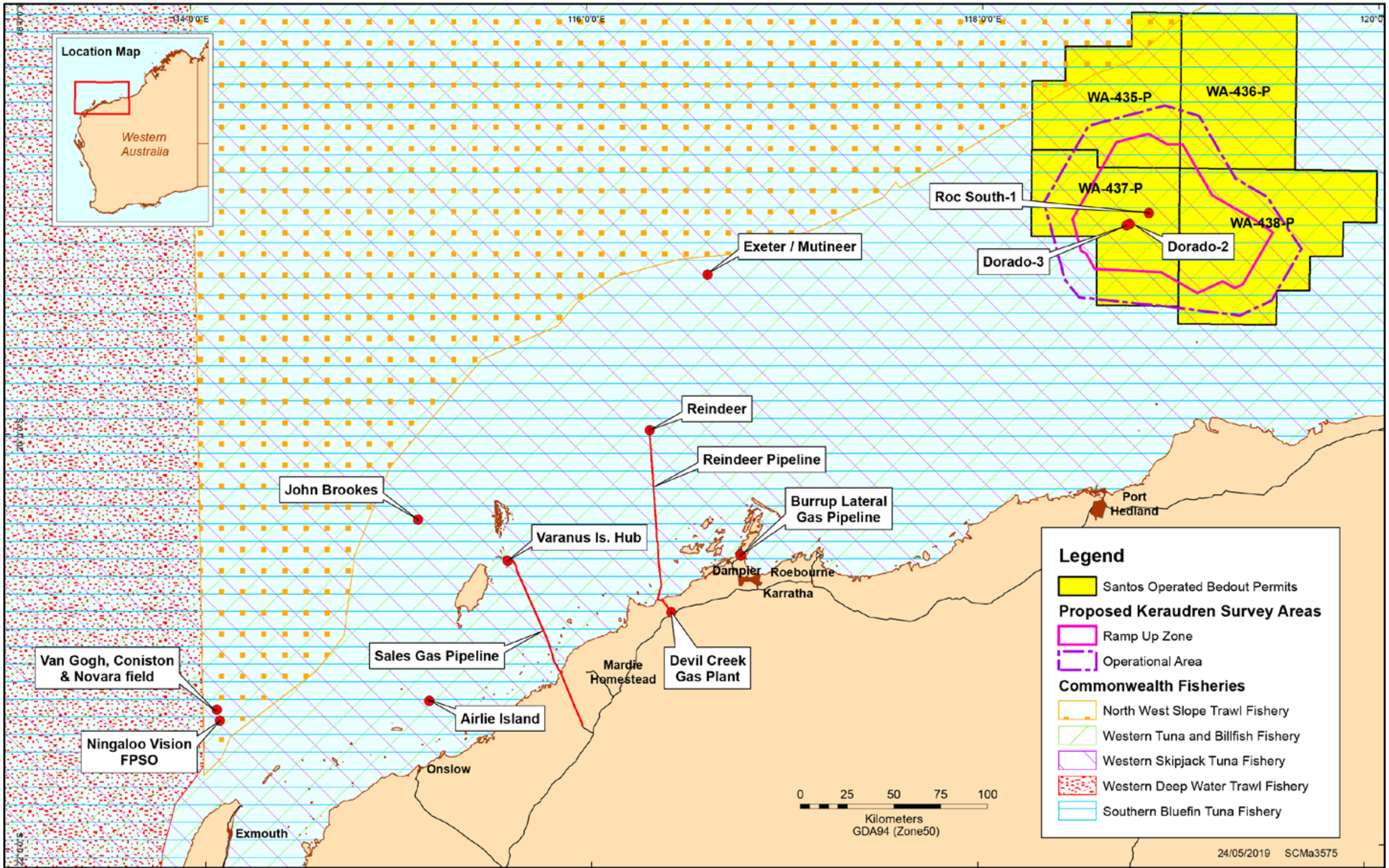
Santos provides an update on activities previously consulted and now completed.

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' West Australian operations

Santos provides an overview of existing operations on the North West Shelf.

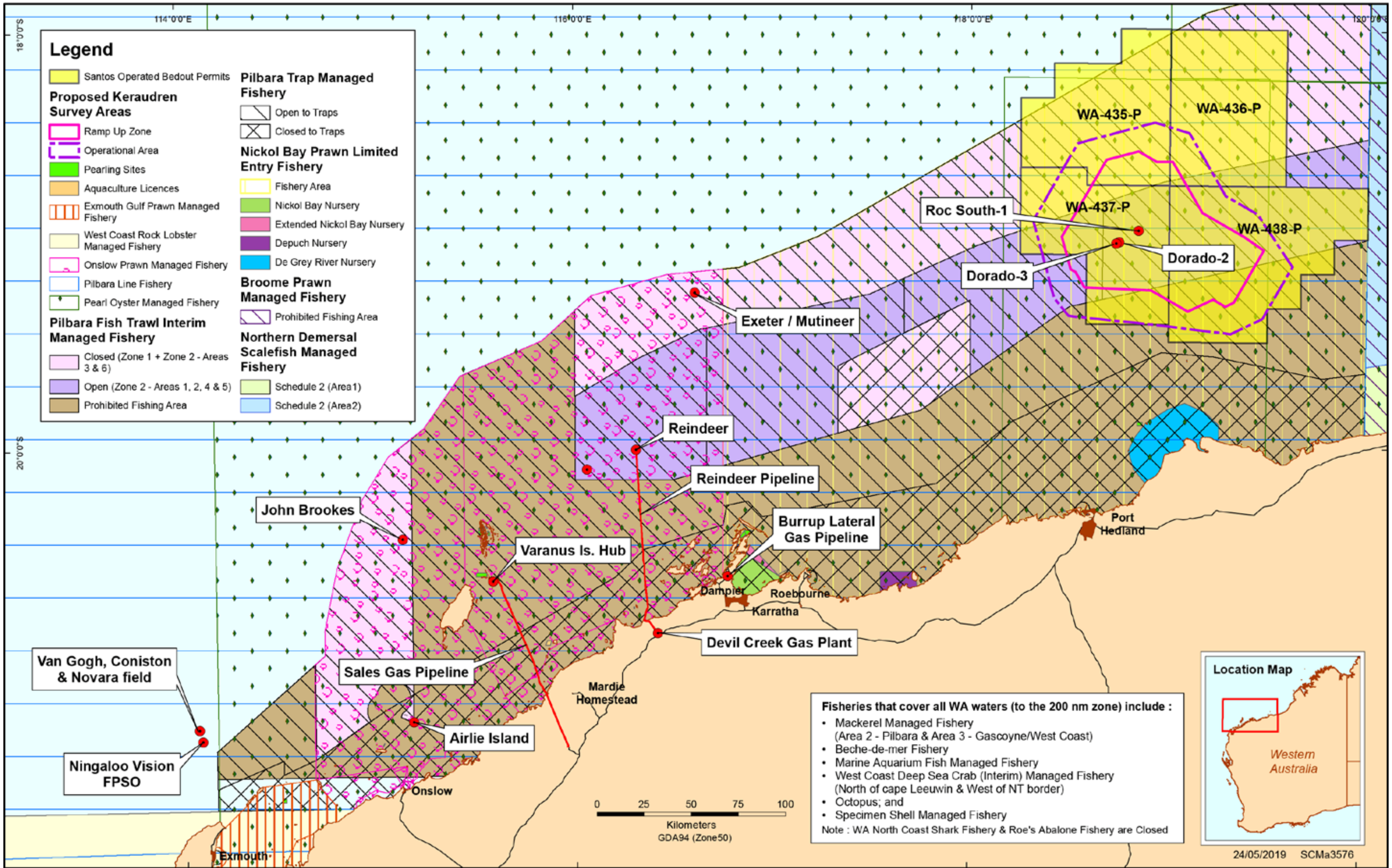
Operational Activity Name	Type of Activity	Water depth	Exclusion zone	Update
Devil Creek Gas Plant (Reindeer facility, pipeline and gas plant)	Gas Production	Reindeer platform at 61 m	500 m around Reindeer Platform	Ongoing operations The five yearly regulatory revision of the two Environment Plans (EPs) 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.



Santos

WESTERN AUSTRALIAN SANTOS ACTIVITIES
COMMONWEALTH FISHING ZONES

Santos



Santos

WESTERN AUSTRALIAN SANTOS ACTIVITIES
STATE FISHING ZONES

Stakeholder Consultation

2019 Follow-Up - Outgoing

From: [redacted]
To: [redacted]
Subject: Santos Consultation | Varanus Island Hub Operations Environment Plans
Date: Monday, 8 July 2019 2:43:00 PM
Attachments: QE Varanus Island Consultation Package.pdf

Good afternoon

Please be advised that Santos is preparing to submit its five-yearly regulatory revision of the two Environment Plans (EPs) which govern activities at the Varanus Island Hub.

Santos previously emailed AMSA a copy of the Consultation Package for this revision on 15 June 2018, and received no comment at the time. A copy of the original consultation pack is attached.

The submission of these EPs was subsequently delayed due to business priorities, and as Santos is now preparing to submit these plans, we wanted to provide AMSA the opportunity to raise any further matters for attention. Please note the EPs contain a section on activity notification and reporting requirements.

In relation to Varanus Island Hub Operations (Commonwealth) 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.

Therefore all correspondence relating to the Varanus Island Hub Operations (Commonwealth) EP will be summarised within the body of the EP. Santos will not use or disclose your personal information in the published EP. Full transcripts of all correspondence will be provided to NOPSEMA in a separate sensitive information document, which is not published. 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.

If you wish to discuss this consultation material further please contact me directly.

Kind regards

Santos

[redacted]

[redacted]

From: [redacted]
To: [redacted]
Subject: Santos Consultation | Varanus Island Hub Operations Environment Plans
Date: Monday, 8 July 2019 2:18:00 PM
Attachments: QE Varanus Island Consultation Package.pdf

Hello [redacted]

Please be advised that Santos is preparing to submit its five-yearly regulatory revision of the two Environment Plans (EPs) which govern activities at the Varanus Island Hub.

Santos previously emailed the Department of Agriculture and Water Resources (DAWR) a copy of the Consultation Package for this revision on 15 June 2018, and received no comment at the time. A copy of the original consultation pack is attached.

The submission of the EPs was subsequently delayed due to business priorities, and as Santos is now preparing to submit these plans, we wanted to provide DAWR the opportunity to raise any further matters for attention.

Please note that in the preparation of these EPs, Santos has also taken into account the department's recent advice on changes to the offshore installation biosecurity guidelines. Santos continues to work through this information as it may relate to the Varanus Island Hub Operations and will discuss this with you in Perth in August. In the interim, we will continue to prepare our Varanus Island Hub Operations EPs for submission and acknowledge that we are in ongoing discussions with you to close out our obligations for biosecurity arrangements.

In relation to Varanus Island Hub Operations (Commonwealth) 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.

Therefore all correspondence relating to the Varanus Island Hub Operations (Commonwealth) EP will be summarised within the body of the EP. Santos will not use or disclose your personal information in the published EP. Full transcripts of all correspondence will be provided to NOPSEMA in a separate sensitive information document, which is not published. 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.

If you wish to discuss this consultation material further please contact me directly.

Kind regards

[redacted]

[redacted]

From:	Consultation, Quadrant
To:	[redacted]
Cc:	[redacted]
Subject:	Santos Consultation | Varanus Island Hub Operations Environment Plans
Date:	Monday, 8 July 2019 2:56:00 PM
Attachments:	QE Varanus Island Consultation Package.pdf

Good afternoon

Please be advised that Santos is preparing to submit its five-yearly regulatory revision of the two Environment Plans (EPs) which govern activities at the Varanus Island Hub.

Santos previously emailed the Department of Biosecurity, Conservation and Attractions (DBCA) a copy of the Consultation Package for this revision on 15 June 2018. DBCA and Santos met on 30 July 2018 to discuss a number of matters, including these plans. DBCA was subsequently provided copies of the Varanus Island Fire and Petroleum Spillage Management Plan and Varanus Island Hub Passive Recreation Plan as these were deemed relevant to the framework document. No further comments on the EPs were received.

The submission of these EPs was subsequently delayed due to business priorities, and as Santos is now preparing to submit these plans, we wanted to provide DBCA the opportunity to raise any further matters for attention.

In relation to Varanus Island Hub Operations (Commonwealth) 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.

Therefore all correspondence relating to the Varanus Island Hub Operations (Commonwealth) EP will be summarised within the body of the EP. Santos will not use or disclose your personal information in the published EP. Full transcripts of all correspondence will be provided to NOPSEMA in a separate sensitive information document, which is not published. 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.

If you wish to discuss this consultation material further please contact me directly.

Kind regards

Santos

[redacted]

From: [redacted]
To: [redacted]
Subject: Santos Consultation | Varanus Island Hub Operations Environment Plans
Date: Monday, 8 July 2019 2:12:00 PM
Attachments: QE Varanus Island Consultation Package.pdf
RE QE Consultation Varanus Island Hub Operations EPs.msg

Hello [redacted]

Please be advised that Santos is preparing to submit its five-yearly regulatory revision of the two Environment Plans (EPs) which govern activities at the Varanus Island Hub.

Santos previously emailed the Department of Mines, Industry Regulation and Safety (DMIRS) a copy of the Consultation Package for this revision on 15 June 2018. DMIRS responded by email on 26 June 2018, with thanks noting suggestions for changes to the State EP which is under DMIRS jurisdiction. Santos WA responded to DMIRS by email on 2 July 2018, noting any removal of infrastructure would be covered under a separate EP and accepting minor editorial notes from DMIRS. No further engagement was required from a Commonwealth waters perspective. DMIRS will assess the Varanus Island State EP in line with relevant legislation. A copy of this communication is attached.

The submission of these EPs was subsequently delayed due to business priorities, and as Santos is now preparing to submit these plans, we wanted to provide DMIRS the opportunity to raise any further matters for attention.

In relation to Varanus Island Hub Operations (Commonwealth) 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.

Therefore all correspondence relating to the Varanus Island Hub Operations (Commonwealth) EP will be summarised within the body of the EP. Santos will not use or disclose your personal information in the published EP. Full transcripts of all correspondence will be provided to NOPSEMA in a separate sensitive information document, which is not published. 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.

If you wish to discuss this consultation material further please contact me directly.

Kind regards

Santos

[redacted]

h[redacted]

From:	Consultation, Quadrant
To:	[redacted]
Cc:	[redacted]
Subject:	Santos Consultation | Varanus Island Hub Operations Environment Plans
Date:	Monday, 8 July 2019 2:25:00 PM
Attachments:	QE Varanus Island Consultation Package.pdf DoT Consultation Varanus Island Hub Operations 02072018.pdf

Hello [redacted]

Please be advised that Santos is preparing to submit its five-yearly regulatory revision of the two Environment Plans (EPs) which govern activities at the Varanus Island Hub.

Santos previously emailed the Department of Transport (DoT) a copy of the Consultation Package for this revision on 15 June 2018, and the department responded via email on 2 July 2018, noting that DoT reviewed the operations OPEP in 2017 and did not need to see the EP unless there are changes to the level of risk or spill response arrangements. A copy of this communication is attached.

The submission of these EPs was subsequently delayed due to business priorities, and as Santos is now preparing to submit these plans, we wanted to provide DoT the opportunity to raise any further matters for attention.

Please note that in the preparation of these EPs, Santos has also taken into account your recent comments on the Santos Reindeer Wellhead Platform and Pipeline EPs. Within the current Varanus Island Hub Operations OPEP review for NOPSEMA, Santos does not believe there are any significant changes to the spill response strategies and spill risks since the last revision provided to DoT, and we will 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).

In relation to Varanus Island Hub Operations (Commonwealth) 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.

Therefore all correspondence relating to the Varanus Island Hub Operations (Commonwealth) EP will be summarised within the body of the EP. Santos will not use or disclose your personal information in the published EP. Full transcripts of all correspondence will be provided to NOPSEMA in a separate sensitive information document, which is not published. 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.

If you wish to discuss this consultation material further please contact me directly.

Kind regards

Santos

[redacted]

From:	Consultation, Quadrant
To:	[redacted]
Cc:	[redacted]
Subject:	Santos Consultation | Varanus Island Hub Operations Environment Plans
Date:	Monday, 8 July 2019 2:50:00 PM
Attachments:	DPIRD Consultation Varanus Island 26072018.pdf QE Varanus Island Consultation Package.pdf Santos Reindeer Wellhead Platform and Pipeline Environment Plans and Ningaloo Vision Operations.msg

Good afternoon

Please be advised that Santos is preparing to submit its five-yearly regulatory revision of the two Environment Plans (EPs) which govern activities at the Varanus Island Hub.

Santos previously emailed the Department of Primary Industries and Regional Development (DPIRD) a copy of the Consultation Package for this revision on 15 June 2018, and DPIRD responded via email in July 2018, noting that DPIRD had no further comment on the VI operational activities. A copy of this communication is attached.

The submission of these EPs was subsequently delayed due to business priorities, and as Santos is now preparing to submit these plans, we wanted to provide DPIRD the opportunity to raise any further matters for attention.

Please note that in the preparation of these EPs, we have also taken into account your recent comments on the Santos Reindeer Wellhead Platform and Pipeline EPs, as per our response to you of 4 July 2019 (attached).

In relation to Varanus Island Hub Operations (Commonwealth) 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.

Therefore all correspondence relating to the Varanus Island Hub Operations (Commonwealth) EP will be summarised within the body of the EP. Santos will not use or disclose your personal information in the published EP. Full transcripts of all correspondence will be provided to NOPSEMA in a separate sensitive information document, which is not published. 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.

If you wish to discuss this consultation material further please contact me directly.

Kind regards

Santos

[redacted]

[redacted]

From: [redacted]
To: [redacted]
Subject: [redacted] Island Hub Operations Environment Plans
Date: Monday, 8 July 2019 2:59:00 PM
Attachments: QE Varanus Island Consultation Package.pdf
WAFIC - 2018 Jun 18 - Consultation _ Varanus Island Hub Operations EPs.pdf

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Hello [redacted]

Please be advised that Santos is preparing to submit its five-yearly regulatory revision of the two Environment Plans (EPs) which govern activities at the Varanus Island Hub.

Santos previously emailed WAFIC a copy of the Consultation Package for this revision on 15 June 2018, and WAFIC responded via email on 18 June 2018, requesting an update on water depths, PSZ and decommissioning. Santos provided water depth and PSZ via email on 21 June 2018, and outlined to WAFIC any decommissioning plans would be covered under a separate approval. A copy of this communication is attached.

The submission of these EPs was subsequently delayed due to business priorities, and as Santos is now preparing to submit these EPs, we wanted to provide WAFIC the opportunity to raise any further matters for attention.

Please note that in the preparation of these EPs, Santos has also taken into account WAFICs recent comments on the Santos Reindeer Wellhead Platform and Pipeline Environment Plans.

In relation to Varanus Island Hub Operations (Commonwealth) 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.

Therefore all correspondence relating to the Varanus Island Hub Operations (Commonwealth) EP will be summarised within the body of the EP. Santos will not use or disclose your personal information in the published EP. Full transcripts of all correspondence will be provided to NOPSEMA in a separate sensitive information document, which is not published. 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.

If you wish to discuss this consultation material further please contact me directly.

Kind regards

Santos

[redacted]

[redacted]

Appendix F: Environment Consequence Descriptors

Consequence Level		I	II	III	IV	V	VI
Acceptability		Acceptable	Acceptable	Unacceptable	Unacceptable	Unacceptable	Unacceptable
Severity Description		**Negligible** ***No impact or negligible impact***	**Minor** ***Detectable but insignificant change to local population, industry or ecosystem factors. Localised effect***	**Moderate** ***Significant impact to local population, industry or ecosystem factors***	**Major** ***Major long-term effect on local population, industry or ecosystem factors***	**Severe** ***Complete loss of local population, industry or ecosystem factors AND/OR extensive regional impacts with slow recovery***	**Critical** ***Irreversible impact to regional population, industry or ecosystem factors***
Environmental Receptors	Fauna In particular, EPBC Act listed threatened/migratory fauna or *WA Biodiversity Conservation Act 2016* 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; 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.	Complete loss of regional population; Complete loss of habitat critical to survival of 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[10]; habitat within a protected area; habitats that include benthic primary producers[11] and/or epi-fauna[12]	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 approximately two years (two season 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.	Extensive destruction of local physical environment/habitat with no recovery; Long term (decades) and wide spread loss of area or function of primary producers on a regional scale.	Complete destruction of regional physical environment/habitat with no recovery. Complete loss of area or function of 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.	Extensive, long term decline in threatened ecological community population size, diversity or function; Complete loss of threatened ecological community.	Complete loss of threatened ecological community with no recovery.

Consequence Level		I	II	III	IV	V	VI
Acceptability		Acceptable	Acceptable	Unacceptable	Unacceptable	Unacceptable	Unacceptable
Severity Description		**Negligible** *No impact or negligible impact*	**Minor** *Detectable but insignificant change to local population, industry or ecosystem factors. Localised effect*	**Moderate** *Significant impact to local population,industry or ecosystem factors*	**Major** *Major long-term effect on local population, industry or ecosystem factors*	**Severe** *Complete loss of local population,industry or ecosystem factors AND/OR extensive regional impacts with slow recovery*	**Critical** *Irreversible impact to regional population, industry or ecosystem factors*
	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.	Extensive loss of one or more of protected area's values; Extensive loss of species population contained within protected area.	Complete loss of one or more of protected area's values with no recovery; Complete loss of species population contained within protected area with no recovery.
	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; Extensive loss of key natural features or populations supporting the local industry.	Permanent shutdown of local or regional industry; Permanent loss of key natural features or populations supporting the local or regional industry.

Appendix G: Spill Modelling Results

Appendix G1: Stochastic Spill Modelling Results for:

- **surface release of condensate from John Brookes wellheads**
- **sub-sea release of condensate from subsea pipeline**
- **sub-sea release of condensate from wellheads**

Appendix G2: High Environmental Value Consequence Summary

Santos

Appendix G1: Stochastic Spill Modelling Results

Modelling results for surface release of condensate from John Brookes wellheads

Receptor	Receptor type	Minimum time to contact (Hours)							Maximum Hydrocarbon Concentration							Maximum oil ashore (m^3)	Maximum length of oiled shoreline (km)
		Moderate Exposure Values				High Exposure Values			Moderate Exposure Values				High Exposure Values				
		Shoreline accumulation (100 g/m²)	Surface hydrocarbons (10 g/m²)	Dissolved aromatics (50 ppb)	Entrained hydrocarbons (100 ppb)	Shoreline accumulation (1000g/m²)	Surface hydrocarbons (25 g/m²)	Dissolved aromatics (400 ppb)	Shoreline accumulation (100 g/m²)	Surface hydrocarbons (10 g/m²) *	Dissolved aromatics (50 ppb)	Entrained hydrocarbons (100 ppb)	Shoreline accumulation (1000g/m²)	Surface hydrocarbons (25 g/m²) *	Dissolved aromatics (400 ppb)	Shoreline accumulation	Shoreline accumulation (100 g/m²)
Barrow Island	Emergent	105	NC	C	230	NC	NC	C	711	NC	E	1077	NC	NC	414	20	61
Muiron Islands	Emergent	568	NC	C	122	NC	NC	NC	144	NC	199	169	NC	NC	NC	3	9
Ningaloo Coast North	Emergent	129	NC	C	105	NC	NC	NC	966	NC	321	823	NC	NC	NC	14	65
Lowendal Islands	Shoreline	NA	NC	C	363	NA	NC	NC	NA	NC	52	515	NA	NC	NC	NA	NC
Montebello Islands	Emergent	171	NC	C	106	413	NC	NC	E	NC	146	1198	1543	NC	NC	33	43
Barrow-Montebello Surrounds*	Intertidal	NA	NC	C	58	NC	NC	C	579	NC	E	1216	NC	NC	412	NA	NA
Montebello AMP	AMP	NA	NC	C	18	NA	NC	C	NA	NC	E	2574	NA	NC	583	NA	NA
Offshore Ningaloo	AMP	NA	1396	C	16	NA	NC	C	NA	NC	E	4434	NA	NC	1238	NA	NA

Receptor	Receptor type	Minimum time to contact (Hours)							Maximum Hydrocarbon Concentration							Maximum oil ashore (m^3)	Maximum length of oiled shoreline (km)
		Moderate Exposure Values				High Exposure Values			Moderate Exposure Values				High Exposure Values				
		Shoreline accumulation (100 g/m^2)	Surface hydrocarbons (10 g/m^2)	Dissolved aromatics (50 ppb)	Entrained hydrocarbons (100 ppb)	Shoreline accumulation (1000g/m^2)	Surface hydrocarbons (25 g/m^2)	Dissolved aromatics (400 ppb)	Shoreline accumulation (100 g/m^2)	Surface hydrocarbons (10 g/m^2) *	Dissolved aromatics (50 ppb)	Entrained hydrocarbons (100 ppb)	Shoreline accumulation (1000g/m^2)	Surface hydrocarbons (25 g/m^2) *	Dissolved aromatics (400 ppb)	Shoreline accumulation	Shoreline accumulation (100 g/m^2)
Outer Ningaloo Coast North	AMP	NA	NC	C	92	NA	NC	C	NA	NC	E	1089	NA	NC	429	NA	NA
Outer NW Ningaloo	AMP	NA	NC	C	64	NA	NC	C	NA	NC	E	2766	NA	NC	412	NA	NA
Southern Islands Coast	Emergent	1245	NC	C	550	NC	NC	NC	E	NC	187	400	NC	NC	NC	8	37
Rankin Bank	Submerged	NA	NC	C	354	NA	NC	NC	NA	NC	63	287	NA	NC	NC	NA	NA
Thevenard Island	Emergent	NC	NC	NC	1261	NC	NC	NC	NC	NC	NC	268	NC	NC	NC	2	7
Glomar Shoals	Emergent	NA	NC	NC	1108	NA	NC	NC	NA	NC	NC	206	NA	NC	NC	NA	NA
Middle Islands Coast	Emergent	NC	NC	NC	676	NC	NC	NC	NC	NC	NC	170	NC	NC	NC	NC	14
Abrolhos West	Submerged	NA	NC	NC	2149	NA	NC	NC	NA	NC	NC	121	NA	NC	NC	NA	<1
Offshore Abrolhos – Perth North	Submerged	NA	NC	NC	2467	NA	NC	NC	NA	NC	NC	112	NA	NC	NC	NA	<1
Offshore Abrolhos NW	Submerged	NA	NC	C	356	NA	NC	NC	NA	NC	109	313	NA	NC	NC	NA	<1

Receptor	Receptor type	Minimum time to contact (Hours)							Maximum Hydrocarbon Concentration							Maximum oil ashore (m^3)	Maximum length of oiled shoreline (km)
		Moderate Exposure Values				High Exposure Values			Moderate Exposure Values				High Exposure Values				
		Shoreline accumulation (100 g/m^2)	Surface hydrocarbons (10 g/m^2)	Dissolved aromatics (50 ppb)	Entrained hydrocarbons (100 ppb)	Shoreline accumulation (1000g/m^2)	Surface hydrocarbons (25 g/m^2)	Dissolved aromatics (400 ppb)	Shoreline accumulation (100 g/m^2)	Surface hydrocarbons (10 g/m^2) *	Dissolved aromatics (50 ppb)	Entrained hydrocarbons (100 ppb)	Shoreline accumulation (1000g/m^2)	Surface hydrocarbons (25 g/m^2) *	Dissolved aromatics (400 ppb)	Shoreline accumulation	Shoreline accumulation (100 g/m^2)
Outer Abrolhos Islands – Shoals	Submerged	NA	NC	NC	2078	NA	NC	NC	NA	NC	NC	186	NA	NC	NC	NA	<1
Rowley Shoals surrounds	Submerged	NA	NC	NC	2796	NA	NC	NC	NA	NC	NC	115	NA	NC	NC	NA	<1
Shark Bay MP	AMP	NA	NC	NC	2763	NA	NC	NC	NA	NC	NC	125	NA	NC	NC	NA	<1

E = Exceeded

C= Contacted at threshold (timeframe and maximum concentration not specified in modelling).

NC= No Contact

* This receptor is only emergent at lowest astronomical tide therefore accumulation is considered temporary only under these tidal conditions.

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Modelling results for sub-sea release of condensate from subsea pipeline

Receptor	Receptor type	Minimum time to contact (Hours)							Maximum Hydrocarbon Concentration							Maximum oil ashore (m^3)	Maximum length of oiled shoreline (km)
		Moderate Exposure Values				High Exposure Values			Moderate Exposure Values				High Exposure Values				
		Shoreline accumulation (100 g/m^2)	Surface hydrocarbons (10 g/m^2)	Dissolved aromatics (50 ppb)	Entrained hydrocarbons (100 ppb)	Shoreline accumulation (1000g/m^2)	Surface hydrocarbons (25 g/m^2)	Dissolved aromatics (400 ppb)	Shoreline accumulation (100 g/m^2)	Surface hydrocarbons (10 g/m^2) *	Dissolved aromatics (50 ppb)	Entrained hydrocarbons (100 ppb)	Shoreline accumulation (1000g/m^2)	Surface hydrocarbons (25 g/m^2) *	Dissolved aromatics (400 ppb)	Shoreline accumulation	Shoreline accumulation (100 g/m^2)
Lowendal Islands	Shoreline	19	7	C	4	NC	8	NC	860	C	292	714	NC	NC	NC	6	4
Montebello Islands	Emergent	16	NC	C	19	NC	NC	NC	764	NC	396	618	NC	NC	NC	11	37
Barrow-Montebello Surrounds*	Emergent	NC	1	C	2	NC	1	C	NC	C	E	2,010	NA	NC	978	NC	NC
Montebello MP	State MP	22	1	C	2	NC	1	C	NC	C	E	2,394	NA	NC	1,181	NC	NC
Barrow Island	Emergent	16	3	C	3	NC	NC	C	E	C	E	803	1,110	NC	719	20	44
Murion Islands	Emergent	NC	NC	NC	294	NC	NC	NC	NC	NC	NC	145	NC	NC	NC	NC	NC
Ningaloo Coast North	Emergent	NC	NC	C	332	NC	NC	NC	NC	NC	91	153	NC	NC	NC	NC	NC
Offshore Ningaloo	AMP	NC	NC	C	149	NC	NC	NC	NC	NC	238	156	NC	NC	NC	NC	NC
Outer Ningaloo Coast North	AMP	NC	NC	C	NC	NC	NC	NC	NC	NC	106	NC	NC	NC	NC	NC	NC
Outer NW Ningaloo	AMP	NC	NC	C	341	NC	NC	NC	NC	NC	107	104	NC	NC	NC	NC	NC
Southern Islands Coast	Coast	NC	NC	C	462	NC	NC	NC	NC	NC	61	186	NC	NC	NC	NC	NC
Thevenard Island	Emergent	NC	NC	NC	196	NC	NC	NC	NC	NC	NC	241	NC	NC	NC	NC	NC

E = exceeded

C= Contacted at threshold (timeframe and maximum concentration not specified in modelling).

NC= No Contact

* This receptor is only emergent at lowest astronomical tide therefore accumulation is considered temporary only under these tidal conditions.

Modelling results for sub-sea release of condensate from wellheads

Receptor	Receptor type	Minimum time to contact (Hours)							Maximum Hydrocarbon Concentration							Maximum oil ashore (m^3)	Maximum length of oiled shoreline (km)
		Moderate Exposure Values				High Exposure Values			Moderate Exposure Values				High Exposure Values				
		Shoreline accumulation (100 g/m^2)	Surface hydrocarbons (10 g/m^2)	Dissolved aromatics (50 ppb)	Entrained hydrocarbons (100 ppb)	Shoreline accumulation (1000g/m^2)	Surface hydrocarbons (25 g/m^2)	Dissolved aromatics (400 ppb)	Shoreline accumulation (100 g/m^2)	Surface hydrocarbons (10 g/m^2) *	Dissolved aromatics (50 ppb)	Entrained hydrocarbons (100 ppb)	Shoreline accumulation (1000g/m^2)	Surface hydrocarbons (25 g/m^2) *	Dissolved aromatics (400 ppb)	Shoreline accumulation	Shoreline accumulation (100 g/m^2)
Barrow Island	Emergent	NC	NC	NC	1596	NC	NC	NC	NC	NC	42	588	NC	NC	NC	NC	NC
Muiron Islands	Emergent	NC	NC	C	1948	NC	NC	NC	NC	NC	104	403	NC	NC	NC	NC	NC
Ningaloo Coast North	Emergent	NC	NC	C	372	NC	NC	NC	NC	NC	269	1697	NC	NC	NC	NC	NC
Lowendal Islands	Shoreline	NC	NC	NC	2626	NC	NC	NC	NC	NC	14	196	NC	NC	NC	NC	NC
Montebello Islands	Emergent	NC	NC	NC	1623	NC	NC	NC	NC	NC	44	223	NC	NC	NC	NC	NC
Barrow-Montebello Surrounds	Emergent	NC	NC	C	1523	NC	NC	NC	NC	NC	160	627	NC	NC	NC	NC	NC
Montebello AMP	AMP	NA	NC	NC	1487	NC	NC	NC	NC	NC	249	1963	NA	NC	NC	NC	NC

Receptor	Receptor type	Minimum time to contact (Hours)							Maximum Hydrocarbon Concentration							Maximum oil ashore (m^3)	Maximum length of oiled shoreline (km)
		Moderate Exposure Values				High Exposure Values			Moderate Exposure Values				High Exposure Values				
		Shoreline accumulation (100 g/m²)	Surface hydrocarbons (10 g/m²)	Dissolved aromatics (50 ppb)	Entrained hydrocarbons (100 ppb)	Shoreline accumulation (1000g/m²)	Surface hydrocarbons (25 g/m²)	Dissolved aromatics (400 ppb)	Shoreline accumulation (100 g/m²)	Surface hydrocarbons (10 g/m²) *	Dissolved aromatics (50 ppb)	Entrained hydrocarbons (100 ppb)	Shoreline accumulation (1000g/m²)	Surface hydrocarbons (25 g/m²) *	Dissolved aromatics (400 ppb)	Shoreline accumulation	Shoreline accumulation (100 g/m²)
Exmouth Gulf Coast	Shoreline	NC	NC	NC	2891	NC	NC	NC	NC	NC	10	129	NC	NC	NC	NC	NC
Ningaloo Coast South	AMP	NC	NC	NC	2079	NC	NC	NC	NC	NC	37	228	NC	NC	NC	NC	NC
Northern Islands Coast	State MP	NC	NC	NC	2984	NC	NC	NC	NC	NC	3	112	NC	NC	NC	NC	NC
Offshore Ningaloo	AMP	NC	NC	C	6	NC	NC	C	NC	NC	E	3579	NC	NC	640	NC	NC
Outer Ningaloo Coast North	AMP	NC	NC	C	1813	NC	NC	NC	NC	NC	293	2710	NC	NC	NC	NC	NC
Outer NW Ningaloo	AMP	NC	NC	C	1813	NC	NC	NC	NC	NC	314	1383	NC	NC	NC	NC	NC
Southern Islands Coast	Coast	NC	NC	NC	1813	NC	NC	NC	NC	NC	290	1028	NC	NC	NC	NC	NC
Rankin Bank	Emergent	NC	NC	C	1628	NC	NC	NC	NC	NC	96	578	NC	NC	NC	NC	NC

Receptor	Receptor type	Minimum time to contact (Hours)							Maximum Hydrocarbon Concentration							Maximum oil ashore (m^3)	Maximum length of oiled shoreline (km)
		Moderate Exposure Values				High Exposure Values			Moderate Exposure Values				High Exposure Values				
		Shoreline accumulation (100 g/m²)	Surface hydrocarbons (10 g/m²)	Dissolved aromatics (50 ppb)	Entrained hydrocarbons (100 ppb)	Shoreline accumulation (1000g/m²)	Surface hydrocarbons (25 g/m²)	Dissolved aromatics (400 ppb)	Shoreline accumulation (100 g/m²)	Surface hydrocarbons (10 g/m²) *	Dissolved aromatics (50 ppb)	Entrained hydrocarbons (100 ppb)	Shoreline accumulation (1000g/m²)	Surface hydrocarbons (25 g/m²) *	Dissolved aromatics (400 ppb)	Shoreline accumulation	Shoreline accumulation (100 g/m²)
Thevenard Island	Emergent	NC	NC	NC	1816	NC	NC	NC	NC	NC	62	1146	NC	NC	NC	NC	NC

E = exceeded
C= Contacted at threshold (timeframe and maximum concentration not specified in modelling).
NC= No Contact

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Appendix G2: High Environmental Consequence Summary

Receptor (hotspot) name	HEV Ranking	Values	Oil Spill Modelling Parameter NC = No Contact		Subsea	Surface	Consequence Category	Consequence Ranking	Final
Outer Ningaloo Coast North (submerged)	1	Habitats The Ningaloo Reef itself and its juxtaposition with coastal terraces, limestone plains, reef sediments. The contact of the reef by entrained oil may reduce the aesthetic appeal and diminish these values. Marine mammals Seasonal aggregations of whale sharks, manta rays, sea turtles and rays. Whale sharks March-July Logger head turtles Green Turtles Dec-March Low density Hawksbill turtles Pygmy Blue Whale feeding	Probability of contact by floating oil at 10 g/m²	(%)	NC	NC	Threatened/ Migratory Fauna Physical Environment/ Habitat Protected Areas Socio-Economic Receptors	II II II II	II
			Minimum time to contact by floating oil 10 g/m²	Time (days)	NC	NC			
			Maximum accumulated oil ashore >100 g/m²	m^3	NC	NC			
			Maximum accumulated concentration >100 g/m²	g/m²	NC	NC			
			Maximum length of shoreline oiled (>100 g/m²)	(km)	NC	NC			

Receptor (hotspot) name	HEV Ranking	Values	Oil Spill Modelling Parameter NC = No Contact		Subsea	Surface	Consequence Category	Consequence Ranking	Final
		Socio-economic and heritage values Very significant for recreational fishing, game fishing and charter boat tourism Protected Areas World Heritage Areas Australian Marine Park	Maximum concentration of entrained oil >100 ppb	(ppb)	526	821			
			Maximum concentration of dissolved hydrocarbon >50 ppb	(ppb)	245	121			
Muiron Islands (emergent)	2	The Muiron Islands are part of the Ningaloo World Heritage Area. Physical habitats Coral reefs Soft coral communities dominate the reefs on the western side of the Muiron Islands whilst habitats on the eastern side of the Muiron Islands are more sheltered,	Probability of contact by floating oil at 10 g/m²	(%)	NC	NC	Threatened/ Migratory Fauna Physical Environment/ Habitat Protected Areas Socio-Economic Receptors	IV IV IV III	IV
			Minimum time to contact by floating oil 10 g/m²	Time (days)	NC	NC			
			Maximum accumulated oil ashore >100 g/m²	m^3	18	9			

Receptor (hotspot) name	HEV Ranking	Values	Oil Spill Modelling Parameter NC = No Contact		Subsea	Surface	Consequence Category	Consequence Ranking	Final
		consisting of sandy beaches and shallow lagoons with diverse soft and hard coral communities (Cassata & Collins, 2008) The northern boundary substrate can be described as a combination of sand covered limestone pavement (Quadrant Energy, 2016) Seagrasses Identified on the eastern side of the Muiron Islands Macroalgae Seagrass and macroalgal habitats are present within the NWS region including Muiron Islands (eastern side)	Maximum accumulated concentration >100 g/m²	g/m²	478	209			
			Maximum length of shoreline oiled (>100 g/m²)	(km)	5	3			
			Maximum concentration of entrained oil >100 ppb	(ppb)	289	480			
			Maximum concentration of dissolved hydrocarbon >50 ppb	(ppb)	174	69			

Receptor (hotspot) name	HEV Ranking	Values	Oil Spill Modelling Parameter NC = No Contact		Subsea	Surface	Consequence Category	Consequence Ranking	Final
		Sandy beaches The western shores comprise sandy beaches sloping away to the shelf backed by low dunes <u>Marine fauna</u> Invertebrates Not identified within the area although noted in the deeper offshore environment or the more protected environment of the nearby Exmouth Gulf (refer Ningaloo Hot Spot) Fish and sharks Shark aggregations are seasonally reported and manta rays are commonly found in the area							

Receptor (hotspot) name	HEV Ranking	Values	Oil Spill Modelling Parameter NC = No Contact		Subsea	Surface	Consequence Category	Consequence Ranking	Final
		Seabirds Significant bird breeding. Several BIAs for breeding/nesting/roosting, foraging and resting include the Murion Islands there are five known rookeries as well isolated rookeries on the Muiron and Sunday Islands Marine reptiles – turtles Provides important aggregation and nesting areas for turtle populations, including the loggerhead (Caretta caretta) and green (*Chelonia mydas*) The North West Cape and Muiron Islands are major nesting sites for							

Receptor (hotspot) name	HEV Ranking	Values	Oil Spill Modelling Parameter NC = No Contact		Subsea	Surface	Consequence Category	Consequence Ranking	Final
		loggerhead turtles, with approximately 400 and 600 females nesting annually on the Ningaloo Coast (particularly, North West Cape area) and Muiron Islands respectively (DEP, 2001) The Recovery Plan for Marine Turtles in Australia (2003) 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 The Muiron Islands are minor nesting sites for flatback and hawksbill turtles (DEC 2009a)							

Receptor (hotspot) name	HEV Ranking	Values	Oil Spill Modelling Parameter NC = No Contact		Subsea	Surface	Consequence Category	Consequence Ranking	Final
		Marine mammals Seasonal aggregations of whale sharks, manta rays, sea turtles and rays. Whale sharks Mar to Jul Pygmy Blue Whale feeding <u>Protected areas</u> The Ningaloo Coast World Heritage Area (WHA) also includes the Muiron Islands as having outstanding universal value for the Ningaloo Coast (Refer to Ningaloo Coast Hot Spot) The Ningaloo Coast WHA includes Muiron Island Marine Management Area (including the Muiron Islands) category IA – Sanctuary Zone							

Receptor (hotspot) name	HEV Ranking	Values	Oil Spill Modelling Parameter NC = No Contact		Subsea	Surface	Consequence Category	Consequence Ranking	Final
		(islands) and II – Marine National Park Zone <u>Socio-economic and heritage values</u> Significant for recreational fishing and charter boat tourism Social amenities and other tourism such as commercial dive charters The unclassified waters of the Muiron Islands Marine Management area are also open to commercial fishing in accordance with the *Fish Resources Management Act 1994* (FRM Act) The Management Plan for the Ningaloo Marine Park and Muiron Islands Marine							

Receptor (hotspot) name	HEV Ranking	Values	Oil Spill Modelling Parameter NC = No Contact		Subsea	Surface	Consequence Category	Consequence Ranking	Final
		Management Area (2005 to 2015) identifies that the area has significant indigenous heritage value associated with historical and current use but the linkage appears to be directly related to the Ningaloo Reef and the adjacent foreshore as opposed to the Muiron Islands							
Ningaloo Coast North (Emergent)	2	<u>Habitats</u> Contains part of the largest fringing reef in Australia Lagoonal., intertidal and subtidal coral communities Nine species of seagrass + macroalgae beds Mangrove bay – Significant for mangroves	Probability of contact by floating oil at 10 g/m²	(%)	NC	NC	Threatened/Migratory Fauna Physical Environment/ Habitat Protected Areas Socio-Economic Receptors	IV IV IV II	IV
			Minimum time to contact by floating oil 10 g/m²	Time (days)	NC	NC			
			Maximum accumulated	m^3	54	23			

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Receptor (hotspot) name	HEV Ranking	Values	Oil Spill Modelling Parameter NC = No Contact		Subsea	Surface	Consequence Category	Consequence Ranking	Final
		Yardie Creek – Significant mangroves and tidal creek Marine mammals Seasonal aggregations of whale sharks, manta rays, sea turtles and rays. Whale sharks March-July Loggerhead turtles Green Turtles Dec-March Low density Hawksbill turtles Pygmy Blue whale feeding Seabirds 33 species of seabirds and avifauna. Main breeding areas at Mangrove Bay, Mangrove Point, Point Maud, the Mildura Wreck Site and Fraser Island Protected Areas Includes 13 out of the 18 sanctuary zones under the state MP.	oil ashore >100 g/m²						
			Maximum accumulated concentration >100 g/m²	g/m²	517	179			
			Maximum length of shoreline oiled (>100 g/m²)	(km)	16	6			
			Maximum concentration of entrained oil >100 ppb	(ppb)	373	581			
			Maximum concentration of dissolved hydrocarbon >50 ppb	(ppb)	119	55			

Receptor (hotspot) name	HEV Ranking	Values	Oil Spill Modelling Parameter NC = No Contact		Subsea	Surface	Consequence Category	Consequence Ranking	Final
		World Heritage Areas Exmouth Peninsula Karst System is an official value of the National Heritage Area <u>Socio-economic and heritage values</u> Tourism Recreational Fishing fishing and charter boat tourism							
Barrow-Montebello Surrounds (Intertidal)	3	<u>Habitats</u> Coral reefs habitat <u>Seabirds</u> Migratory birds <u>Turtles</u> Internesting <u>Whales</u> Humpback/pygmy blue whale migration	Probability of contact by floating oil at 10 g/m²	(%)	NC	NC	Threatened/Migratory Fauna Physical Environment/ Habitat Protected Areas Socio-Economic Receptors	III II II II Fauna consequence allocated III due to turtle nesting	III
			Minimum time to contact by floating oil 10 g/m²	Time (days)	NC	NC			
			Maximum accumulated	m^3	NC	NC			

Receptor (hotspot) name	HEV Ranking	Values	Oil Spill Modelling Parameter NC = No Contact		Subsea	Surface	Consequence Category	Consequence Ranking	Final
		<u>Socio-economic</u> Significant for recreational fishing and charter boat tourism	oil ashore >100 g/m²						
			Maximum accumulated concentration >100 g/m²	g/m²	NC	NC			
			Maximum length of shoreline oiled (>100 g/m²)	(km)	NC	NC			
			Maximum concentration of entrained oil >100 ppb	(ppb)	308	494			
			Maximum concentration of dissolved hydrocarbon >50 ppb	(ppb)	456	254			
Montebello Islands (Emergent)	3	<u>Habitats</u> Reefs – coral spawning: Mar & Oct	Probability of contact by floating oil at 10 g/m²	(%)	NC	NC	Threatened/Migratory Fauna	IV IV IV	IV

Receptor (hotspot) name	HEV Ranking	Values	Oil Spill Modelling Parameter NC = No Contact		Subsea	Surface	Consequence Category	Consequence Ranking	Final
		Algae (40%) Mangroves (considered globally unique as they are offshore) Fish habitat Intertidal sand flat communities Turtles Loggerhead and green (significant rookery), hawksbill, flatback turtles – Loggerhead turtle nesting: Dec-Jan; green turtle nesting: Nov to Apr, peak period from Jan-Feb; flatback turtle nesting: Dec-Jan; hawksbill turtle nesting: Oct to Jan Northwest and Eastern Trimouille Islands (hawksbill) Western Reef and Southern Bay at Northwest Island (green)	Minimum time to contact by floating oil 10 g/m²	Time (days)	NC	NC	Physical Environment/ Habitat Protected Areas Socio-Economic Receptors	III	
			Maximum accumulated oil ashore >100 g/m²	m^3	33	13			
			Maximum accumulated concentration >100 g/m²	g/m²	342	165			
			Maximum length of shoreline oiled (>100 g/m²)	(km)	11	3			
			Maximum concentration of entrained oil >100 ppb	(ppb)	203	286			
			Maximum concentration	(ppb)	446	249			

Receptor (hotspot) name	HEV Ranking	Values	Oil Spill Modelling Parameter NC = No Contact		Subsea	Surface	Consequence Category	Consequence Ranking	Final
		<u>Seabirds</u> Migratory and threatened seabirds – 14 species Significant nesting (Sept to Feb), foraging and resting areas <u>Whales</u> Humpback (Jun to Jul), Pygmy blue (Apr to Aug) 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)	of dissolved hydrocarbon >50 ppb						
	3	<u>Habitats</u>	Probability of contact by	(%)	NC	NC		IV	IV

Receptor (hotspot) name	HEV Ranking	Values	Oil Spill Modelling Parameter NC = No Contact		Subsea	Surface	Consequence Category	Consequence Ranking	Final
Lowendal Islands (Emergent)		Important shallow lagoons with seagrass for dugongs Deep-water benthic (soft-sediment) habitats Dugong Reef and Batman Reef (eastern side Island) Mangroves are considered globally unique as they are offshore Macroalgal reefs (40%) Turtles Important hawksbill (Beacon, Parakeelya, Kaia and Pipeline), loggerhead and green turtle nesting (minor) Varanus pipeline, Harriet and Andersons Beaches) Nesting is reported to occur throughout the year in WA, peaking between October and January	floating oil at 10 g/m^2				Threatened/Migratory Fauna Physical Environment/ Habitat Protected Areas Socio-Economic Receptors	IV IV III	
			Minimum time to contact by floating oil 10 g/m^2	Time (days)	NC	NC			
			Maximum accumulated oil ashore >100 g/m^2	m^3	8	3			
			Maximum accumulated concentration >100 g/m^2	g/m^2	182	74			
			Maximum length of shoreline oiled (>100 g/m^2)	(km)	2	NC			
			Maximum concentration of entrained oil >100 ppb	(ppb)	83	117			

Receptor (hotspot) name	HEV Ranking	Values	Oil Spill Modelling Parameter NC = No Contact		Subsea	Surface	Consequence Category	Consequence Ranking	Final
		Significant flatback rookery, nesting season for flatback turtles peaks in December and January with subsequent peak hatchling emergence in February and March <u>Seabirds</u> Approximately 89 species of avifauna, 12 to 14 species of migratory and threatened seabirds <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 dissolved hydrocarbon >50 ppb	(ppb)	38	24			

Receptor (hotspot) name	HEV Ranking	Values	Oil Spill Modelling Parameter NC = No Contact		Subsea	Surface	Consequence Category	Consequence Ranking	Final
		<u>Socio-economic and heritage values</u> Social amenities and other tourism, very significant for recreational fishing and charter boat tourism							
Barrow Island (Emergent)	3	<u>Habitats</u> Bandicoot Bay – conservation area *Fisheries Act* (benthic fauna/seabird protection), mudflats, rock platforms, mangroves, clay pans Mangroves in Bandicoot Bay (considered globally unique) Coral reefs (eastern side) – Biggada Reef (coral spawning: Mar & Oct) Biggada Creek <u>Turtles</u>	Probability of contact by floating oil at 10 g/m²	(%)	NC	NC	Threatened/Migratory Fauna Physical Environment/ Habitat Protected Areas Socio-Economic Receptors	IV IV IV III	IV
			Minimum time to contact by floating oil 10 g/m²	Time (days)	NC	NC			
			Maximum accumulated oil ashore >100 g/m²	m³	17	7			
			Maximum accumulated	g/m²	243	130			

Receptor (hotspot) name	HEV Ranking	Values	Oil Spill Modelling Parameter NC = No Contact		Subsea	Surface	Consequence Category	Consequence Ranking	Final
		Regionally and nationally significant green turtle (western side) and flatback turtle (eastern side) nesting beaches Turtle Bay north beach North and west coasts – John Wayne Beach also loggerhead and hawksbill turtles. Peak turtle nesting periods – Loggerhead turtle nesting: Dec-Jan; green turtle nesting: Nov to Apr, peak period from Jan to Feb; flatback turtle nesting: Dec to Jan; hawksbill turtle nesting: Oct to Jan <u>Seabirds</u> Migratory birds (important habitat) (important bird area) 10th of top 147 bird sites	concentration >100 g/m²						
			Maximum length of shoreline oiled (>100 g/m²)	(km)	6	2			
			Maximum concentration of entrained oil >100 ppb	(ppb)	235	405			
			Maximum concentration of dissolved hydrocarbon >50 ppb	(ppb)	314	118			

Receptor (hotspot) name	HEV Ranking	Values	Oil Spill Modelling Parameter NC = No Contact		Subsea	Surface	Consequence Category	Consequence Ranking	Final
		Highest population of migratory birds in Barrow Island Nature Reserve (south-southeast island) Double island important bird nesting (shearwaters, sea eagles) <u>Whales</u> Pygmy blue whale northern migration (Apr to Aug) <u>Cultural heritage</u> Important Aboriginal cultural: 13 listed sites incl. pearling camps <u>Socio-economic</u> Significant for recreational fishing and charter boat tourism Nominated place (national heritage)							
	3	<u>Physical habitats</u>	Probability of contact by	(%)	NC	NC		II	II

Receptor (hotspot) name	HEV Ranking	Values	Oil Spill Modelling Parameter NC = No Contact		Subsea	Surface	Consequence Category	Consequence Ranking	Final
Outer NW Ningaloo (Submerged)		Coral reef Seagrasses Macroalgal beds Non-coral benthic habitats high and unique sponge biodiversity Marine fauna Invertebrates Cetacean migration Finfish and rays Whale sharks – migratory and aggregation site Manta rays aggregation 500 finfish species recorded Birds 33 species seabirds and avifauna present (13 resident and 20 migratory) 13 JAMBA/CAMBA species Marine mammals	floating oil at 10 g/m^2				Threatened/Migratory Fauna Physical Environment/ Habitat Protected Areas Socio-Economic Receptors	II II II	
			Minimum time to contact by floating oil 10 g/m^2	Time (days)	NC	NC			
			Maximum accumulated oil ashore >100 g/m^2	m^3	NC	NC			
			Maximum accumulated concentration >100 g/m^2	g/m^2	NC	NC			
			Maximum length of shoreline oiled (>100 g/m^2)	(km)	NC	NC			
			Maximum concentration of entrained oil >100 ppb	(ppb)	499	779			

Receptor (hotspot) name	HEV Ranking	Values	Oil Spill Modelling Parameter NC = No Contact		Subsea	Surface	Consequence Category	Consequence Ranking	Final
		13 species of toothed whale and dolphin and seven species of baleen whale Protected area Key Ecological Feature (Commonwealth waters adjacent to Ningaloo Reef) and Continental Slope Demersal Fish Communities Socio-economic and heritage values Sanctuary zones under state MP National Heritage Place Shipwrecks important as diving sites	Maximum concentration of dissolved hydrocarbon >50 ppb	(ppb)	246	124			
Ningaloo Coast South (Emergent)	3	Refer Outer NW Ningaloo and Ningaloo Coast North	Probability of contact by floating oil at 10 g/m²	(%)	NC	NC	Threatened/Migratory Fauna Physical	III III III	III

Receptor (hotspot) name	HEV Ranking	Values	Oil Spill Modelling Parameter NC = No Contact		Subsea	Surface	Consequence Category	Consequence Ranking	Final
			Minimum time to contact by floating oil 10 g/m²	Time (days)	NC	NC	Environment/ Habitat Protected Areas Socio-Economic Receptors	II	
			Maximum accumulated oil ashore >100 g/m²	m^3	9	5			
			Maximum accumulated concentration >100 g/m²	g/m²	10	20			
			Maximum length of shoreline oiled (>100 g/m²)	(km)	NC	NC			
			Maximum concentration of entrained oil >100 ppb	(ppb)	32	45			
			Maximum concentration	(ppb)	2	2			

Receptor (hotspot) name	HEV Ranking	Values	Oil Spill Modelling Parameter NC = No Contact		Subsea	Surface	Consequence Category	Consequence Ranking	Final
			of dissolved hydrocarbon >50 ppb						