Mutineer-Exeter Cessation of Production and Decommissioning Environment Plan

PROJECT/FACILITY	MEFF
REVIEW INTERVAL (MONTHS)	No Review Required
SAFETY CRITICAL DOCUMENT	NO

Rev	**Owner**	**Reviewer/s** *Managerial/Technical/Site*	**Approver**
	Environment Supervisor	**Team Lead - Environment**	**Manager - Retirement**
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Rev	Rev Date	Author/Editor	Amendment
5	22/07/2022	Santos	Submission to NOPSEMA for decommissioning activities
4D	15/07/2022	Advisian, for Santos	Revised for Santos internal review
4C	16/06/2022	Advisian, for Santos	Revised for Santos internal review
4B	02/05/2022	Advisian, for Santos	Revised for Santos internal review
4A	18/03/2022	Advisian, for Santos	Revised to include seabed decommissioning activities for Santos Review
4	17/02/2022	Advisian, for Santos	Revised and resubmitted to NOPSEMA for Floating Asset Removal activities
3A	17/02/2022	Advisian, for Santos	Response to NOPSEMA RFFWI for Santos Review
3	17/12/2021	Advisian, for Santos	Revised to incorporate floating(submerged) asset removal (FAR) and explain the approvals pathway to decommissioning. Document number updated within new Santos system to 9885-650-PLN-0001. Put into new Santos template, continuous improvements made as a result of NOPSEMA assessment on other Santos EPs.
2	7/08/2018	Santos	Revised to incorporate update to ALARP assessment for source control options.
1	29/05/2018	Santos	Updated with supplementary information provided in Santos' response to NOPSEMA's RFWI, Consultation feedback from DoT, and new listing information about scalloped hammerhead shark.
0	12/03/2018	Santos	Submission to NOPSEMA
B	08/03/2018	Santos	Final Santos review
A	25/01/2018	Santos	For internal review

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Units of measurement

Unit	Description
°C	degrees centigrade
g/m^2	grams per square metre
cP	centipoise
dB	decibels
dB(A)	decibels A-weighting
hrs	hours
Hz	hertz
kHz	kilohertz
km	kilometre (1000 metres)
km^2	square kilometres
L	litre (1000 ml)
m	metre (100 cm)
m^2	square metre
m^3	cubic metre
mg/L	milligrams per litre
ml	millilitre
nm	nautical mile (1.856 km)
Pa	Pascal (unit of pressure)
ppb	parts per billion
ppm	parts per million
t	tonne (1000 kg)

Abbreviations and acronyms

Acronym/Abbreviation	Definition
AFFF	aqueous film-forming foam
AFMA	Australian Fishing Management Authority
AHO	Australian Hydrographic Office
ALARP	as low as reasonably practicable
AMOSC	Australian Marine Oil Spill Centre
AMP	Australian Marine Park (Commonwealth)
AMSA	Australian Maritime Safety Authority
API	American Petroleum Institute
APPEA	Australian Petroleum Production and Exploration Association
ASBTIA	Australian Southern Bluefin Tuna Industry Association
ATBA	area to be avoided
BIA	biologically important area
CFA	Commonwealth Fishing Association
CHARM	chemical hazard and risk management
CM	control measure
CoP	cessation of production
CP	cathodic protection
DAH	dissolved aromatic hydrocarbon
DAWE	Department of Agriculture, Water and Environment
DBCA	Department of Biodiversity, Conservation and Attractions (Western Australia)
DCCEEW	Department of Climate Change, Energy, the Environment and Water
DEWHA	Department of the Environment, Water, Heritage and the Arts
DISER	Department of Industry Science, Energy and Resources
DMIRS	Department of Mines, Industry Regulation and Safety
DNP	Director of National Parks
DoEE	Department of Environment and Energy
DoF	the former Department of Fisheries (Western Australia), now amalgamated with otherDepartments to form Department of Primary Industries and Regional Development
DoT	Western Australia Department of Transport
DPIRD	Department of Primary Industries and Regional Development
DP	dynamic positioning
DSEWPaC	the former Department of Sustainability, Environment, Water,Population and Communities
DTM	disconnectable turret mooring

Acronym/Abbreviation	Definition
EHU	electro-hydraulic umbilical
EMBA	environment that may be affected
ENVID	environmental hazard identification workshop
ESSA	environmental sensitive sea areas
EP	Environment Plan
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
EPO	environmental performance outcome
EPS	environmental performance standard
EPU	electrical power umbilical
ESD	ecologically sustainable development
FID	Final Investment Decision
FPSO	floating production, storage and offloading unit
GHD	GHD Pty Ltd
GHG	greenhouse gas
HEV	high environmental value
HOCNF	harmonised offshore chemical notification format
HSE	health, safety and environment
IBC	intermediate bulk container
IMO	International Maritime Organization
IMMR	inspection, monitoring, maintenance and repair
IMS	invasive marine species
IMSMP	Invasive Marine Species Management Plan
ISU	integrated services umbilical
IUCN	International Union for Conservation of Nature
JRCC	Joint Rescue Coordination Centre
KEF	key ecological feature
LOWC	loss of well control
MARPOL	International Convention for the Prevention of Pollution from Ships
MDO	marine diesel oil
ME	Mutineer-Exeter (Development)
MEFF	Mutineer, Exeter, Fletcher, Finucane
MEG	monoethylene glycol
MEVA	moderate exposure value area
MNES	matter of national environment significance
MoC	management of change

Acronym/Abbreviation	Definition
MODU	mobile offshore drilling unit
MoU	Memorandum of Understanding
MPNMP	Marine Park Network Management Plan
MTWA	Marine Tourism WA
MWA	mid-water arch
NC	no contact
NEBA	net environmental benefit analysis
NOPSEMA	National Offshore Petroleum Safety and Environmental Management Authority
NWS	North West Shelf
OCNS	Offshore Chemical Notification Scheme
ODS	ozone-depleting substance
OIW	oil in water
OPEP	Oil Pollution Emergency Plan
OPGGS(E)R	Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009
OPGGS Act	*Offshore Petroleum and Greenhouse Gas Storage Act 2006*
OVID	Offshore Vessel Inspection Database
OWM	oil weathering model
P&A	plug and abandonment
PAH	polycyclic aromatic hydrocarbon
PLONOR	pose little or no risk (to the environment)
PLV	pipelay vessel (PLV)
PMS	planned maintenance system
PMST	Protected Matters Search Tool
PPA	Pearl Producers Association
PSZ	petroleum safety zone
PTS	permanent threshold shift
PUDU	production umbilical distribution unit
ROV	remotely operated vehicle
Santos	Santos Ltd
SDS	safety datasheet
SEL	sound exposure level measured as dB re 1 $\mu Pa^2 \cdot s$
SINTEF	The Foundation for Scientific and Industrial Research at the Norwegian Institute of Technology
SOPEP	Shipboard Oil Pollution Emergency Plan

Acronym/Abbreviation	Definition
SMPEP	Shipboard Marine Pollution Emergency Plan
SMS	Santos Management System
SPL	sound pressure level
TTS	temporary threshold shift
UTA	umbilical termination assembly
WA	Western Australia
WAFIC	Western Australian Fishing Industry Council
WDCS	Whale and Dolphin Conservation Society
WOMP	Well Operations Management Plan
4LPP	Four-layer polypropylene
3LPE	Three-layer polyethylene

1. Introduction

1.1 Environment Plan summary

Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009 (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; and (ix) details of the titleholder's nominated liaison person for the activity. (b) must be to the satisfaction of the Regulator.

This revision of the Mutineer, Exeter, Fletcher and Finucane Cessation of Production Environment Plan Summary has been prepared from material provided in the 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 3.1**
A description of the receiving environment	**Section 5** and **Appendix D**
A description of the activity	**Section 4**
Details of the environmental impacts and risks	**Sections 8 and 9**
The control measures for the activity	**Sections 8 and 9**
The arrangements for ongoing monitoring of the titleholder's environmental performance	**Section 10**
Response arrangements in the oil pollution emergency plan	**Sections 8.9**, **9.5**, **9.6 and 9.8** **See Mutineer, Exeter, Fletcher and Finucane Cessation of Production Oil Pollution Emergency Plan (9885-650-PLN-0002)**
Consultation already undertaken and plans for ongoing consultation	**Section 6**

Details of the titleholders nominated liaison person for the activity	**Section 1.6.1**

1.2 Background

Santos Ltd (Santos) is the registered titleholder for production licences WA-54-L, WA-26-L and WA-27-L, which cover the Mutineer, Exeter, Fletcher and Finucane (MEFF) light crude oil fields, located in water depths of 130 to 160 m on the North West Shelf (NWS), around 160 km offshore from Dampier. Santos produced hydrocarbons from the Mutineer, Exeter, Fletcher and Finucane light crude oil fields (previously known as the Mutineer Exeter (ME) Development) in these permits between 2005 and 2018. Production occurred from a series of subsea wells linked by subsea pipelines via a disconnectable turret mooring (DTM) to a Floating Production Storage and Offloading unit (FPSO).

Operation of the facility was performed under the MEFF Development Field Operations (Operations) Environment Plan (ME-7000-A02-F003), accepted by the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) in July 2014. Activities described in the Operations EP included onboard processing of production fluids (and associated discharges), ongoing vessel-based inspection and intervention activities, as well as periodic disconnection of the FPSO, typically in response to cyclones or other operational (e.g., maintenance) requirements. During disconnection periods, the production wells were shut in, the DTM was lowered to around 30 m below the surface and the subsea equipment remained in place.

Production from the fields ceased in 2018, when Santos shut in production from the remaining wells in April 2018.The subsea production system was seawater flushed, preserved then the FPSO was disconnected from the DTM and departed the field in quarter Q3 2018. The subsea equipment remained in place and the development transitioned to a 'cessation' phase that will continue until field decommissioning occurs.

The MEFF fields are currently managed under the following documents approved by NOPSEMA:

+ Mutineer Exeter Cessation of Production (CoP) Environment Plan (9885-650-PLN-0001) last accepted by NOPSEMA on 21st March 2022.
+ Mutineer Exeter Cessation of Production Oil Pollution Emergency Plan (OPEP) (9885-650-PLN-0002) last accepted by NOPSEMA on 21st March 2022.
+ Mutineer Exeter Cessation of Production Safety Case (ME-7000-REP-0253) – accepted 19th July 2018.
+ Mutineer, Exeter, Finucane and Fletcher Inactive and Temporary Abandoned Wells Well Operations Management Plan (WOMP) (9885-200-IMP-0001) – accepted 28th March 2022.

Disconnection of the FPSO and sail away from the Operational Area has already been completed and is not part of the scope of this EP. The last accepted revision of the MEFF CoP EP described the initial phase of subsea equipment decommissioning, being removal of the floating assets which consist of the disconnectable turret mooring (DTM) and two mid-water arch (MWA) assemblies, in Q4 2022. The permanent plug and abandonment (P&A) of the wells will be undertaken in accordance with a separate EP, with activity commencing in H1 2024 and taking approximately 7 months. This EP has been further revised to include decommissioning of the remaining subsea equipment, being the equipment located on the seabed during production, which is planned to commence in H2 2024 and be completed by the end of 2025. Removal of the majority of the subsea equipment, including flowlines and umbilicals, is planned to commence after completion of the wells P&A. However, early removal of some subsea equipment located around the drill centres may be undertaken during well P&A if the opportunity arises.

Timing and duration of these activities is subject to change due to project schedule requirements, vessel availability, unforeseen circumstances and weather. This EP revision for Decommissioning risk assesses decommissioning activities throughout the year (all seasons) to provide operational flexibility. All the above timeframes are subject to change and, as such, no particular time periods have been nominated. Removal of subsea equipment may be carried out over multiple campaigns. Asset integrity for the purposes of removal has been demonstrated till the end of 2026 using cathodic protection measurements obtained during the 2021 inspection campaign. Several options for removal of the subsea equipment from the seabed have been identified. Selection of the final removal methodology is subject to further studies and availability of suitable vessels and other equipment.

1.3 Scope of this Environment Plan

This EP covers the continued cessation phase of the MEFF Development, floating asset removal, and the final field decommissioning phase. Cessation phase commenced when production ceased in 2018, flushing activities were completed and the FPSO departed the field. The petroleum activities covered in this EP include:

+ the presence of all equipment on title and in the water column, including the mooring system, up until removal and during the field decommissioning phase
+ inspection, monitoring, maintenance and repair (IMR) activities on subsea equipment in the title area until removed or decommissioned under this EP
+ removal of floating asset (DTM and MWAs) from the title area
+ removal of subsea equipment normally located on the seabed during production
+ decommissioning and abandonment in situ of select subsea equipment normally located on the seabed during production.

This revision of the MEFF CoP and Decommissioning EP is a 5 year revision and as such, Santos seek that the expiry date will be 5 years from the acceptance of the EP to allow for field decommissioning by the end of 2025, and then providing sufficient time for EP compliance reporting and title relinquishment.

1.4 Purpose of this Environment Plan

The purpose of this EP is to meet the requirements of the Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009 (OPGGS(E)R) for acceptance by NOPSEMA, specifically to provide the following:

+ description of all property brought onto title, including its status and condition (**Section 4**)
+ description of how Santos will maintain all property on the title, as required by s572 (2) of the *Offshore Petroleum and Greenhouse Gas Storage Act 2006* (OPGGS Act) to ensure it can be removed, such that end states are not precluded (**Section 4**)
+ detailed plan for the removal or abandonment in situ of all equipment and execution timing (**Section 4**)
+ description of the activities associated with the ongoing cessation of production phase and field decommissioning phase of the MEFF Development (**Section 4**)
+ description of the existing environment (**Section 5**) that may be affected by the activity
+ implementation strategy (**Section 10**) that will be used to measure and report on environmental performance to ensure impacts and risks during planned and unplanned events are reduced to as low as reasonably practicable (ALARP) and acceptable levels.

In addition, this EP also details how Santos will meet the requirements of s270 of the OPGGS Act to allow Santos to surrender titles once the activities under this EP have ended, and all obligations under this EP have been completed. Section 270 of the OPGGS Act requires titleholders applying to surrender a petroleum title (among other things):

+ to provide, to the satisfaction of NOPSEMA, for the conservation and protection of natural resources in the title
+ to the satisfaction of NOPSEMA, make good any damage to the seabed or subsoil in the surrender area caused by any person engaged or concerned in the operations authorised by the title.

A demonstration of how the relevant requirements of s270 and the associated draft Section 270 NOPSEMA Advice - Consent to Surrender Title policy (NOPSEMA 2021) requirements are met by this EP is provided in **Section 10.5**.

1.5 Decommissioning environment plan and project planning activities

Santos has previously committed to an approvals pathway to decommissioning which included the following three steps.

<u>Step 1</u>This step involved a revision of the MEFF Cessation of Operations EP to include floating asset removal (DTMs and mid-water arches (MWAs)). This particular revision of the CoP EP was submitted to NOPSEMA in December 2021, accepted as Rev 4 on 21 March 2022.

<u>Step 2:</u>

Submit a revision to the MEFF CoP EP by no later than 31st August 2022 (This EP revision) which provides for the end state decommissioning of the MEFF Field. The matters addressed in the revision to the CoP EP are the same as in Step 1 but include additional matters specific to remaining subsea equipment decommissioning as outlined below:

+ detailed plans of the proposed subsea decommissioning activities. In particular, the fate of all property on the title, proposed decommissioning methodology, scope of work and execution strategy
+ an evaluation of the feasibility of all options, including partial and complete property removal
+ an evaluation of environmental impacts and risks of all feasible options, including complete property removal, to enable NOPSEMA to have regard to the Australian Government Decommissioning Guideline policy principle that deviations will provide an equal or better environmental outcome when compared to complete property removal. The evaluation of all the environmental impacts and risks of each option must include consideration of control measures necessary to manage the impacts and risks
+ evaluation of all environmental impacts and risks within Australia's environment including, where relevant, indirect consequences that may arise from the petroleum activity of removing, or not removing, property from a title area
+ where deviation/s to removal of property or relocation of property is proposed, Santos has address arrangements for monitoring and management
+ an evaluation of all impacts and risks from the proposed decommissioning end state activities to demonstrate that the end state option provides a net environmental benefit and impacts and risks are managed to acceptable levels and ALARP
+ consideration of relevant persons' consultation with respect to the options being proposed
+ this revision of the CoP EP includes end state decommissioning as described above, and as such will require a 5 year extension. Therefore, if accepted by NOPSEMA, this EP will be valid for five years from the date of NOPSEMA acceptance.

Step 3:

Submit a P&A EP by 31st August 2022 which provides for well plugging and closing activities. The matters to be addressed in the P&A EP are:

+ description of all property brought onto title, including its current status and condition
+ description of all the activities associated with the plug and abandonment of all wells on title
+ detailed plans of P & A activities and the execution timings.

In terms of project planning to support Steps 2 and 3, indicative milestones (at the time of writing this EP), for future decommissioning planning are as follows:

+ P&A Select phase completed Q3 2022
+ Rig contract for P&A awarded by Q3 2022
+ Seabed asset removal Select phase completed Q4 2022
+ Seabed asset removal contract development and tendering in 2023
+ Seabed asset removal final investment decision (FID) and main contract award(s) Q1 2024.

The following timings are anticipated with respect to the execution of decommissioning activities:

+ Floating asset removal is planned to commence in Q4 2022 with removal of buoyant equipment planned to be completed by the end of 2022.
+ Well P&A activity is planned to commence in H1 2024, with an expected campaign of around 7 months.
+ Seabed equipment decommissioning is planned to resume after completing the well P&A campaign; therefore, further subsea decommissioning is planned to commence in Q4 2024. However, activities to support seabed equipment decommissioning, such as as-found ROV surveys, may commence prior to the conclusion of the P&A campaign (refer to **Section 4.2.2**).
+ Early removal of subsea equipment located around the drill centres may be undertaken should the opportunity arise.

1.6 Details of the titleholder

Santos is the registered titleholder for WA-26-L, WA-27-L and WA-54-L, authorised pursuant to subsection 775B(2) of the Commonwealth OPGGS Act to take eligible voluntary actions on behalf of the titleholders. **Table 1-1** provides details of the titleholders and their contact details.

1.6.1 Details of Santos' nominated liaison person

Details for Santos' Nominated Liaison Person for the activity are as follows:

Name:	Dawn MacInnes (Team Leader - Environment)
Business address:	100 St Georges Terrace, Perth, Western Australia (WA) 6000
Telephone number:	(08) 6218 7100
Email address:	offshore.environment.admin@santos.com

1.6.2 Notification procedure in the event of changed details

In the event there is a change in the titleholder, the titleholder's nominated liaison person or change in the contact details for the titleholder or liaison person, Santos will notify NOPSEMA and provide updated details as soon as practicable and prior to the change occurring.

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

Table 1-1: Titleholder details for WA-26-L, WA-27-L and WA-54-L

Titleholder	ACN	Address
Santos Limited	007550923	Business Address (Head Office): 60 Flinders Street, Adelaide, South Australia 5000 Telephone number: +61 8 8116 5000 Fax number: +61 8 8116 5050 offshore.environment.admin@santos.com
Kufpec (Australia) Pty Ltd	001800924	Business Address: Administrative Shuwaikh – Area 4 – Street 102 – Building No. 9, PO Box 5291 Safat, 13053 Kuwait Telephone number: +965 1836000 Fax number: +965 24951818 Email address: kufpec@kufpec.com
JX Nippon Oil and Gas Exploration (Australia) Pty Ltd	078323743	Business Address (Head Office): 1-2 Otemachi 1-chome, Chiyoda-ku, Tokyo, 100-8163 Japan Telephone number: +81(0)3-6257-6000 Fax number: +81 (0)3-6213-3511 Email address: jxnoes.operation@jxnoes.com.au

1.7 Environmental management framework

The activity will be conducted in accordance with the Santos Environment, Health and Safety Policy **Appendix A**) and Santos Management System (**Section 10**). In addition, there are a number of Commonwealth and Western Australian Acts / Regulations and international agreements and conventions relevant to the activity, as described in **Section 2** and **Appendix B**.

Santos

2. Relevant requirements

2.1 Legislative Requirements for Decommissioning

2.1.1 Offshore Petroleum and Greenhouse Gas Storage Act 2006

The OPGGS Act provides the regulatory framework for all offshore exploration and production activities in Commonwealth waters (those areas beyond three nautical miles from the Territorial sea baseline and in the Commonwealth Petroleum Jurisdiction Boundary). The Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009 (referred to as the Environment Regulations) have been made under the auspices of the OPGGS Act for the purposes of ensuring (as described in Section 3) "…any petroleum activity or greenhouse gas activity carried out in an offshore area is:

+ carried out in a manner consistent with the principles of ecologically sustainable development set out in section 3A of the EPBC Act
+ carried out in a manner by which the environmental impacts and risks of the activity will be reduced to as low as reasonably practicable
+ carried out in a manner by which the environmental impacts and risks of the activity will be of an acceptable level".

Section 572 of the OPGGS Act requires that titleholder maintain their property and remove their property from a petroleum title area when it is no longer in use, which is consistent with the requirement of Article 60 of UNCLOS. However, the Commonwealth recognises that removal of property may not be feasible, or may result in environmental, safety and economic outcomes that are worse than leaving property in situ. The Offshore Petroleum Decommissioning Guideline (Commonwealth of Australia, 2018) outlines the Commonwealth's principles on decommissioning property used for offshore oil and gas exploration and production:

+ decommissioning is the responsibility of the titleholder
+ early planning for decommissioning is encouraged
+ complete removal of property is the base case
+ decommissioning must be completed before the end of the title.

Noting these principles, the Offshore Petroleum Decommissioning Guideline (Commonwealth of Australia, 2018) states that NOPSEMA may consider other options than complete removal. The guideline requires titleholder to demonstrate that any proposed alternatives to full removal must result in equal or better environmental, safety and well integrity outcomes compared to full removal.

The Section 572 Maintenance and Removal of Property policy (NOPSEMA 2020) outlined NOPSEMA's position on Section 572 of the OPGGS Act and the Offshore Petroleum Decommissioning Guideline (Commonwealth of Australia, 2018). This policy reinforces full removal of property is the base case for decommissioning and outlines NOPSEMA's position on alternatives to full removal of property. The policy requires that any EP proposing an alternative to full removal must include:

+ an evaluation of the feasibility of all options, including partial and complete removal of property.
+ an evaluation of environmental impacts and risks of all feasible options, including complete property removal, to enable NOPSEMA to have regard to the Australian Government Decommissioning Guideline policy principle that deviations will provide an equal or better environmental outcome when compared to complete property removal. The evaluation of all the environmental impacts and risks of each option must include consideration of control measures necessary to manage the impacts and risks.

- evaluation of all environmental impacts and risks within Australia's environment including, where relevant, indirect consequences that may arise from the petroleum activity of removing property from a title area.
- where deviation/s to removal of property or relocation of property is proposed, titleholders are to address arrangements for long term monitoring and management. Environment plans requiring long term monitoring for property will be subject to environmental performance reporting requirements and compliance monitoring by NOPSEMA for the duration of the monitoring program. NOPSEMA advises the Joint Authority of EPs requiring long term monitoring for property and this may be a matter taken into account when considering surrender of titles.
- consideration of relevant persons' consultation with respect to the options being proposed.

Section 270 of the OPGGS Act relates to the surrender of petroleum titles. Section 270 requires titleholders applying to surrender a petroleum title (among other things):

- to provide, to the satisfaction of NOPSEMA, for the conservation and protection of natural resources in the title
- to the satisfaction of NOPSEMA, make good any damage to the seabed or subsoil in the surrender area caused by any person engaged or concerned in the operations authorised by the title.

The draft Section 270 NOPSEMA Advice - Consent to Surrender Title policy (NOPSEMA 2021) provides the most detailed advice to date from NOPSEMA on addressing arrangements for long term monitoring. Section 10.3 – Monitoring and Survey Expectations of Section 270 NOPSEMA Advice - Consent to Surrender Title policy (NOPSEMA 2021) states the following monitoring and survey expectations held by NOPSEMA:

- the final condition of the surrender area has been delivered as described in permissioning documents and control measures to manage the impacts and risks have been effective.
- the final impacts and risks upon the environment shall be determined by comparison between initial baseline condition monitoring and survey data and the end state condition.
- subsequent monitoring and surveys may be required based upon an assessment of risk to confirm the final condition has not changed and control measures to manage the impacts and risks remain effective. Consideration shall be given to the risks in perpetuity associated with property that is not removed.
- performance reports shall be provided for the duration of monitoring and survey activities.

Section 10.4 – Reporting of the draft Section 270 NOPSEMA Advice - Consent to Surrender Title policy (NOPSEMA 2021) outlines NOPSEMA expectations for reporting, which is applicable for reporting on long term monitoring arrangements. NOPSEMA expects reports should (NOPSEMA 2021):

- demonstrate that all conditions and obligations included in the accepted final permissioning document have been met
- provide evidence that assumptions, performance standards and measurement criteria have been met where applied to conditions or obligations
- provide detail of any criteria or obligation that has not been met, and any changes to the conditions or obligations approved in the accepted permissioning document
- describe any variations from the accepted decommissioning operations and work plan
- confirm the control measures applied to manage the impacts and risks associated with an accepted deviation have been effective

- describe any immediate consequences observed as a result of decommissioning operations and works.

2.1.2 Environment Protection and Biodiversity Conservation Act 1986

The EPBC Act aims to protect and manage nationally and internationally important flora, fauna, ecological communities and heritage places in Australia. These are defined in the Act as Matters of National Environmental Significance (MNES). NOPSEMA, through the Streamlining Offshore Petroleum Environmental Approvals Program, implements these requirements with respect to offshore petroleum activity in Commonwealth waters. The Streamlining Offshore Petroleum Environmental Approvals Program is applicable to all offshore petroleum activity authorised by the OPGGS Act and requires the petroleum activity to be conducted in accordance with an accepted EP, consistent with the principles of ecologically sustainable development (ESD). The definition of 'environment' in the Streamlining Offshore Petroleum Environmental Approvals Program is consistent with that used in the EPBC Act and encompass all matters protected under Part 3 of the EPBC Act. Under s268 of the EPBC Act:

> "A Commonwealth agency must not take any action that contravenes a recovery plan or a threat abatement plan."

In respect to offshore petroleum activities in Commonwealth waters, the above is implemented by NOPSEMA. Commitments relating to listed threatened species and ecological communities under the Act are included in the Program Report (Commonwealth of Australia, 2014):

- NOPSEMA will not accept an Environment Plan that proposes activities which will result in unacceptable impacts to a listed threatened species or ecological community
- NOPSEMA will not accept an Environment Plan that is inconsistent with a recovery plan or threat abatement plan for a listed threatened species or ecological community
- NOPSEMA will have regard to any approved conservation advice relating to a threatened species or ecological community before accepting an Environment Plan.

Recovery and management plans relevant to this EP are discussed as applicable in **Sections 8** and **9**.

2.1.3 Environment Protection (Sea Dumping) Act 1981

The Sea Dumping Act 1981 requires sea dumping permits to be obtained for particular activities and gives effect to the United Nations Convention on the Law of the Sea and the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (London Convention) and associated Protocol.

In instances where infrastructure is proposed to be left on the seabed, the activity may be considered a dumping activity that is regulated under the Sea Dumping Act. In these instances, permits are required from Department of Climate Change, Energy, the Environment and Water (DCCEEW) prior to these activities.

2.1.4 Other Commonwealth and State Legislation

Refer to **Appendix B** for further information on other applicable Commonwealth and Western Australian Acts / Regulations relevant to the activity.

2.1.5 United Nations Convention on the Law of the Sea (UNCLOS)

Article 60 of the 1982 United Nations Convention on the Law of the Sea (UNCLOS), to which Australia is a party, states:

> "Any installations or structures which are abandoned or disused shall be removed to ensure safety of navigation, taking into account any generally accepted international standards established in this regard by the competent international organization. Such removal shall

also have due regard to fishing, the protection of the marine environment and the rights and duties of other States."

The International Maritime Organization (IMO), a body created by agreement of member states of the United Nations, is regarded as the competent organization to deal with this requirement. Following UNCLOS, the IMO published Resolution A.672(16) Guidelines and Standards for the Removal of Offshore Installations and Structures on the Continental Shelf and in the Exclusive Economic Zone (IMO 1989). This resolution recognizes that structures on the continental shelf should be removed, but coastal states (such as Australia) may make decisions to leave structures partially or completely in the sea. Australia is a member state of the IMO.

3. MEFF Overview and Decommissioning options

3.1 Location

The MEFF fields are located approximately 160 km north of Dampier in production licences WA-26-L, WA-27-L and WA-54-L (**Figure 3-1**). Water depth at MEFF ranges from 130 m to 160 m.

The activities covered by this EP will occur in the immediate vicinity of the field equipment, located within the operational area shown on **Figure 3-1** and within the coordinates presented in **Table 3-1**.The coordinates of key field equipment are provided in **Table 3-2**.

Table 3-1: Coordinates for the operational area

Operational Area	Latitude	Longitude
Point 1	19° 9' 55.21" S	116° 35' 4.72" E
Point 2	19° 9' 55.21" S	116° 40' 4.72" E
Point 3	19° 14' 55.21" S	116° 40' 4.72" E
Point 4	19° 14' 55.21" S	116° 45' 4.72" E
Point 5	19° 9' 55.21" S	116° 45' 4.72" E
Point 6	19° 9' 55.20" S	116° 50' 4.72" E
Point 7	19° 19' 55.21" S	116° 50' 4.72" E
Point 8	19° 19' 55.22" S	116° 35' 4.72" E
Point 9	19° 19' 55.22" S	116° 30' 4.72" E
Point 10	19° 14' 55.22" S	116° 30' 4.72" E
Point 11	19° 14' 55.21" S	116° 35' 4.72" E
Point 12	19° 9' 55.21" S	116° 35' 4.72" E

Table 3-2: Geographical location of key equipment

Equipment	Latitude	Longitude
Dis-connectable Turret Mooring (DTM)	19° 16' 33.5" S	116° 36' 45.6" E
Mutineer Booster Pump Manifold (MBPM)	19° 15' 32.8" S	116° 38' 16.3" E
Exeter Booster Pump Manifold (EBPM)	19° 18' 35.4" S	116° 33' 41.1" E
Fletcher Pipeline End Manifold (PLEM)	19° 14' 43.8" S	116° 47' 43.9" E
Finucane Pipeline End Manifold (PLEM)	19° 18' 17.3" S	116° 45' 32.9" E

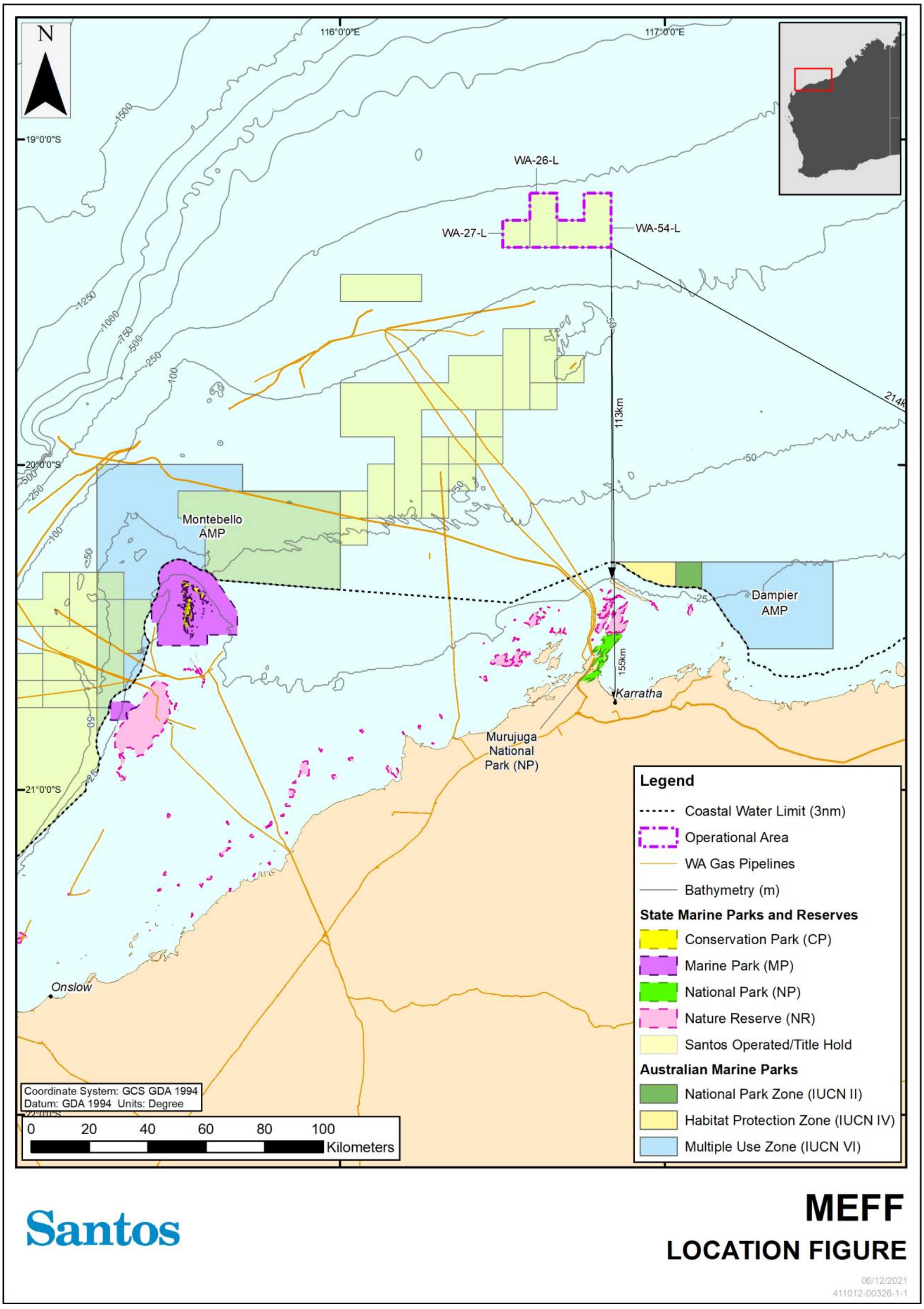

Figure 3-1: Mutineer, Exeter, Fletcher, Finucane Field location map

3.2 General Details

Cessation Phase

The MEFF Development during the cessation phase comprises the following:

- A subsea production system with a production centre in each of the MEFF fields. The subsea production system has been flushed of hydrocarbons with treated seawater and left in a preservation state since the FPSO departed the field in July 2018. The reservoirs are isolated from the subsea production system at the Xmas trees (XTs), although the subsea production system remains connected to the DTM via risers; and
- A DTM (approximately 30 m below the sea surface) with six deeply buried steel anchors and the six corresponding steel mooring chains of approximately 710m per mooring (whereby approximately 130m is unburied), and two MWAs (approximately 82 m below the sea surface) are located between the Mutineer and Exeter fields.

For the cessation period, between flushing before the FPSO left the field in 2018 and final decommissioning, all well valves will remain isolated unless they are required to be operated to allow decommissioning activities.

During this time, subsea inspections of the DTM and the subsea production system on title, will occur to ensure ongoing integrity. These inspections and interventions are performed by remotely operated vehicle (ROV) or diving from a support vessel. Typical subsea inspection and intervention activities performed may include:

- DTM inspections, such as inspecting the spider buoy and mooring lines
- riser, flowline, umbilical and MWA inspections
- subsea production centre inspections, such as inspecting the XTs, manifolds, spools, umbilical termination assemblies (UTAs), production umbilical distribution units (PUDUs), jumpers, etc
- cathodic potential measurements
- maintenance and repair, such as replacing anodes or installing anode skids
- recovery of dropped objects
- clearing debris (e.g., calcareous marine growth) using high-pressure water jetter and/or flapper tool
- close visual inspection and measurements of critical components
- seabed burial and environmental survey using:
  - multi-beam echo sounder
  - side scan sonar
  - sub bottom profiling
  - seabed grab sampling
  - autonomous underwater vehicle towed camera for identifying debris or raise seabed features.

Decommissioning Phase

Based on the outcomes from the comparative environmental impact assessment of feasible decommissioning options (detailed in **Section 3)**, Santos proposes the following decommissioning strategy:

Equipment to be left in situ:

Two steel, epoxy coated gravity bases (approximately 19m x 6m x 3,1m high) complete with concrete ballast (approximately 6m x 1.4m x 2.35m high) weighing about 330t each set and their associated tether chains (approximately 80m each); andSix deeply buried steel anchors and the six corresponding steel mooring chains of approximately 130m of chain being unburied/to be laid on the seabed and expected to bury over time.All other equipment will be removed and disposed of, including:

- floating assets:
  - DTM
  - MWAs
- seabed assets:
  - 12” rigid production flowlines and piggybacked 2” coiled tubing well service flowlines
  - 10.2”, 9” and 3” flexible flowlines, umbilicals and flexible risers
  - Manifold (including flowmeters) and mudmats
  - pipeline end manifolds
  - rigid tie-in spools
  - hydraulic flying leads and electric flying leads
  - production umbilical distribution units (PUDU) and umbilical termination assemblies (UTA)
  - Xmas trees complete with guidebase (if not recovered during P&A)
  - Wellheads (if not removed during P&A)
  - MWA tether chains
  - DTM mooring riser wires
  - Umbilical riser bases
  - Auxiliary Items (Concrete Mattresses, grout bags, sandbags, etc.)

3.3 Facilities Description

The MEFF subsea equipment is depicted in **Figure 3-2**. The MV-11 FPSO sailed away in July 2018, leaving the DTM system in place with the spider buoy around 30 m below sea level and remaining connected to six mooring chains. The MWAs also remain in place around 82 m below sea level. **Figure 3-3** shows the DTM and MWAs arrangement. An inspection in March 2021 confirmed the location of the DTM spider buoy, MWAs and confirmed that all mooring chains and tethers are connected. Ongoing integrity management is as per a risk-based inspection regime to ensure the floating assets (DTM and MWA’s), as well as the subsea equipment can be removed from title. **Table 3-3** shows the quantities, condition and status of subsea equipment that remains in place post cessation of production and FPSO sail away, and the potential hydrocarbon and chemicals that could be released during removal of the seabed assets.

In 2018, prior to FPSO disconnection and sail away, flushing of the subsea production system was performed and confirmed to achieve a residual oil in water (OIW) concentration of 30 to 40 ppm at the FPSO (Ref 9885-011-TIN-0001 – MEFF Historical Flushing Records). **Table 4-1** shows the expected residual hydrocarbon content for the production system post the 2018 flushing campaigns using 40 ppm as a conservative approach for calculations, as well as maximum hydrocarbon discharges during disconnection of risers and flowlines during the floating asset removal activities. This detail is presented in **Section 4.6.2**.

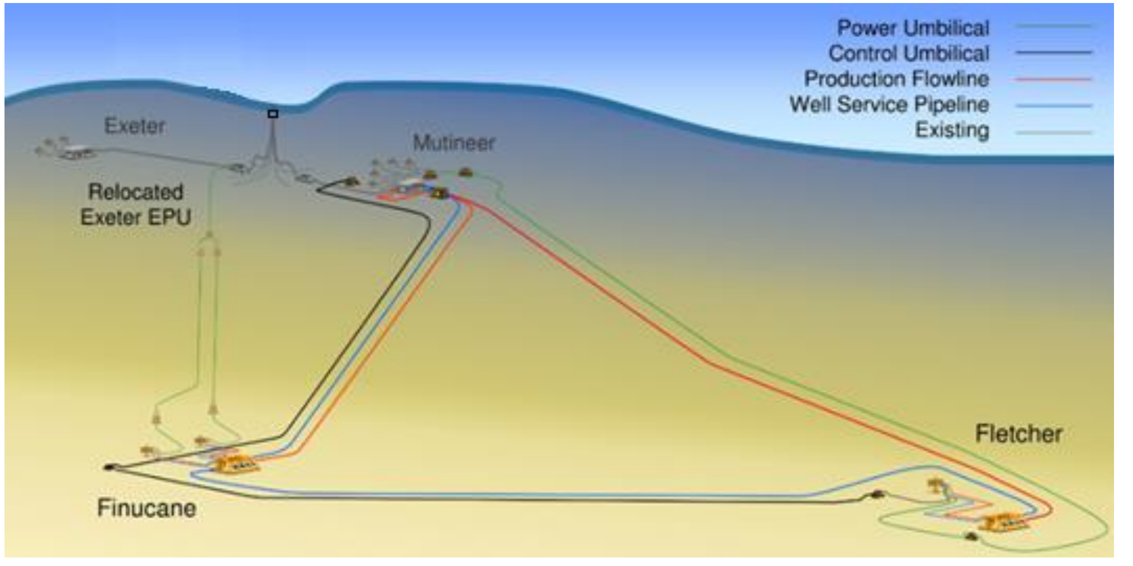

Figure 3-2: Mutineer, Exeter, Fletcher, Finucane subsea facilities

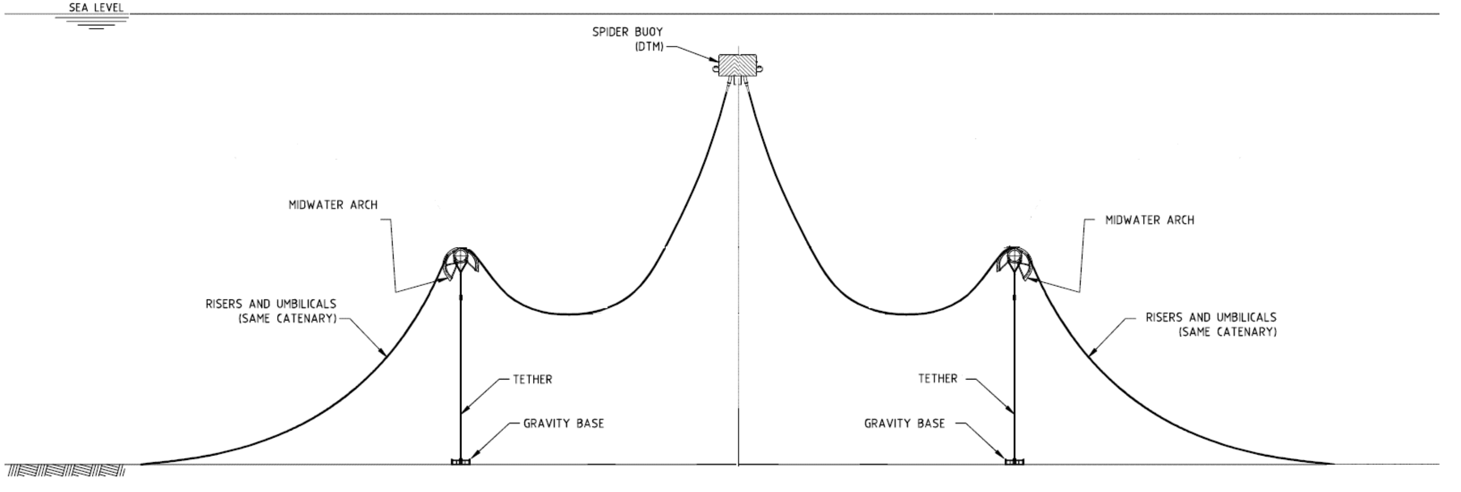

Figure 3-3: Schematic of disconnectable turret mooring and mid-water arches arrangement

Table 3-3: Summary of the status and condition of Mutineer, Exeter, Fletcher, Finucane equipment on title

Equipment Description	Permit (Field)	Qty	Condition	Status	Approximate Dimensions and Weight (each)
Subsea Xmas trees, flowbases and guidebases	WA-27-L (Exeter)	3	Exeter-4H – XT with Guidebase, jumper spool connected to manifold protected by cathodic protection (CP).	Exeter-4H – Shut-in with controls disconnected and barrier tested 2018.	Dimensions: 4.22 m x 4.22 m x 4.95 m Weight: 50 Te
			Exeter-7 – Guidebase only with jumper spool connected to manifold protected by CP.	Exeter-7 – Temporarily abandoned, deep cement plugs installed.	
			Exeter-8HL1 – Guidebase only with jumper spool connected to manifold protected by CP.	Exeter-8HL1 – Temporarily abandoned, cement plug and surface plug installed.	
	WA-26-L (Mutineer)	5	Mutieer-4 – XT with Guidebase, jumper spool connected to manifold protected by CP.	Mutieer-4 – Shut-in with controls disconnected and barrier tested 2018.	Dimensions: 4.22 m x 4.22 m x 4.95 m Weight: 50 Te
			Mutieer-5 – XT with Guidebase, jumper spool connected to manifold protected by CP.	Mutieer-5 – Shut-in with controls disconnected and barrier tested 2018.	
			Mutieer-9H – XT with Guidebase, jumper spool connected to manifold protected by CP.	Mutieer-9H – Shut-in with controls disconnected and barrier tested 2018.	
			Mutieer-12 – XT with Flowbase, jumper spool connected to manifold protected by CP.	Mutieer-12 – Shut-in with controls disconnected and barrier tested 2018.	
			Mutieer-15 – XT with Flowbase, jumper spool connected to manifold protected by CP.	Mutieer-15 – Shut-in with controls disconnected and barrier tested 2018.	
	WA-54-L (Fletcher)	1	Fletcher-5H – XT with Flowbase, jumper spool connected to manifold protected by CP.	Fletcher-5H – Shut-in with controls disconnected and barrier tested 2018.	Dimensions: 3.9m x 3.9m x 2.9m Weight: 55Te
	WA-54-L (Finucane)	2	Finucane South-2H – XT with Flowbase, jumper spool connected to manifold protected by CP.	Finucane South-2H – Shut-in with controls disconnected and barrier tested 2018.	Dimensions: 3.9 m x 3.9 m x 2.9 m Weight: 55 Te
			Finucane South-3H – XT with Flowbase, jumper spool connected to manifold protected by CP.	Finucane South-3H – Shut-in with controls disconnected and barrier tested 2018.	
			Finucane South-1A – well head only.	Finucane South-1A – Temporarily abandoned, deep/shallow cement plugs installed.	
DTM (inclusive of six wire chain mooring)	WA-26-L (Mutineer)	1	One DTM protected by CP with ten flexible risers and umbilicals connected. Held in position by 6 off mooring lines.	DTM is currently around 30 m below mean sea level since disconnection from the FPSO in 2018.	Dimensions: Φ12 m x 7.3 m Weight (DTM): 550 Te Weight (6 off Mooring System): 1,310 Te Weight (6 off Mooring Riser Wire): 25 Te
12-inch flexible production risers	WA-27-L (Exeter)	1	Production risers flushed before FPSO disconnection 2018.	Both risers connected to the DTM via the pull-in head and riser isolation valve hang-off assembly.	Length: 0.43km Weight: 75t

Equipment Description	Permit (Field)	Qty	Condition	Status	Approximate Dimensions and Weight (each)
	WA-26-L (Mutineer)	1			Length: 0.43km Weight: 75t
	WA-54-L (Fletcher)	0	N/A	N/A	N/A
	WA-54-L (Finucane)	0			
2-inch flexible well service risers	WA-27-L (Exeter)	1	Well service risers flushed before FPSO disconnection 2018.	Both risers connected to the DTM via riser pull-in head.	Length: 0.43km Weight: 25t
	WA-26-L (Mutineer)	1			Length: 0.43km Weight: 25t
	WA-54-L (Fletcher)	0	N/A	N/A	N/A
	WA-54-L (Finucane)	0			
Umbilical dynamic risers (integrated services and electrical power types)	WA-27-L (Exeter)	3	Integrated service umbilical (ISU) cores containing Morlina Oil were flushed with treated seawater before FPSO disconnection in 2018, remaining cores contain fluids approved for discharge under the OECA process.	Umbilical risers connected to the DTM via the riser pull-in head.	
	WA-26-L (Mutineer)	3			
	WA-54-L (Fletcher)	0	N/A	N/A	
	WA-54-L (Finucane)	0	N/A	N/A	
MWA	WA-27-L (Exeter)	1	Connected to the gravity bases via tethers, inspected in 2021 and protected by CP.	Both around 82 m below mean sea level.	Dimensions: Φ4 m x 23 m Weight: 95 Te
	WA-26-L (Mutineer)	1			
	WA-54-L (Fletcher)	0	N/A	N/A	
	WA-54-L (Finucane)	0	N/A	N/A	
MWA tether and gravity base	WA-27-L (Exeter)	1	Chain measurements taken in 2021 and within tolerance.	Connected to the MWA tethers.	Dimensions: 19 m x 6.4 m x 3.1 m Weight (Gravity Base): 229 T Weight (2 x Concrete Ballast): 104 Te Weight (2 x Chain Tether): 26.5 Te
	WA-26-L (Mutineer)	1			Dimensions: 19 m x 6.4 m x 3.1 m Weight (Gravity Base): 229 T Weight (2 x Concrete Ballast): 104 Te Weight (2 x Chain Tether): 26.5 Te
	WA-54-L (Fletcher)	0	N/A	N/A	N/A
	WA-54-L (Finucane)	0	N/A	N/A	
Production flexible flowline (10.2-inch and 9-inch)	WA-27-L (Exeter)	0	N/A; only rigid flowlines for Mutineer and Exeter.	N/A	
	WA-26-L (Mutineer)	0			
	WA-54-L (Fletcher)	1	9-inch flexible flowline is protected by CP and flushed before the FPSO disconnection 2018.	The 16,911 m flowline is currently connected to manifolds at each end.	Length: 17 km Weight: 1,698Te

Equipment Description	Permit (Field)	Qty	Condition	Status	Approximate Dimensions and Weight (each)
	WA-54-L (Finucane)	1	10.2-inch flexible flowline is protected by CP and flushed before the FPSO disconnection 2018.	The 14,137 m flowline is currently connected to manifolds at each end.	Length: 14.2 km Weight: 1,358 Te
3-inch well service flexible flowline	WA-27-L (Exeter)	0	N/A; only flexible flowlines for Finucane and Fletcher.	N/A	
	WA-26-L (Mutineer)	0			
	WA-54-L (Fletcher)	1	3-inch flexible flowline is protected by CP and flushed before the FPSO disconnection 2018.	The 6,582 m flowlines are currently connected to manifolds and/or well service riser.	Length: 6.6 km Weight: 107 Te
	WA-54-L (Finucane)	1	3-inch flexible flowline is protected by CP and flushed before the FPSO disconnection 2018.	The 14,123 m flowlines are currently connected to manifolds and/or well service riser.	Length: 14.2 km Weight: 237 Te
12-inch production rigid flowline	WA-27-L (Exeter)	1	12-inch rigid flowline is protected by CP and flushed before the FPSO disconnection 2018.	The 6,235 m flowline is currently connected to manifold and production riser.	Length: 9.2 km combined Weight: 1,525 Te combined
	WA-26-L (Mutineer)	1	12-inch rigid flowline is protected by CP and flushed before the FPSO disconnection 2018.	The 2,934 m flowline is currently connected to manifold and production riser.	
	WA-54-L (Fletcher)	0	N/A; only flexible flowlines for Finucane and Fletcher.	N/A	N/A
	WA-54-L (Finucane)	0			
2-inch well service rigid flowline	WA-27-L (Exeter)	1	2-inch rigid flowline is protected by CP and flushed before the FPSO disconnection 2018.	The 6,235 m flowline is piggybacked with 1,024 two piece clamps approximately every 6 m to the 12-inch rigid production flowline and currently connected to manifold and well service riser.	Length: 9.2 km combined Weight: 72 Te combined
	WA-26-L (Mutineer)	1	2-inch rigid flowline is protected by CP and flushed before the FPSO disconnection 2018.	The 2,934 m flowline is piggybacked with 480 two piece clamps approximately every 6 m to the 12-inch rigid production flowline and currently connected to manifold and well service riser.	
	WA-54-L (Fletcher)	0	N/A, only flexible flowlines for Finucane and Fletcher.	N/A	N/A
	WA-54-L (Finucane)	0			
Rigid production tie-in spool (manifold tie-in)	WA-27-L (Exeter)	1	12-inch rigid tie-in spool is protected by CP and flushed before the FPSO disconnection 2018.	The spool is currently connected to Exeter manifold and the Exeter rigid production flowline.	Weight (12-inch): 13.9 Te
	WA-26-L (Mutineer)	2	8-inch rigid tie-in spool is protected by CP and flushed before the FPSO disconnection 2018.	The spool is currently connected to Mutineer manifold and Finucane/Mutineer pipeline end manifold.	Weight (8-inch): 6.1 Te Weight (12-inch): 13.9 Te
			12-inch rigid tie-in spool is protected by CP and flushed before the FPSO disconnection 2018	The spool is currently connected to Mutineer manifold and the Mutineer rigid production flowline.	
	WA-54-L (Fletcher)	0	N/A; flexible flowline connected to manifold rigid pipework via a bolted flange.	N/A	N/A
	WA-54-L (Finucane)	0			

Equipment Description	Permit (Field)	Qty	Condition	Status	Approximate Dimensions and Weight (each)
Rigid well services tie-in spool (manifold tie-in)	WA-27-L (Exeter)	1	2-inch rigid well service tie-in spool is protected by CP and flushed before the FPSO disconnection 2018.	The spool is currently piggybacked to the 12-inch production spool connected to Exeter manifold and the Exeter rigid production flowline.	Weight: <5 Te each
	WA-26-L (Mutineer)	2	3.5-inch rigid well service tie-in spool is protected by CP and flushed before the FPSO disconnection 2018.	The spool is currently connected to Mutineer manifold and Finucane/Mutineer pipeline end manifold.	
			2-inch rigid well service tie-in spool is protected by CP and flushed before the FPSO disconnection 2018.	The spool is currently piggybacked to the 12-inch production flowline section connected to Mutineer manifold and the Mutineer flexible riser.	
	WA-54-L (Fletcher)	0	N/A	N/A	
	WA-54-L (Finucane)	0			
6-inch / 2-inch rigid well jumper spool bundle	WA-27-L (Exeter)	3	Well jumper spools are protected by CP and flushed before the FPSO disconnected 2018 (applicable to wells with XTs only).	The 6-inch well jumper spools with piggybacked 2-inch well service spool are connected to XTs and manifolds.	Weight: 7 Te
	WA-26-L (Mutineer)	5			Weight: 14 Te
	WA-54-L (Fletcher)	1			Weight: 6 Te
	WA-54-L (Finucane)	2			Weight: 12 Te
Umbilicals (electrical power umbilicals (EPUs), electro-hydraulic umbilicals (EHUs) and integrated service umbilicals (ISU))	WA-27-L (Exeter)	3	EPU1 6894 m length (including riser section)	In situ connected to UTA at drill centre and DTM at the FPSO location.	Length: 90.9 km combined Weight: 1,895 Te combined
			EPU2 6934 m length (including riser section)	In situ connected to mid-way UTA (Finucane) and DTM at the FPSO location.	
			ISU 6874 m length (including riser section) Integrated service umbilical (ISU) cores containing Morlina Oil were flushed with treated seawater before FPSO disconnection in 2018, remaining cores contain fluids approved for discharge under the OECA process.	In situ connected to PUDU at drill centre and DTM at the FPSO location.	
	WA-26-L (Mutineer)	3	EPU1 3534 m length (including riser section)	In situ connected to UTA at drill centre and DTM at the FPSO location.	
			EPU2 3584 m length (including riser section)	In situ connected to UTA at drill centre and DTM at the FPSO location.	

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Equipment Description	Permit (Field)	Qty	Condition	Status	Approximate Dimensions and Weight (each)
			ISU 3475 m length (including riser section) Integrated service umbilical (ISU) cores containing Morlina Oil were flushed with treated seawater before FPSO disconnection in 2018, remaining cores contain fluids approved for discharge under the OECA process.	In situ flushed clean 2018, connected to PUDU at drill centre and DTM at the FPSO location.	
	WA-54-L (Fletcher)	1	EPU 16,999 m length	In situ connected to UTA at Fletcher drill centre and UTA at Mutineer drill centre.	
	WA-54-L (Finucane)	4	EPU1 10,940 m length	In situ connected to UTA at drill centre and mid-way UTA.	
			EPU2 10,978 m length	In situ connected to UTA at drill centre and mid-way UTA.	
			EHU 14,193 m length	In situ flushed clean 2018, connected to UTA at Finucane drill centre and UTA at Mutineer drill centre.	
			EHU 6,469 m length (between Finucane & Fletcher).	In situ flushed clean 2018, connected to UTA at Finucane drill centre and UTA at Fletcher drill centre.	
Umbilical UTAs	WA-27-L (Exeter)	4	Protected by CP.	In situ connected to umbilicals.	Dimensions: 4 m x 3 m x 3 m Weight (combined): 20 Te
	WA-26-L (Mutineer)	4			Dimensions: 4 m x 3 m x 3 m Weight (combined): 23 Te
	WA-54-L (Fletcher)	2			Dimensions: 3 m x 3 m x 3 m Weight (combined): 10 Te
	WA-54-L (Finucane)	3			Dimensions: 3 m x 3 m x 3 m Weight (combined): 15 Te
Umbilical PUDUs	WA-27-L (Exeter)	1	Exeter PUDU protected by CP.	In situ connected to umbilicals.	Dimensions: 5.1m x 3 m x 3 m Weight: 8 Te
	WA-26-L (Mutineer)	1	Mutineer PUDU is currently unprotected from CP.		Dimensions: 5.1m x 3 m x 3 m Weight: 8 Te
	WA-54-L (Fletcher)	0	N/A	N/A	N/A
	WA-54-L (Finucane)	0	N/A	N/A	N/A
Electrical flying leads	WA-27-L (Exeter)	18	Connected to assets.	In situ stabilised with sandbags.	25 m to 100 m long 4.3 km total length
	WA-26-L (Mutineer)	30			
	WA-54-L (Fletcher)	4			
	WA-54-L (Finucane)	13			
Hydraulic flying leads	WA-27-L (Exeter)	6		In situ stabilised with sandbags.	35 m to 100 m long 1.2 km total length
	WA-26-L (Mutineer)	10			

Equipment Description	Permit (Field)	Qty	Condition	Status	Approximate Dimensions and Weight (each)
	WA-54-L (Fletcher)	1	Nine hydraulic flying leads were disconnected from the XTs in 2018, the rest remain connected.		
	WA-54-L (Finucane)	2			
Manifold structures (with base foundation)	WA-27-L (Exeter)	1	Manifold pipework flushed before FPSO disconnection 2018. The structure and pipework are protected by CP.	In situ	Dimensions: 11.5 m x 8 m x 5.3 m Weight (Module): 87 Te Weight (Base): 29 Te Flowmeter Weight (2 No.): 5 Te
	WA-26-L (Mutineer)	1			Dimensions: 11.5 m x 8 m x 5.3 m Weight (Module): 106 Te Weight (Base): 29 Te Flowmeter Weight (4 No.): 9 Te
	WA-54-L (Fletcher)	1	Manifold pipework flushed before FPSO disconnection 2018. The structure and pipework are protected by CP.		Dimensions: 4.7m x 4.7 m x 4.4 m Weight: 22 Te Flowmeter Weight (1No.): 1 Te
	WA-54-L (Finucane)	1			Dimensions: 6 m x 4.5 m x 4.4 m Weight: 32 Te Flowmeter Weight (2 No.): 2 Te
	WA-26-L (Mutineer)	1	Pipeline end manifold (FC-M2) pipework flushed before FPSO disconnection 2018. The structure and pipework are protected by CP.		Dimensions: 6.9 m x 4.8 m x 4 m Weight: 31 Te
Anode skid	WA-26-L (Mutineer)	2	For CP of manifold and EPU1 UTA structures.	In situ	Dimensions: 2.5 m x 1.5 m x 2.3 m Weight (combined): 12 Te
	WA-27-L (Exeter)	2	For CP of manifold and EPU1 UTA structures.	In situ	
Pipe crossing structure	WA-26-L (Mutineer)	1	Support structure for Finucane EHU crossing the Mutineer flowlines.	In situ	Dimensions: 2.5 m x 2 m x 1.5 m Weight: 2.5 Te
Umbilical riser base	WA-27-L (Exeter)	1	Protected by CP.	In situ under umbilical riser sections	Dimensions: 6 m x 3 m x 1.1 m Weight (combined): 11 Te
	WA-26-L (Mutineer)	1			

Notes:

(1) The flowlines and risers are not thought to contain any hazardous materials however will be screened for NORMs and mercury if they are recovered to deck. In the event NORMs or mercury was to be detected it will be disposed of accordingly at a licensed disposal facility.

3.4 Decommissioning Overview

Santos has explored a range of feasible decommissioning options for the MEFF field. A description of the process that Santos has pursued is outlined in Section 3.4.

3.4.1 Selection of feasible decommissioning options

Santos is preparing to decommission the MEFF fields and leave them in an end-state that allows surrender of the associated petroleum titles. Full removal is the base case for decommissioning of titleholder's property in Commonwealth waters under the OPGGS Act, which is consistent with Australia's international commitments, as detailed in **Section 2** and **Appendix B**.

A comparative environmental impact assessment (CEIA) was undertaken by Santos to compare the relative environmental outcomes of the feasible decommissioning options for various equipment groups where alternatives to full removal were considered (

Table 3-4**)**. Full removal is the decommissioning option selected for all other equipment groups as listed in **Table 4-2**.

Table 3-4: Candidate equipment groups for alternatives to full removal and feasible decommissioning options

Equipment Group	Abandon In Situ	Augmentation [1]	Full Removal
Gravity bases and concrete ballast	Yes	Yes	Yes
Mooring anchors and chains	Yes	No	Yes

(1) Augmentation consists of subsea construction (i.e., artificial reefs are created alongside the existing equipment to provide additional habitat complexity and ecological benefit).

3.4.2 Comparative environmental impact assessment of feasible decommissioning options

Each of the feasible decommissioning options for the equipment groups in

Table 3-4 has different environmental, safety, technical, cost, and socio-economic outcomes. NOPSEMA's Section 572 Maintenance and Removal of Property policy (NOPSEMA 2020) requires that Santos evaluate the environmental impacts and risks of the feasible decommissioning options listed in

Table 3-4. Santos did this by undertaking a CEIA of the feasible decommissioning options, which is provided as **Appendix C**. The CEIA used the analytic hierarchy process (AHP) to determine the relative impacts of each of the feasible decommissioning options on environmental values and sensitivities that may credibly be impacted.

The CEIA compared the environmental impacts and risks from the planned events for each of the feasible decommissioning options. The assessment considered the suite of environmental values that may be impacted by any of the feasible decommissioning options. For each environmental value, the relative environmental outcomes of each of the feasible decommissioning options was determined by a series of pairwise comparisons.

The CEIA did not consider the risks to environmental values that may arise from unplanned events as these are identified as risks relating to execution of decommissioning removal activities. The risk profile of each of the feasible decommissioning options is broadly similar, with unplanned events generally arising from vessel-based activities (e.g., introductions of invasive marine species and hydrocarbon spills). Santos has a proven ability to prevent vessel-based risks from unplanned events becoming realised, and hence the environmental risk profiles of the feasible options were not considered to differentiate the feasible decommissioning options.

Of the feasible decommissioning options for the candidate equipment groups, Santos' preferred option is abandonment in situ. This option has excellent safety and cost outcomes and preserves the environment that has developed on and around the candidate equipment groups. Abandonment in situ of these equipment groups is the basis of the description of the activity (**Section 4**), which informs the description of the existing environment (**Section 5**), assessment of impacts and risks (**Sections 8 and 9**) and implementation strategy (**Section 10**). The CEIA demonstrates that abandonment in situ yields equal or better environmental outcomes than full removal for both equipment groups, with the resulting weighting within environmental criteria shown in **Table 3-5** and **Figure 3-4**. Hence, the requirements in NOPSEMA's Section 572 Maintenance and Removal of Property policy (NOPSEMA 2020) in relation to considering alternatives to full removal have been met:

+ All feasible decommissioning options for the equipment groups that are candidates for alternatives have been considered
+ Santos' preferred option, abandonment in situ, has been shown to result in better environmental outcomes than full removal.

Only the gravity bases and concrete ballast and the mooring anchors and chains are candidates for abandonment in situ. All other equipment will be removed (**Section 4**).

Table 3-5 Relative preferences of the feasible decommissioning options for the candidate equipment groups

Equipment Group	Abandon In Situ	Augmentation	Full Removal
Gravity bases and concrete ballast	38.64%	42.77%	18.59%
Mooring anchors and chains	71.60%	-	28.40%

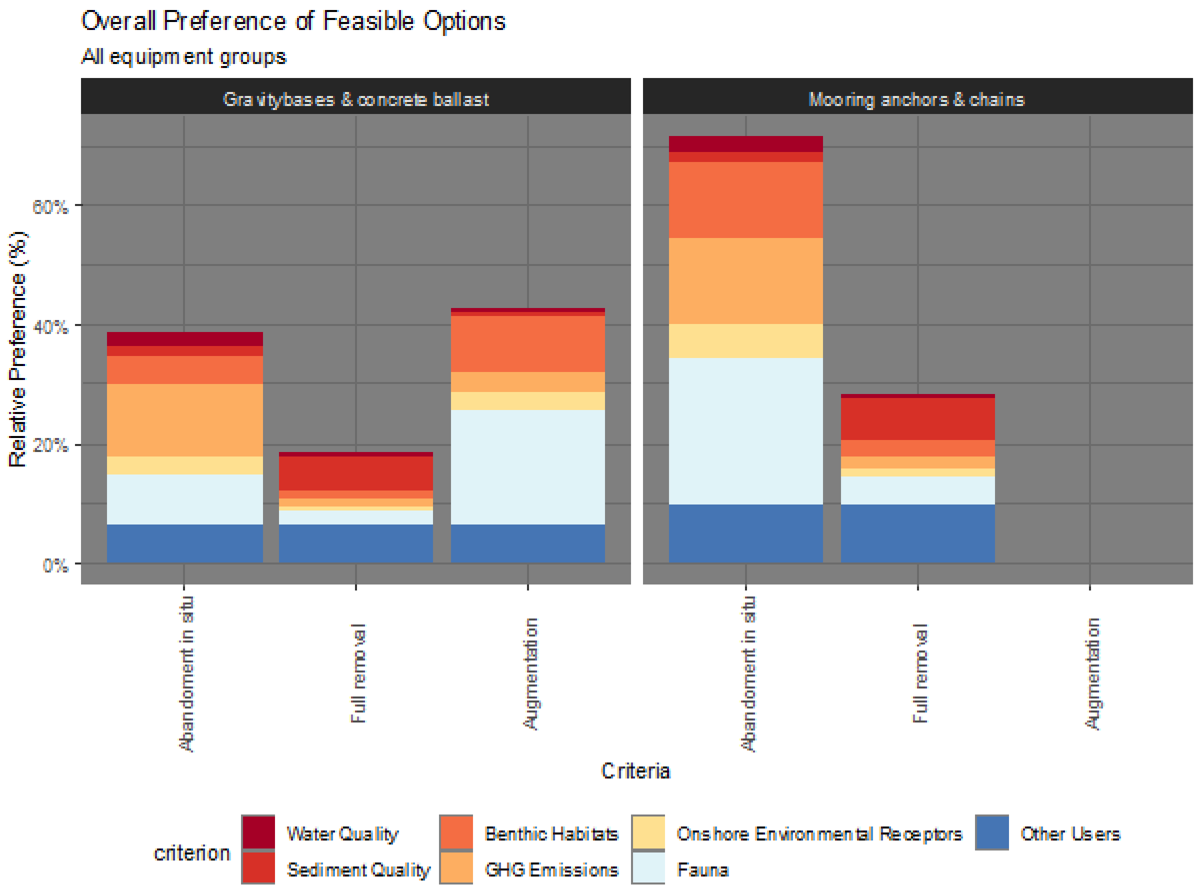

Figure 3-4: Stacked bar plot of relative preference of the feasible options faceted by equipment group

4. Activity description

4.1 Activity Overview

This EP is revised to build on the previous version and now includes ongoing MEFF Cessation of Production activities, Floating Asset Removal and Seabed Decommissioning Activities which includes Seabed Asset Removal and the abandonment of some equipment in situ. A description of the activities is provided in Section 4.1 to Section 4.10.

4.2 Activity duration and timing

4.2.1 Floating asset removal and inspection and maintenance campaigns

It is envisaged the total duration of the floating asset removal activities covered by this environment plan will be up to 45 days in the operational area. However, with potential for unfavourable weather and operational delays this could extend the project duration for floating asset removal activities to a period of 90 days in the operational area. Individual general inspection and maintenance campaigns are expected to take around 14 days. Activities could be undertaken at any time of the year. Activities would be continuous over a 24-hour period and are expected to be conducted over multiple and concurrent campaigns during these time frames.

No SIMOPS (such as general inspection and maintenance activities) will take place in the MEFF fields during the floating asset removal campaign.

4.2.2 Seabed asset removal and preparation for leaving in situ

Decommissioning of the seabed assets may take up to 12 months cumulative duration, is expected to commence in H2 2024 and will be completed by end 2025. Some activities associated with the decommissioning of seabed assets may commence prior to the conclusion of P&A activities (expected in Q4 2024), such as ROV surveys, preparing seabed equipment for later removal by removing marine growth, clearing sediment and / or cutting and seabed equipment recovery to vessel. When ongoing, activities will be 24 hours per day, seven days per week. Timing and duration of these activities is subject to change due to project schedule requirements, vessel availability, unforeseen circumstances and weather. This EP has risk assessed decommissioning activities throughout the year (all seasons) to provide operational flexibility. Removal of seabed assets and abandonment in situ activities may be carried out over multiple campaigns noting asset integrity for the purposes of safely removing all equipment has been demonstrated till the end of 2026 (CP results from the 2021 inspection campaign considered asset integrity until this time).

4.3 Vessels

Floating asset removal, seabed asset removal and abandonment in situ activities will be carried out by at least one primary vessel and may be supported by one or more support vessel. Typically, there will be two vessels in the operational area with a maximum of four at any one time. Primary vessels will typically be a dynamic positioning (DP) vessel with crane (or other lift means) and minimum one work class ROV. The primary vessel/s is expected to depart and then re-enter the operational area on several occasions. The support vessel(s) will provide operational, logistical, safety and equipment management support and will be used on an ad-hoc basis such that it may not be in the field throughout the entire duration of the activity, and may come and go as required in its logistical and support capacity to provision the primary vessel/s. The exact vessels are yet to be confirmed.

The activity may be supported by one or a combination of:

+ tugs including anchor handling tugs
+ barges
+ crew transfer vessel
+ heavy lift vessel

+ dynamically positioned pipelay vessel (PLV)
+ supply vessel
+ dive support vessel and rescue vessel.

Inspection and maintenance activities are expected to be conducted with one vessel with minimum one ROV.

Positioning beacons may also be placed on vessel equipment (e.g., cranes), ROV or structures while undertaking the activities.

4.4 Logistics support

Helicopters may be used to transfer crew and equipment to and from vessels and assist in an emergency as required. Support vessels may also be required for materials, equipment, provisions, personnel, and waste transfers.

4.5 Field management activities (general)

A risk-based inspection (RBI) assessment has been completed to determine the requirements and optimum intervals for undertaking inspection, monitoring, maintenance and repair (IMMR) activities with the maximum interval for inspection not exceeding five years.

IMMR of subsea field equipment will be performed in accordance with the MEFF Integrity Management Plan (Ref ME-7000-REP-0071). IMMR activities will not occur concurrently when floating asset removal activities are undertaken in the MEFF fields.

The IMMR tasks that may be undertaken are:

+ DTM inspections, such as inspecting the spider buoy and mooring lines
+ riser, flowline, umbilical and MWA inspections
+ subsea production centre inspections, such as inspecting the XTs, manifolds, spools, UTAs, PUDUs and jumpers
+ cathodic potential measurements
+ maintenance and repair, such as replacing anodes or installing anode skids
+ recovery of dropped objects
+ clearing debris (e.g., calcareous marine growth) using high-pressure water jetter and/or flapper tool
+ close visual inspection and measurements of critical components
+ seabed burial and environmental survey:
  - multi-beam echo sounder
  - side scan sonar
  - sub bottom profiling
  - seabed grab sampling
  - autonomous underwater vehicle
  - towed camera for identification of debris or raise seabed features.

The last inspection campaign was completed in 2021 which assessed:

+ condition and location of the floating assets (DTM & MWA) including the mooring lines
+ condition of equipment at all four production centres, including close visual inspection of wellheads and trees

- condition of the production risers and rigid flowlines, including observation of the extent of burial
- a CP check across the field.

A CP assessment was performed based on the field results obtained that demonstrates integrity for all hydrocarbon retaining assets until the end of 2026.

Post floating asset removal, IMMR will continue to be carried out as required in accordance with the Integrity Management Plan (ME-7000-REP-0071) so as to not preclude future removal of subsea equipment. The next scheduled IMMR campaign is planned for 2023.

4.6 Floating asset removal

Floating equipment that will be recovered from the field and taken to shore for either land-based disposal, recycling or reuse, in accordance with applicable legislation includes:

- one DTM
- two MWAs.

Floating assets will be removed using at least one primary vessel and a support vessel(s). The equipment that will be recovered from the field will be taken to shore for either land-based recycling, reuse or disposal, in accordance with applicable legislation.

Note, if it is safe and cost effective to do so, the following equipment may be removed during the floating asset removal campaign:

- six umbilical risers
- two 2-inch well service risers
- two 12-inch production risers
- four MWA tether chain assemblies
- six DTM mooring lines.

In the event the equipment is not removed as part of the floating asset removal campaign they will remain wet-stored in field and the equipment will be maintained as required to ensure it can be removed in the future (**Section 4.7**) in accordance with s572 of the OPGGS Act.

Floating asset removal and equipment recovery comprises the following steps with the detailed procedure for removal subject to a risk assessment:

- survey subsea equipment in the MEFF fields using ROV
- remove marine growth using high-pressure water jetting or a flapper tool (or similar) to reduce weight and expose and clean lift points and cutting locations for safe handling
- disconnect production, well service, umbilical risers, mooring chains, tether and other structure using subsea cutting tools as required
- attach lifting or tow devices to existing lifting or tow points or alternative locations as required
- allow positively buoyant equipment to rise to the surface
- tow buoyant equipment out of the permit area or lift onto a vessel in the permit area
- retrieve equipment from the seabed using lifting devices (e.g., spreader baskets, grabs).

4.6.1 Barrier testing activities

The XTs were previously tested previously as described in the WOMP. Santos plans to undertake barrier testing to verify isolations to allow the safe disconnection of the production and well service risers and not disturb the XT barrier envelope unnecessarily.

Once the risers have been disconnected, blind flanges or plugs will be installed to reinstate the production system to its as found (closed) state so the overall number of valves and barriers in the system will be the same as before the DTM was removed with no increase in risk as a result of removing the floating assets.

4.6.1.1 Barrier testing equipment and procedure

Inflow (leak off) tests may be performed at the manifold locations to verify there is no flow from the wells, which are closed in at the XT valves and have been previously barrier tested and verified from the FPSO.

Barrier pressure testing may be performed on the manifold isolation valves to verify that they meet industry performance standards, applicable to the valve type, required to be considered a barrier.

The barrier pressure testing may be conducted via an ROV complete with a bladder via hot stab. Other methods may see the involvement of other ROV operated tools or downlines/umbilicals from the vessel(s).

For valve intervention at the manifolds, standard hydraulic or electric torque tools will be used.

4.6.1.2 Barrier testing fluids

Water based fluids such as hydraulic fluid, monoethylene glycol (MEG) or methanol will be used for the barrier testing. Barrier testing fluids will be contained in a bladder mounted to an ROV. The maximum volume of the bladder is 365 litres (L).

4.6.1.3 Fluid release during barrier testing

During barrier testing activities, there may be a requirement to release small amounts of barrier testing fluids, treated seawater and potential residual hydrocarbons (approximately 25 L per barrier test) to the marine environment in order to test barrier integrity. Small amounts of fluid (residual hydrocarbon, barrier testing fluid and treated seawater) may end up being released to allow for:

+ venting the subsea system (e.g., jumper spool) to ambient pressure to allow the commencement of an inflow test in a safe manner.

There may also be potential for minor discharges from ROV or tooling hydraulics (typically mineral oil) to the marine environment during subsea operations.

4.6.2 Riser disconnection

To enable the DTM and MWAs to be recovered, the production, well service and umbilical risers (ten risers in total) will need to be disconnected from the DTM and MWA. Note: The proven XT (or manifold) valves shall remain as the primary isolation between the well and environment until P&A of the wells is conducted.

Risers and umbilicals will be disconnected and potentially require cutting using a subsea cutting tool (such as diamond wire saw, hydraulic shear cutter, super grinder or multi cutters) during disconnection activities.

Once released from the DTM, all risers will be released from the MWA which may involve removal of shims plates and lifting the risers out of the MWA gutters. The risers will be wet-stored on the seabed for recovery during the seabed asset removal campaign, if they are not removed from title during the floating asset removal campaign. The two 12-inch production risers and 2-inch well service risers will be plugged for wet storing.

The six umbilicals will be left uncapped for wet storing:

+ Four of the umbilical risers are EPUs.
+ Two of the umbilical risers are ISUs and the hydraulics lines have already been flushed in 2018 and subsequently disconnected from the XT to prevent further contamination.

- The ISUs were flushed with treated seawater and the other four umbilicals contain scale inhibitor, hydraulic control fluid and glycol, and these chemicals (and residual hydrocarbon contained in treated seawater in the ISUs) may be released to the marine environment when the umbilicals are disconnected and wet-stored uncapped on the seabed. These chemicals have an Offshore Chemical Notification Scheme (OCNS) ranking of D (**Section 4.11**) and / or have previously been accepted for discharge under the Field Operations EP (ME-7000-A02-F003).

During riser disconnection, the as left contents of the two production risers (maximum of 50 L of hydrocarbon per riser) will be released to the marine environment (**Table 4-1**).

Table 4-1: Estimated residual volumes of hydrocarbon in the Mutineer, Exeter, Fletcher, Finucane production system (during floating asset removal activities only)

Production system equipment	System Volume (m^3)	Calculated residual hydrocarbon @ 40ppm OIW (L)	Maximum hydrocarbon discharge during disconnection (L)(1)
Mutineer riser	31	1	50
Exeter riser	31	1	50
Mutineer flowline (rigid)	193	8	0
Exeter flowline (rigid)	404	16	0
Fletcher flowline	694	28	0
Finucane flowline	745	30	0
Total volume	**2098**	**84**	**100**

(1) It should be noted that in addition to the calculated residual hydrocarbon within the risers and flowline bores, there may be additional hydrocarbon trapped within the rough bore that is unable to be removed by flushing, as well as hydrocarbon that may have migrated from other sections to the high points over the MWA and at the DTM. Based on conservative calculations, the maximum hydrocarbon release during disconnection is considered to be 50 L, for a total of 100 L of hydrocarbon.

4.6.3 Disconnectable turret mooring recovery

The DTM arrangement consists of:

- DTM
- six mooring chain arrangements
- six mooring anchors.

The DTM is positioned around 30 m below mean sea level and held in position by six mooring chain arrangements including mooring anchors. **Figure 4-1** and **Figure 4-2** show the DTM arrangement.

To enable the DTM to be released in a controlled manner, the risers will be released sequentially to allow the DTM to rise through the water column over a series of steps noting the structure is buoyant. The mooring chains will also be disconnected from the DTM sequentially to allow the DTM to continue to rise to surface over a series of steps.

The DTM will be connected to support lines from the vessel and or tug (prior to disconnecting the final tether chains) as required to enable suitable vessel offset as the DTM rises to surface and to prevent the DTM from drifting away.

Once at the sea surface, the two possible methods to transport the DTM to shore are:

- recovery to a vessel/barge

+ surface-towed to shore using a towing bridal and tug.

Mooring chains will be cut using a subsea cutting tool during the recovery of the DTM. The DTM will be bridled / rigged for towing.

The DTM mooring chains will be laid on the seabed. If deemed safe and practicable to do so, the riser wire will be recovered during the floating asset removal or later during seabed asset removal. If left for later removal, the riser wire will be secured to the seabed assemblies. The mooring chain and anchors will be abandoned in situ (**Section 4.8.2**).

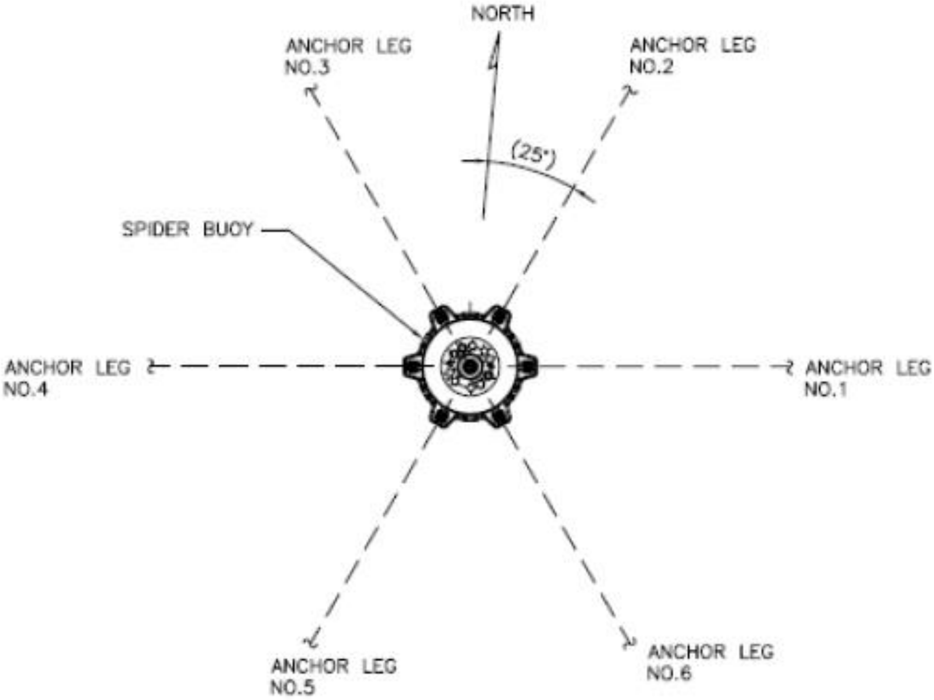

Figure 4-1: Disconnectable turret mooring pattern

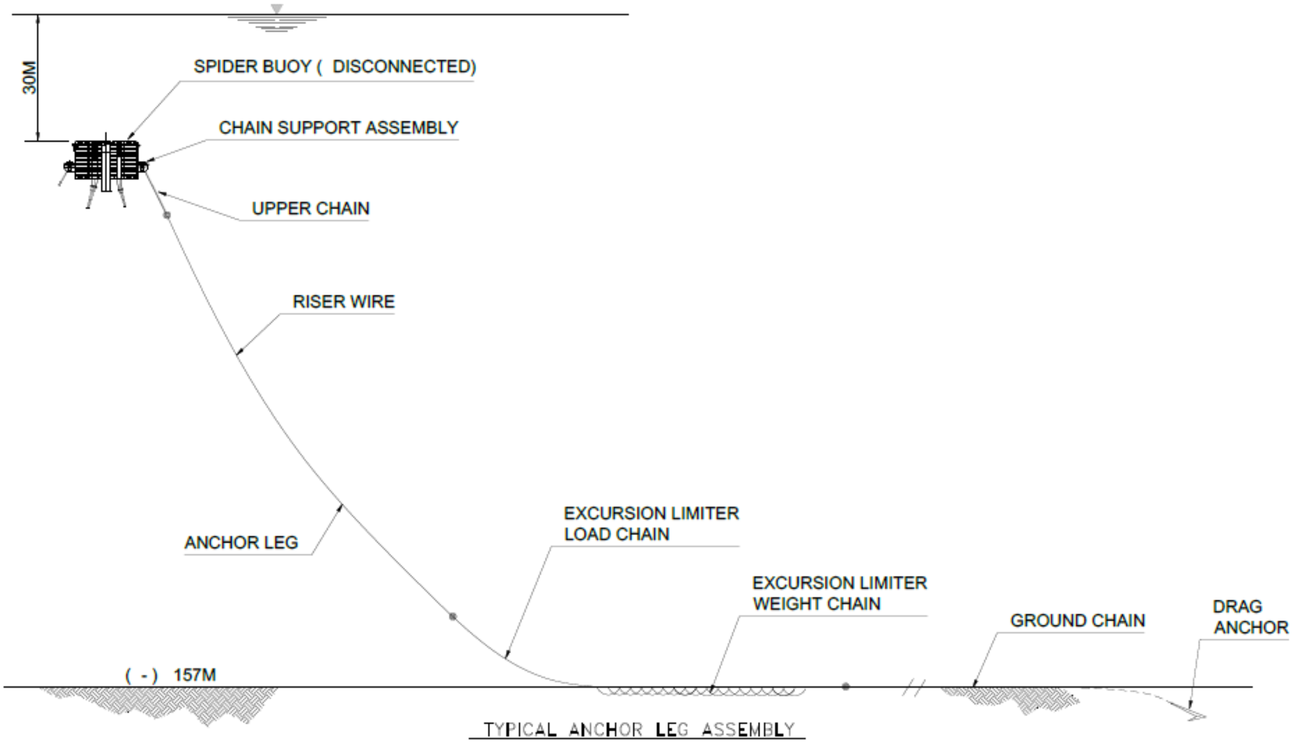

Figure 4-2: Disconnectable turret mooring arrangement

4.6.4 Mid water arches recovery

There are two MWAs that will be recovered. The MWA arrangement consists of:

- mid water arch
- chain tethers
- gravity base, complete with concrete ballast blocks.

Each MWA is positioned around 82 m below the sea surface and is held in position by two chain tethers connected to a gravity base. **Figure 4-3** shows the MWA arrangement.

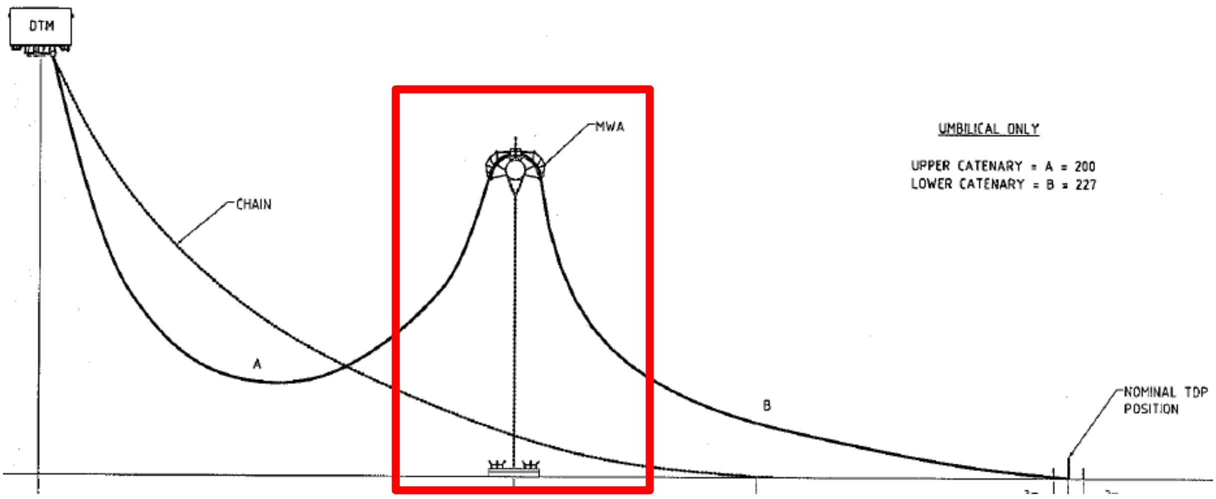

Figure 4-3: Mid-water arch (typical)

The MWA will be released from the gravity base via a controlled release. This may be achieved by cutting a single line connected to the gravity base using an ROV. Prior to final release, the MWAs will be connected to one or more support lines from a vessel that enables suitable vessel offset as the MWAs rise to surface and prevent the MWAs from drifting away. Once the MWA is at the sea surface, the two possible methods to transport the MWAs to shore are:

1. recovered to a vessel / barge
2. surface-towed to shore using a towing bridal and tug.

Where required, installation aids (e.g. recovery skid) may be installed on the MWAs to aid recovery and or tow. After MWA recovery, the chain tethers may be recovered via vessel crane directly, using recovery baskets (if required) or using a tug. The gravity bases complete with concrete ballast blocks will be abandoned in situ (**Section 4.8.1**).

4.6.5 Tow

Recovered equipment may be transported out of the MEFF operational area and wider title area, either secured to the deck on board a suitable vessel or by towing in water behind a suitable vessel. The final decision on whether to lift equipment out of the water to the back of a vessel deck in the field or to first tow to sheltered waters, will be primarily based on safety considerations. For example, during installation, the DTM was towed into the field and then installed whereas the MWAs were transported on the deck of a vessel and then installed.

If the floating assets are towed, a tow plan will be prepared and developed with consideration for matters such as navigational hazards, navigational controls, required notifications, way points, applicable nautical charts, places of refuge, Environmental Sensitive Sea Area's (ESSA) and designated Area to be Avoided (ATBA).

Connection points (towing points) on the towed equipment will be inspected during the install of the towing gear to confirm suitability for towing as detailed in the tow plan.

Based on MWA and DTM having remained in a floating condition all its offshore life since installation, it is considered highly unlikely that these floating assets would sink during recovery or tow. However, in the event that this occurs due to other external factors during recovery, they could be cut into smaller, manageable, pieces on the seabed and recovered to surface and transferred via vessel.

4.6.6 Disposal

Once the floating assets have been delivered to port they will be cut into pieces suitable for transport for disposal or recycling in accordance with relevant legislation of the receiving jurisdiction and by suitably qualified contractors.. Any hazardous waste will be disposed of onshore at a licensed facility. Disposal or recycling facilities for floating assets will be in Australia only.

Recovered equipment will be managed to its end fate, with consideration of the hierarchy of:

1. reuse
2. repurpose
3. recycle
4. dispose.

No reuse or repurpose opportunities have been identified at the time of preparing this EP.

The DTM and MWA are made of steel (approximately 98%), are painted to provide resistance to corrosion and are free of hazardous materials. The DTM and MWAs will be considered for steel recycling where practicable, potentially significantly reducing the amount of material requiring disposal via landfill.

Santos does not anticipate any other contaminants (e.g. NORM and mercury). However, should any assets recovered to surface be of concern they will be assessed for contamination. In the case that contamination is identified, the equipment will be managed as per Santos procedures appropriate for the contamination type and level. All waste will be handled and disposed of in accordance with Federal, and State requirements.

4.6.7 Wet-storage of equipment

During the removal of floating assets (DTM and MWAs), the wet storage / wet parking of equipment on the seabed, such as DTM mooring chains, umbilical, production and well service risers, may be required. Equipment that is temporarily wet stored until the seabed asset removal campaign, will be located close to original DTM position, and wholly within the footprint of the existing mooring anchor pattern. Wet-storage areas will be surveyed (pre and post wet parking).

4.7 Removal of seabed equipment

Decommissioning activities described below may occur in any sequence and in multiple campaigns if required, depending on technical requirements, site and weather conditions and availability of personnel, equipment and vessels at the time.

Removal of seabed equipment will include a variety of activities as outlined in **Section 4.7.1** to **Section 4.7.7.**

4.7.1 Marine and Calcareous Growth Removal

Marine and calcareous growth may be removed subsea prior to equipment removal using tools such as either high-pressure water jetter, flapper tool, scraping tool and/or acid soaking. Removal of marine growth is required to enable safe operations and reduce the weight of the equipment to aid recovery and lift operations.

Marine growth from recovered seabed equipment will be removed either in the water column or may be removed on the vessel deck using high-pressure water and brushes. Any removed marine growth on the vessel deck will be discharged to the marine environment from the deck.

4.7.2 Sediment Relocation

If sediment build up around seabed equipment has the potential to impede decommissioning activities, a water jet, ROV-mounted suction pump or mass flow excavator may be used to move sediment in the immediate vicinity of the equipment, to allow inspection / intervention works and removal of equipment to be performed.

4.7.3 As-found ROV surveys

As found surveys using an ROV may be conducted on seabed equipment present in the field and planned for removal. The survey aims to identify any issues with the equipment which have the potential to affect the approach to decommissioning. The as-found survey may also identify miscellaneous debris for recovery.

4.7.4 Release of residual gas and / or hydrocarbons

The flexible risers, flowlines, manifolds and spools were flushed with treated seawater during the operational phase to ALARP and acceptable concentrations of hydrocarbons, but may contain some residual hydrocarbons that were not able to be flushed (**Table 3-3**). As this equipment is recovered, the contents will be drained or vented to the environment. Total released volumes are estimated in **Table 3-3**.

4.7.5 Release of chemicals from umbilicals and electrical / hydraulic flying leads

As the umbilicals and flying leads are recovered, the contents will be drained to the environment. Estimated release volumes are included in **Table 3-3**.

4.7.6 Removal and recovery of equipment

Removal and recovery of seabed equipment is described in **Table 4-2**. The planned or potential discharges associated with the removal and recovery of seabed equipment is included in **Table 3-3**.

Table 4-2: Removal and recovery of equipment

Equipment	Removal Options
Flexible flowlines	Flexible and rigid lines may be recovered via methods such as: • reverse lay to vessel and subsequently cut up on deck, reeled or loaded into a carousel • cut up on seabed and recovered to deck via crane, either loose or in baskets. Pipework will be left open ended.
Rigid flowlines	
Umbilicals	
Flexible risers	
Manifolds and mudmats	Manifolds and mudmats will be cut free of adjoining pipework then recovered with rigging connected to structure lift points or alternative locations using a crane or winch. Pipework will be left open ended.
Pipeline end manifolds (PLEM)	PLEMs will be cut free of adjoining pipework then recovered with rigging connected to structure lift points or alternative locations using a crane or winch. Alternatively, a grapple system may be utilised for recovery. Pipework will be left open ended.
Rigid tie-in spools	Spools will be cut free and lifted either directly to deck or in a subsea basket. Spools may be recovered whole or in sections. Pipework will be left open ended.
Hydraulic and electric flying leads (HFLs and EFLs)	Flying leads will be disconnected or cut free from the associated structures and recovered by crane, winch or in an ROV basket. Flying leads may be recovered whole or in sections. Pipework will be left open ended.
Production umbilical distribution unit (PUDU) and umbilical termination assemblies (UTA)	PUDUs and UTAs may be recovered attached to their umbilical or cut free and recovered separately. Recovery will be via rigging connected to structure lift points or alternative locations using crane, winch or in an ROV basket. Alternatively, a grapple system may be utilised for recovery. Pipework will be left open ended.
Riser wire	Riser wire will be cut free and recovered using a crane or winch.
Tether chains	Tether chains will be cut free and recovered using a crane, winch or in an ROV basket.
Umbilical riser base, anode skids and pipe crossing structures	These structures will be recovered with rigging connected to structure lift points or alternative locations using a crane, winch or in an ROV basket. Alternatively, a grapple system may be utilised for recovery.
Auxiliary items including concrete mattresses, grout bags and sandbags	Sand / grout bags may be cut open to release contents to seabed, then bags lifted via attached slings to recover to surface or in ROV basket. Concrete mattresses will be recovered using rigging connected to a crane, winch or in a subsea basket. Alternatively, a grapple system may be utilised for recovery.
Xmas trees (if not recovered during P&A)	These structures will be recovered with rigging using a crane, winch or in an ROV basket. Alternatively, a grapple system may be utilised for recovery.

Equipment	Removal Options
	Pipework will be left open ended.
Wellhead removal	P&A activities may be completed without removing wellheads. In this scenario, wellheads may be cut and recovered under this EP as part of the removal of seabed assets activities. Wellheads will be cut using a subsea cutting tool, such as a diamond wire cutter, and recovered to vessel directly by crane.

4.7.7 Disposal

Non-hazardous waste from recovered equipment will be transported back to shore for disposal or recycling. Hazardous waste will be disposed of onshore at a licensed facility. Recovered equipment may be transported overseas for recycling. All waste streams will be managed in accordance with relevant legislation of the receiving jurisdiction and by suitably qualified contractors.

Recovered seabed assets will be documented and tracked to their end fate. Waste management solutions will be assessed against the waste management hierarchy of:

1. reuse
2. repurpose
3. recycle
4. dispose.

Waste management of seabed assets is discussed further in **Section 8.6**.

4.7.7.1 Manifold and PLEM flowmeter disposal

The waste materials from the flowmeters will be classified in accordance with the Australian Radiation Protection and Nuclear Safety Agency (ARPANSA) radioactive waste classification scheme and disposed of accordingly.

4.8 Abandonment in situ of seabed equipment

As outlined in **Section 3.4.2** Santos undertook a Comparative Environment Impact Assessment of feasible decommissioning options and some equipment was determined to be suitable for abandonment in situ as outlined in **Table 4-3**.

Table 4-3: Abandonment in situ of equipment

Equipment	Abandonment Process
Gravity bases and concrete ballast	Abandonment in situ of the gravity bases and concrete ballast consists of leaving these as is following disconnection and removal of the attached tethers and MWAs.
Mooring anchors and chains	Abandonment in situ of the mooring chains and anchors consists of laying the chain ends on the seabed following disconnection and recovery of the riser wires.

4.8.1 Gravity bases

There are two gravity bases within the MEFF operational area to which the MWA are tethered until the MWAs are removed as part of the floating asset removal campaign. The MWAs will be removed as described in **Section 4.6.4.** Details of the constituents of the gravity bases and ballast modules are provided in **Table 4-4** and discussed below.

Table 4-4: Gravity bases and ballast modules details

Item	Qty	Dimensions	Composition (Each Unit)					Combined Weight (t)
			Steel	Plastic	Concrete	Anode	Epoxy Paint	
Gravity Bases	2	19m x 6.4m x 3.1m	218.15t	0.2kg	10t	0.85t	0.376t	458.8
Ballast Modules	4	6.02m x 1.4m x 2.35m	6.91t	-	45.29t	-	0.041t	209
Total weight (t)								667.8

Plastics:

There are two 4” ball valves located on the top of each gravity base buoyancy tank which are expected to contain a small quantity of plastics in the form of gaskets, seating material, O-rings and stem packing. It is estimated that these materials total approximately 0.1kg per valve assembly.

Paint:

The structures were painted with the following coating system with an average Dry Film Thickness (DTF)of 520 microns (ME-4200-M07-0002 Mutineer Exeter Project – Project Data Book):

+ 1st coat – Hempel Hempadur Multi-Strength 45751 – 50630 Red (self-priming, high-build, epoxy-polyamide/amine coating)
+ 2nd coat – Hempel Hempadur Multi-Strength 45751 – 12340 Grey (self-priming, high-build, epoxy-polyamide/amine coating)
+ Topcoat – Hempel Hempadur Mastic 45881 – 20306 Yellow (polyamide curing, high solids epoxy paint).

Concrete:

The concrete used in the structures is Grade 40 Normal Mix, with the following composition (ME-4200-M07-0002 Mutineer Exeter Project – Project Data Book):

+ 420kg/m3 Cement (Ordinary Portland Cement)
+ 1010kg/m3 Coarse Aggregate (20mm graded crushed granite)
+ 735kg/m3 Fine Aggregate (Natural Sand)
+ 600ml per 100kg cement Water Reducer Retarder.

Anodes:

A total of 855.9kg of anode consumable (Aluminium-Zinc-Indium) was installed on each base (9x anodes at 95.1kg Nett consumable) (ME-4200-M07-0002 Mutineer Exeter Project – Project Data Book).

Anode consumable composition:

+ Aluminium at ~95%
+ Zinc at 4.75% - 5.75%
+ Indium at 0.018% - 0.025%
+ Other at max 0.05% (Silicon, Copper, Iron, Cadmium).

Steel:

The structures were constructed using the following steel grades for the various components (ME-4200-M07-0002 Mutineer Exeter Project – Project Data Book):

- Plate – ABS EH36 & ABS Grade A
- Angle Bar – S275JR
- Tubulars – ASTM A106 Grade B
- Elbows – ASTM A234
- Flanges – ANSI B16.5.

Table 4-5 provides the estimated tonnage of each steel element based the chemical composition of the steels used in the construction.

Table 4-5: Gravity bases and ballast modules steel constituents and estimated tonnage

Steel grade	Chemical composition (t)													
	FE	C	Cb	Cr	Cu	Mn	Mo	N	Ni	Nb	P	Si	S	V
	Iron	Carbon	Columbium	Chromium	Copper	Manganese	Molybdenum	Nitrogen	Nickel	Niobium	Phorphorus	Silicon	Sulfur	Vandadium
ASTM EH36	97.6	0.18	0.05	0.25	0.35	1.6	0.08		0.4	0.05	0.04	0.5	0.05	0.1
ABS Grade A	97	0.26				0.65					0.05		0.05	
S275JR	98.2	0.22				1.5		0.009			0.45		0.045	
ASTM A106 Grade B	97	0.3		0.4	0.4	1.06	0.15		0.4		0.35	0.1	0.035	0.08
Estimated tonnage (t0	**447**	**0.84**	**0.24**	**1.16**	**1.63**	**7.43**	**0.38**	**0.009**	**1.86**	**0.24**	**0.19**	**2.32**	**0.24**	**0.47**

4.8.2 Mooring chains and anchors

All six DTM mooring anchors were confirmed fully buried during the 2021 environmental survey (GHD 2021). No seabed disturbance was observed at any of the anchor locations. The anchors are expected to be buried at a depth of 6 to 13 m.

The 2021 survey also confirmed that approximately 580 m of each mooring chain was buried, leaving approximately 130 m of each chain unburied. After disconnection of the DTM, the remaining unburied lengths of mooring chains will be laid on the seabed and may become buried over time.

Paint:

The anchors are coated with a thin layer of black epoxy-based paint (estimated DFT of 40 microns). Total weight of paint per anchor is estimated to be under 5 kg.

Steel:

The anchors, chains and shackles are made entirely of steel with the chains and shackles being chain grade RQ3.

The chemical composition of the steels used in the mooring components are similar to other structural steel grades, with an Iron content in the order of 97%, and the remaining percentage made up by a combination of other trace elements (e.g. Carbon, Manganese, Aluminium, Vanadium, Niobium, Titanium, etc.).

Mooring chains and anchor details are provided in **Table 4-6**.

Table 4-6: Mooring chains and anchor details

Item	Qty	Approximate Unit Weight	Length		Approximate Combined Weight (t)
			Each	Total	
Anchor 17t Vryhof Stevpris MK 5 Steel Anchor c/w shackle	6 units	17,000 kg/each	-	-	102
Ground Chain (RQ3) 80mm Studless Steel Chain	6 lengths	125 kg/m	500m	3,000m	375
Joining Shackle (RQ3S) 112mm Steel 'D' Shackle	6 units	229.5 kg/each	-	-	1.38
Excursion Limiter Load Chain (RQ3) 112mm Studless Steel Chain	6 lengths	245 kg/m	225m	1,350m	330.75
Weight Chain Hanger Shackle (RQ3S) 75mm Steel 'D' Shackle	120 units	175 kg/each	-	-	21
Excursion Limiter Weight Chain (RQ3) 118mm Studless Steel Chain	3540 links	129.6 kg/each	27.8m	1,668m	458.78
Joining Shackle (RQ3S) 110mm Steel D Shackle	6 units	205 kg/each	-	-	1.23
				TOTAL WEIGHT (t)	**1,290.14**

4.9 Diving

Diving operations have been included as there is the possibility that diving is required to support the activities described in this EP. Diving is not considered to pose any credible environmental impacts or risks other than the impacts and risk posed by the vessels. Diving will take place from a dive support vessel.

4.10 As-left seabed surveys

As left surveys will be undertaken using an ROV during decommissioning activities to:

- confirm that all seabed equipment has been removed as described in **Section 4.7**
- confirm the state and position of the equipment left in situ, as described in **Section 4.8** at the time of abandonment
- assess any damage to the seabed as a result of removal activities
- meet monitoring requirements described in **Section 10.5**.

4.11 Chemical assessment

A risk-based approach to select chemical products ranked under the 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 by the Chemical Hazard Assessment and Risk Management (CHARM) mathematical model, which uses aquatic toxicity, biodegradation and bioaccumulation data. The hazard quotient 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) accepts 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 their use and associated risk is acceptable and ALARP.

As described above, potential alternative chemicals are investigated 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 chemicals 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 to the marine environment.

4.11.1 Ecotoxicity assessment

Table 4-7 and **Table 4-8** act as guidance in assessing the ecotoxicity of chemicals during the investigation of potential alternatives. **Table 4-7** is used by Cefas to group a chemical based on ecotoxicity results, ‘A’ representing highest toxicity/risk to environment and ‘E’ lowest. **Table 4-8** shows classifications/categories of toxicity against aquatic toxicity results.

Table 4-7: Initial Offshore Chemical Notification Scheme ranking

Initial grouping	A	B	C	D	E
Result for aquatic-toxicity data (ppm)	<1	≥1-10	>10-100	>100-1000	>1000
Result for sediment-toxicity data (ppm)	<10	≥10-100	>100-1000	>1000-10,000	>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 4-8: 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
Category Acute 2 Hazard statement – Toxic to aquatic life	Fish	LC_{50} (96hr) of >1 mg/L to ≤10 mg/L
	Crustacea	EC_{50} (48hr) of >1 mg/L to ≤10 mg/L
	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

4.11.2 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:

a. Readily biodegradable: results of >X% biodegradation in 28 days to an OSPAR harmonised offshore chemical notification format (HOCNF)-accepted ready biodegradation protocol.

b. Moderately biodegradable: results >20% and <X% to an OSPAR HOCNF-accepted ready biodegradation protocol.

c. 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)
+ 70% in 28 days (OECD 301A, 301E).

4.11.3 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:

d. 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.

e. 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), as applicable.

5. Existing environment description

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 petroleum 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 the following: (c) the world heritage values of a declared World Heritage property within the meaning of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act); (d) the national heritage values of a National Heritage place within the meaning of that Act; (e) the ecological character of a declared Ramsar wetland within the meaning of that Act; (f) the presence of a listed threatened species or listed threatened ecological community within the meaning of that Act; (g) the presence of a listed migratory species within the meaning of that Act; (h) 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

5.1 Environment that may be affected

This section describes the key physical, biological, socio-economic and cultural characteristics of the existing environment that may be affected by the activity, from both planned and unplanned events associated with the activity. The description of the environment applies to the operational area (the area within which planned activities will occur), and the environment that may be affected (EMBA) by unplanned events within the operational area.

A detailed and comprehensive description of the environment (required by OPGGS(E)R 2009, Section 13(3)) in the operational area and EMBA is provided in **Section 5.2** and within the *Values and Sensitivities of the Western Australian Marine Environment* (EA-00-RI-10062, **Appendix D**). Copies of the DCCEEW Protected Matters Search Tool (PMST) outputs for the operational area and the EMBA are also available in **Appendix E**. An updated PMST report was generated to identify any changes to listed MNES between the submission of the previous revision of this EP and this current revision. Recent changes to the PMST mean that the updated tool uses a discrete grid system to determine the MNES that might be impacted in an area of interest. Therefore, the PMST returns all the MNES that intersect the same grid cells that are intersected by an area of interest. With marine matters of national environmental significance, a coarser grid resolution is used. This means there is an increased likelihood of "false positives" in marine areas. The results of the updated PMST report were screened against GIS data sets and current literature to determine and remove those sensitivities identified by the report that are outside of the area of interest. As a result, no additional sensitives were identified within the area of interest in the updated PMST report.

The EMBA encompasses the environment that may be affected by planned and unplanned events. Most planned and unplanned events associated with the activity may affect the environment up to a few kilometres from the operational area e.g., from noise impacts (as identified in **Section 8**) However, a large unplanned hydrocarbon spill would extend substantially beyond this (**Section 9**).

5.1.1 Protected Matters Search Tool reports

PMST searches were undertaken on the operational area and the EMBA. The PMST searches were completed using the exact co-ordinates that are used to produce the figures throughout **Section 3**, ensuring 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 coordinates are also provided within the PMST report to allow for duplication of the search and verification if required. Santos does not have control over the PMST output, but instead has provided the reports and coordinates to ensure transparency.

5.1.2 Determining the environment that may be affected

Stochastic hydrocarbon dispersion and fate modelling, applied to the worst-case spill scenario identified as relevant to the activity (**Section 9.5**), was undertaken to inform the EMBA. 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 5-2** for the exposure values used and to **Section 9.5.4** for further information about the reasons why these exposure values have been selected and how they relate to the risk assessment.

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 in the event of an actual spill.

5.1.2.1 Modelling locations

The worst-case discharge from the worst-case credible loss of well control (LOWC) scenario has been modelled at the Mutineer-4 well location, as this was identified as the highest oil-producing well, given lower water cut and higher reservoir pressure. The worst-case marine diesel oil (MDO) discharge from a vessel collision scenario was modelled at the southeast corner of the operational area as this represented the closest point of the operational area to any environmental sensitivities. The co-ordinates of these location are provided in **Table 5-1**.

Table 5-1: Spill modelling locations

Scenario	Latitude	Longitude
Worst-case LOWC	19° 15' 32.8" S	116° 38' 16.3" E
Worst-case MDO discharge	19° 20' S	116° 50' E

To ensure a representative EMBA was correctly assessed in this EP, the EMBA for both of the modelled scenarios (LOWC and Vessel Collision) were combined to show the greatest extent of a potential spill with the area and create one defined EMBA (**Figure 5-1**). The majority of seabed asset removal activities are expected to commence after the completion of the P&A campaign, meaning a LOWC scenario is no longer possible during these activities. To provide context for the extent of the

EMBA for the vessel collision scenario only (for vessel based decommissioning activities), a comparison of the EMBAs of both scenarios is provided in **Figure 5-3**. However, this EP assess the impacts and risks of the activities based on the overall combined EMBA (**Figure 5-1**).

5.1.2.2 Hydrocarbon exposure values

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 and explained within **Section 9.5.4**. Applying the same method used to determine the EMBA, spatial areas were derived for moderate and high exposure values (**Figure 5-2**).

A low exposure threshold, which approximates a range of socio-economic effects, is considered to provide a conservative extent of potential impacts. Biological impacts are expected to occur within the moderate and high exposure values which represent a subset of the EMBAs. The EMBA exposure values are shown in **Table 5-2**. Refer to **Section 9.5.4** for further information about the spill trajectory modelling thresholds that have been selected. The moderate exposure value area (MEVA) is represented in this section to inform the impact assessment in **Section 9.6** and **Section 9.7**.

Table 5-2: Hydrocarbon exposure values of the environment that may be affected

Hydrocarbon Phase	Exposure Value		
	Low	Moderate	High
Surface (g/m^2)	1	10	50
Shoreline accumulation (g/m^2)	10	100	1000
Dissolved aromatics (ppb)	10	50	400
Entrained (ppb)	10	100	-

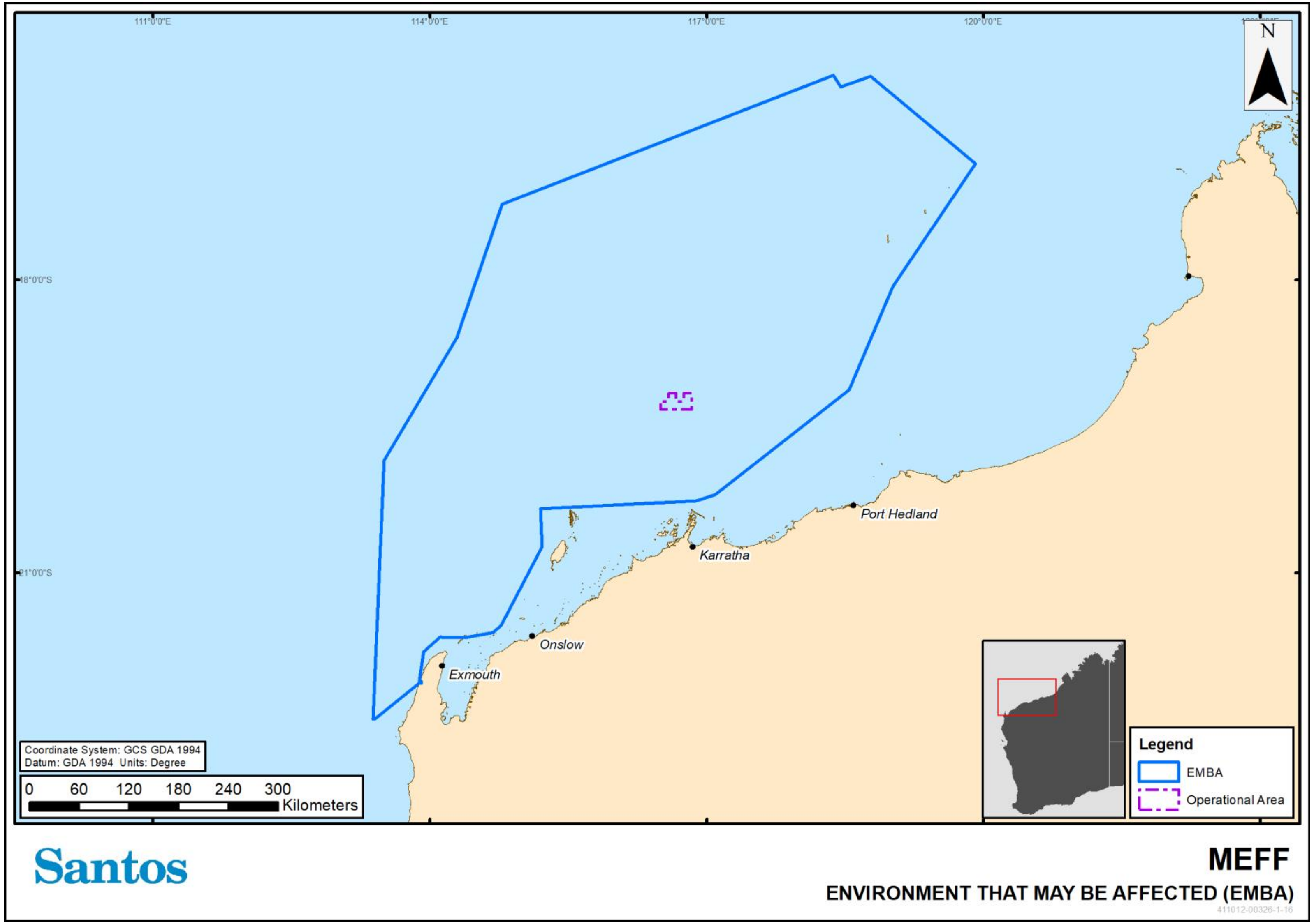

Figure 5-1: Environment that may be affected

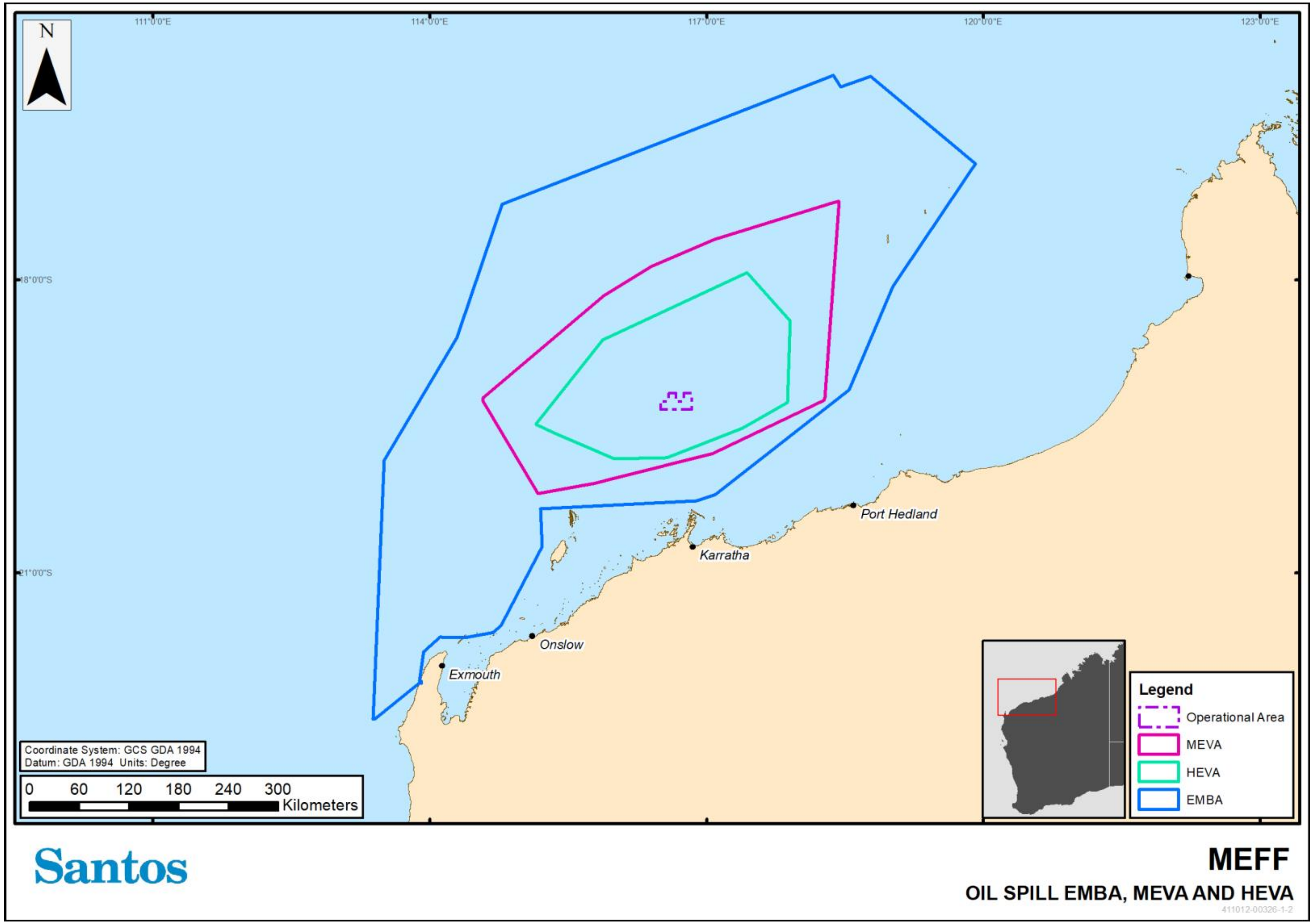

Figure 5-2: Overall environment that may be affected, moderate exposure value area and high exposure value area for the loss of well control and marine diesel oil scenarios

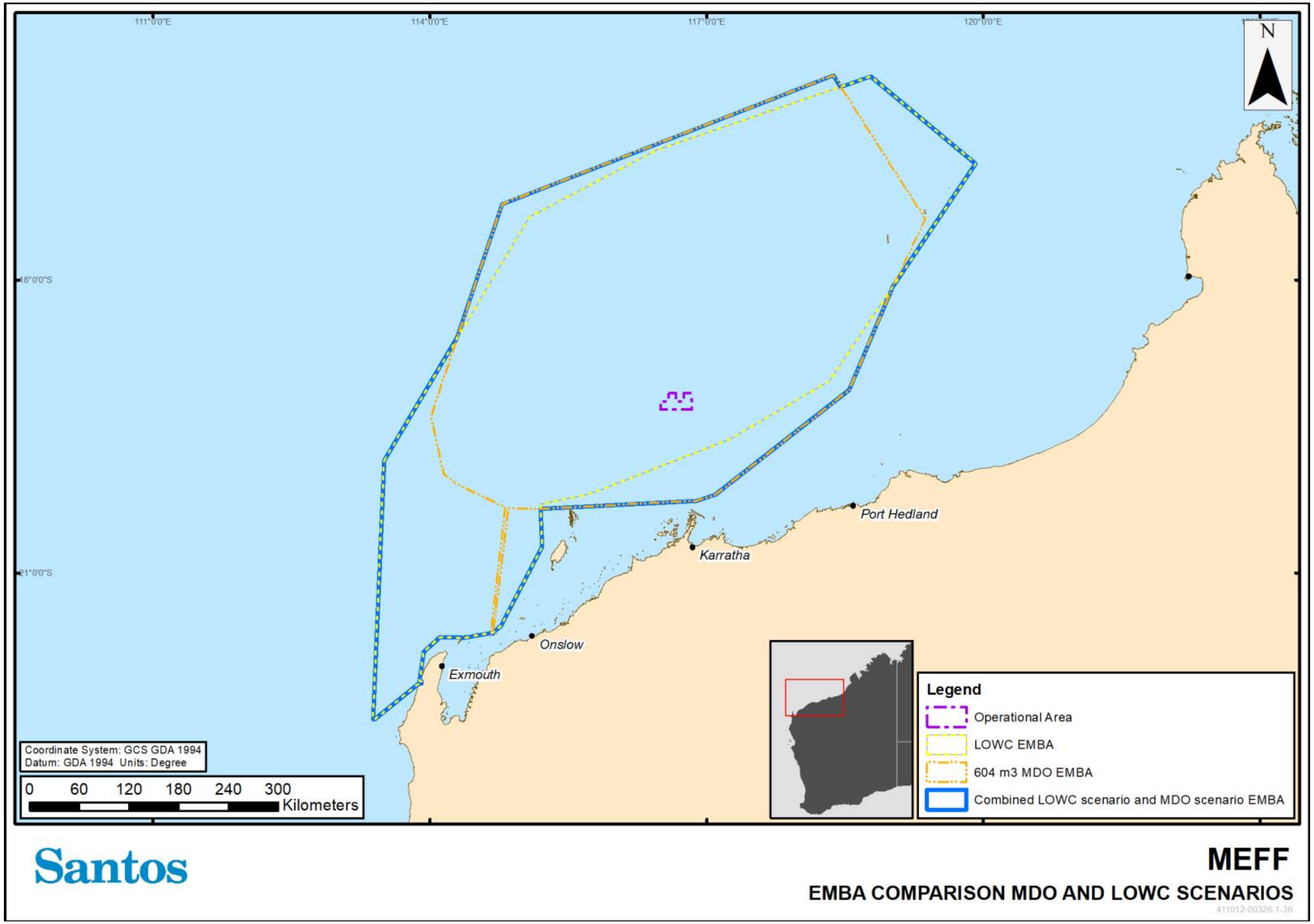

Figure 5-3: EMBA comparison loss of well control and marine diesel scenarios

5.2 Environmental values and sensitivities

5.2.1 Bioregions

Based on the Integrated Marine and Coastal Regionalisation of Australia (IMCRA) Version 4.0 (Commonwealth of Australia, 2006), the bioregions overlapped by the operational area and EMBA are provided in **Table 5-3** and **Figure 5-4**.

Table 5-3: Integrated Marine and Coastal Regionalisation of Australia 4.0 provincial bioregions relevant to the activity

Bioregion	Operational Area	EMBA
Northwest Shelf Province	✓	✓
Northwest Transition	✓	✓
Central Western Transition	✗	✓
Central Western Shelf Transition	✗	✓
Northwest Province	✗	✓

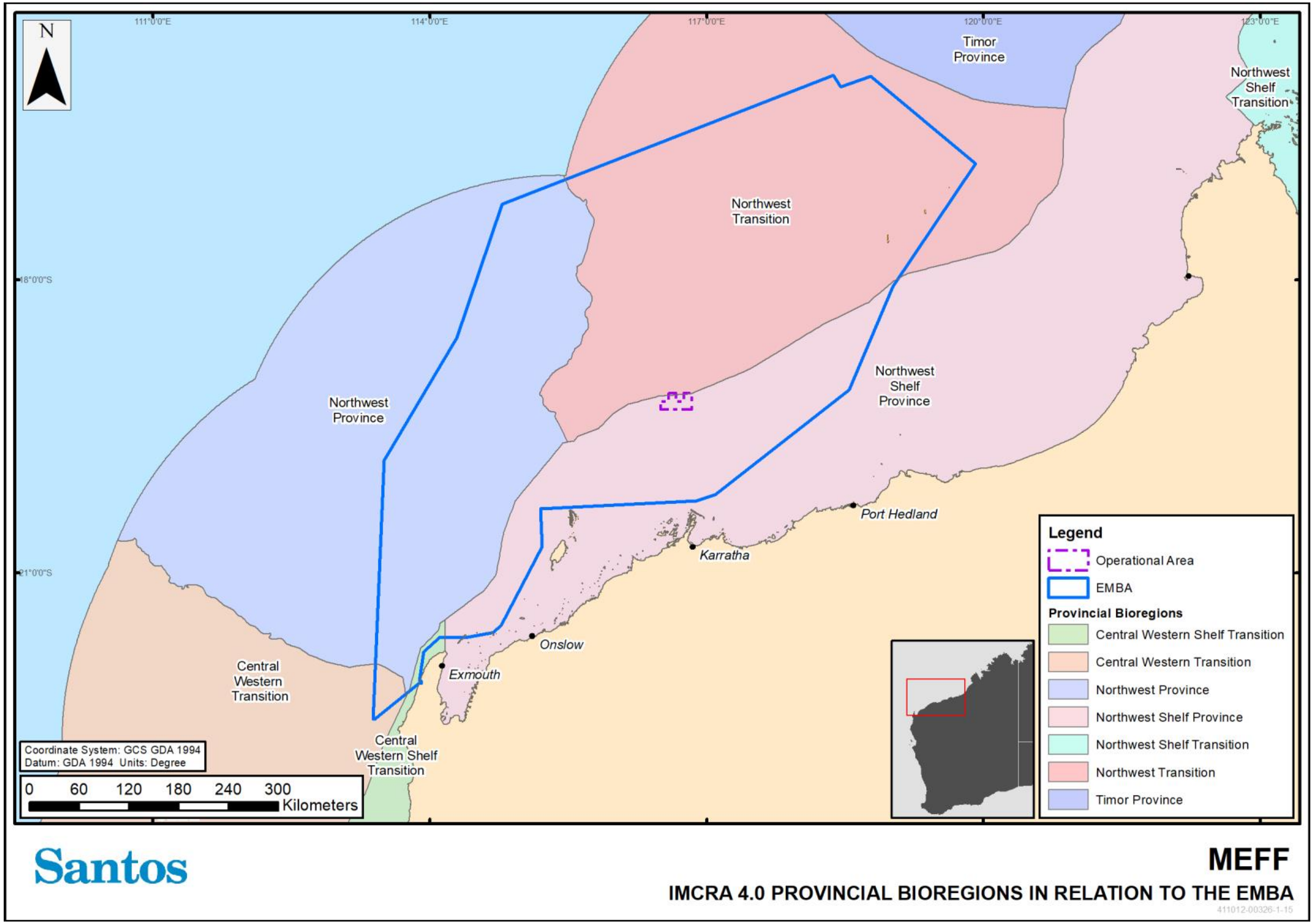

Figure 5-4: Integrated Marine and Coastal Regionalisation of Australia 4.0 provincial bioregions in relation to the environment that may be affected

5.2.2 Benthic habitats

The presence of marine and coastal habitats within the operational area and EMBA is summarised in **Table 5-4** and a detailed description of these habitats with reference to the IMCRA provincial bioregions is provided in Values and Sensitivities of the Western Australian Marine Environment (EA-00-RI-10062, **Appendix D**).

5.2.2.1 Operational area

A geophysical and geotechnical survey of the operational area undertaken in August 2011 indicates the seabed is relatively flat, smooth and featureless, in water depths ranging from around 132 m at lowest astronomical tide in the southeast to 163 m at lowest astronomical tide in the north-west. The only bathymetric features identified were those associated with Santos' existing petroleum production equipment linked to the Mutineer-Exeter operations and previous drilling campaigns (Neptune Geomatics, 2011).

Only one seabed type was identified in the operational area by the survey, this being low relief unconsolidated (high volume) calcareous silty fine sand (Neptune Geomatics, 2011). This is consistent with other studies (DEWHA, 2007), which indicate more than 60% of the sediments on the NWS are carbonate-derived.

Table 5-4: Habitats associated with receptors identified within the environment that may be affected

Category	Receptor	Operational Area Presence	EMBA Presence						Relevant Events That May Impact on the Receptors
			Northwest Province	Northwest Shelf Province	Northwest Transition	Northwest Shelf Transition	Central Western Province	Central Western Shelf Transition	
Benthic Habitats	Coral reefs	✗	✗	✓	✓	✓	✓	✓	Unplanned Hydrocarbon release due to subsea or surface loss of well control. Diesel release from vessel collision.
	Seagrass	✗	✓	✓	✓	✓	✓	✓	
	Macroalgae	✗	✗	✓	✓	✓	✓	✓	
	Non-coral benthic invertebrates	✓	✓	✓	✓	✓	✓	✓	Planned Seabed disturbance. Planned operational discharges. Unplanned Hydrocarbon release due to subsea or surface loss of well control. Diesel release from vessel collision. Unplanned release of solids.
Shoreline Habitats	Mangroves	✗	✗	✓	✗	✓	✓	✓	Unplanned Hydrocarbon release due to subsea or surface well release. Diesel release from vessel collision.
	Intertidal platforms	✗	✗	✓	✓	✓	✓	✓	
	Sandy beaches	✗	✗	✓	✗	✓	✓	✓	
	Rocky shorelines	✗	✓	✓	✓	✓	✓	✓	

5.2.3 Protected and significant areas

Protected and significant areas identified in the operational areas and EMBA are listed in **Table 5-5** and illustrated in **Figure 5-5** to **Figure 5-8**. Note: protected and significant areas that are terrestrial and not linked to the shoreline but occur in the EPBC Protected Matters search of the EMBA have been excluded as they are not relevant with respect to hydrocarbon concentrations of floating oil, in-water hydrocarbons (entrained and dissolved oil) and shoreline accumulations

5.2.3.1 Australian marine parks and state marine parks, management areas and reserves

The operational area does not intercept any Australian Marine Parks (AMPs) or State Marine Parks, Management Areas or Reserves. The closest AMP is the Montebello AMP, located around 99 km from the operational area. AMPs are recognised under the EPBC Act for protecting and maintaining biological diversity and contributing to a national representative network of marine protected areas. Management plans for AMPs have been developed and came into force on 1 July 2018. Under these plans AMPs are allocated conservation objectives (International Union for Conservation of Nature [IUCN] Protected Area Category) based on the Australian IUCN reserve management principles in Schedule 8 of the EPBC Regulations 2000. These principles determine what activities are acceptable within a protected area under the EPBC Act. The management zones, associated with the AMPs, and the relevant objectives are detailed in **Table 5-6**.

The EMBA overlaps a number of AMPs and state marine parks, management areas and nature reserves. These areas are shown in **Figure 5-5** and **Figure 5-6** and are further discussed in **Appendix E**.

5.2.3.2 Key ecological features

Key ecological features (KEFs) which are components of the marine ecosystem that are considered to be important for biodiversity or ecosystem function and integrity of the Commonwealth Marine Area, are also included in the EPBC Act Protected Matters Database results (**Appendix D**). The Ancient Coastline at 12 m depth contour KEF (the Ancient Coastline KEF) intersects the south-eastern portion of the Operational area. A number of other KEFs are present within the EMBA (**Figure 5-7**).

5.2.3.3 Heritage areas

Australia's heritage is managed by various levels of government and peak bodies that identify and list places for their heritage values. Significant heritage places are identified and grouped (by type) into lists that guide the protection and management of heritage values. No heritage areas are located within the operational areas, but several are within the EMBA. These areas are shown in **Figure 5-8** and are further discussed in **Appendix E**.

5.2.3.4 Wetlands of international or national importance

Wetlands are a critical part of our natural environment. They protect our shores from wave action, reduce the impacts of floods, absorb pollutants and improve water quality. They provide habitat for animals and plants and many contain a wide diversity of life, supporting plants and animals that are found nowhere else. No wetlands of international or national importance are located within the operational area or EMBA. The nationally important wetlands of Mermaid Reef and Cape Range subterranean waterways are located within the EMBA.

Table 5-5: Distance from respective operational area boundaries to protected areas within the environment that may be affected

Value/Sensitivity Name	Status, Zone or IUCN Classification	Presence in Operational Area	Presence in MEVA	Presence in EMBA	Distance to Operational Area (km)
North-West Marine Region					
Australian Marine Parks					
Montebello Marine Park (MP)	Multiple Use Zone (IUCN VI)	✗	✓	✓	98
Gascoyne MP	Multiple Use Zone (IUCN VI)	✗	✓	✓	325
Ningaloo MP	Recreational Use Zone (IUCN IV)	✗	✓	✓	351
Argo-Rowley Terrace MP	Multiple Use Zone (IUCN VI)	✗	✓	✓	158
	Special Purpose Zone (Trawl) (IUCN VI)	✗	✗	✓	271
Mermaid Reef MP	National Park Zone (IUCN II)	✗	✗	✓	358
State Marine Parks, Management Areas and Reserves					
Montebello Islands MP	Multiple Use Zone (IUCN VI)	✗	✓	✓	146
Muiron Islands Marine Management Area	Unclassified (IUCN VI)	✗	✗	✓	332
	Conservation Area (IUCN IA)	✗	✗	✓	336
Ningaloo MP	Recreational Use Zone (IUCN IV)	✗	✗	✓	351
Rowley Shoals MP	Sanctuary Zone (IUCN IA)	✗	✗	✓	339
	Recreation Zone (IUCN II)	✗	✗	✓	271
	General Use (IUCN II)	✗	✗	✓	288
World and National Heritage Areas					
The Ningaloo Coast	–	✗	✗	✓	332
Barrow Island and the Montebello-Barrow Islands Marine Conservation Reserves	–	✗	✗	✓	146

Value/Sensitivity Name	Status, Zone or IUCN Classification	Presence in Operational Area	Presence in MEVA	Presence in EMBA	Distance to Operational Area (km)
Commonwealth Heritage Places					
Mermaid Reef – Rowley Shoals	–	✗	✗	✓	368
Ningaloo Marine Area – Commonwealth Waters	–	✗	✗	✓	351
Wetlands of National Importance					
Mermaid Reef	–	✗	✗	✓	368
Cape Range Subterranean Waterways	–	✗	✗	✓	388
Key Ecological Features					
Ancient coastline at 125 m depth contour	–	✓	✓	✓	0
Glomar Shoals	–	✗	✓	✓	16
Continental slope demersal fish communities	–	✗	✓	✓	112
Exmouth Plateau	–	✗	✗	✓	221
Mermaid Reef and Commonwealth waters	–	✗	✗	✓	262
Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula	–	✗	✗	✓	305
Commonwealth waters adjacent to Ningaloo Reef	–	✗	✗	✓	351

Table 5-6: Management zones for the Australian and State marine parks found within the environment that may be affected 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	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 5-7**.

Table 5-7: Prescriptions/conditions from the North-West and North Marine Parks Network Management Plan 2018 relevant to the activities in this Environment Plan

Prescription/ Condition Number	Prescription/Condition	Relevant Section of EP
North-West MPNMP (Director of National Parks (DNP), 2018a)		
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 + 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 Table 6-2 (Stakeholder Consultation), reporting under Section 7 of the OPEP
Class Approval – Mining Operations and Green House Gas Activities – for North-West MPNMP (DNP, 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	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 10.10** (Reporting) and Section 7 of 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

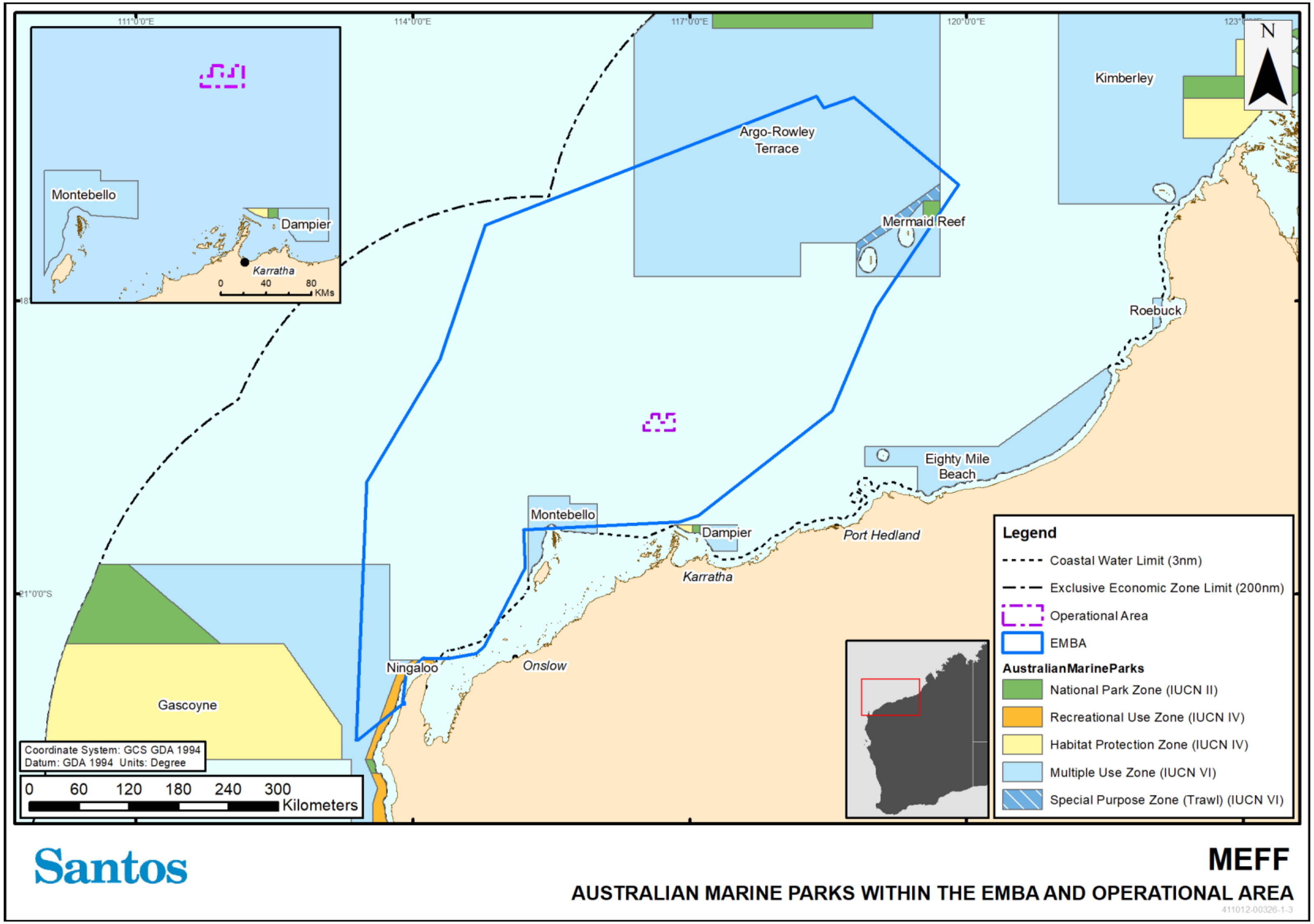

Figure 5-5: Australian marine parks within the environment that may be affected and operational area

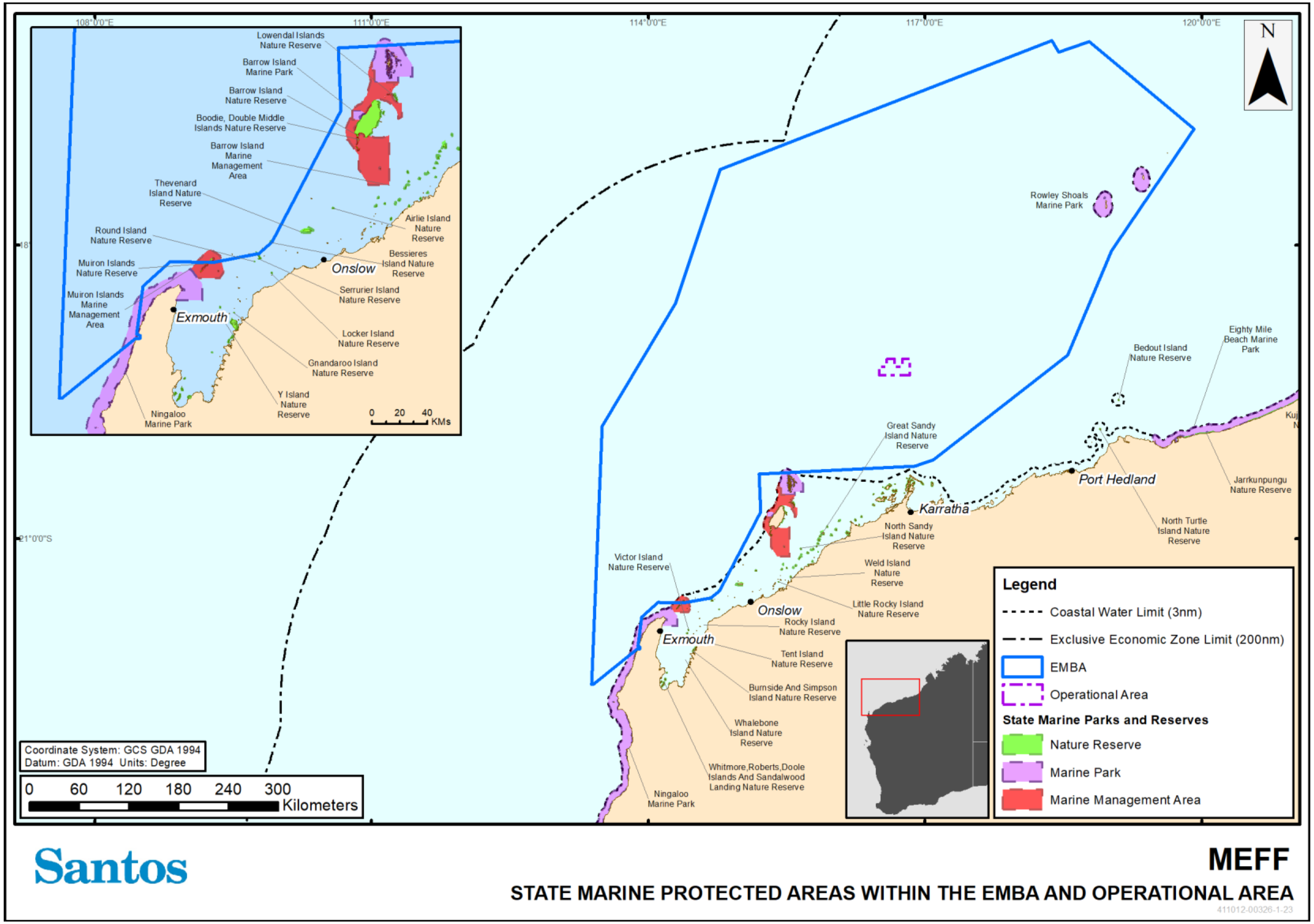

Figure 5-6: State marine protected areas within the environment that may be affected and operational area

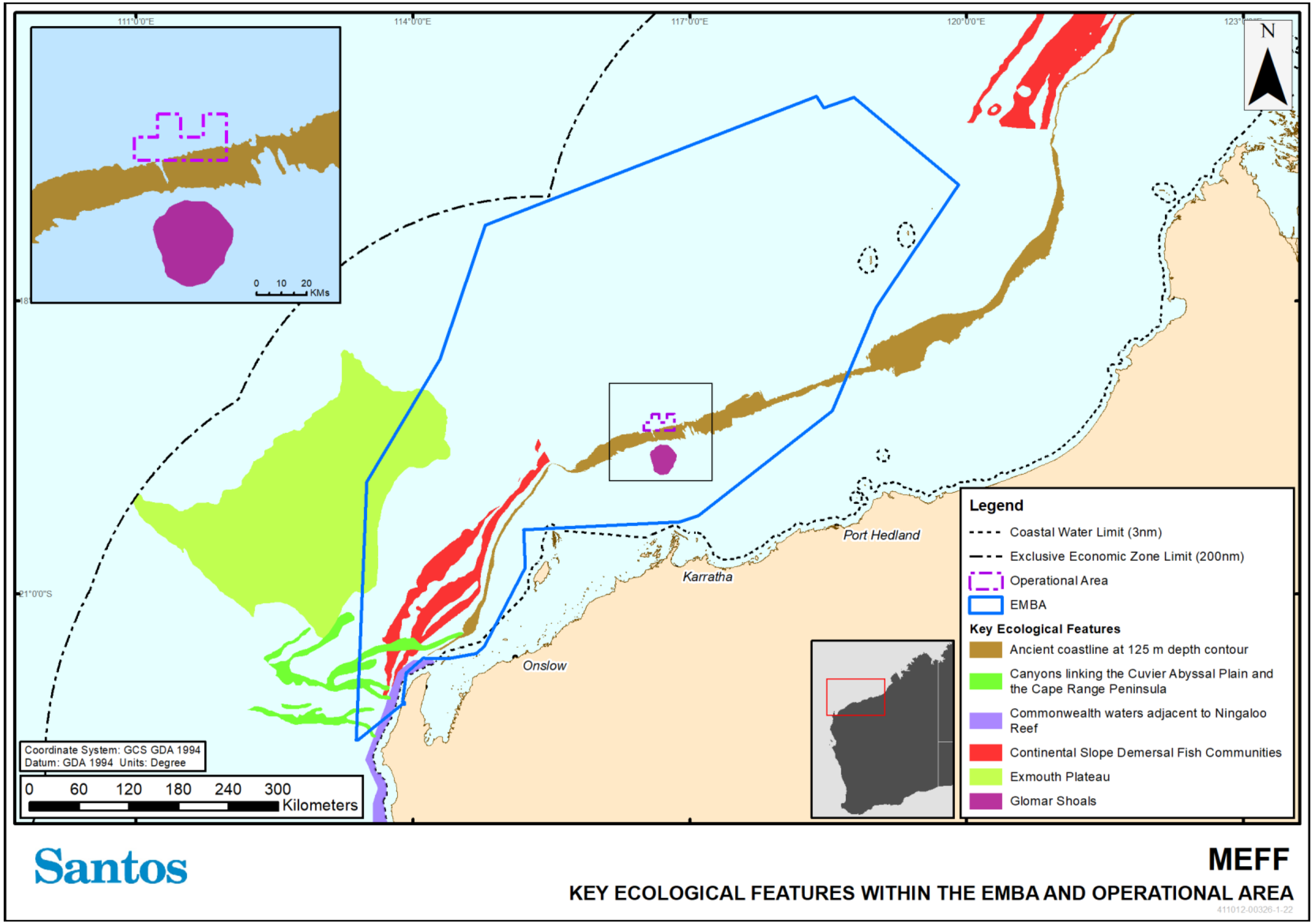

Figure 5-7: Key ecological features within and near the environment that may be affected and operational area

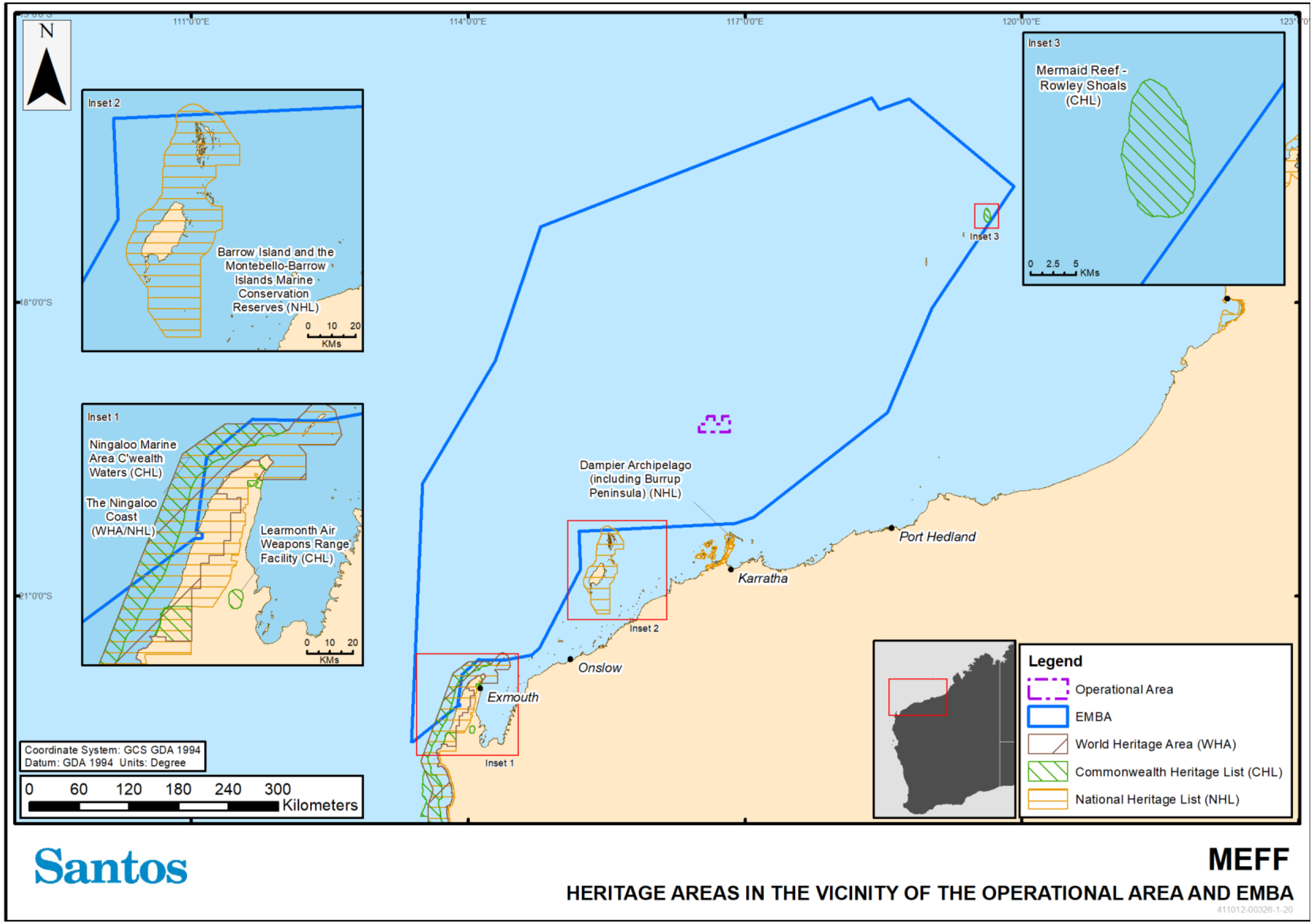

Figure 5-8: Heritage areas in the vicinity of the operational area and within the environment that may be affected

5.2.4 Threatened and migratory fauna

The Protected Matters Search Tool (**Appendix E**) identified 14 listed threatened species and 31 migratory species under the EPBC Act 1999 in the operational area.

In the EMBA, 34 listed threatened species and 56 migratory species were identified as potentially occurring in marine or shoreline habitats. 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. 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. 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, MEVA or the EMBA and the relevant planned and unplanned events that may impact them are discussed in **Table 5-8**.

Appendix D provides a comprehensive description of species that may be present within the EMBA.

Table 5-8: Environmental values and sensitivities within the environment that may be affected and operational area – threatened and migratory marine fauna

Value/sensitivity		EPBC Act Status	Operational Area		MEVA		EMBA		Relevant events
Common name	Scientific name		Presence	Type of Presence	Presence	Type of Presence	Presence	Type of Presence	
Protected Species and Communities: Fish and Sharks									
Narrow sawfish, knifetooth sawfish	*Anoxypristis cuspidata*	Migratory	✓	Species or species habitat known to occur in area	✓	Species or species habitat known to occur in area	✓	Species or species habitat known to occur in area	Planned + Light emissions + Noise emissions + Planned operational discharges + Planned chemical and hydrocarbon discharges + Spill response operations Unplanned + Hydrocarbon releases/spills + Interaction with marine fauna + Introduction of invasive marine species (IMS)
Grey nurse shark (west coast population)	*Carcharias taurus* (west coast population)	Vulnerable	✗	N/A	✓	Species or species habitat known to occur in area	✓	Species or species habitat known to occur in area	
Oceanic whitetip shark	*Carcharhinus longimanus*	Migratory	✓	Species or species habitat likely to occur in area	✓	Species or species habitat likely to occur in area	✓	Species or species habitat likely to occur in area	
White shark, great white shark	*Carcharodon carcharias*	Vulnerable, Migratory	✓	Species or species habitat may occur in area	✓	Species or species habitat may occur in area	✓	Species or species habitat may occur in area	

Value/sensitivity		EPBC Act Status	Operational Area		MEVA		EMBA		Relevant events
Common name	Scientific name		Presence	Type of Presence	Presence	Type of Presence	Presence	Type of Presence	
Dwarf sawfish, Queensland sawfish	*Pristis clavata*	Vulnerable, Migratory	✗	N/A	✓	Species or species habitat known to occur in area	✓	Species or species habitat known to occur in area	
Green sawfish, Dindagubba, narrowsnout sawfish	*Pristis zijsron*	Vulnerable, Migratory	✓	Species or species habitat known to occur in area	✓	Species or species habitat known to occur in area	✓	Species or species habitat known to occur in area	
Whale shark	*Rhincodon typus*	Vulnerable, Migratory	✓	Foraging, feeding or related behaviour known to occur in area	✓	Foraging, feeding or related behaviour known to occur in area	✓	Foraging, feeding or related behaviour known to occur in area	
Shortfin mako, mako shark	*Isurus oxyrinchus*	Migratory	✓	Species or species habitat likely to occur in area	✓	Species or species habitat likely to occur in area	✓	Species or species habitat likely to occur in area	

Value/sensitivity		EPBC Act Status	Operational Area		MEVA		EMBA		Relevant events
Common name	Scientific name		Presence	Type of Presence	Presence	Type of Presence	Presence	Type of Presence	
Longfin mako shark	*Isurus paucus*	Migratory	✓	Species or species habitat likely to occur in area	✓	Species or species habitat likely to occur in area	✓	Species or species habitat likely to occur in area	
Reef manta ray, coastal manta ray	*Manta alfredi*	Migratory	✓	Species or species habitat likely to occur in area	✓	Species or species habitat likely to occur in area	✓	Species or species habitat known to occur in area	
Giant manta ray, chevron manta ray, Pacific manta ray	*Manta birostris*	Migratory	✓	Species or species habitat likely to occur in area	✓	Species or species habitat likely to occur in area	✓	Species or species habitat known to occur in area	
Protected Species and Communities: Marine Mammals									
Sei whale	*Balaenoptera borealis*	Vulnerable, Migratory	✓	Species or species habitat likely occur in area	✓	Species or species habitat likely occur in area	✓	Species or species habitat likely to occur in area	Planned + Noise emissions + Planned operational discharges

Value/sensitivity		EPBC Act Status	Operational Area		MEVA		EMBA		Relevant events
Common name	Scientific name		Presence	Type of Presence	Presence	Type of Presence	Presence	Type of Presence	
Fin whale	*Balaenoptera physalusk*	Vulnerable, Migratory	✓	Species or species habitat likely to occur in area	✓	Species or species habitat likely to occur in area	✓	Species or species habitat likely to occur in area	+ Planned hydrocarbon and chemical discharges + Spill response operations <u>Unplanned</u> + Hydrocarbon releases/spills + Marine fauna interaction
Blue whale	*Balaenoptera musculus*	Endangered, Migratory	✓	Species or species habitat likely to occur in area	✓	Migration route known to occur in area	✓	Migration route known to occur in area	
Humpback whale	*Megaptera novaeangliae*	Vulnerable, Migratory	✓	Species or species habitat known to occur in area	✓	Species or species habitat known to occur in area	✓	Species or species habitat known to occur in area	
Antarctic minke whale, dark-shoulder minke whale	*Balaenoptera bonaerensis*	Migratory	✗	N/A	✓	Species or species habitat likely to occur in area	✓	Species or species habitat likely to occur in area	

Value/sensitivity		EPBC Act Status	Operational Area		MEVA		EMBA		Relevant events
Common name	Scientific name		Presence	Type of Presence	Presence	Type of Presence	Presence	Type of Presence	
Bryde's whale	*Balaenoptera edeni*	Migratory	✓	Species or species habitat likely to occur in area	✓	Species or species habitat likely to occur in area.	✓	Species or species habitat likely to occur in area	
Sperm whale	*Physeter macrocephalus*	Migratory	✓	Species or species habitat may occur in area	✓	Species or species habitat may occur in area	✓	Species or species habitat may occur in area	
Dugong	*Dugong dugon*	Migratory	✗	N/A	✓	Species or species habitat may occur in area	✓	Breeding known to occur in area	
Killer whale, orca	*Orcinus orca*	Migratory	✓	Species or species habitat may occur in area	✓	Species or species habitat may occur in area	✓	Species or species habitat may occur in area	
Indo-Pacific humpback dolphin	*Sousa chinensis*	Migratory	✗	N/A	✓	Species or species habitat may occur in area	✓	Breeding known to occur in area	

Value/sensitivity		EPBC Act Status	Operational Area		MEVA		EMBA		Relevant events
Common name	Scientific name		Presence	Type of Presence	Presence	Type of Presence	Presence	Type of Presence	
Spotted bottlenose dolphin	*Tursiops aduncus* (Arafura/Timor Sea populations)	Migratory	✓	Species or species habitat may occur in area	✓	Species or species habitat may occur in area	✓	Species or species habitat known to occur in area	
Australian snubfin/snubnose dolphin	*Orcaella heinsohni*	Migratory	✗	N/A	✓	Species or species habitat may occur in area	✓	Species or species habitat known to occur in area	
Southern Right Whale	*Eubalaena australis*	Migratory	✗	N/A	✓	Species or species habitat may occur in area	✓	Species or species habitat likely to occur in area	
Protected Species and Communities: Marine Reptiles									
Short-nosed seasnake	*Aipysurus apraefrontalis*	Critically Endangered	✗	N/A	✓	Species or species habitat likely to occur in area	✓	Species or species habitat likely to occur in area	Planned + Light emissions + Noise emissions + Planned operational

Value/sensitivity		EPBC Act Status	Operational Area		MEVA		EMBA		Relevant events
Common name	Scientific name		Presence	Type of Presence	Presence	Type of Presence	Presence	Type of Presence	
Leaf-scaled seasnake	*Aipysurus foliosquama*	Critically Endangered	✗	N/A	✓	Species or species habitat likely to occur in area	✓	Species or species habitat known to occur in area	discharges + Planned hydrocarbon and chemical discharges + Spill response operations <u>Unplanned</u> + Hydrocarbon releases/spills + Marine fauna interactions + Introduction of IMS
Loggerhead turtle	*Caretta*	Endangered, Migratory	✓	Species or species habitat likely to occur in area	✓	Foraging, feeding or related behaviour known to occur in area	✓	Foraging, feeding or related behaviour known to occur in area	
Green turtle	*Chelonia mydas*	Vulnerable, Migratory	✓	Species or species habitat likely to occur in area	✓	Breeding known to occur in area	✓	Breeding known to occur in area	
Leatherback turtle	*Dermochelys coriacea*	Endangered, Migratory	✓	Species or species habitat likely to occur in area	✓	Species or species habitat likely to occur in area	✓	Species or species habitat known to occur in area	

Value/sensitivity		EPBC Act Status	Operational Area		MEVA		EMBA		Relevant events
Common name	Scientific name		Presence	Type of Presence	Presence	Type of Presence	Presence	Type of Presence	
Hawksbill turtle	*Eretmochelys imbricata*	Vulnerable, Migratory	✓	Species or species habitat likely to occur in area	✓	Breeding known to occur in area	✓	Breeding known to occur in area	
Flatback turtle	*Natator depressus*	Vulnerable, Migratory	✓	Species or species habitat likely to occur in area	✓	Breeding known to occur in area	✓	Breeding known to occur in area	
Protected Species and Communities: Marine Birds									
Red knot, knot	*Calidris canutus*	Endangered, Migratory	✓	Species or species habitat may occur in area	✓	Species or species habitat likely to occur in area	✓	Species or species habitat known to occur in area	<u>Planned</u> + Light emissions + Planned operational discharges + Spill response operations <u>Unplanned</u> Hydrocarbon releases/spills
Eastern curlew, far eastern curlew	*Numenius madagascariensis*	Critically Endangered, Migratory	✓	Species or species habitat may occur in area	✓	Species or species habitat likely to occur in area	✓	Species or species habitat known to occur in area	

Value/sensitivity		EPBC Act Status	Operational Area		MEVA		EMBA		Relevant events
Common name	Scientific name		Presence	Type of Presence	Presence	Type of Presence	Presence	Type of Presence	
Common noddy	*Anous stolidus*	Migratory	✓	Species or species habitat may occur in area	✓	Species or species habitat may occur in area	✓	Species or species habitat likely to occur in area	
Streaked shearwater	*Calonectris leucomelas*	Migratory	✓	Species or species habitat may occur in area	✓	Species or species habitat may occur in area	✓	Species or species habitat known to occur in area	
Lesser frigatebird	*Fregata ariel*	Migratory	✓	Species or species habitat likely to occur in area	✓	Breeding known to occur in area	✓	Breeding known to occur in area	
Great frigatebird	*Fregata minor*	Migratory	✓	Species or species habitat may occur in area	✓	Species or species habitat may occur in area	✓	Species or species habitat likely to occur in area	

Value/sensitivity		EPBC Act Status	Operational Area		MEVA		EMBA		Relevant events
Common name	Scientific name		Presence	Type of Presence	Presence	Type of Presence	Presence	Type of Presence	
Common sandpiper	*Actitis hypoleucos*	Migratory	✓	Species or species habitat may occur in area	✓	Species or species habitat may occur in area	✓	Species or species habitat known to occur in area	
Sharp-tailed sandpiper	*Calidris acuminata*	Migratory	✓	Species or species habitat may occur in area	✓	Species or species habitat may occur in area	✓	Species or species habitat known to occur in area	
Pectoral sandpiper	*Calidris melanotos*	Migratory	✓	Species or species habitat may occur in area	✓	Species or species habitat likely to occur in area	✓	Species or species habitat may occur in area	
Curlew sandpiper	*Calidris ferruginea*	Critically Endangered, Migratory	✗	Species or species habitat may occur in area	✓	Species or species habitat likely to occur in area	✓	Species or species habitat known to occur in area	
Greater sand plover, large sand plover	*Charadrius leschenaultii*	Vulnerable, Migratory	✗	N/A	✗	N/A	✓	Species or species habitat likely to occur in area	

Value/sensitivity		EPBC Act Status	Operational Area		MEVA		EMBA		Relevant events
Common name	Scientific name		Presence	Type of Presence	Presence	Type of Presence	Presence	Type of Presence	
Northern Siberian bar-tailed godwit, bar-tailed godwit (menzbieri)	*Limosa lapponica menzbieri*	Critically Endangered	✗	N/A	✗	N/A	✓	Species or species habitat known to occur in area	
Southern giant-petrel, southern giant petrel	*Macronectes giganteus*	Endangered, Migratory	✗	N/A	✓	Species or species habitat may occur in area	✓	Species or species habitat may occur in area	
Abbott's booby	*Papasula abbotti*	Endangered	✗	N/A	✗	N/A	✓	Species or species habitat may occur in area	
Night parrot	*Pezoporus occidentalis*	Endangered	✗	N/A	✗	N/A	✓	Species or species habitat may occur in area	
Soft-plumaged petrel	*Pterodroma mollis*	Vulnerable	✗	N/A	✗	N/A	✓	Foraging, feeding or related behaviour likely to occur in area	

Value/sensitivity		EPBC Act Status	Operational Area		MEVA		EMBA		Relevant events
Common name	Scientific name		Presence	Type of Presence	Presence	Type of Presence	Presence	Type of Presence	
Australian painted snipe	*Rostratula australis*	Endangered	✗	N/A	✓	Species or species habitat may occur in area	✓	Species or species habitat may occur in area	
Australian fairy tern	*Sternula nereis*	Vulnerable	✗	N/A	✓	Foraging, feeding or related behaviour likely to occur in area	✓	Foraging, feeding or related behaviour likely to occur in area	
Campbell albatross	*Thalassarache impavida*	Vulnerable, Migratory	✗	N/A	✗	N/A	✓	Species or species habitat may occur in area	
Fork-tailed swift	*Apus pacificus*	Migratory	✗	N/A	✗	N/A	✓	Species or species habitat likely to occur in area	
Flesh-footed shearwater	*Ardenna carneipes*	Migratory	✗	N/A	✗	N/A	✓	Foraging, feeding or related behaviour likely to occur in area	

Value/sensitivity		EPBC Act Status	Operational Area		MEVA		EMBA		Relevant events
Common name	Scientific name		Presence	Type of Presence	Presence	Type of Presence	Presence	Type of Presence	
Wedge-tailed shearwater	*Ardenna pacifica*	Migratory	✗	N/A	✗	N/A	✓	Breeding known to occur in area	
White-tailed tropicbird	*Phaethon lepturus*	Migratory	✗	N/A	✓	Breeding known to occur in area	✓	Breeding known to occur in area	
Red-tailed tropicbird	*Phaethon rubricauda*	Migratory	✗	N/A	✗	N/A	✓	Breeding known to occur in area	
Roseate tern	*Sterna dougallii*	Migratory	✗	N/A	✗	N/A	✓	Breeding likely to occur in area	
Little tern	*Sternula albifrons*	Migratory	✗	N/A	✓	Breeding known to occur in area	✓	Breeding known to occur in area	
Oriental plover	*Charadrius veredus*	Migratory	✗	N/A	✗	N/A	✓	Species or species habitat may occur in area	
Oriental pratincole	*Glareola maldivarum*	Migratory	✗	N/A	✗	N/A	✓	Species or species habitat may occur in area	

Value/sensitivity		EPBC Act Status	Operational Area		MEVA		EMBA		Relevant events
Common name	Scientific name		Presence	Type of Presence	Presence	Type of Presence	Presence	Type of Presence	
Bar-tailed godwit	*Limosa lapponica*	Migratory	✗	N/A	✗	N/A	✓	Species or species habitat known to occur in area	
Osprey	*Pandion haliaetus*	Migratory	✗	N/A	✓	Species or species habitat may occur in area	✓	Breeding known to occur in area	
Greater crested tern	*Thalasseus bergii*	Migratory	✗	N/A	✗	N/A	✓	Breeding known to occur in area	
Common greenshank, greenshank	*Tringa nebularia*	Migratory	✗	N/A	✗	N/A	✓	Species or species habitat likely to occur in area	

5.2.4.1 Biologically important areas and critical habitat

Biologically important areas (BIAs) such as an aggregation, breeding, resting, nesting or feeding area, or known migratory routes for these species within the operational area and EMBA, are shown in **Figure 5-9** to **Figure 5-16** and are also described in **Table 5-9**.

DCCEEW may make recovery plans for threatened fauna listed under the EPBC Act. The Act requires that 'habitat critical to the survival of the listed threatened species' is identified in recovery plans. Critical habitat within the EMBA has only been identified for marine reptiles as listed in **Table 5-9**.

Table 5-9: Biologically important areas identified in the operational area and environment that may be affected

Fauna group	Species	BIA Type	Presence in Operational Area	Presence in MEVA	Presence in EMBA	Habitat critical within EMBA
Sharks and Rays	Whale shark	Foraging	✓	✓	✓	N/A
Marine Mammals	Dugong	Breeding	✗	✗	✓	N/A
		Calving	✗	✗	✓	N/A
		Nursing	✗	✗	✓	N/A
		Foraging	✗	✗	✓	N/A
	Humpback whale	Migration	✗	✓	✓	N/A
	Pygmy blue whale	Migration	✗	✓	✓	N/A
		Distribution	✓	✓	✓	N/A
		Foraging	✗	✗	✓	N/A
Marine Reptiles	Flatback turtle	Foraging	✗	✗	✓	Barrow Island, Montebello Islands; 60 km internesting buffer Dampier Archipelago, including 60 km Internesting buffer
		Aggregation	✗	✗	✓	
		Mating	✗	✗	✓	
		Migration	✗	✗	✓	
		Nesting/ internesting	✗	✓	✓	
	Green turtle	Foraging	✗	✓	✓	Montebello Islands and Ningaloo coast; 20 km internesting buffer
		Nesting/ internesting	✗	✓	✓	
		Mating	✗	✗	✓	
		Basking	✗	✗	✗	
		Migration	✗	✗	✗	
		Aggregation	✗	✗	✗	

Fauna group	Species	BIA Type	Presence in Operational Area	Presence in MEVA	Presence in EMBA	Habitat critical within EMBA
	Hawksbill turtle	Foraging	✗	✗	✗	Montebello Islands, Lowendal Islands, Ningaloo Coast and Dampier Archipelago, 20 km internesting buffer
		Nesting/ internesting	✗	✓	✓	
		Mating	✗	✗	✗	
		Migration	✗	✗	✗	
	Loggerhead turtle	Foraging	✗	✗	✓	Ningaloo coast, 20 km internesting buffer
		Nesting/ internesting	✗	✗	✓	
	Lesser crested tern	Breeding	✗	✗	✓	N/A
	Fairy tern	Breeding	✗	✗	✓	N/A
	Lesser frigatebird	Breeding	✗	✗	✓	N/A
	Little tern	Resting	✗	✗	✓	N/A
	Roseate tern	Breeding	✗	✓	✓	N/A
	Wedge-tailed shearwater	Breeding	✗	✓	✓	N/A
	White-tailed tropicbird	Breeding	✗	✗	✓	N/A

Relevant conservation advices, recovery plans and management plans for marine fauna identified in the PMST are provided in **Table 5-10**.

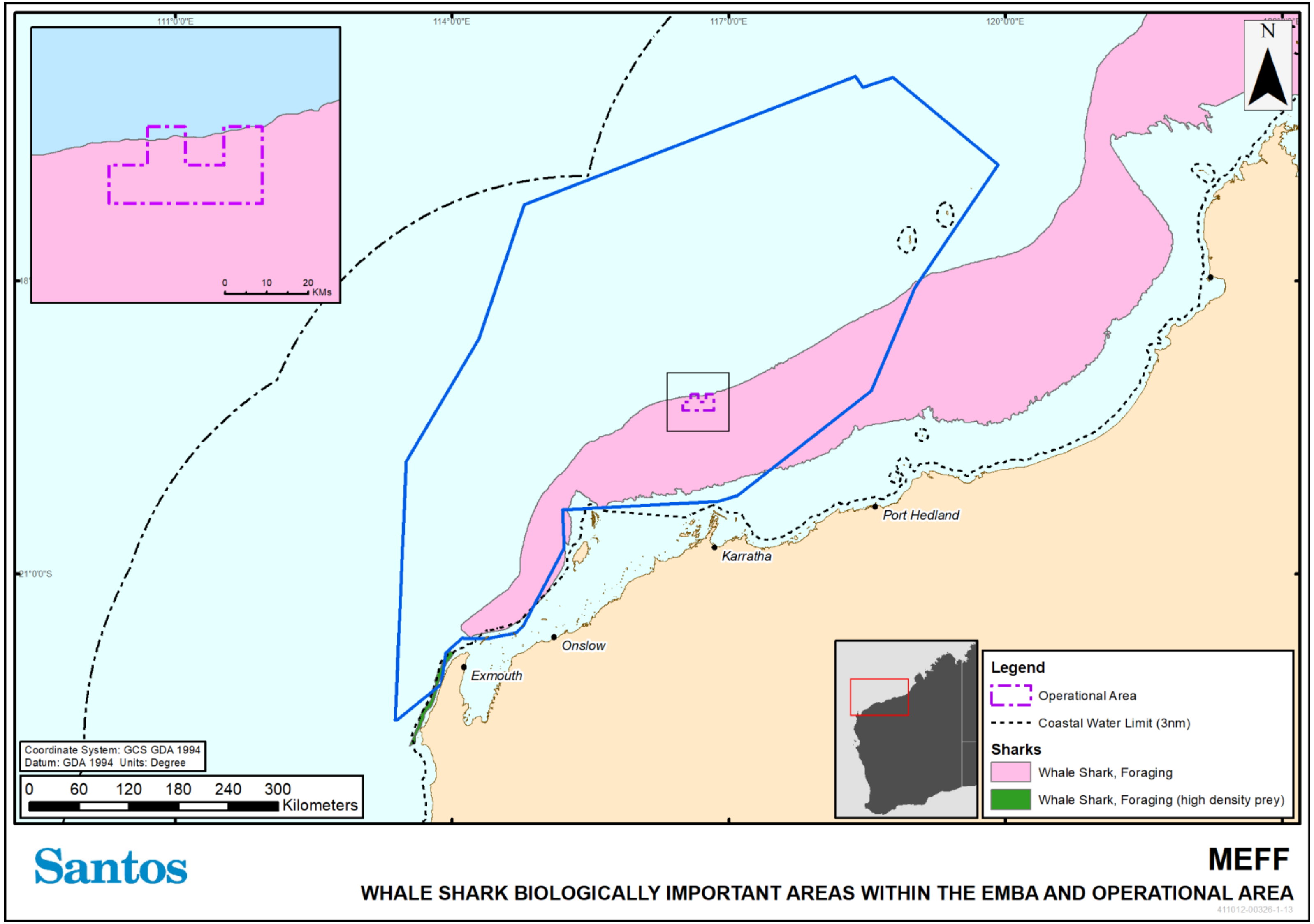

Figure 5-9: Biologically important areas for protected whale sharks within the vicinity of the environment that may be affected and operational area

Santos

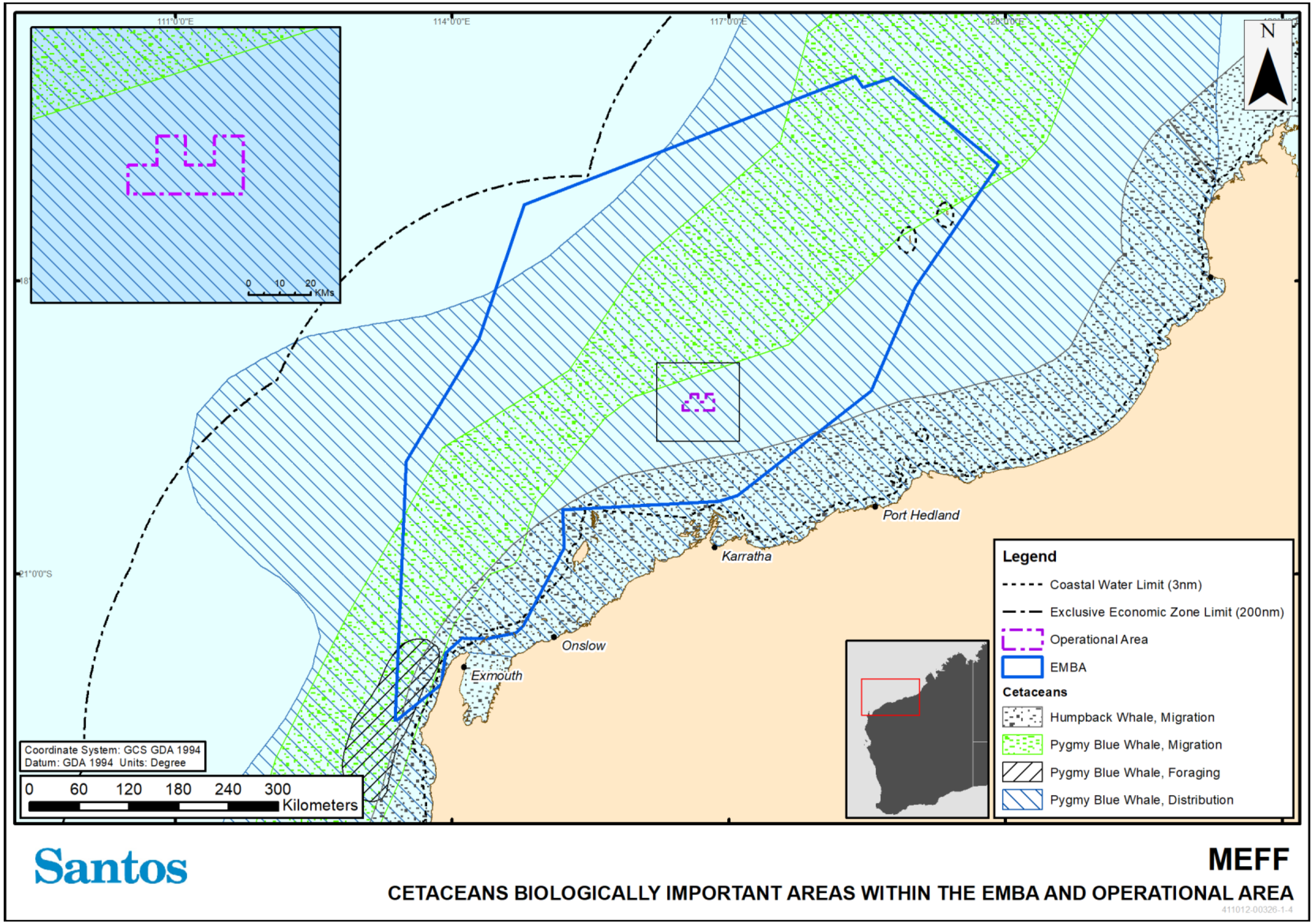

Figure 5-10: Biologically important areas for protected cetaceans within the vicinity of the environment that may be affected and operational area

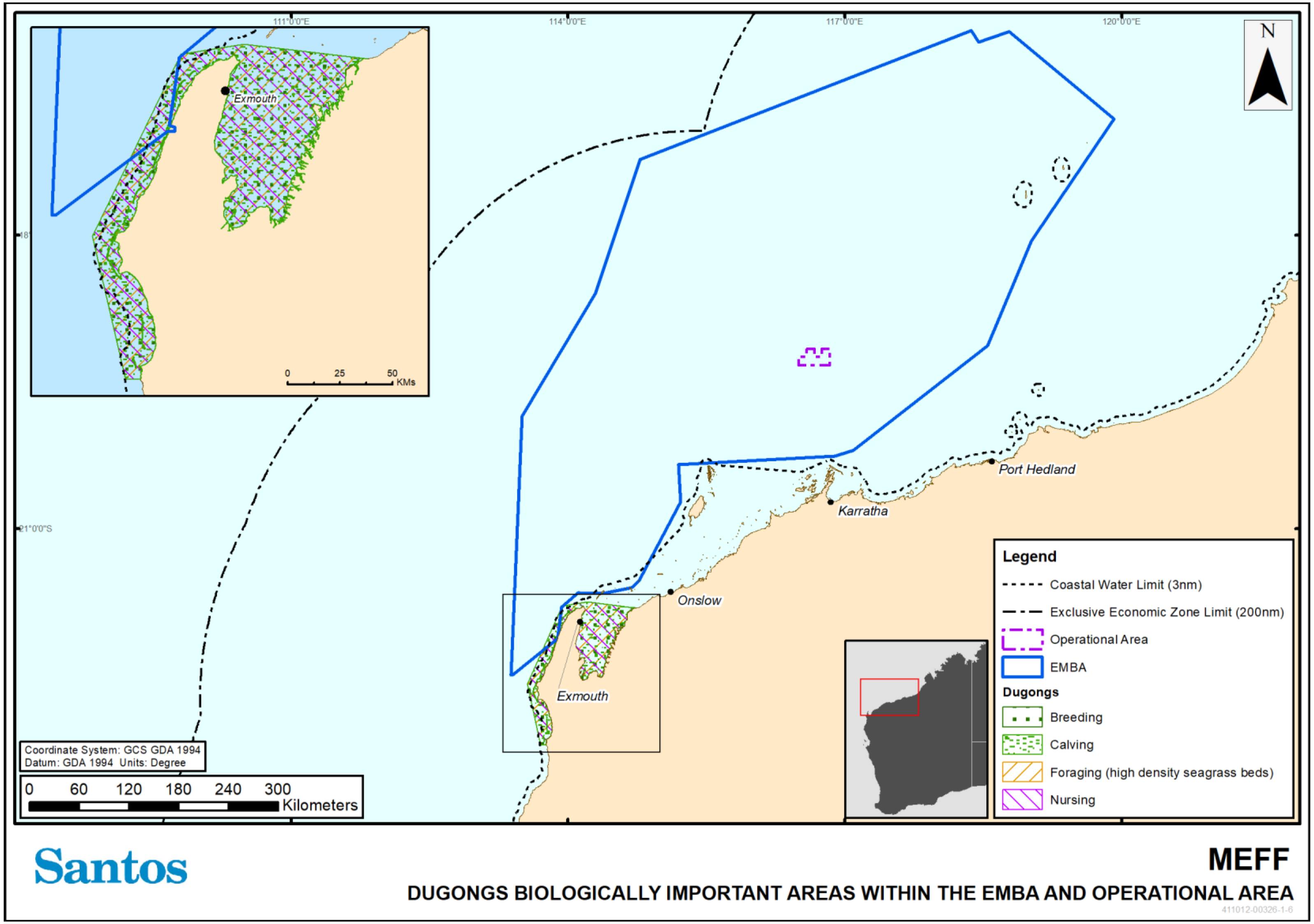

Figure 5-11: Biologically important areas for dugong within the vicinity of the environment that may be affected and operational area

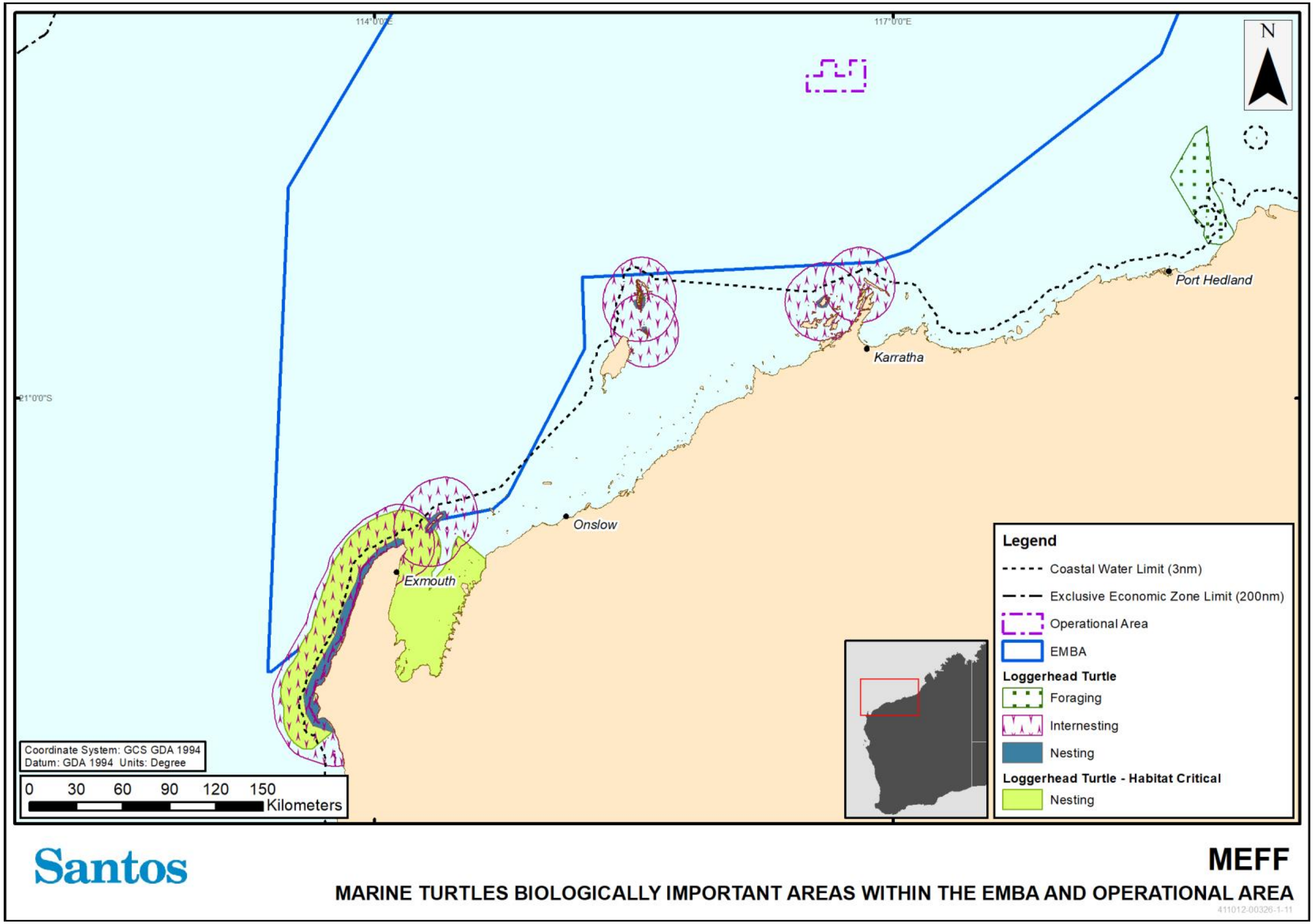

Figure 5-12: Biologically important areas for loggerhead turtles within the vicinity of the environment that may be affected and operational area

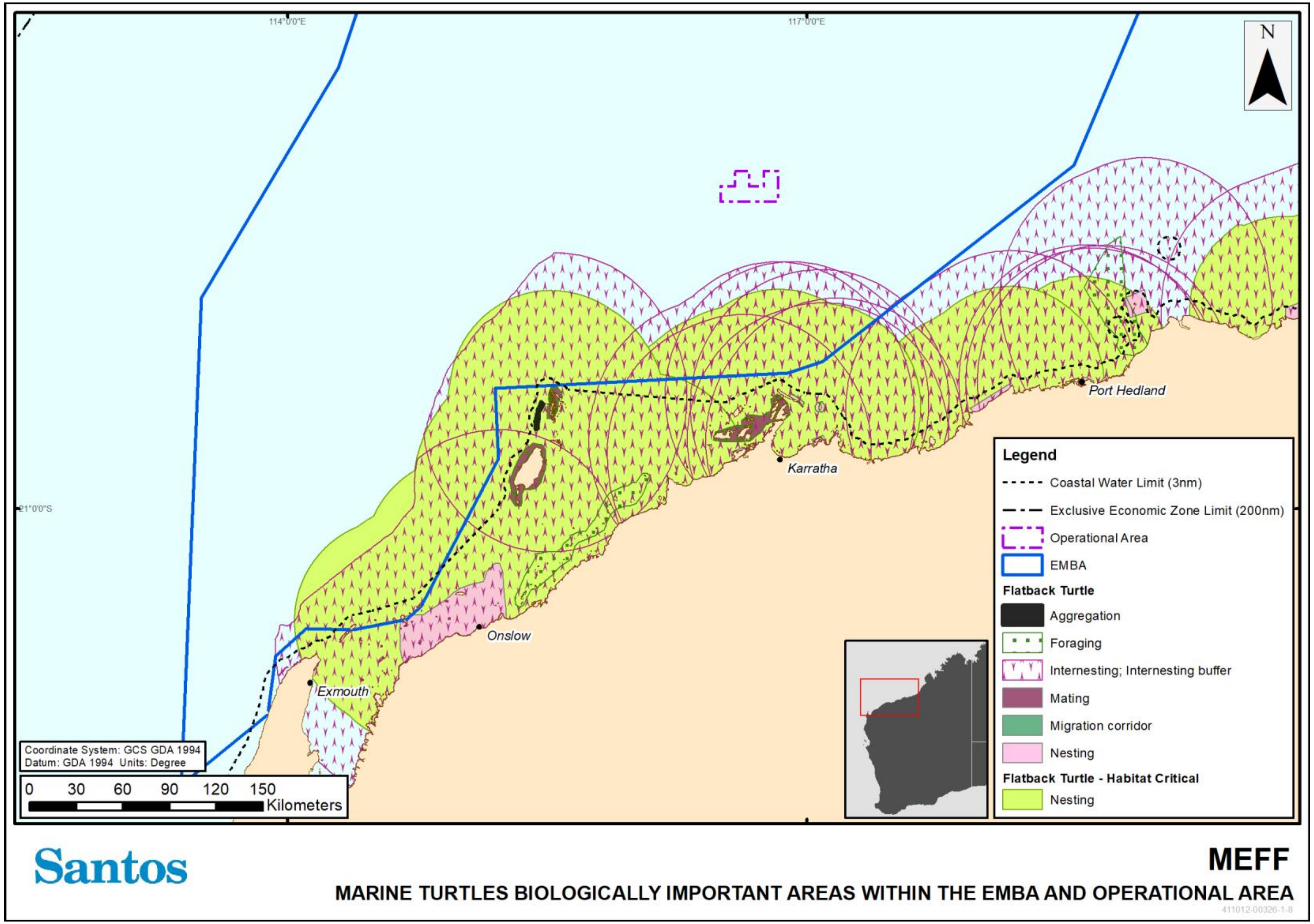

Figure 5-13: Biologically important areas for flatback turtles within the vicinity of the environment that may be affected and operational area

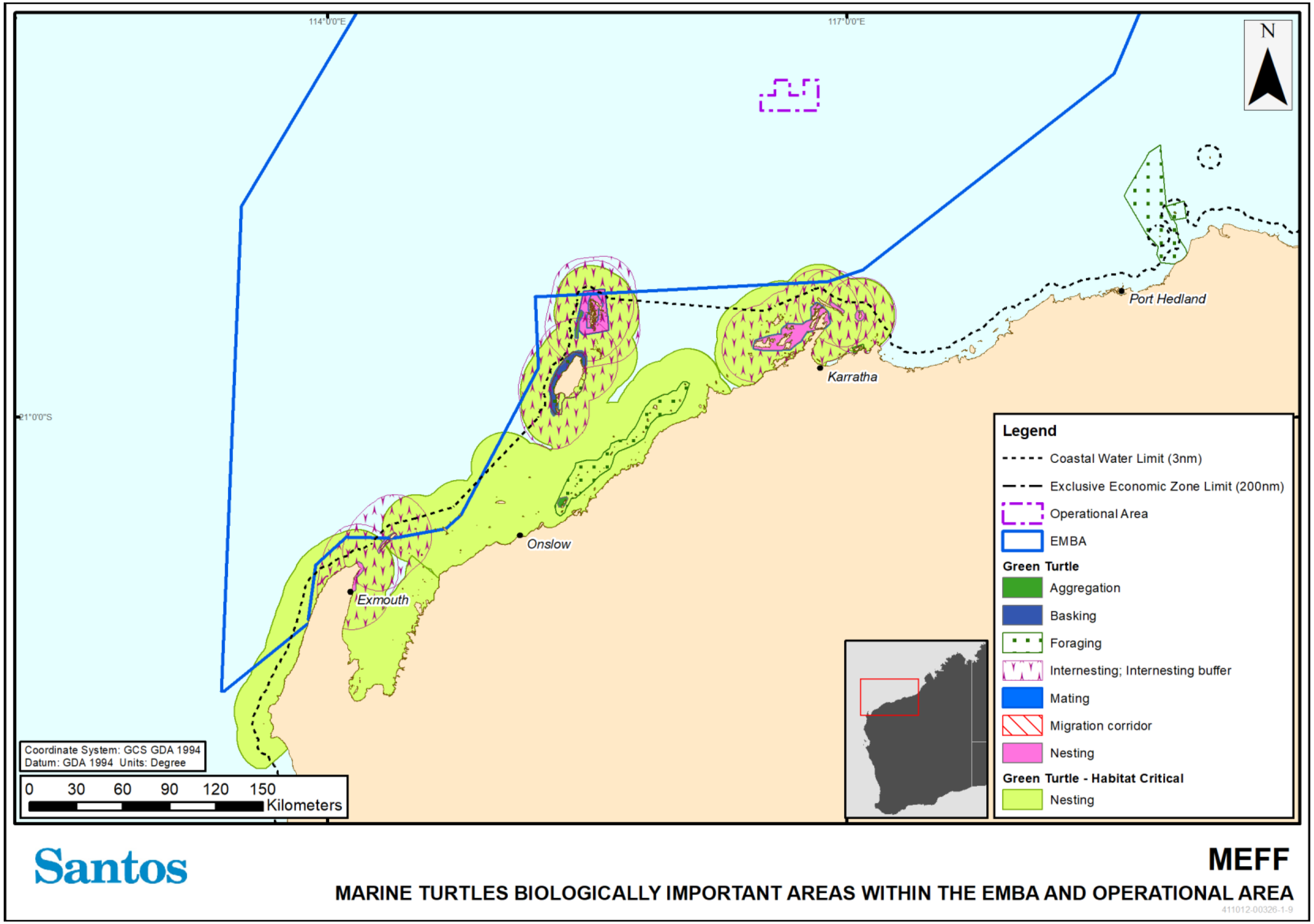

Figure 5-14: Biologically important areas for green turtles within the vicinity of the environment that may be affected and operational area

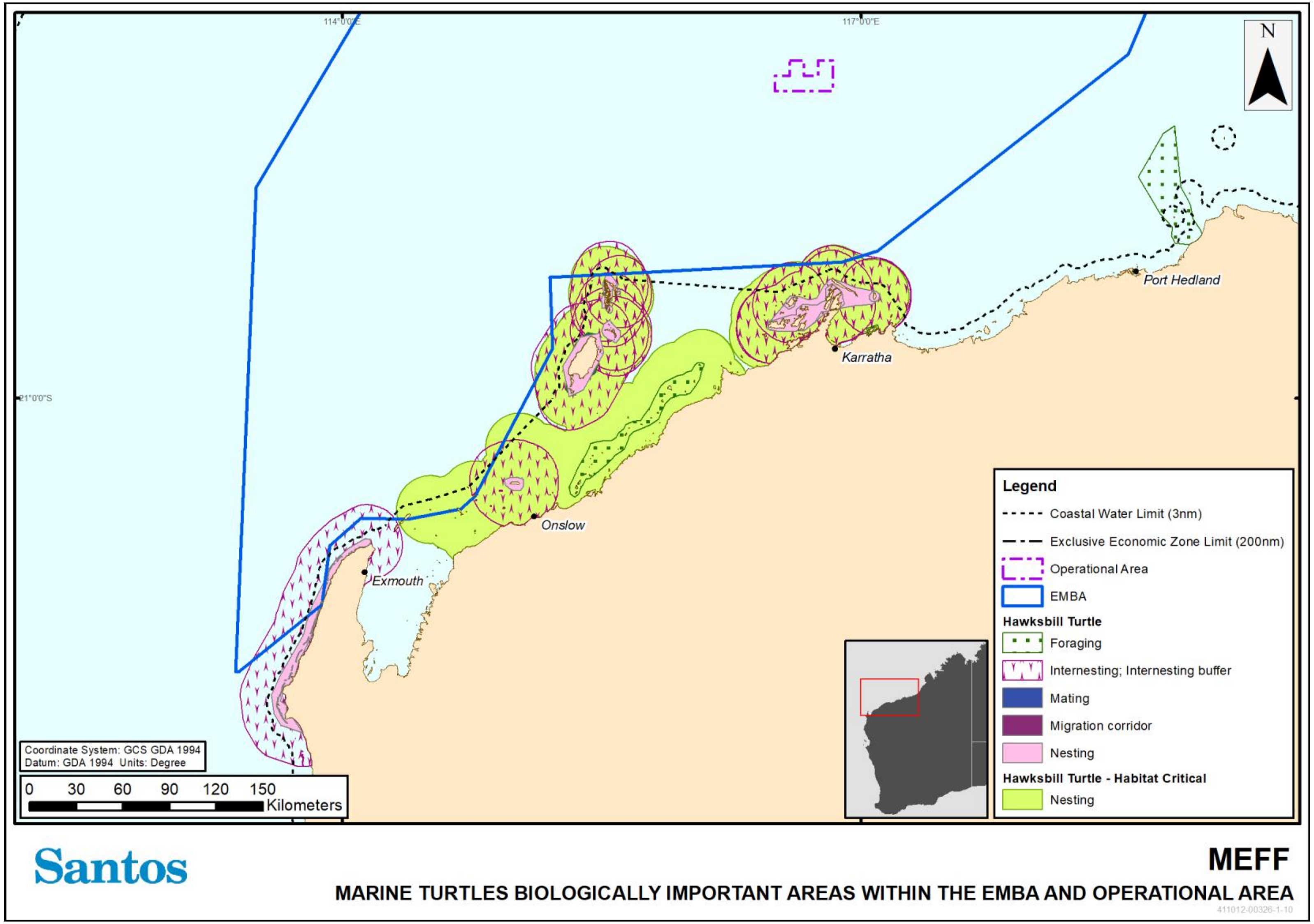

Figure 5-15: Biologically important areas for hawksbill turtles within the vicinity of the environment that may be affected and operational area

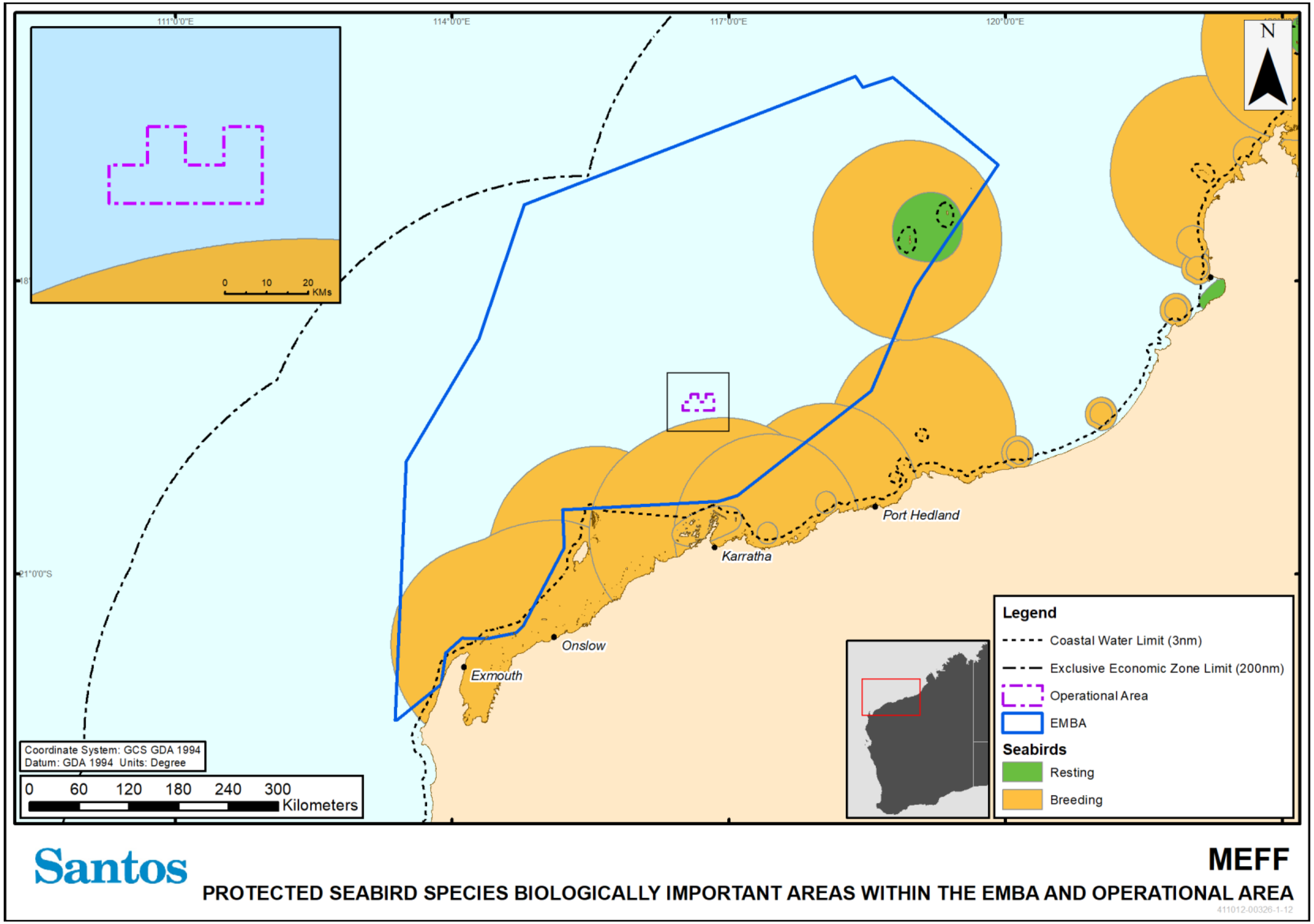

Figure 5-16: Biologically important areas for seabirds within the vicinity of the environment that may be affected and operational area

5.2.4.2 Recovery plans

Recovery plans set out the research and management actions necessary to stop the decline of and support the recovery of listed threatened species. **Table 5-10** summarises the actions relevant to the activity, with more information about the specific requirements of the relevant plans of management (including Conservation Advices and Conservation Management Plans) that would be applicable to the activity and demonstrates where current management requirements have been considered.

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Table 5-10: Relevant threats identified in recovery plans, conservation advice and management plans for species that occur or may occur within the operational area and environment that may be affected

Fauna type		Recovery plan / conservation advice / management plan	Threats / strategies identified as relevant to the activity	Addressed (where relevant) in EP section
All	All vertebrate fauna	Threat Abatement Plan for Impacts of Marine Debris on Vertebrate wildlife of Australia's coasts and oceans (Department of Environment and Energy (DoEE), 2018)	Marine debris	**8.8**, **9.1**
Fish and Sharks	Dwarf sawfish	Sawfish and River Sharks Multispecies Recovery Plan (DoE, 2015a)	Habitat degradation and modification	**8.6**, **9.1**, **9.6**, **9.7**
	Green sawfish	Commonwealth Conservation Advice on *Pristis zijsron* (green sawfish) (DEWHA, 2008)	Habitat degradation and modification	**9.6**, **9.7**
		Sawfish and River Sharks Multispecies Recovery Plan (DoE, 2015a)		
	Narrow sawfish	Sawfish and River Sharks Multispecies Recovery Plan (DoE, 2015a)	Habitat degradation and modification	**9.6**, **9.7**
	Great white shark	Recovery plan for the White Shark (*Carcharodon carcharias*) (DSEWPaC, 2013a)	Ecosystem effects as a result of habitat modification and climate change	**9.6**, **9.7**
	Grey nurse shark	Recovery Plan for the Grey Nurse Shark (*Carcharias taurus*) (DoE, 2014)	Pollution and disease	**9.6**, **9.7**
			Ecosystem effects – habitat modification and climate change	**9.6**, **9.7**
	Whale shark	Approved Conservation Advice for *Rhincodon typus* (whale shark) (TSSC, 2015a)	Boat strike from large vessels	**9.3**
			Habitat disruption from mineral exploration, production and transportation	**9.6**, **9.7**

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Fauna type		Recovery plan / conservation advice / management plan	Threats / strategies identified as relevant to the activity	Addressed (where relevant) in EP section
Marine mammals	Blue whale	Blue Whale Conservation Management Plan 2015–2025 (DoE, 2015b)	Noise interference	**8.4**
			Habitat modification	**9.6**, **9.7**
			Vessel disturbance	**9.3**
	Southern right whale	Conservation Management Plan for the Southern Right Whale 2011–2021 (DSEWPaC, 2012)	Vessel disturbance	**9.3**
			Habitat modification	**9.6**, **9.7**
			Noise interference	**8.4**
			Entanglement (marine debris)	**9.1**, **9.3**
	Fin whale	Approved Conservation Advice for *Balaenoptera physalus* (fin whale) (TSSC, 2015b)	Habitat degradation including pollution (increasing port expansion and coastal development)	**9.6**, **9.7**
			Pollution (persistent toxic pollutants)	**9.6**, **9.7**
			Noise interference	**8.4**
			Vessel strike	**9.3**
	Sei whale	Approved Conservation Advice for *Balaenoptera borealis* (sei whale) (TSSC, 2015c)	Habitat degradation including pollution (increasing port expansion and coastal development)	**9.6**, **9.7**
			Pollution (persistent toxic pollutants)	**9.6**, **9.7**
			Vessel strike	**9.3**
	Humpback whale	Approved Conservation Advice for *Megaptera novaeangliae* (humpback whale) (TSSC, 2015d)	Noise interference	**8.4**
			Habitat degradation including coastal development and port expansion	**9.6**, **9.7**

Fauna type		Recovery plan / conservation advice / management plan	Threats / strategies identified as relevant to the activity	Addressed (where relevant) in EP section
Reptiles	Short-nosed sea snake	Approved Conservation Advice for *Aipysurus apraefrontalis* (Short-nosed Sea Snake) (TSSC, 2011a)	Habitat degradation	**9.6**, **9.7**
	All marine turtle	National Light Pollution Guidelines for Wildlife Including Marine Turtles, Seabirds and Migratory Shorebirds (Commonwealth of Australia, 2020)	Light pollution	**8.3**
	Loggerhead turtle	Recovery Plan for Marine Turtles in Australia 2017–2027 (Commonwealth of Australia, 2017)	Deteriorating water quality	**8.6**, **8.7**, **9.4**, **9.6**, **9.7**
			Marine debris	**8.8**, **9.1**
			Loss of habitat	**9.6**, **9.7**
			Vessel disturbance	**9.3**
			Light pollution	**8.3**
	Green turtle	Recovery Plan for Marine Turtles in Australia 2017–2027 (Commonwealth of Australia, 2017)	Deteriorating water quality	**8.6**, **8.7**, **9.4**, **9.6**, **9.7**
			Marine debris	**8.8**, **9.1**
			Vessel disturbance	**9.6**, **9.7**
			Light pollution	**8.3**
	Leatherback turtle	Commonwealth Conservation Advice on *Dermochelys coriacea* (2008)	Boat strike	**9.3**
			Changes to breeding sites	**9.6**, **9.7**
		Recovery Plan for Marine Turtles in Australia 2017–2027 (Commonwealth of Australia, 2017)	Deteriorating water quality	**8.6**, **8.7**, **9.4**, **9.6**, **9.7**
			Marine debris	**8.8**, **9.1**
			Loss of habitat	**9.6**, **9.7**
			Vessel disturbance	**9.3**
			Light pollution	**8.3**

Fauna type		Recovery plan / conservation advice / management plan	Threats / strategies identified as relevant to the activity	Addressed (where relevant) in EP section
	Hawksbill turtle	Recovery Plan for Marine Turtles in Australia 2017–2027 (Commonwealth of Australia, 2017)	Deteriorating water quality	**8.6**, **8.7**, **9.4**, **9.6**, **9.7**
			Marine debris	**8.8**, **9.1**
			Loss of habitat	**9.6**, **9.7**
			Vessel disturbance	**9.3**
			Light pollution	**8.3**
	Flatback turtle	Recovery Plan for Marine Turtles in Australia 2017–2027 (Commonwealth of Australia, 2017)	Deteriorating water quality	**8.6**, **8.7**, **9.4**, **9.6**, **9.7**
			Marine debris	**8.8**, **9.1**
			Loss of habitat	**9.6**, **9.7**
			Noise interference	**8.4**
			Vessel disturbance	**9.3**
			Light pollution	**8.3**
	Olive Ridley turtle	Recovery Plan for Marine Turtles in Australia 2017–2027 (Commonwealth of Australia, 2017)	Deteriorating water quality	**8.6**, **8.7**, **9.4**, **9.6**, **9.7**
			Marine debris	**8.8**, **9.1**
			Loss of habitat	**9.6**, **9.7**
			Vessel disturbance	**9.3**
			Light pollution	**8.3**

Fauna type		Recovery plan / conservation advice / management plan	Threats / strategies identified as relevant to the activity	Addressed (where relevant) in EP section
Birds	All seabirds and shorebirds	National Light Pollution Guidelines for Wildlife Including Marine Turtles, Seabirds and Migratory Shorebirds (Commonwealth of Australia, 2020)	Light pollution	**8.3**
	All seabirds	Draft Wildlife Conservation Plan for Seabirds (Commonwealth of Australia 2019)	Light pollution	**8.3**
			Habitat loss and degradation from pollution	**9.6**, **9.7**
	Australian fairy tern	Commonwealth Conservation Advice on *Sternula nereis* (Fairy Tern) (DSEWPaC 2011b)	Oil spills, particularly in Victoria	**9.6**, **9.7**
	Curlew sandpiper	Approved Conservation Advice for *Calidris ferruginea* (Curlew Sandpiper) (DoE 2015d)	Habitat loss and degradation from pollution	**9.6**, **9.7**
	Eastern curlew	Approved Conservation Advice for *Numenius madagascariensis* (Eastern Curlew) (DoE, 2015c)	Habitat loss and degradation from pollution	**9.6**, **9.7**
	Red knot	Approved Conservation Advice for *Calidris canutus* (Red knot) (TSSC, 2016a)	Pollution/contamination impacts	**9.6**, **9.7**
			Habitat loss and degradation	**9.6**, **9.7**
	Southern giant petrel	National Recovery Plan for Threatened Albatrosses and Giant Petrels 2011–2016 (DSEWPaC, 2011c)	Marine pollution	**9.6**, **9.7**
	Northern Siberian bar-tailed godwit	Conservation Advice *Limosa lapponica menzbieri* (Bar-tailed godwit (northern Siberian)) (TSSC, 2016b)	Habitat loss disturbance and modifications	**9.6**, **9.7**
	Australian painted snipe	Approved Conservation Advice for *Rostratula australis* (Australian Painted Snipe) (DSEWPaC, 2013b)	Habitat loss disturbance and modifications	**9.6**, **9.7**

5.2.5 Socio-economic receptors

The operational area is located around 160 km north of Dampier. 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 5-11**.

Table 5-11: Socio-economic activities that may occur in the operational areas

Value/ Sensitivity	Description	Operational Area Presence	Relevant Events Within Operational Area	Relevant Events Within EMBA
Commercial fisheries – Commonwealth (**Figure 5-17**)	Three Commonwealth fisheries overlap the operational area (**Section 5.2.5.1**): + Western Tuna and Billfish Fishery + Southern Bluefin Tuna Fishery + Western Skipjack Tuna Fishery. Although the fishery management zones overlap the operational area, activity within or near the operational area is not expected: + Since 2005, there has been fewer than five vessels active in the Western Tuna and Billfish Fishery, down from 50 active vessels in 2000 (ABARES Fishery Status Reports, 2019). + 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 Santos offshore activities (ABARES Fishery Status Reports, 2019). + There has been no fishing effort in the Skipjack Tuna Fishery since the 2009 season, during which activity concentrated off South Australia (ABARES Fishery Status Reports, 2019).	✓	Planned Interaction with other users (**Section 8.1**)	<u>Unplanned</u> MDO spill from vessel collision and hydrocarbon release LOWC (**Sections 9.6** and **9.7**)

Value/ Sensitivity	Description	Operational Area Presence	Relevant Events Within Operational Area	Relevant Events Within EMBA
Commercial fisheries – State (**Figure 5-18** and **Figure 5-19**)	State fisheries that overlap the operational area are (**Section 5.2.5.1**): + Pilbara Trawl and Trap Managed Fisheries + Pilbara Line Managed Fishery + Pilbara Crab Managed Fishery + Mackerel Managed Fishery Area 2 + Onslow Prawn Limited Entry Fishery + South-West Coast Salmon Fishery + Nickol Bay Prawn Limited Fishery + Abalone Fishery + Marine Aquarium Managed Fishery + Specimen Shell Managed Fishery + West Coast Deep Sea Crustacean Managed Fishery. A number of these fisheries are open within the operational area and EMBA; however, they are not active in these areas.	✓	Planned Interaction with other users (**Section 8.1**)	<u>Unplanned</u> (MDO spill from vessel collision and hydrocarbon release LOWC (**Sections 9.6** and **9.7**)
Oil and gas (**Figure 5-20**)	Various petroleum exploration and production activities have been undertaken within the NWS; however, there are none in the vicinity of the operational area. The nearest operating facility to the operational areas is Woodside's Angel oil field and associated equipment, located around 25 km south of the operational area. Vessels servicing oil and gas operations in the region may pass through the area enroute 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.	-	<u>Planned</u> Interaction with other users (**Section 8.1**)	<u>Unplanned</u> MDO spill from vessel collision and hydrocarbon release LOWC (**Sections 9.6 and 9.7**)

Value/ Sensitivity	Description	Operational Area Presence	Relevant Events Within Operational Area	Relevant Events Within EMBA
Shipping (**Figure 5-21**)	Shipping using NWS waters includes iron ore carriers, oil tankers and other vessels proceeding to or from the ports of Dampier, Port Walcott and Port Hedland. However, these are predominantly heading north from these ports. The eastern boundary of the operational area abuts the Dampier shipping fairway. The shipping fairways of the region service Dampier and Karratha. Therefore, vessel traffic is expected in the vicinity of the operational area.	✓	Planned Interaction with other users (**Section 8.1**)	Unplanned MDO spill from vessel collision and hydrocarbon release LOWC (**Sections 9.6 and 9.7**)
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 LOWC.	-	N/A	Unplanned MDO spill from vessel collision and hydrocarbon release LOWC (**Sections 9.6 and 9.7**)
Defence	In consultation, Defence has not raised any concerns with this proposed activity (**Section 5.2.5.7**).	-	N/A	N/A
Shipwrecks	No shipwrecks were found to intercept the operational area. Multiple shipwrecks are listed to occur within the EMBA.	-	N/A	Unplanned MDO spill from vessel collision and hydrocarbon release LOWC (**Sections 9.6 and 9.7**)

Value/ Sensitivity	Description	Operational Area Presence	Relevant Events Within Operational Area	Relevant Events Within EMBA
Tourism	Owing to the water depth and distance from shore 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 Ningaloo Coast, Rowley Shoals and Montebello Islands. These activities are usually concentrated in the vicinity of the population centres, such as Exmouth, Dampier and Onslow. The EMBA encompasses a number of marine parks and reserves (see **Section 5.2.3**). Thus, ecotourism based on specific local values (game fish, nearshore reef snorkelling and diving) could be impacted by unplanned events.	-	N/A	Unplanned MDO spill from vessel collision and hydrocarbon release LOWC (**Sections 9.6 and 9.7**)
Cultural Heritage	No known sites of Aboriginal Heritage significance occur within the operational area. Multiple registered Aboriginal Heritage sites occur within the EMBA. Aboriginal heritage sites in WA are protected under the *Aboriginal Heritage Act 1972*, whether or not they are registered with the Department of Planning, Lands and Heritage. While sea country is a recognised value, the registered site list is land-based sites, therefore could be impacted by unplanned hydrocarbon releases.	-	N/A	Unplanned MDO spill from vessel collision and hydrocarbon release LOWC (**Sections 9.6** and **9.7**)

5.2.5.1 Commercial fisheries

Offshore and coastal waters in the North-West Marine Region support a valuable and diverse commercial fishing industry. The major fisheries in the Pilbara region target tropical finfish, large pelagic fish, crustaceans (prawns and scampi) and pearl oysters (Patterson *et al*., 2019).

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

Commonwealth and State fisheries overlapping with the operational area and the EMBA are illustrated in **Figure 5-17** to **Figure 5-19**. **Table 5-12** describes each of these fisheries.

Previous consultation with DPIRD has identified commercial fishing interests that exist in or close to proposed activities under this EP. 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 **Section 5.2.6**.

Table 5-12: Commonwealth and State managed fisheries permitted within the operational area

Fishery	Overlap		Description	Relevant Events within the Operational Area
	Op Area	EMBA		
Commonwealth Managed Fisheries				
Western Tuna and Billfish Fishery	✓	✓	Extends westward from Cape York Peninsula (142°30' E) off Queensland to 34° S off the WA west coast. It also extends eastward from 34° S off the west coast of WA across the Great Australian Bight to 141° E at the South Australian–Victorian border. Since 2005, there has been fewer than five vessels active in the Western Tuna and Billfish Fishery each year, which has reportedly declined from 50 active vessels in 2000 (Williams *et al.*, 2019). Fishing activity in the Western Tuna and Billfish Fishery concentrates in waters off southwest Western Australia, and off South Australia (Williams *et al.*, 2019).	No active commercial fishing in the area in the past years.
Southern Bluefin Tuna	✓	✓	Since 1992 juvenile Southern Bluefin Tuna have been targeted in the Great Australian Bight and waters off South Australia.	No active commercial fishing effort reported in WA, as fishing efforts are concentrated off South Australia.
Western Skipjack Tuna Fishery	✓	✓	There has been no fishing effort since the 2009 season in South Australia. No current effort on the NWS.	There has been no effort in the fishery since the 2008-09 fishing season (Patterson *et al.*, 2019).
North West Slope Trawl	✗	✓	Extends from 114° E to around 125° E off the WA coast between the 200 m isobath and the outer limit of the Australian Fishing Zone. Targets scampi and prawns.	N/A
Western Deepwater Trawl Fishery	✗	✓	Demersal trawl seaward of the 200 m isobaths. Fishing effort for a diverse range of tropical and temperate species.	N/A

Fishery	Overlap		Description	Relevant Events within the Operational Area
	Op Area	EMBA		
State Managed Fisheries (North-west Bioregion)				
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.	N/A
Nickol Bay Prawn Managed Fishery	✓	✓	Primarily targets banana prawns using otter trawl methods along the western part of the NWS in coastal shallow waters. There has been no record of any fishing effort from this fishery in the operational area.	N/A
Onslow Prawn Limited Entry 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 114°39.9' on the landward side of the 200 m depth isobath'. Prawn trawling activities focus on inshore areas between Onslow and Karratha. Only five days of fishing effort was undertaken (one boat) in 2017, and total landings were negligible (Kangas *et al*., 2019). There has been no record of any fishing effort from this fishery in the operational area.	As prawn trawling activities focus on inshore, shallow waters, planned events are not expected to impact fishing activities.

Fishery	Overlap		Description	Relevant Events within the Operational Area
	Op Area	EMBA		
Pilbara Demersal Scalefish Fisheries (includes trap and trawl 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.	The operational area intersects the trap fishery and a closed area for the trawl fishery. FishCube data identified the trawl fishery as being the only fishery active in data blocks that overlap the operational area within the last ten years. However, given the operational area overlaps the closed area for this fishery, the activity was likely further to the south in the open zone (but still within the same FishCube data blocks). No trap fishing activity has been recorded in the operational area.
Pilbara Line Fishery	✓	✓	The Pilbara Line Fishery fishing boat licensees are permitted to operate anywhere within 'Pilbara 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 on the mainland of Western Australia west along the parallel to the intersection of 21° 56' S latitude and the boundary of the Australian Fishing Zone and north to longitude 120° E. In the 2018 season there were nine individual licences in the Pilbara Line Fishery, held by seven operators (Newman *et al.*, 2019).	In the 2018 season there were nine individual licences in the Pilbara Line Fishery, held by seven operators. According to FishCube data less than three vessels were active during the season. No activity from this fishery has been recorded within the operational area.
Pilbara Crab Managed Fishery	✓	✓	The boundaries of this fishery include waters between 114°39.9' E and 120° E, and on the landward side of the 200 m depth isobath.	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 (Gaughan and Santoro, 2018). No activity from this fishery has been recorded within the operational area.

Fishery	Overlap		Description	Relevant Events within the Operational Area
	Op Area	EMBA		
Mackerel Managed Fishery	✓	✓	Trolling or handline. Near-surface trolling gear from vessels in coastal areas around reefs, shoals and headlands.	Very low level of activity was recorded in the FIshCube data blocks that operational area ten years ago. There has been no recent (less than ten years) activity from this fishery in the operational area. The bulk of the total catch is taken in the Kimberley area.
State Managed Fisheries (Whole of State)				
Marine Aquarium Fish Fishery	✓	✓	All year. Effort in the operational area is unlikely due to the depth and the dive-based method of collection. Unlikely to occur.	Disruption to fishing activities unlikely, given water depths in which fisheries operate.
Specimen Shell Managed Fishery	✓	✓	All year. Effort in the operational area is unlikely due to the depth and the dive-based method of collection. Unlikely to occur.	
West Coast Deep Sea Crustacean Managed Fishery	✓	✓	Baited pots targeting crabs, occurs between Cape Leeuwin and the Northern Territory border on the seaward side of the 150 m isobath. There were six vessels operating in 2017 (How and Orme, 2019).	Given fishing effort is concentrated south of Exmouth, interaction with fishers during the activity is unlikely.
Abalone Managed 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.	Disruption is unlikely to occur in the operational area due to depths and method of collection.
South-West Coast Salmon Fishery	✓	✓	There are currently six licences. Licensees are not restricted to specific beaches but in practice only a few beaches are fished (DEH, 2004). In 2018 there were three active vessels in this fishery (Stewart *et al*., 2018).	Given the methods of fishing and level of effort and catch in previous years, interaction with fishers is not expected during the activity.

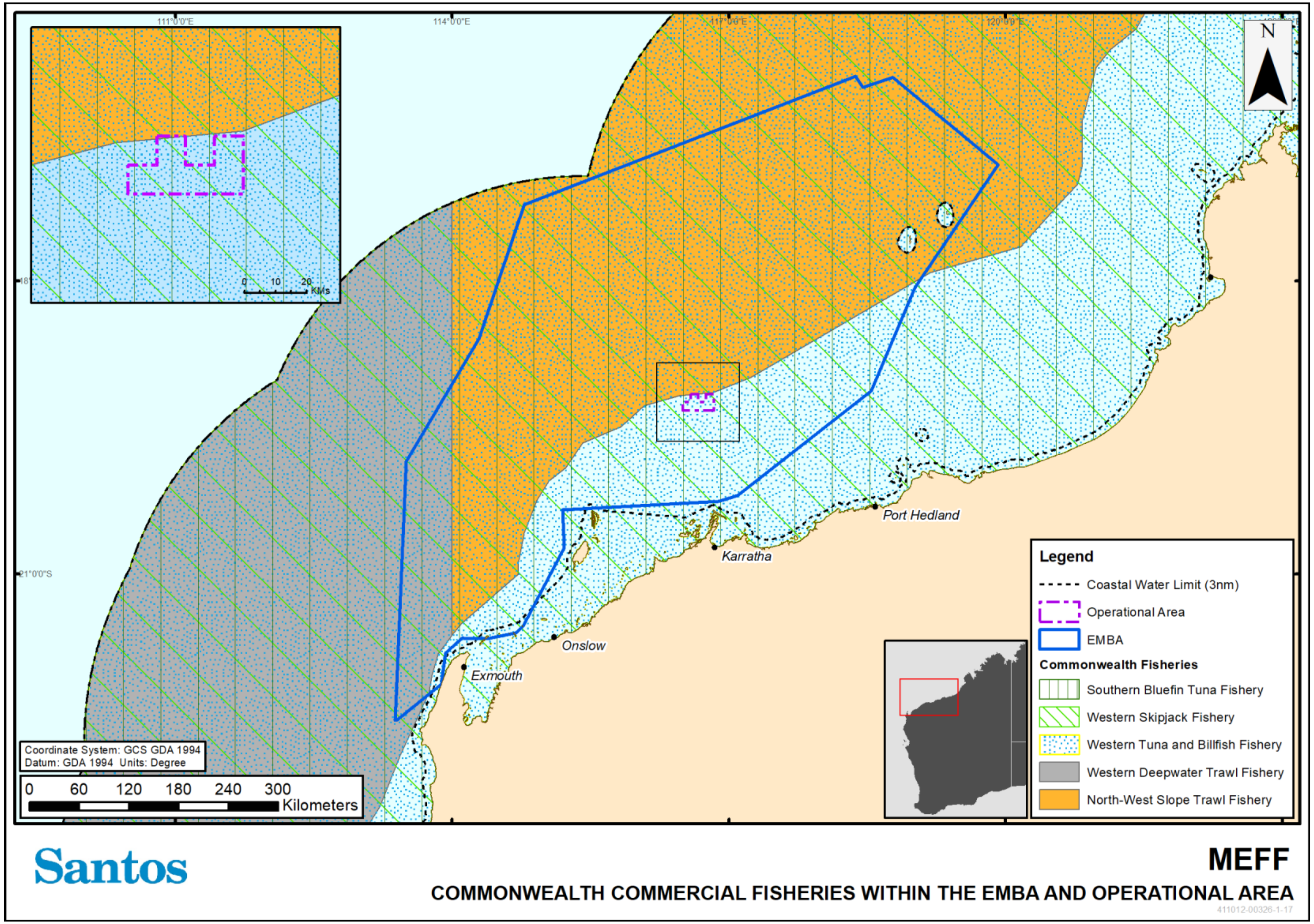

Figure 5-17: Commonwealth commercial fisheries within the environment that may be affected and operational area

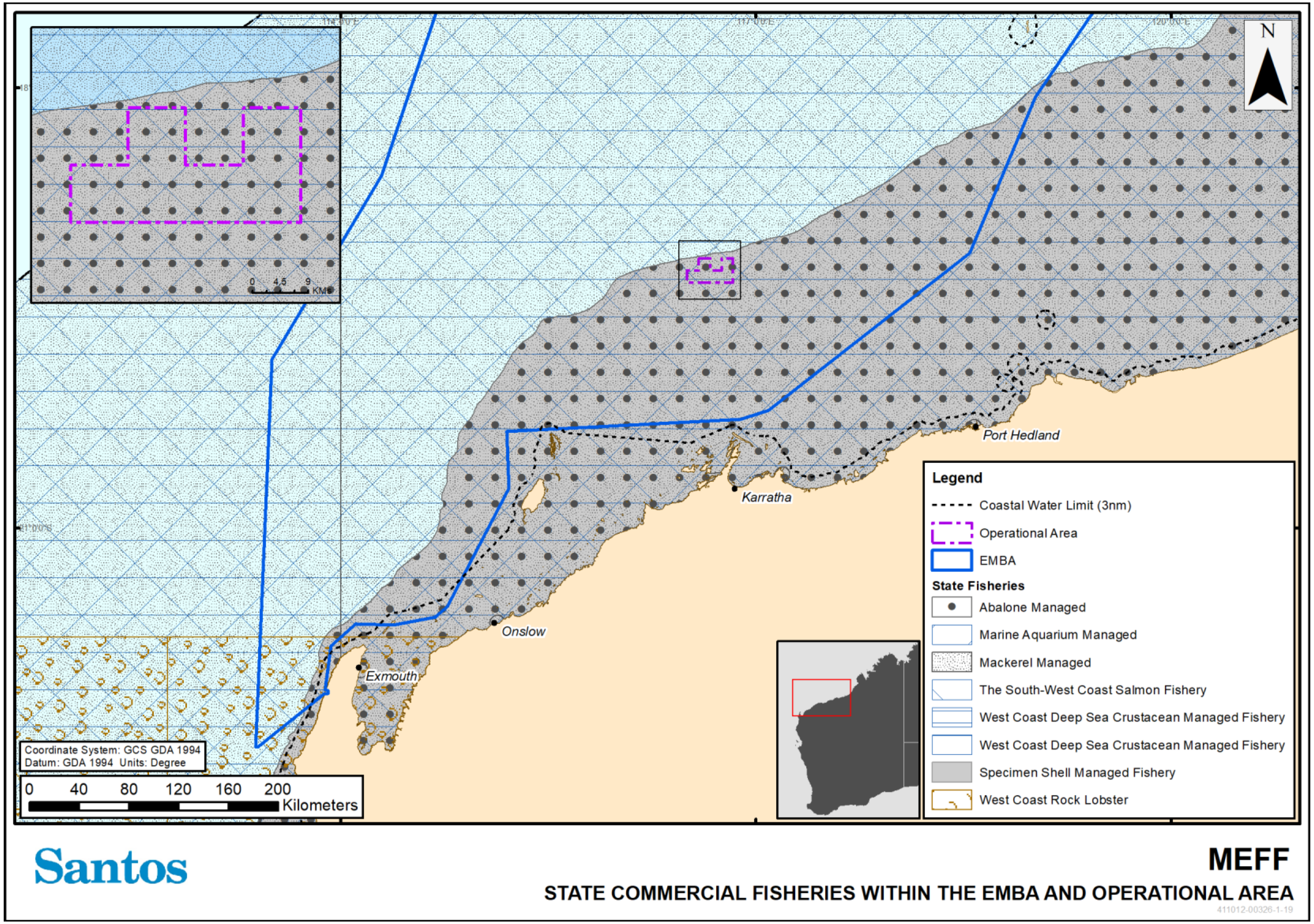

Figure 5-18: State commercial fisheries within the environment that may be affected and the operational area

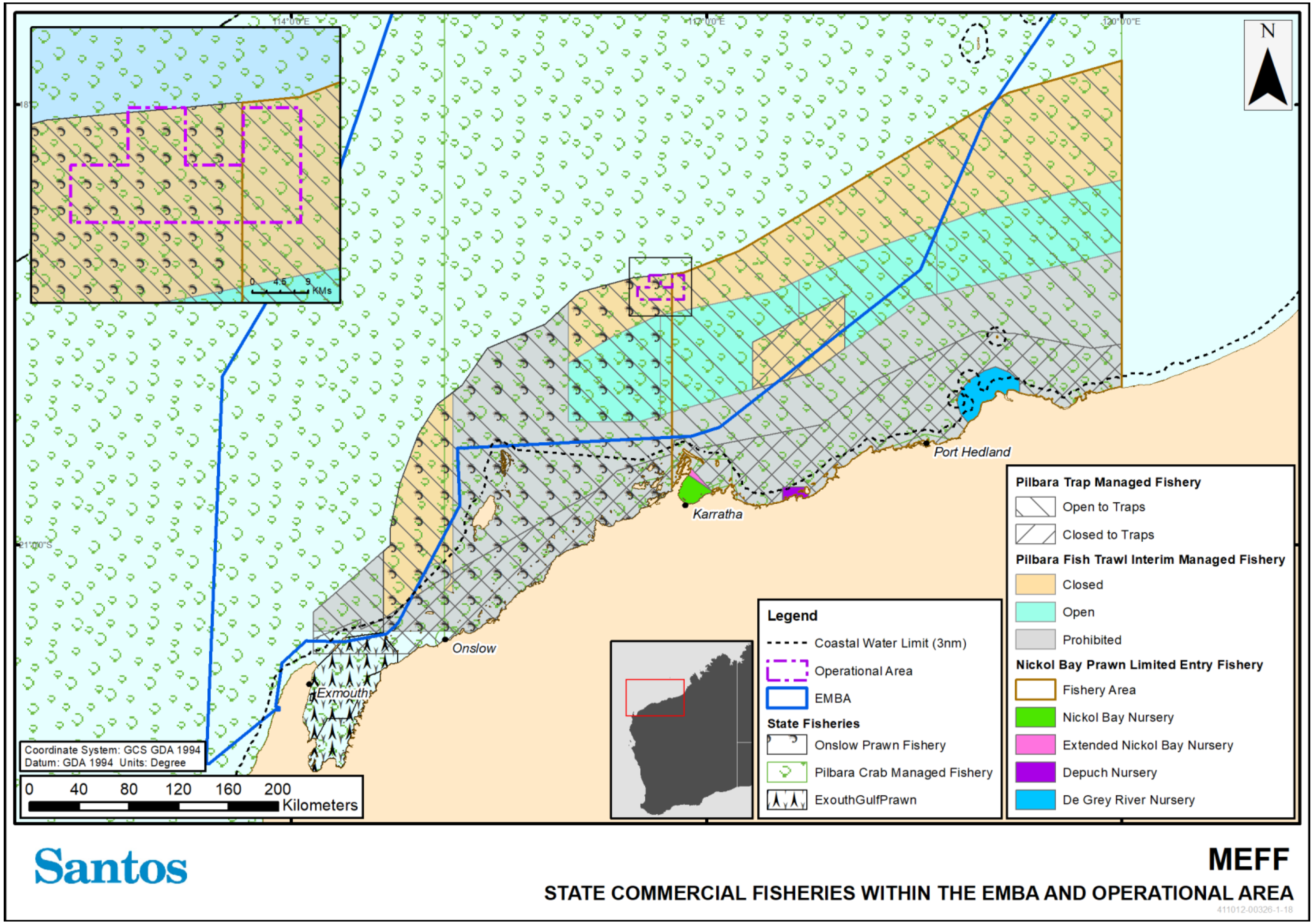

Figure 5-19: State commercial fisheries within the environment that may be affected and the operational area

5.2.5.2 Recreational fisheries

The operational area occurs in the North Coast Bioregion, where recreational fishing is experiencing significant growth, with a distinct seasonal peak in winter (Gaughan and Santoro, 2018). Offshore islands, coral reefs and continental shelf provide species of major recreational interest including tropical snapper, cods, coral and coronation trout, sharks, trevally, tuskfish, tunas, mackerels and billfish (Gaughan and Santoro, 2018). Given the water depths, lack of seabed features and distance offshore of the operational area, recreational fishing activity is not expected. Therefore, no interaction with recreational fishers is anticipated in the operational areas but may occur in the EMBA.

5.2.5.3 Tourism and recreation

Tourism and recreational use, including recreation fishing, is unlikely in the operational area due to the water depth, absence of seabed features and distance (around 160 km) from the mainland and island shorelines and the presence of the exclusion area around existing petroleum equipment (noted on navigation charts).

5.2.5.4 Oil and gas industry

The NWS is a major oil and gas hub in Australia, with various companies operating on the Shelf. The operational area is in a relatively isolated area of the NWS with respect to the main oil and gas operational and exploratory fields and there are no other oil and gas operations present.

The flowlines and associated platforms and subsea wells that form part of the NWS Joint Venture are the major petroleum features of the immediate region (**Figure 5-20**). There are two sales gas trunklines orientated in a southeast direction to Dampier, where gas and condensate are processed at the Woodside-operated gas plant.

Further to the southwest of the operational area (about 195 km), Santos operates the Varanus Island oil and gas hub, which processes oil and gas from platforms and subsea wells in the region, offloading oil from the island to shipping tankers and piping processed gas to the WA mainland (connecting to the Dampier to Bunbury Natural Gas Pipeline) via two sales gas flowlines.

5.2.5.5 Commercial shipping

The Dampier shipping fairway is the main northern approach to the Port of Dampier and overlaps the eastern boundary of the operational area (**Figure 5-21**). However, the DTM is located around 13 nm away from the shipping fairway. General marine vessel traffic may traverse the operational area.

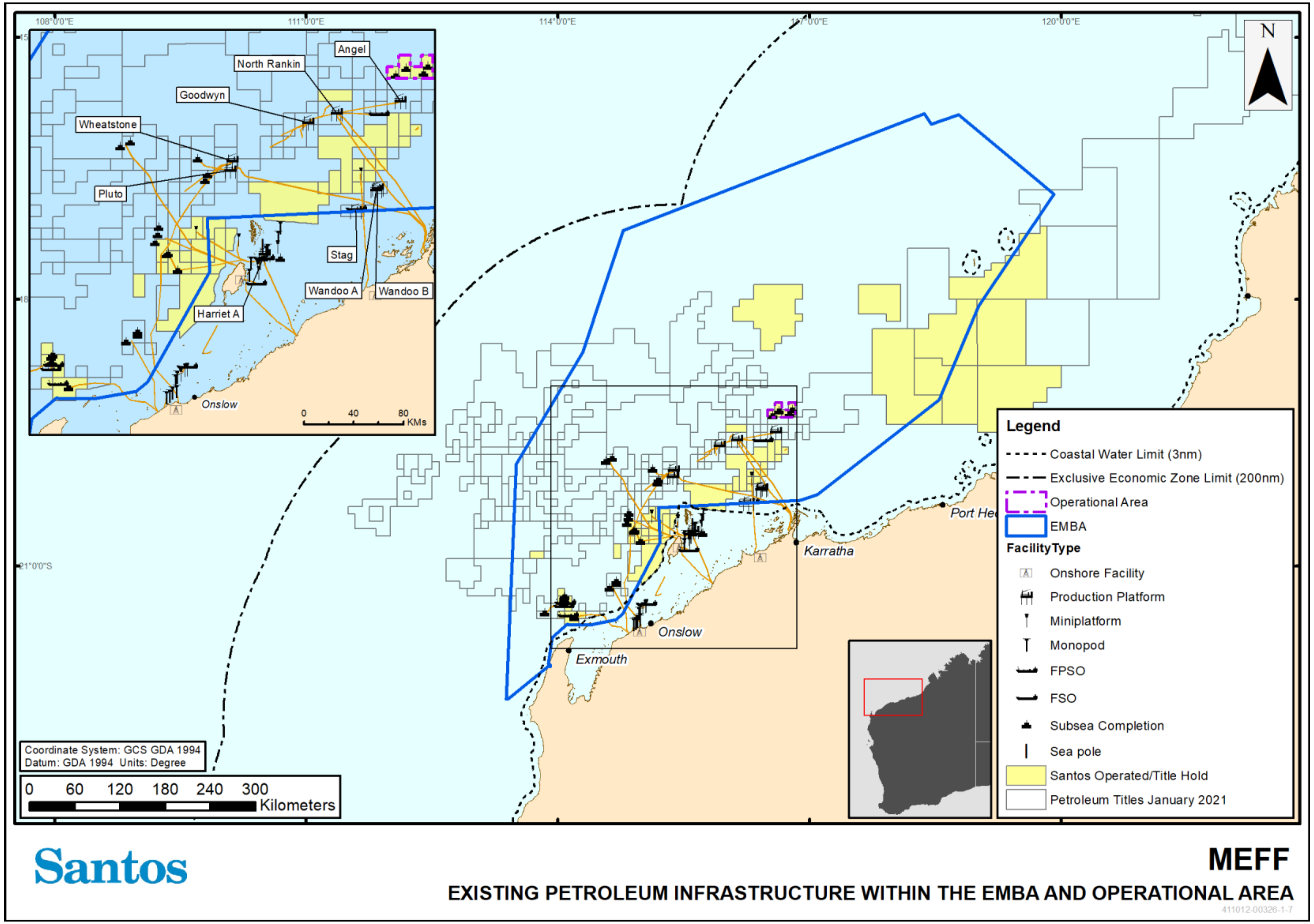

Figure 5-20: Existing oil and gas equipment within the environment that may be affected

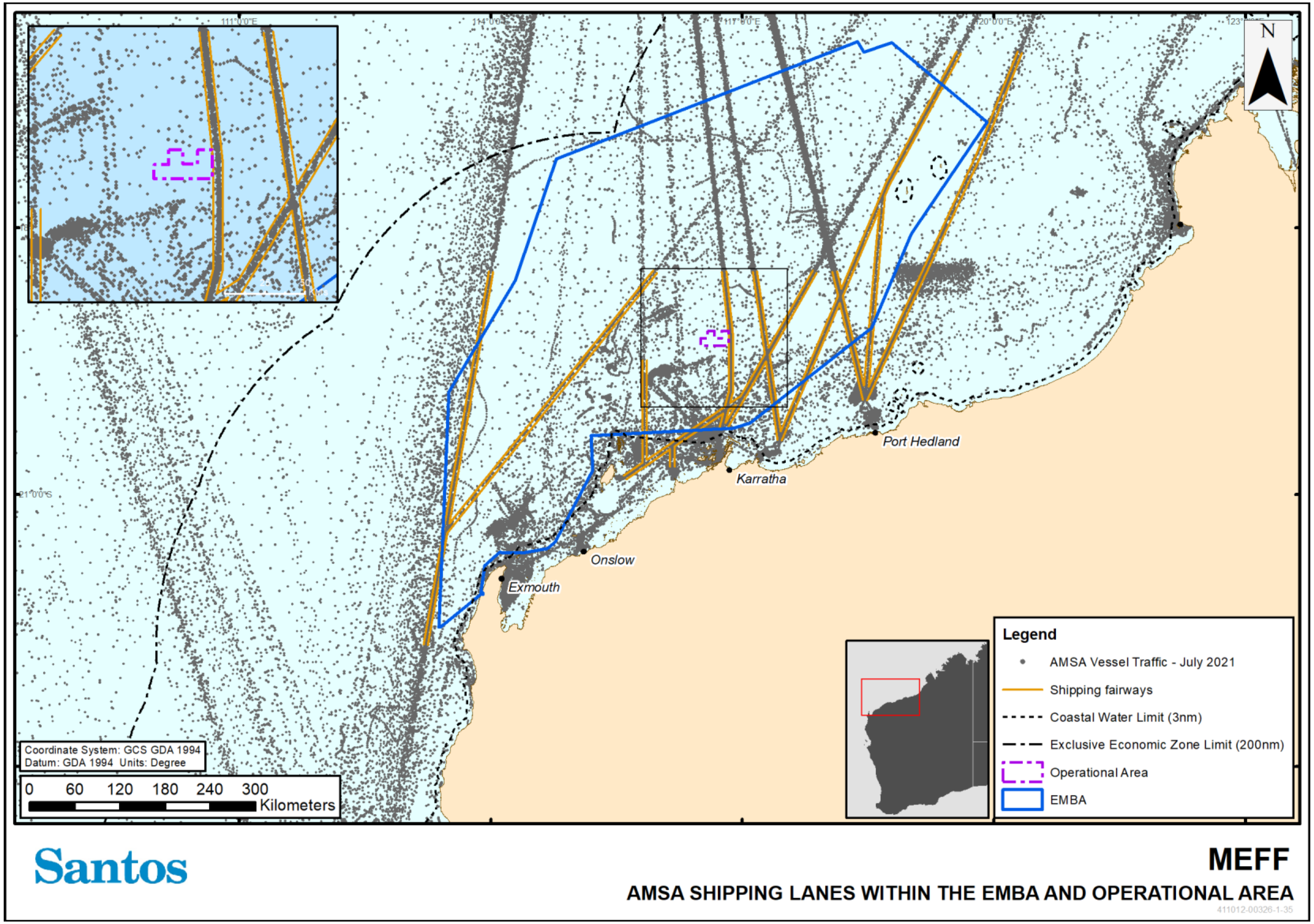

Figure 5-21: Australian Maritime Safety Authority ship locations and shipping routes within and close to the environment that may be affected

5.2.5.6 Heritage values and shipwrecks

There are no listed World Heritage Areas, aboriginal heritage, cultural heritage places or records of shipwrecks within or in the vicinity of the operational area.

Based on the predictions from the spill modelling, the Ningaloo Coast is the only World Heritage Area and National Heritage Property within the EMBA in the event of a worst-case spill.

Refer to **Appendix D** for further information.

5.2.5.7 Defence

There are no defence areas within or in the vicinity of the operational area. The Learmonth Royal Australian Air Force base maintains a restricted airspace area, which overlaps the region. Relevant existing defence areas within the EMBA are shown in **Figure 5-22**.

5.2.6 Windows of sensitivity

Timing of peak activity for threatened species and other relevant, significant sensitivities is summarised in **Table 5-13**.

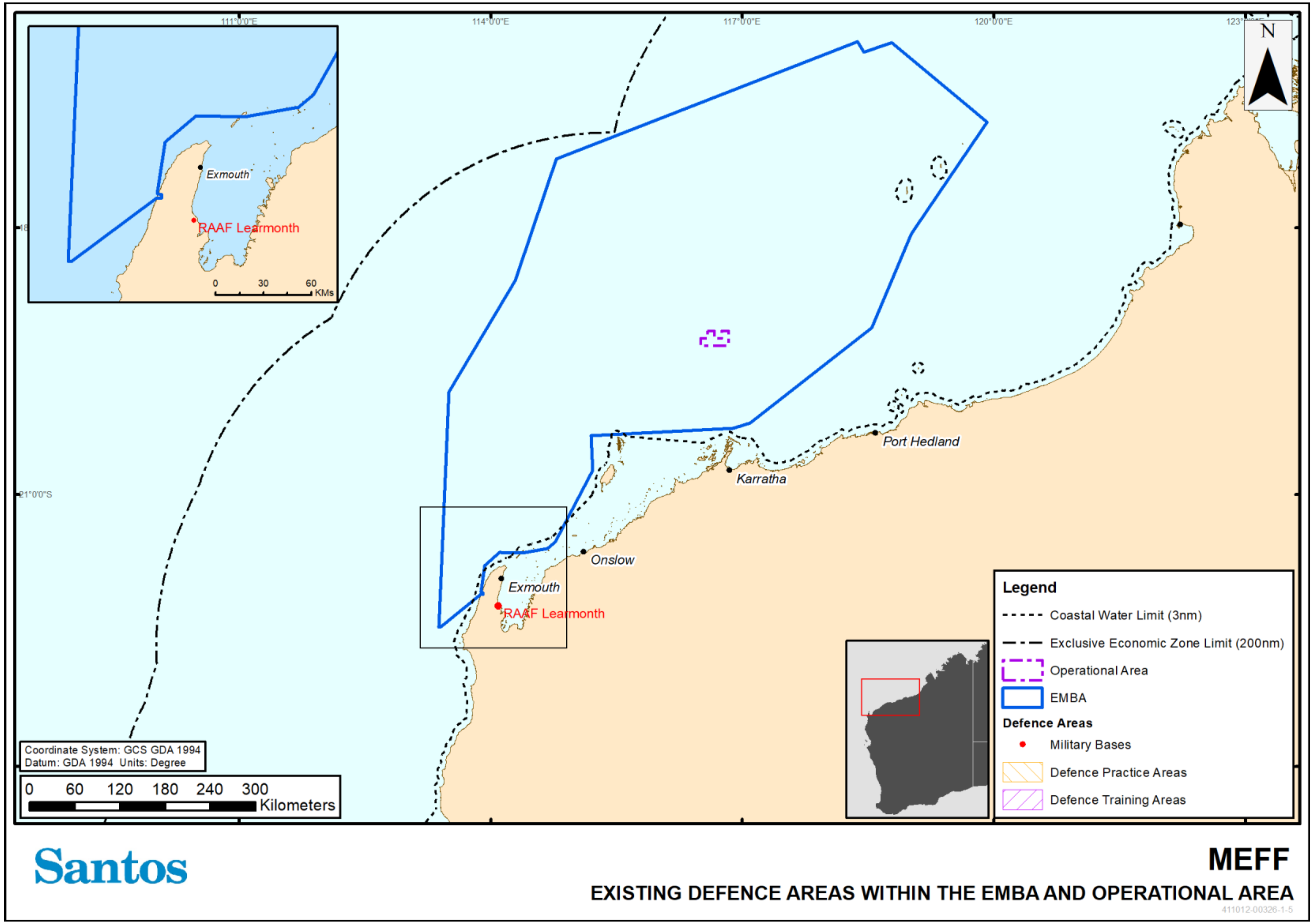

Figure 5-22: Existing defence equipment within the environment that may be affected

Table 5-13: Windows of sensitivity in the vicinity of the operational area and environment that may be affected

Categories	Receptors (critical life stages)	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Proposed activity timing													
Physical environment and habitats	Non-coral benthic invertebrates												
	Coral (spawning)												
	Macroalgae	growing				shedding fronds				growing			
	Other benthic habitats												
Marine fauna (including threatened or migratory 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												

Categories	Receptors (critical life stages)	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
	Dugong (breeding)												
	Australian sea lion (breeding)	Breeding and caring for young											
	Humpback whale (migration)						northern			southern			
	Sei whales (migration)					Low density, same general pattern of migration as most other baleen whales							
	Southern right whale (migration)					northern				southern			
	Blue whale (migration)					northern					southern		
	Marine Reptiles												
	Hawksbill turtles (resident adult and juveniles)[2]	Widespread throughout NWS 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 NWS 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]												

Categories	Receptors (critical life stages)	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
	Green turtles (resident adult and juveniles)[2]	Widespread throughout the NWS 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]												
	Green turtle nesting and internesting)[2]												
	Green turtle (hatching)[2]												
	Loggerhead turtles (resident adult and juveniles)[2]	Widespread throughout the NWS 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 NWS year-round											
	Olive Ridley turtles	Can occur at low density across the NWS year-round											
	Short-nosed seasnake	Can occur at low density across the NWS year-round											
	Seabirds												
	Terns, shearwaters, petrels (nesting)												
Socio Economic Receptors	Commercial Managed Fisheries												
	Oil and gas												
	Shipping												

Categories	Receptors (critical life stages)	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
	Tourism/ recreational	None applicable											

Key/Notes		Peak activity, presence reliable and predictable	[1] Information provided from previous DPIRD 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	

6. 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.
Regulation 14(9)
The implementation strategy must provide for appropriate consultation with: (b) relevant authorities of the Commonwealth, a State or Territory; and (c) other relevant interested persons or organisations.
Regulation 16
The environment plan must contain the following: (d) report on all consultations between the operator and any relevant person, for Regulation 11A, 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 operator'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.

6.1 Summary

Stakeholders in **Table 6-1** were informed of IMMR and floating asset decommissioning activities covered in the previous revision of this EP (Mutineer-Exeter Cessation of Operations Environment Plan) commencing in August 2021, principally via provision of a Mutineer-Exeter Cessation of Operations Environment Plan Revision consultation package. The package was distributed to identified stakeholders, including provision of maps showing the operational area relevant to specific stakeholder interests where relevant.

These stakeholders were provided additional information in November 2021 following confirmation that planned activities would not include cleaning the flowlines by flushing them with chemically treated seawater as was previously advised.

A further assessment of stakeholders was undertaken in December 2021 following an internal review of the Operational Area for proposed activities that resulted in a decrease in the size of the Operational Area. Santos assessed the relevance of stakeholders to this change and provided an update to those stakeholders with interests in marine safety and navigation, commercial fishing, recreational fishing and oil spill preparedness. Stakeholders were provided new coordinates and existing consultation information for comparison.

In planning for the EP, further review of DPIRD FishCube data identified fishing effort in the area in 2011 by licence holders in the Mackerel Managed Fishery (Area 2). While potential interaction is unlikely, Santos extended consultation activities to include licence holders in this fishery, as well as providing an update to DPIRD and Western Australian Fishing Industry Council (WAFIC) on this consultation activity.

Santos' Quarterly Consultation Update issued in November 2021 also contained reference to the Mutineer-Exeter Cessation of Operations Environment Plan Revision and this update is provided to a number of the stakeholders identified in **Table 6-1**.

Based on Santos' experience with previous activities in the basin and from subsequent stakeholder feedback and regulator discussions, the primary stakeholder issue of concern for this activity is:

+ Interaction with other marine users and commercial fishers (addressed in **Section 8.1**).

Santos has considered all stakeholder responses and assessed the merits of all objections and claims about the potential impact of the proposed activity. The process adopted to assess these claims is outlined in **Section 6.4**. Santos' response statements to the objections and claims are summarised in **Table 6-3** and any specific commitments made as a result of stakeholder consultation are listed in **Table 10-7** if it is a notification requirement**.**

Additional consultation was undertaken from June 2022 with stakeholders relevant to decommissioning activities, initially through consultation for a Comparative Environmental Impact Assessment process and subsequently to support the development of this Environment Plan. A focus of these activities was to identify and engage those government, industry and community stakeholders who were likely to be most impacted by, or who had the highest levels of interest in, end state arrangements.

Santos considers that consultation with relevant stakeholders has been adequate to inform the development of this EP. Notwithstanding this, Santos recognises the importance of ongoing stakeholder consultation, and this is described in **Section 6.5**.

6.2 Stakeholder Identification

Santos understands retaining a broad licence to operate depends on the development and maintenance of positive and constructive relationships with a comprehensive group of stakeholders in the community, government, non-government, other business sectors and other users of the marine environment. Fostering effective consultation between Santos and relevant stakeholders is an important part of this process.

Santos began the stakeholder identification process for this EP with a review of its stakeholder database, including stakeholders consulted for other recent activities in the area. The list of stakeholders was then reviewed and refined based on the defined operational areas and the relevance of the stakeholder according to Regulation 11A of the OPGGS(E)R and NOPSEMA Bulletin #2 Clarifying statutory requirements and good practice consultation (November 2019).

More specifically, stakeholders for this EP were identified through:

+ regular review of legislation applicable to petroleum and marine activities
+ identification of marine user groups and interest groups active in the area (e.g., commercial fisheries, other oil and gas producers, merchant shipping)
+ a review of the most recent DPIRD FishCube data as required
+ updated fishing licence holder contact details, from these identified fisheries, as provided by DPIRD
+ discussions with identified stakeholders to identify other potentially impacted persons

+ active participation in industry bodies and collaborations (e.g., Australian Petroleum Production and Exploration Association (APPEA), Australian Marine Oil Spill Centre (AMOSC), National Energy Resources Australia).

Identified stakeholders and an assessment of their relevance under the OPGGS(E)R for the purposes of consultation for activities relevant to floating asset removal are listed in **Table 6-1.**

Table 6-1: Assessment of relevance of identified stakeholders for the proposed activity

Stakeholder	Relevant to activity	Relevance / reason for engagement
Commonwealth government departments / agencies		
Australian Fisheries Management Authority	Considered relevant persons under Regulation 11A(1) (a)	AFMA is responsible for managing Commonwealth fisheries and is a relevant agency where the activity has the potential to impact on fisheries resources in AFMA-managed fisheries. The operational area intersects Commonwealth-managed fisheries. While there has been no recent fishing effort in these fisheries, Santos has consulted AFMA, given its interest in petroleum activities where licence holders are entitled to fish.
Australian Hydrographic Office (AHO)	Considered relevant persons under Regulation 11A(1) (a)	AHO is the part of the Commonwealth Department of Defence responsible for maintaining and disseminating nautical charts, including the distribution of Notice to Mariners. The operational area is in Commonwealth waters.
Australian Maritime Safety Authority – maritime safety	Considered relevant persons under Regulation 11A(1) (a)	AMSA is the statutory and control agency for maritime safety and vessel emergencies in Commonwealth Waters. AMSA is a relevant agency when proposed offshore activities may impact on the safe navigation of commercial shipping in Australian waters. The operational area is in Commonwealth waters.
Australian Maritime Safety Authority – marine pollution	Considered relevant persons under Regulation 11A(1) (a)	AMSA is the statutory and control agency for marine pollution Commonwealth Waters. The operational area is in Commonwealth waters.
Department of Defence (Defence)	Considered relevant persons under Regulation 11A(1) (a)	Defence is a relevant agency where the proposed activity may impact operational requirements; encroach on known training areas and/or restricted airspace, or when nautical products or other maritime safety information is required to be updated. The operational area is in Commonwealth waters.
Department of Climate Change, Energy, the Environment and Water – Biosecurity (marine pests)	Considered relevant persons under Regulation 11A(1) (a)	The DCCEEW (marine pests) has primary policy and regulatory responsibility for managing biosecurity for incoming goods and conveyances, including biosecurity for marine pests. The Department is the relevant agency where an offshore activity has the potential to transfer marine pests between installations and mainland Australia. The operational area is in Commonwealth waters.

Stakeholder	Relevant to activity	Relevance / reason for engagement
Department of Climate Change, Energy, the Environment and Water – Fisheries	Considered relevant persons under Regulation 11A(1) (a)	DCCEEW (fisheries) has primary policy responsibility for promoting the biological, economic and social sustainability of Australian fisheries. The Department is the relevant agency where the activity has the potential to negatively impact fishing operations and/or fishing habitats in Commonwealth waters. The operational area intersects Commonwealth-managed fisheries. While there has been no recent fishing effort in these fisheries, Santos has consulted DCCEEW, given its interest in petroleum activities where licence holders are entitled to fish.
Department of Climate Change, Energy, the Environment and Water –Biosecurity (vessels, aircraft and personnel)	Considered relevant persons under Regulation 11A(1) (a)	DCCEEW (vessels and aircraft) has inspection and reporting requirements to ensure all conveyances (vessels, installations and aircraft) arriving in Australian territory comply with international health regulations and that any biosecurity risk is managed. The department is the relevant agency where the titleholder's activity involves: + the movement of aircraft or vessels between Australia and offshore petroleum activities either inside or outside Australian territory + the exposure of an aircraft or vessel (which leaves Australian territory not subject to biosecurity control) to offshore petroleum activities.
Department of Industry Science, Energy and Resources (DISER)	Considered relevant persons under Regulation 11A(1) (a)	DISER is the department of the relevant Commonwealth Minister and is required to be consulted under subregulation 11A (1) of the Environment Regulations.
Director of National Parks	Considered relevant persons under Regulation 11A(1) (a)	The DNP is the statutory authority responsible for administration, management and control of Commonwealth marine reserves. The Director of National Parks is a relevant person for consultation where: + the activity or part of the activity is within the boundaries of a proclaimed Commonwealth marine reserve + activities proposed to occur outside a reserve may impact on the values within a Commonwealth marine reserve, and/or + an environmental incident occurs in Commonwealth waters surrounding a Commonwealth marine reserve and may impact on the values within the reserve.

Stakeholder	Relevant to activity	Relevance / reason for engagement
State government departments / agencies		
Department of Biodiversity, Conservation and Attractions (DBCA)	Considered relevant persons under Regulation 11A(1) (b)	DBCA is a relevant State agency responsible for the management of State marine parks and reserves and protected marine fauna and flora.
Department of Mines, Industry Regulation and Safety (DMIRS)	Considered relevant persons under Regulation 11A(1) (c)	DMIRS is the department of the relevant State Minister and is required to be consulted under subregulation 11A (1) of the Environment Regulations.
Department of Primary Industries and Regional Development	Considered relevant persons under Regulation 11A(1) (b)	DPIRD is responsible for managed West Australian State fisheries. The operational area intersects State-managed fisheries, of which the Pilbara Trawl Interim Managed Fishery has been active in the operational area.
Department of Transport (DoT)	Considered relevant persons under Regulation 11A(1) (b)	DoT is the control agency for marine pollution emergencies in State waters.
Industry bodies		
Australian Petroleum Production & Exploration Association	Considered relevant persons under Regulation 11A(1) (e)	Peak industry association for companies that explore and produce oil and gas in Australia. APPEA has facilitated industry-wide discussion aimed at enhancing and strengthening Australia's offshore oil and gas decommissioning framework.
Australian Southern Bluefin Tuna Industry Association (ASBTIA)	Considered relevant persons under Regulation 11A(1) (e)	ASBTIA represents the Australian southern bluefin tuna industry. ASBTIA is also listed on the AFMA website as a contact for petroleum operators to use when consultation with Commonwealth fishing operators is required. The operational area intersects the Southern Bluefin Tuna Fishery. While there has been no recent fishing effort, Santos has consulted ASBTIA on behalf of licence holders who are entitled to fish in the operational area.
Commonwealth Fisheries Association (CFA)	Considered relevant persons under Regulation 11A(1) (e)	CFA was engaged as a representative body for Commonwealth fisheries. The operational areas intersect with several Commonwealth-managed fisheries. CFA is also listed on the AFMA website as a contact for petroleum operators to use when consultation with fishing operators is required. The operational area intersects the Western Skipjack Tuna Fishery. While there has been no recent fishing effort, Santos has consulted CFA on behalf of licence holders who are entitled to fish in the operational area.

Stakeholder	Relevant to activity	Relevance / reason for engagement
Marine Tourism WA (MTWA)	Considered relevant persons under Regulation 11A(1) (e)	MTWA represents the charter sector in WA. MTWA is identified as being able to assist in reaching its membership to inform them of activity timing should this be requested. While marine tourism is unlikely in the operational area, Santos has consulted MTWA on behalf of member companies who are entitled to undertake activities in the operational area.
Pearl Producers Association (PPA)	Considered relevant persons under Regulation 11A(1) (e)	PPA is the peak representative organisation of The Australian South Sea Pearling Industry. PPA membership includes all *Pinctada maxima* pearl oyster licensees that operate within the Australian North-west Bioregion. While there is no recent fishing effort in the operational area, Santos has consulted PPA based on previous request to be kept informed of Santos' activities.
Recfishwest	Considered relevant persons under Regulation 11A(1) (e)	Recfishwest is the peak body representing recreational fishers in WA. Recfishwest is identified as being able to assist in reaching its membership to inform of activity timing should this be requested. While recreational fishing is unlikely in the operational area, Santos has consulted Recfishwest on behalf of recreational fishers who are entitled to undertake activities in the operational area.
Tuna Australia	Considered relevant persons under Regulation 11A(1) (e)	Represents statutory fishing right owners, holders, fish processors and sellers, and associate members of the Eastern & Western tuna and billfish fisheries. The operational area intersects the Western Billfish and Tuna Fishery. While there has been no recent fishing effort, Santos has consulted Tuna Australia on behalf of licence holders who are entitled to fish in the operational area.
Western Australian Fishing Industry Council	Considered relevant persons under Regulation 11A(1) (e)	WAFIC is the peak industry body representing the interests of the WA commercial fishing, pearling and aquaculture sector. The operational area intersects State-managed fisheries, of which the Pilbara Trawl (Interim) Managed Fishery has been active in the operational area.

Stakeholder	Relevant to activity	Relevance / reason for engagement
Commercial fisheries – State Managed		
Mackerel Managed Fishery (Area 2)	Considered relevant persons under Regulation 11A(1) (d)	The operational area intersects the Mackerel Managed Fishery. DPIRD information indicates historic fishing effort (**Section 8.1)** and licence holders in this fishery should be consulted.
Pilbara Fish Trawl Interim Managed Fishery	Considered relevant persons under Regulation 11A(1) (d)	The operational area intersects the Pilbara Fish Trawl Interim Managed Fishery. DPIRD information indicates recent fishing effort (**Section 8.1)** and licence holders in this fishery should be consulted.
Other industry		
Finder	Considered relevant persons under Regulation 11A(1) (d)	Finder is a nearby titleholder.
Woodside	Considered relevant persons under Regulation 11A(1) (d)	Woodside is the adjacent titleholder.
Other stakeholders		
Australian Marine Oil Spill Centre	Considered relevant persons under Regulation 11A(1) (d)	AMOSC operates Australia's major oil spill response equipment stockpile on behalf of the Australian oil and gas industry.

6.2.1 Environmental Impact Assessment

Stakeholder identification for the revision of this Environment Plan also considered the need for ongoing engagement with stakeholders who participated from February 2022 in a comparative Environmental Impact Assessment (CEIA) to help inform end-state decommissioning planning of the MEFF field.

Consultation for the CEIA included engagement with a range of government, industry and community stakeholders who were identified on the basis of those who were likely to be most impacted by, or who had the highest levels of interest in, end state arrangements.

The purpose of the engagements was to:

- Provide an opportunity for stakeholders to discuss decommissioning alternatives being assessed by Santos.
- Provide stakeholders with an overview of the assessment criteria being used in the CEIA process.
- Outline to stakeholders how their feedback would be incorporated into the CEIA process.
- Validate or challenge Santos's assumptions on stakeholder positions with respect to their relationship to the end state.

Stakeholders invited to provide feedback as part of the CEIA process included:

- Australian Government Departments
  - Australian Fisheries Management Authority

- Department of Agriculture, Water and the Environment (Sea Dumping)
  - Director of National Parks
- Western Australian Government Departments
  - Department of Biodiversity and Conservation Attractions
  - Department of Jobs, Tourism, Science and Innovation
  - Department of Primary Industries & Regional Development,
  - Department of Transport (maritime safety)
  - Pilbara Development Commission
  - Pilbara Ports Authority
- Regional Governments
  - City of Karratha
  - Shire of Ashburton
- Commercial fishing licence holders
- Dampier and Onslow-based fishing clubs
- Industry associations
  - Karratha & Districts Chamber of Commerce and Industry
  - Onslow Chamber of Commerce and Industry
  - Marine Tourism WA
  - Recfishwest
  - Western Australian Fishing Industry Council

The CEIA process confirmed that the MEFF location was:

- Out of reach for Dampier/Karratha based recreational fishers and charter operators.
- Outside of port authority limits and not of interest to regional port authorities.
- Not of interest to Onslow-based stakeholders.
- Not of interest to stakeholders with an interest in commercial fishing in Commonwealth managed fisheries, given historic effort elsewhere for target species.
- Of interest to some Dampier/Karratha based stakeholders (local Government and industry) for potential project participation.

Identified stakeholders and an assessment of their relevance under the OPGGS(E)R for the purposes of consultation for activities relevant to decommissioning are listed in **Table 6-2.** This assessment meets Regulation 11A of the OPGGS (E) Regulations and published NOPSEMA guidelines [1] [2] for the identification and consultation of stakeholders relevant to proposed activities.

[1] **HAVE YOUR SAY on environmental aspects of offshore energy activities** (June 2021) - https://www.nopsema.gov.au/sites/default/files/documents/2021-06/A782856.pdf
[2] **Consultation with Commonwealth agencies with responsibilities in the marine area** (March 2022) - https://www.nopsema.gov.au/sites/default/files/documents/2022-03/A705589_0.pdf

Table 6-2: Assessment of relevance or identified stakeholders for decommissioning

Stakeholder	Relevant to Activity	Relevance / Reason for Engagement
Commonwealth government departments/agencies		
Australian Border Force (ABF)	Considered relevant persons under Regulation 11A(1)(a)	ABF is responsible for the security of Australia's offshore maritime waters. The operational area is in Commonwealth waters.
Australian Fisheries Management Authority (AFMA)	Not considered a relevant person under Regulation 11A(1)(e)	AFMA is responsible for managing Commonwealth fisheries and is a relevant agency where the activity has the potential to impact on fisheries resources in AFMA-managed fisheries. The operational area intersects Commonwealth-managed fisheries and there has been no fishing effort in the operational area for the past 10 years. Santos has provided the consultation package to AFMA for information.
Australian Hydrographic Office (AHO)	Considered relevant persons under Regulation 11A(1)(a)	AHO is responsible for maintaining and disseminating nautical charts, including the distribution of Notice to Mariners. The operational area is in Commonwealth waters.
Australian Maritime Safety Authority (AMSA) – maritime safety	Considered relevant persons under Regulation 11A(1)(a)	AMSA is the statutory and control agency for maritime safety and vessel emergencies in Commonwealth Waters. AMSA is a relevant agency when proposed offshore activities may impact on the safe navigation of commercial shipping in Australian waters. The operational area is in Commonwealth waters.
Australian Maritime Safety Authority (AMSA) - marine pollution	Considered relevant persons under Regulation 11A(1)(a)	AMSA is the statutory and control agency for marine pollution Commonwealth Waters. The operational area is in Commonwealth waters.
Department of Climate Change, Energy, the Environment and Water– Biosecurity (DCCEEW) – marine pests	Considered relevant persons under Regulation 11A(1)(a)	DAWE (marine pests) has primary policy and regulatory responsibility for managing biosecurity for incoming goods and conveyances, including biosecurity for marine pests. The Department is the relevant agency where an offshore activity has the potential to transfer marine pests between installations and mainland Australia.
Department of Agriculture, Water and the Environment (DAWE) –	Considered relevant persons under Regulation 11A(1)(a)	DAWE (vessels, aircraft and personnel) has inspection and reporting requirements to ensure that all conveyances (vessels, installations and aircraft) arriving in Australian territory comply

Stakeholder	Relevant to Activity	Relevance / Reason for Engagement
Biosecurity (vessels, aircraft and personnel)		with international health regulations and that any biosecurity risk is managed.
Department of Agriculture, Water and the Environment (DAWE) – Fisheries	Not considered a relevant person under Regulation 11A(1)(e)	DAWE (fisheries) has primary policy responsibility for promoting the biological, economic and social sustainability of Australian fisheries. The Department is the relevant agency where the activity has the potential to negatively impact fishing operations and/or fishing habitats in Commonwealth waters. The operational area intersects Commonwealth-managed fisheries and there has been no fishing effort in the operational area for the past 10 years. Santos has provided the consultation package to DAWE for information.
Department of Industry, Science, Energy and Resources (DISER)	Considered relevant persons under Regulation 11A(1)(e)	DISER is the department of the relevant Commonwealth Minister and is required to be consulted under subregulation 11A (1) of the Environment Regulations.
Director of National Parks (DNP)	Not considered a relevant person under Regulation 11A(1)(e)	DNP is the statutory authority responsible for administration, management and control of Commonwealth marine reserves (CMRs). The Director of National Parks is a relevant person for consultation where: + the activity or part of the activity is within the boundaries of a proclaimed Commonwealth marine reserve + activities proposed to occur outside a reserve may impact on the values within a Commonwealth marine reserve; and / or + an environmental incident occurs in Commonwealth waters surrounding a Commonwealth marine reserve and may impact on the values within the reserve. While the operational area does not intersect a Commonwealth marine park, Santos has provided the consultation package to DNP for information.
WA Government departments/agencies		
Department of Biodiversity and Conservation Attractions (DBCA)	Not considered a relevant person under Regulation 11A(1)(e)	DBCA is a relevant State agency responsible for the management of State marine parks and reserves and protected marine fauna and flora. While the operational area does not intersect a DBCA managed area, Santos has provided information to DBCA for information.

Stakeholder	Relevant to Activity	Relevance / Reason for Engagement
WA Department of Mines, Industry Regulation and Safety (DMIRS)	Considered relevant persons under Regulation 11A(1)(e)	DMIRS is the department of the relevant State Minister and is required to be consulted under subregulation 11A (1) of the Environment Regulations.
Department of Primary Industries and Regional Development (DPIRD)	Not considered a relevant person under Regulation 11A(1)(e)	DPIRD is responsible for management of West Australian State fisheries. The operational area intersects State-managed fisheries. While there has been no fishing effort in the operational area for the past 10 years, Santos has provided the consultation package to DPIRD for information.
Department of Transport (DoT)	Considered relevant persons under Regulation 11A(1)(e)	DoT is the control agency for marine pollution emergencies in State waters.
Industry bodies		
Australian Petroleum Production & Exploration Association (APPEA)	Not considered a relevant person under Regulation 11A(1)(e)	APPEA is the peak national body representing Australia's upstream oil and gas sector and has been provided the consultation package for information.
Australian Southern Bluefin Tuna Industry Association (ASBTIA)	Not considered a relevant person under Regulation 11A(1)(e)	ASBTIA represents the Australian Southern Bluefin Tuna Fishery and is listed on the AFMA website as a contact for petroleum operators to use when consultation with the Australian Southern Bluefin Tuna and Skipjack Tuna Fisheries is required. The operational area intersects the Australian Southern Bluefin Tuna and Skipjack Tuna Fisheries and there has been no fishing effort in the last 10 years (**Table 5-12**). Santos has provided the consultation package to ASBTIA for information on behalf of licence holders who are entitled to fish in the operational area.
Commonwealth Fisheries Association (CFA)	Not considered a relevant person under Regulation 11A(1)(e)	The CFA is the peak organisation representing Commonwealth fishers. The CFA is listed on the AFMA website as a contact for petroleum operators to use when consultation with the Northern Prawn, North West Slope Trawl, Western Deepwater Trawl, the Skipjack Tuna and the Eastern Tuna and Billfish Fisheries is required. The operational area intersects the Western Tuna and Billfish and Skipjack Tuna Fisheries and there has been no fishing effort in the last 10 years **(Table 5-12**). Santos has provided the consultation package to CFA for information on behalf of licence

Stakeholder	Relevant to Activity	Relevance / Reason for Engagement
		holders who are entitled to fish in the operational area.
Marine Tourism Western Australia (MTWA)	Not considered a relevant person under Regulation 11A(1)(e)	MTWA represents the charter sector in WA. Santos has provided the consultation package to MTWA for information on behalf of its members.
Pearl Producers Association (PPA)	Not considered a relevant person under Regulation 11A(1)(e)	PPA is the peak representative organisation of The Australian South Sea Pearling Industry. PPA membership includes all *Pinctada maxima* pearl oyster licensees that operate within the Australian North-west Bioregion. While there is no recent fishing effort in the operational area, Santos has provided the consultation package to PPA for information based on previous requests for the PPA to be kept informed of planned activities.
Recfishwest	Not considered a relevant person under Regulation 11A(1)(e))	Recfishwest is the peak body representing recreational fishers in WA. Santos has provided the consultation package to Recfishwest for information on behalf of recreational fishers. Advice from regional fishing clubs during the CEIA process indicated that the MEFF location was not of interest to recreational fishers due to the distance from shore.
Tuna Australia	Not considered a relevant person under Regulation 11A(1)(e)	Tuna Australia represents the interests of the Eastern and Western Tuna and Billfish Fisheries of Australia. Tuna Australia is listed on the AFMA website as a contact for petroleum operators to use when consultation with the Eastern and Western Tuna and Billfish Fisheries is required. The operational area intersects the Western Tuna and Billfish Fishery and there has been no fishing effort in the last 10 years (**Table 5-12**). Santos has provided the consultation package to Tuna Australia for information on behalf of licence holders who are entitled to fish in the operational area.
Western Australian Fishing Industry Council (WAFIC)	Considered relevant persons under Regulation 11A(1)(e)	WAFIC is the peak industry body representing the interests of the WA commercial fishing, pearling and aquaculture sectors. The operational area intersects State-managed fisheries, including the closed area of the Pilbara Trawl Managed Fishery. Historic fishing data shows active trawl fishing to the south of the Operational Area. There has also been historic fishing (2011) in the

Stakeholder	Relevant to Activity	Relevance / Reason for Engagement
		Operational Area by the Mackerel Managed Fishery (Area 2).
Commercial Fisheries – Commonwealth Managed		
Australian Southern Bluefin Tuna Fishery	Not considered a relevant person under Regulation 11A(1)(e)	ABARES information indicates no fishing effort in the operational area in the last 10 years (**Table 5-12**). Santos has provided consultation material to representative organisations on behalf of licence holders in this fishery.
Skipjack Tuna Fishery	Not considered a relevant person under Regulation 11A(1)(e)	ABARES information indicates no fishing effort in the operational area in the last 10 years (**Table 5-12**). Santos has provided consultation material to representative organisations on behalf of licence holders in this fishery.
Western Tuna & Billfish Fishery	Not considered a relevant person under Regulation 11A(1)(e)	ABARES information indicates no fishing effort in the operational area in the last 10 years (**Table 5-12**). Santos has provided consultation material to representative organisations on behalf of licence holders in this fishery.
Commercial Fisheries – State Managed		
Mackerel Managed Fishery (Area 2)	Considered relevant persons under Regulation 11A(1)(d)	DPIRD information indicates historic fishing effort (**Table 5-12**). in the Operational Area and licence holders in this have been consulted.
Pilbara Trawl Managed Fishery	Considered relevant persons under Regulation 11A(1)(d)	DPIRD information indicates historic fishing effort (**Table 5-12**) adjacent to the Operational Area and licence holders in this have been consulted on the basis that the fishery (currently closed at the MEFF location) may be opened at a future date.
Other industry		
Finder Energy	Considered relevant persons under Regulation 11A(1)(a)	Finder Energy is an adjacent titleholder and has been consulted.
Woodside Energy	Considered relevant persons under Regulation 11A(1)(a)	Woodside Energy is an adjacent titleholder and has been consulted.
Other stakeholders		
Australian Marine Oil Spill Centre (AMOSC)	Considered relevant persons under Regulation 11A(1)(a)	AMOSC operates the Australian oil industry's major oil spill response facility.
Pilbara Development Commission (PDC)	Not considered a relevant person under Regulation 11A(1)(e)	PDC supports and promotes economic development in the Pilbara Region on behalf of the Western Australian Government.

Stakeholder	Relevant to Activity	Relevance / Reason for Engagement
		Santos engaged PDC as part of the CEIA process for MEFF end state planning. PDC requested to be kept informed about planned decommissioning activities.
City of Karratha (CK)	Not considered a relevant person under Regulation 11A(1)(e)	The City of Karratha is one of four local government areas in the Pilbara region of Western Australia and manages the interests of business located in Karratha and Dampier. Santos engaged CK as part of the CEIA process for MEFF end state planning. CK requested to be kept informed about planned decommissioning activities.
Karratha and Districts Chamber of Commerce and Industry (KDCCI)	Not considered a relevant person under Regulation 11A(1)(e)	KDCCI is the industry representative organisation for businesses in the Karratha/Dampier area. Santos engaged KDCCI as part of the CEIA process for MEFF end state planning. KDCCI requested to be kept informed about planned decommissioning activities.
Charter operators	Not considered a relevant person under Regulation 11A(1)(e)	Santos has not consulted marine tourism operators given advice from MTWA during the CEIA process for a separate MEFF decommissioning Environment Plan that the MEFF location was not of interest to charter operators given the distance from shore.

6.3 Stakeholder consultation

The approach to stakeholder consultation for this EP follows the process adopted by Santos for all its EPs. This includes:

+ providing more information to commercial fishers, targeted to their fishery, in the initial consultation packs
+ clearly identifying and maintaining current lists of ‘relevant’ persons
+ clearly documenting and tracking notification commitments to relevant persons.

Stakeholders, wherever possible, were provided personal emails with information tailored to their functions, interests and activities, including outlining why they have been identified as a relevant stakeholder.

The consultation package contains details such as an activity summary, location map, coordinates, water depth, distance to key regional features, exclusion zone details and estimated timing and duration. This consultation package outlined potential risks and impacts together with a summary of proposed management control measures.

Where relevant, individual fishing licence holders and representative bodies were also provided a map and information relevant to their specific fishery.

The intent of providing this level of information early in the consultation process was to facilitate each party proceeding with their business in a safe and efficient manner, and without loss or conflict, by minimising the extent of interruption by the activities on commercial fishing operators' activities to the lowest practicable level.

Stakeholder consultation material is summarised in **Table 6-3** and **Table 6-4**. **Table 6-3** covers stakeholder materials related to the MEFF CoP EP (Rev 4, as accepted by NOPSEMA in March 2022, which provided for Santos to undertake floating asset removal). **Table 6-4** includes stakeholder materials related to this current version of the CoP EP, which is a further revision of the previous EP, and now includes activities related to decommissioning activities.

Stakeholders were afforded at least six weeks to review consultation packs, although Santos accepted stakeholder feedback after this period.

6.4 Assessment of stakeholder objections and claims

A summary of the stakeholder consultation undertaken for this EP, including Santos' assessment of all stakeholder comments received, is outlined in **Table 6-3** and **Table 6-4.**

Full transcripts between Santos and stakeholders are provided in the *MEFF Decommissioning Environment Plan Revision Sensitive Stakeholder Information Report* (9885-650-PLN-0003) as a confidential submission to NOPSEMA.

Santos adopted the following process to address objections and claims received during the consultation process:

+ Santos acknowledged receiving all comments made by stakeholders.
+ Santos assessed the merits of all objections and claims made by stakeholders. This included assessing all reasonably available options for resolving or mitigating the degree to which a stakeholder's functions, interests or activities may be affected. Control measures were proposed and adopted where reasonably practicable.
+ Santos responded to all stakeholder objections and claims, and advised the stakeholder how each of their objections and claims would be addressed in the EP.
+ As soon as possible, or on publication of the EP on the NOPSEMA website, Santos advised all stakeholders, or their representative industry body, that the EP was available for public review and comment.

A similar process was applied to information provided and requests made by stakeholders not deemed to be an objection or claim.

Santos recognises the importance of ensuring a high degree of transparency in how a titleholder manages ongoing stakeholder consultation during the life of a five-year EP. As such, should additional stakeholder comments be received to those described in **Table 6-3** and **Table 6-4**, Santos will assess the comments using the above process and update the EP to document the assessment of additional objections or claims.

In relation to stakeholder consultation Santos is of the opinion that Regulation 10A of the OPGGS(E) Regulations has been met.

Table 6-3: Consultation summary for FAR activity

<table>
<tr><th>Stakeholder</th><th colspan="2">Stakeholder Consultation Summary (OPGGS(E) Regulation 16 (b)(i))</th></tr>
<tr><th colspan="3">Commonwealth departments/agencies</th></tr>
<tr><td rowspan="3">Australian Fisheries Management Authority</td><td colspan="2">AFMA was provided the consultation package via email on 31 August 2021.
AFMA responded on 1 September 2021 noting its expectation for consultation with fishers who have entitlements to fish within the proposed area. AFMA advised this can be done through the relevant fishing industry associations or directly with fishers who hold entitlements in the area. Santos has consulted with relevant fishing industry associations as outlined in Section 5.2.5.1 on the basis that these fisheries have not been active in the operational area in recent years.
Santos responded to AFMA on 18 October 2021 acknowledging that, while there was no recent fishing activity in the operational area for the proposed activity, Santos has consulted the following representative organisations on behalf of relevant Commonwealth fishing licence holders:
• Australian Southern Bluefin Tuna Industry Association, representing Southern Bluefin Tuna Fishery licence holders
• Tuna Australia, representing Western Tuna and Billfish Fishery licence holders
• Commonwealth Fisheries Association, representing Western Skipjack Tuna Fishery licence holders.
AFMA was provided additional information via email on 22 November 2021 advising that there had been a change to planned activities as previously consulted, specifically that flowlines would not be subject to additional flushing with chemically treated seawater, based on an assessment of historical flushing records and further engineering studies that have been undertaken.
AFMA was provided additional information via email on 8 December 2021 advising that there had been a change to the Operational Area for proposed activities. AFMA was provided the updated coordinates and a figure showing the updated Operational Area in relation to Commonwealth and State marine reserves, ports and offshore equipment. For comparison purposes, Santos also provided the initial Operational Area as shown in the information sheet sent previously to AFMA.
This stakeholder also receives Santos' Quarterly Consultation Update for WA.
Santos has also consulted DCCEEW, given its interests in the management of Commonwealth fisheries.
Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.</td></tr>
<tr><th>Assessment of the merits of objections and claims (OPGGS(E) Regulation 16 (b)(ii)), information and requests</th><th>Statement of response, or proposed response, to the objections and claims (OPGGS(E) Regulation 16 (b)(iii)), and information and requests</th></tr>
<tr><td>No assessment required.</td><td>No response required.</td></tr>
</table>

<table>
<tr><th>Stakeholder</th><th colspan="2">Stakeholder Consultation Summary (OPGGS(E) Regulation 16 (b)(i))</th></tr>
<tr><td rowspan="3">Australian Hydrographic Office</td><td colspan="2">AHO was provided the consultation package via email on 31 August 2021.
AHO acknowledged receipt of information 1 September 2021.
AHO was provided additional information via email on 22 November 2021 advising that there had been a change to planned activities as previously consulted, specifically that flowlines would not be subject to additional flushing with chemically treated seawater, based on an assessment of historical flushing records and further engineering studies that have been undertaken.
AHO was provided additional information via email on 8 December 2021 advising that there had been a change to the Operational Area for proposed activities. AHO was provided the updated coordinates and a figure showing the updated Operational Area in relation to Commonwealth and State marine reserves, ports and offshore equipment. For comparison purposes, Santos also provided the initial Operational Area as shown in the information sheet sent previously to AHO.
No formal response has been received from the AHO.
AHO notification requirements, as requested by AMSA and Defence (refer this table), are addressed in Table 10-7.
This stakeholder also receives Santos' Quarterly Consultation Update for WA.
Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.</td></tr>
<tr><th>Assessment of the merits of objections and claims (OPGGS(E) Regulation 16 (b)(ii)), information and requests</th><th>Statement of response, or proposed response, to the objections and claims (OPGGS(E) Regulation 16 (b)(iii)), and information and requests</th></tr>
<tr><td>No assessment required.</td><td>No response required.</td></tr>
<tr><td>Australian Maritime Safety Authority – maritime safety</td><td colspan="2">AMSA was provided the consultation package via email on 31 August 2021.
AMSA responded on 1 September 2021 requesting timely and relevant Maritime Safety Information is promulgated for the area and nature of operations as follows:
• Contact AHO at datacentre@hydro.gov.au no less than four weeks before operations, with details relevant to the operations. AHO will promulgate the appropriate Notice to Mariners, which will ensure other vessels receive information about activities. [REQUEST 001]
• Notify AMSA's Joint Rescue Coordination Centre (JRCC) by email rccaus@amsa.gov.au for promulgation of radio-navigation warnings at least 24 to 48 hours before operations commence. JRCC will require vessel details (including name, callsign and Maritime Mobile Service Identity), satellite communications details (including INMARSAT-C and satellite telephone numbers), area of operation, requested clearance from other vessels and any other information that may contribute to safety at sea. JRCC will also need to be advised when operations start and end. [REQUEST 002]</td></tr>
</table>

<table>
<tr><th>Stakeholder</th><th colspan="2">Stakeholder Consultation Summary (OPGGS(E) Regulation 16 (b)(i))</th></tr>
<tr><td rowspan="4"></td><td colspan="2">

Provide updates to both the Australian Hydrographic Office and the JRCC on progress and, importantly, any changes to the intended operations. [REQUEST 003]
Exhibit appropriate lights and shapes to reflect the nature of operations –we remind vessels of their obligation to comply with the International Rules for Preventing Collisions at Sea (COLREGs), in particular, the use of appropriate lights and shapes to reflect the nature of your operations (e.g., restricted in the ability to manoeuvre). Vessels should also ensure their navigation status is set correctly in the ship’s Automatic Identification System unit. [REQUEST 004]
To obtain a vessel traffic plot showing Automatic Identification System traffic data for your area of interest, please visit AMSA’s spatial data gateway and Spatial@AMSA portal to download digital data sets and maps. [INFORMATION 001]

Santos responded to AMSA on 18 October 2021 and addressed the matters raised in its feedback of 1 September 2021 (refer assessment of stakeholder objections, claims, information and requests below).
AMSA was provided additional information via email on 22 November 2021 advising there had been a change to planned activities as previously consulted, specifically that flowlines would not be subject to additional flushing with chemically treated seawater, based on an assessment of historical flushing records and further engineering studies that have been undertaken.
AMSA was provided additional information via email on 8 December 2021 advising that there had been a change to the Operational Area for proposed activities. AMSA was provided the updated coordinates and a figure showing the updated Operational Area in relation to Commonwealth and State marine reserves, ports and offshore equipment. For comparison purposes, Santos also provided the initial Operational Area as shown in the information sheet sent previously to AMSA.
AMSA responded on 14 December 2021 confirming its initial advice will continue to apply. [INFORMATION 002]
This stakeholder also receives Santos’ Quarterly Consultation Update for WA.
Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.
</td></tr>
<tr><th>Assessment of the merits of objections and claims (OPGGS(E) Regulation 16 (b)(ii)), information and requests</th><th>Statement of response, or proposed response, to the objections and claims (OPGGS(E) Regulation 16 (b)(iii)), and information and requests</th></tr>
<tr><td>[REQUEST 001] Santos will notify AHO no less than four weeks before operations commence where practicable.
Notification requirements are addressed in Table 10-7.</td><td>Santos responded to AMSA confirming the notifications requirements would be addressed in the EP.</td></tr>
<tr><td>[REQUEST 002] Santos will notify AMSA’s JRCC at least 24 to 48 hours before operations commence for each activity and advise when operations start and end.</td><td>Santos responded to AMSA confirming the notifications requirements would be addressed in the EP.</td></tr>
</table>

Stakeholder	Stakeholder Consultation Summary (OPGGS(E) Regulation 16 (b)(i))	
	Notification requirements are addressed in **Table 10-7**.	
	[REQUEST 003] Santos will notify both AHO and AMSA's JRCC on any changes to the intended operations. Notification requirements are addressed in **Table 10-7**.	Santos responded to AMSA confirming the notifications requirements would be addressed in the EP.
	[REQUEST 004] Santos noted the advice on obligations to comply with COLREGs, in particular, the use of appropriate lights and shapes to reflect the nature of operations and this is addressed in **Section 0**.	Santos responded to AMSA and noted the information provided.
	[INFORMATION 001] Santos notes the information provided on traffic data.	Santos responded to AMSA and noted the information provided.
	[INFORMATION 002] Santos notes the currency of AMSAs initial advice.	Santos responded to AMSA and noted the information provided.
Australian Maritime Safety Authority – marine pollution	AMSA was provided the consultation package via email on 31 August 2021. AFMA was provided additional information via email on 22 November 2021 advising that there had been a change to planned activities as previously consulted, specifically that flowlines would not be subject to additional flushing with chemically treated seawater, based on an assessment of historical flushing records and further engineering studies that have been undertaken. AMSA was provided additional information via email on 8 December 2021 advising that there had been a change to the Operational Area for proposed activities. AMSA was provided the updated coordinates and a figure showing the updated Operational Area in relation to Commonwealth and State marine reserves, ports and offshore equipment. For comparison purposes, Santos also provided the initial Operational Area as shown in the information sheet sent previously to AMSA. No formal response has been received from AMSA. Management of oil spill preparedness is addressed in the OPEP in Section 4. Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.	
	Assessment of the merits of objections and claims (OPGGS(E) Regulation 16 (b)(ii)), information and requests	**Statement of response, or proposed response, to the objections and claims (OPGGS(E) Regulation 16 (b)(iii)), and information and requests**
	No assessment required.	No response required.

<table>
<tr><th>Stakeholder</th><th colspan="2">Stakeholder Consultation Summary (OPGGS(E) Regulation 16 (b)(i))</th></tr>
<tr><td rowspan="3">Department of Climate Change, Energy, the Environment and Water–Biosecurity (marine pests)</td><td colspan="2">DCCEEW was provided information via email on 29 November 2021 advising of the activity and an additional activity update, specifically that flowlines would not be subject to additional flushing with chemically treated seawater, based on an assessment of historical flushing records and further engineering studies that have been undertaken.
Management of invasive marine pest species is addressed in Section 9.2.
This stakeholder also receives Santos' Quarterly Consultation Update for WA.
Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.</td></tr>
<tr><td>Assessment of the merits of objections and claims (OPGGS(E) Regulation 16 (b)(ii)), information and requests</td><td>Statement of response, or proposed response, to the objections and claims (OPGGS(E) Regulation 16 (b)(iii)), and information and requests</td></tr>
<tr><td>No assessment required.</td><td>No response required.</td></tr>
<tr><td rowspan="3">Department of Climate Change, Energy, the Environment and Water – fisheries</td><td colspan="2">DCCEEW was provided the consultation package via email on 31 August 2021.
DCCEEW was provided additional information via email on 22 November 2021 advising that there had been a change to planned activities as previously consulted, specifically that flowlines would not be subject to additional flushing with chemically treated seawater, based on an assessment of historical flushing records and further engineering studies that have been undertaken.
DCCEEW was provided additional information via email on 8 December 2021 advising that there had been a change to the Operational Area for proposed activities. DCCEEW was provided the updated coordinates and a figure showing the updated Operational Area in relation to Commonwealth and State marine reserves, ports and offshore equipment. For comparison purposes, Santos also provided the initial Operational Area as shown in the information sheet sent previously to DCCEEW.
No formal response has been received from DCCEEW.
Santos has assessed the impact to fish and commercial fisheries in Section 8.
While there has been no recent fishing effort in these fisheries, Santos has also consulted AFMA and representative bodies, given their interest in petroleum activities where licence holders are entitled to fish.
Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.</td></tr>
<tr><td>Assessment of the merits of objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(ii))</td><td>Statement of response, or proposed response, to the objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(iii))</td></tr>
<tr><td>No assessment required.</td><td>No response required.</td></tr>
</table>

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<tr><th>Stakeholder</th><th colspan="2">Stakeholder Consultation Summary (OPGGS(E) Regulation 16 (b)(i))</th></tr>
<tr><td rowspan="3">Department of Climate Change, Energy, the Environment and Water – Biosecurity (vessels, aircraft and personnel)</td><td colspan="2">DCCEEW was provided information via email on 29 November 2021 advising of the activity and an additional activity update, specifically that flowlines would not be subject to additional flushing with chemically treated seawater, based on an assessment of historical flushing records and further engineering studies that have been undertaken.
Management of invasive marine pest species is addressed in Section 9.2.
This stakeholder also receives Santos' Quarterly Consultation Update for WA.
Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.</td></tr>
<tr><td>Assessment of the merits of objections and claims (OPGGS(E) Regulation 16 (b)(ii)), information and requests</td><td>Statement of response, or proposed response, to the objections and claims (OPGGS(E) Regulation 16 (b)(iii)), and information and requests</td></tr>
<tr><td>No assessment required.</td><td>No response required.</td></tr>
<tr><td rowspan="3">Department of Defence</td><td colspan="2">Department of Defence was provided the consultation package via email on 31 August 2021.
Department of Defence was provided additional information via email on 22 November 2021 advising that there had been a change to planned activities as previously consulted, specifically that flowlines would not be subject to additional flushing with chemically treated seawater, based on an assessment of historical flushing records and further engineering studies that have been undertaken.
No formal response has been received from the Department of Defence.
This stakeholder also receives Santos' Quarterly Consultation Update for WA.
Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.</td></tr>
<tr><td>Assessment of the merits of objections and claims (OPGGS(E) Regulation 16 (b)(ii)), information and requests</td><td>Statement of response, or proposed response, to the objections and claims (OPGGS(E) Regulation 16 (b)(iii)), and information and requests</td></tr>
<tr><td>No assessment required.</td><td>No response required.</td></tr>
<tr><td>Director of National Parks</td><td colspan="2">The DNP was provided consultation package via email on 31 August 2021.
DNP responded on 6 October 2021 advising:
• Based on the factsheet provided, DNP noted the planned activities do not overlap any Australian Marine Parks. DNP noted Santos' advice that the operational area is around 99 km, 105 km and 158 km to Montebello, Dampier and Argo-Rowley Terrace marine parks respectively. Therefore, there were no authorisation requirements from the DNP. [INFORMATION 001]</td></tr>
</table>

<table>
<tr><th>Stakeholder</th><th colspan="2">Stakeholder Consultation Summary (OPGGS(E) Regulation 16 (b)(i))</th></tr>
<tr><td rowspan="2"></td><td colspan="2">

- DNP requested that in preparing the EP, Santos should consider the Australian marine parks and their representativeness. In the context of the management plan objectives and values, Santos should ensure the EP: **[REQUEST 001]**
  - identifies and manages all impacts and risks on Australian marine park values (including ecosystem values) to an acceptable level and has considered all options to avoid or reduce them to as low as reasonably practicable
  - clearly demonstrates that the activity will not be inconsistent with the management plan.
- DNP advised the North West Marine Parks Network Management Plan 2018 came into effect on 1 July 2018 and provided further information about values for Montebello, Dampier and Argo-Rowley Terrace marine parks. DNP also advised that Australian marine park values are broadly defined into four categories: natural (including ecosystems), cultural, heritage and socio-economic. Information about the values for the marine parks is also located on the Australian Marine Parks Science Atlas. **[INFORMATION 002]**
- In the case of an emergency response, DNP should be made aware of oil/gas pollution incidences which occur within a marine park or are likely to impact on a marine park as soon as possible. Notification should be provided to the 24-hour Marine Compliance Duty Officer. The notification should include: **[REQUEST 002]**
  - titleholder details
  - time and location of the incident (including name of marine park likely to be affected)
  - proposed response arrangements as per the OPEP (e.g., dispersant, containment, etc)
  - confirmation of providing access to relevant monitoring and evaluation reports when available
  - contact details for the response coordinator.

  Note, DNP may request daily or weekly Situation Reports, depending on the scale and severity of the pollution incident.

Santos responded to DNP on 18 October 2021 and addressed the matters raised in their correspondence of 6 October 2021.

DNP was provided additional information via email on 22 November 2021 advising that there had been a change to planned activities as previously consulted, specifically that flowlines would not be subject to additional flushing with chemically treated seawater, based on an assessment of historical flushing records and further engineering studies that have been undertaken.

Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.
</td></tr>
<tr><th>Assessment of the merits of objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(ii))</th><th>Statement of response, or proposed response, to the objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(iii))</th></tr>
</table>

Stakeholder	Stakeholder Consultation Summary (OPGGS(E) Regulation 16 (b)(i))	
	[INFORMATION 001] Santos notes no authorisations are required from the DNP.	Santos responded to DNP and acknowledged their advice.
	[REQUEST 001] Santos has considered NOPSEMA Guidance Note Petroleum Activities and Australian Marine Parks (N-04750-GN1785 A620236, 03/06/2020). Santos has identified the relevant Australian Marine Parks and their values (**Section 5.2.3**).	Santos responded to DNP and confirmed it has followed the NOPSEMA guidance note in preparation of the EP.
	[INFORMATION 002] Santos has considered information within the Australian Marine Parks North-West Marine Parks Network Management Plan (2018) and Australian Marine Parks Science Atlas. Refer to **Section 5.2.3**.	Santos responded to DNP and acknowledged their advice.
	[REQUEST 003] Santos has addressed DNP emergency notification requirements in **Table 10-7** of the EP and Section 7 of the OPEP.	Santos responded to DNP the OPEP for the activity includes DNPs notification requirements. These can be found in Section 7 of the OPEP.
Department of Industry Science, Energy and Resources	DISER was provided the consultation package via email on 31 August 2021. DISER was provided additional information via email on 22 November 2021 advising that there had been a change to planned activities as previously consulted, specifically that flowlines would not be subject to additional flushing with chemically treated seawater, based on an assessment of historical flushing records and further engineering studies that have been undertaken. DISER was provided additional information via email on 8 December 2021 advising that there had been a change to the Operational Area for proposed activities. DISER was provided the updated coordinates and a figure showing the updated Operational Area in relation to Commonwealth and State marine reserves, ports and offshore equipment. For comparison purposes, Santos also provided the initial Operational Area as shown in the information sheet sent previously to DISER. No formal response has been received from DISER. Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.	
	Assessment of the merits of objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(ii))	**Statement of response, or proposed response, to the objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(iii))**
	No assessment required.	No response required.

<table>
<tr><th>Stakeholder</th><th colspan="2">Stakeholder Consultation Summary (OPGGS(E) Regulation 16 (b)(i))</th></tr>
<tr><th colspan="3">State departments/agencies</th></tr>
<tr><td rowspan="3">Department of Biodiversity and Conservation Attractions</td><td colspan="2">DBCA was provided the consultation package via email on 31 August 2021.
DBCA responded on 7 September 2021 advising DBCA advised it had no comments in relation to the Department’s Conservation and Land Management Act 1984 and Biodiversity Conservation Act 2016 related responsibilities.
Santos responded on 18 October 2021, acknowledging DBCA did not have any comments on the proposed activity.
DBCA was provided additional information via email on 22 November 2021 advising that there had been a change to planned activities as previously consulted, specifically that flowlines would not be subject to additional flushing with chemically treated seawater, based on an assessment of historical flushing records and further engineering studies that have been undertaken.
This stakeholder also receives Santos’ Quarterly Consultation Update for WA.
Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.</td></tr>
<tr><th>Assessment of the merits of objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(ii))</th><th>Statement of response, or proposed response, to the objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(iii))</th></tr>
<tr><td>No assessment required.</td><td>No response required.</td></tr>
<tr><td>WA Department of Mines, Industry Regulation and Safety</td><td colspan="2">DMIRS was provided the consultation package via email on 31 August 2021.
No formal response has been received from DMIRS.
This stakeholder also receives Santos’ Quarterly Consultation Update for WA.
DMIRS was provided additional information via email on 22 November 2021 advising that there had been a change to planned activities as previously consulted, specifically that flowlines would not be subject to additional flushing with chemically treated seawater, based on an assessment of historical flushing records and further engineering studies that have been undertaken.
DMIRS was provided additional information via email on 8 December 2021 advising that there had been a change to the Operational Area for proposed activities. DMIRS was provided the updated coordinates and a figure showing the updated Operational Area in relation to Commonwealth and State marine reserves, ports and offshore equipment. For comparison purposes, Santos also provided the initial Operational Area as shown in the information sheet sent previously to DMIRS.
Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.</td></tr>
</table>

<table>
<tr><th>Stakeholder</th><th colspan="2">Stakeholder Consultation Summary (OPGGS(E) Regulation 16 (b)(i))</th></tr>
<tr><td rowspan="2"></td><td>Assessment of the merits of objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(ii))</td><td>Statement of response, or proposed response, to the objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(iii))</td></tr>
<tr><td>No assessment required.</td><td>No response required.</td></tr>
<tr><td rowspan="3">WA Department of Primary Industries & Regional Development</td><td colspan="2">DPIRD was provided the consultation package via email on 31 August 2021.
No formal response has been received from DPIRD.
Santos has assessed the impact to fish and commercial fisheries in Section 8.
DPIRD was provided additional information via email on 22 November 2021 advising that there had been a change to planned activities as previously consulted, specifically that flowlines would not be subject to additional flushing with chemically treated seawater, based on an assessment of historical flushing records and further engineering studies that have been undertaken.
DPIRD was provided additional information via email on 8 December 2021 advising that there had been a change to the Operational Area for proposed activities. DPIRD was provided the updated coordinates and a figure showing the updated Operational Area in relation to Commonwealth and State marine reserves, ports and offshore equipment. For comparison purposes, Santos also provided the initial Operational Area as shown in the information sheet sent previously to DPIRD.
DPIRD was also provided an update on Santos' decision to consult additional commercial fishery licence holders and their representative organisation, WAFIC, following a further assessment of DPIRD FishCube data in planning for the EP.
This stakeholder also receives Santos' Quarterly Consultation Update for WA.
Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.</td></tr>
<tr><td>Assessment of the merits of objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(ii))</td><td>Statement of response, or proposed response, to the objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(iii))</td></tr>
<tr><td>No assessment required.</td><td>No response required.</td></tr>
<tr><td>WA Department of Transport</td><td colspan="2">DoT was provided the consultation package via email on 31 August 2021.
DoT responded on 13 September 2021 advising:
• if there is a risk of a spill impacting State waters from the activity, please ensure the Department of Transport is consulted as outlined in the Department of Transport Offshore Petroleum Industry Guidance Note – Marine Oil Pollution: Response and Consultation Arrangements (July 2020). [REQUEST 001]</td></tr>
</table>

Stakeholder	Stakeholder Consultation Summary (OPGGS(E) Regulation 16 (b)(i))
	Santos responded to DoT on 18 October 2021 noting its consultation expectations and that a copy of the OPEP would be provided upon submission of the EP to NOPSEMA. DoT was provided additional information via email on 22 November 2021 advising that there had been a change to planned activities as previously consulted, specifically that flowlines would not be subject to additional flushing with chemically treated seawater, based on an assessment of historical flushing records and further engineering studies that have been undertaken. DoT was provided additional information via email on 8 December 2021 advising that there had been a change to the Operational Area for proposed activities. DoT was provided the updated coordinates and a figure showing the updated Operational Area in relation to Commonwealth and State marine reserves, ports and offshore equipment. For comparison purposes, Santos also provided the initial Operational Area as shown in the information sheet sent previously to DoT. Santos emailed DoT on 30 November 2021 seeking feedback DoTs expectation for OPEP review. DoT responded by email on 3 December 2021 confirming that it required for review the version of the OPEP sent to NOPSEMA. Santos provided a copy of the OPEP to DoT on 15 December 2021.DoT responded by email on 17 December 2021 advising it would review the OPEP and respond with comments. Santos emailed DoT on 24 January 2022, seeking comments/feedback from DoT noting that Santos had not heard from DoT since December 2021. DoT responded by email on 25 January 2022 and provided the following comments on the OPEP: • DoT advised that Santos had not provided information to DoT in with its guidance note and requested future submissions are aligned to DoT's expectations. **[INFORMATION 001]** • DoT sought clarification on worst-case loss of well control scenarios. **[REQUEST 001]** • DoT sought further information on whether the differences in viscosity and pour points may change the initial weathering of Mutineer Exeter crude (MEC) and the analogue oil type used for modelling (Vale). **[REQUEST 002]** • DoT sought further information on changes to the properties of Vale following initial weathering and how these may be applied to determine the fate of MEC. **[REQUEST 003]** • DoT requested that Santos amend its OPEP to clarify that DoT was the control agency for Level 1 vessel spills in State waters, not Level 2/3 spills as noted in the OPEP sent to DoT for review. **[REQUEST 004]** Santos emailed DoT on 3 February 2022 and 7 February 2022, addressing the matters raised in its feedback of 25 January 2022. DoT called Santos on 7 February 2022 to acknowledge receipt of the OPEP and emailed Santos on 14 February 2022 with some comments. One required clarification which was closed out and DoT confirmed they had no further comments, via email on 15 February 2022. There are no outstanding matters in relation to DoT.

<table>
<tr><th>Stakeholder</th><th colspan="2">Stakeholder Consultation Summary (OPGGS(E) Regulation 16 (b)(i))</th></tr>
<tr><td rowspan="8"></td><td colspan="2">This stakeholder also receives Santos’ Quarterly Consultation Update for WA.
Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.</td></tr>
<tr><th>Assessment of the merits of objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(ii))</th><th>Statement of response, or proposed response, to the objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(iii))</th></tr>
<tr><td>[REQUEST 001] Santos will ensure consultation with the DoT as outlined in the Department of Transport Offshore Petroleum Industry Guidance Note – Marine Oil Pollution: Response and Consultation Arrangements (July 2020).</td><td>Santos responded to DoT and acknowledged the request.
Santos provided a copy of the OPEP to DoT on 15 December 2021.</td></tr>
<tr><td>[INFORMATION 001] Santos notes DoT’s feedback.</td><td>Santos responded to DoT and acknowledged its advice.</td></tr>
<tr><td>[REQUEST 001] Santos notes DoT’s feedback.</td><td>Santos responded to DoT and provided additional information on worst-case loss of well control scenarios.</td></tr>
<tr><td>[REQUEST 002] Santos notes DoT’s feedback.</td><td>Santos responded to DoT and provided additional information on differences in viscosity and pour point for actual crude and analogue used for stochastic modelling.</td></tr>
<tr><td>[REQUEST 003] Santos notes DoT’s feedback.</td><td>Santos responded to DoT and provided additional information on differences in weathering for actual crude and analogue used for stochastic modelling.</td></tr>
<tr><td>[REQUEST 004] Santos notes DoT’s feedback.</td><td>Santos responded to DoT and acknowledged its OPEP had been updated based on DoT’s advice.</td></tr>
<tr><th colspan="3">Industry Bodies</th></tr>
<tr><td>Australian Petroleum Production & Exploration Association</td><td colspan="2">APPEA was provided the consultation package via email on 31 August 2021.
No formal response has been received from APPEA.
Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.</td></tr>
</table>

Stakeholder	Stakeholder Consultation Summary (OPGGS(E) Regulation 16 (b)(i))	
	Assessment of the merits of objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(ii))	**Statement of response, or proposed response, to the objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(iii))**
	No assessment required.	No response required.
Australian Southern Bluefin Tuna Industry Association	ASBTIA was provided the consultation package via email on 31 August 2021. ASBTIA was provided additional information via email on 22 November 2021 advising that there had been a change to planned activities as previously consulted, specifically that flowlines would not be subject to additional flushing with chemically treated seawater, based on an assessment of historical flushing records and further engineering studies that have been undertaken. ASBTIA was provided additional information via email on 8 December 2021 advising that there had been a change to the Operational Area for proposed activities. ASBTIA was provided the updated coordinates and a figure showing the updated Operational Area in relation to Commonwealth and State marine reserves, ports and offshore equipment. For comparison purposes, Santos also provided the initial Operational Area as shown in the information sheet sent previously to ASBTIA. No formal response has been received from ASBTIA. This stakeholder also receives Santos' Quarterly Consultation Update for WA. All listed fisheries are described in **Section 5.2.5**, and potential impact to fisheries, fish habitat and commercial fishers are discussed in **Section 8**. Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.	
	Assessment of the merits of objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(ii))	**Statement of response, or proposed response, to the objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(iii))**
	No assessment required.	No response required.
Commonwealth Fisheries Association	CFA was provided the consultation package via email on 31 August 2021. CFA was provided additional information via email on 22 November 2021 advising that there had been a change to planned activities as previously consulted, specifically that flowlines would not be subject to additional flushing with chemically treated seawater, based on an assessment of historical flushing records and further engineering studies that have been undertaken. CFA was provided additional information via email on 8 December 2021 advising that there had been a change to the Operational Area for proposed activities. CFA was provided the updated coordinates and a figure showing the updated Operational Area in	

<table>
<tr><th>Stakeholder</th><th colspan="2">Stakeholder Consultation Summary (OPGGS(E) Regulation 16 (b)(i))</th></tr>
<tr><td rowspan="3"></td><td colspan="2">relation to Commonwealth and State marine reserves, ports and offshore equipment. For comparison purposes, Santos also provided the initial Operational Area as shown in the information sheet sent previously to CFA.
No formal response has been received from CFA.
This stakeholder also receives Santos' Quarterly Consultation Update for WA.
All listed fisheries are described in Section 5.2.5, and potential impact to fisheries, fish habitat and commercial fishers are discussed in Section 8.
Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.</td></tr>
<tr><th>Assessment of the merits of objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(ii))</th><th>Statement of response, or proposed response, to the objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(iii))</th></tr>
<tr><td>No assessment required.</td><td>No response required.</td></tr>
<tr><td>Marine Tourism WA</td><td colspan="2">MTWA was provided the consultation package via email on 22 October 2021 following a phone call to understand the potential for charter boat activity in the region.
MTWA was provided additional information via email on 22 November 2021 advising that there had been a change to planned activities as previously consulted, specifically that flowlines would not be subject to additional flushing with chemically treated seawater, based on an assessment of historical flushing records and further engineering studies that have been undertaken.
MTWA was provided additional information via email on 8 December 2021 advising that there had been a change to the Operational Area for proposed activities. MTWA was provided the updated coordinates and a figure showing the updated Operational Area in relation to Commonwealth and State marine reserves, ports and offshore equipment. For comparison purposes, Santos also provided the initial Operational Area as shown in the information sheet sent previously to MTWA.
No formal response has been received from MTWA.
This stakeholder also receives Santos' Quarterly Consultation Update for WA.
All listed fisheries are described in Section 5.2.5, and potential impact to fisheries, fish habitat and commercial fishers are discussed in Section 8.
Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.</td></tr>
</table>

<table>
<tr><th>Stakeholder</th><th colspan="2">Stakeholder Consultation Summary (OPGGS(E) Regulation 16 (b)(i))</th></tr>
<tr><td rowspan="2"></td><td>Assessment of the merits of objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(ii))</td><td>Statement of response, or proposed response, to the objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(iii))</td></tr>
<tr><td>No assessment required.</td><td>No response required.</td></tr>
<tr><td rowspan="3">Pearl Producers Association</td><td colspan="2">PPA was provided the consultation package via email on 31 August 2021.
PPA was provided additional information via email on 22 November 2021 advising that there had been a change to planned activities as previously consulted, specifically that flowlines would not be subject to additional flushing with chemically treated seawater, based on an assessment of historical flushing records and further engineering studies that have been undertaken.
No formal response has been received from PPA.
This stakeholder also receives Santos’ Quarterly Consultation Update for WA.
All listed fisheries are described in Section 5.2.5, and potential impact to fisheries, fish habitat and commercial fishers are discussed in Section 8.
Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.</td></tr>
<tr><td>Assessment of the merits of objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(ii))</td><td>Statement of response, or proposed response, to the objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(iii))</td></tr>
<tr><td>No assessment required.</td><td>No response required.</td></tr>
<tr><td>Recfishwest</td><td colspan="2">Recfishwest was provided the consultation package via email on 31 August 2021.
Recfishwest was provided additional information via email on 22 November 2021 advising that there had been a change to planned activities as previously consulted, specifically that flowlines would not be subject to additional flushing with chemically treated seawater, based on an assessment of historical flushing records and further engineering studies that have been undertaken.
Recfishwest was provided additional information via email on 8 December 2021 advising that there had been a change to the Operational Area for proposed activities. Recfishwest was provided the updated coordinates and a figure showing the updated Operational Area in relation to Commonwealth and State marine reserves, ports and offshore equipment. For comparison purposes, Santos also provided the initial Operational Area as shown in the information sheet sent previously to Recfishwest.
No formal response has been received from Recfishwest.
This stakeholder also receives Santos’ Quarterly Consultation Update for WA.</td></tr>
</table>

Stakeholder	Stakeholder Consultation Summary (OPGGS(E) Regulation 16 (b)(i))	
	All listed fisheries are described in **Section 5.2.5**, and potential impact to fisheries, fish habitat and commercial fishers are discussed in **Section 8**. Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.	
	Assessment of the merits of objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(ii))	**Statement of response, or proposed response, to the objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(iii))**
	No assessment required.	No response required.
Tuna Australia	Tuna Australia was provided the consultation package via email on 1 September 2021. Tuna Australia was provided additional information via email on 22 November 2021 advising that there had been a change to planned activities as previously consulted, specifically that flowlines would not be subject to additional flushing with chemically treated seawater, based on an assessment of historical flushing records and further engineering studies that have been undertaken. Tuna Australia was provided additional information via email on 8 December 2021 advising that there had been a change to the Operational Area for proposed activities. Tuna Australia was provided the updated coordinates and a figure showing the updated Operational Area in relation to Commonwealth and State marine reserves, ports and offshore equipment. For comparison purposes, Santos also provided the initial Operational Area as shown in the information sheet sent previously to Tuna Australia. No formal response has been received from Tuna Australia. This stakeholder also receives Santos' Quarterly Consultation Update for WA. All listed fisheries are described in **Section 5.2.5**, and potential impact to fisheries, fish habitat and commercial fishers are discussed in **Section 8**. Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.	
	Assessment of the merits of objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(ii))	**Statement of response, or proposed response, to the objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(iii))**
	No assessment required.	No response required.
	WAFIC was provided the consultation package via email on 31 August 2021.	

<table>
<tr><th>Stakeholder</th><th colspan="2">Stakeholder Consultation Summary (OPGGS(E) Regulation 16 (b)(i))</th></tr>
<tr><td rowspan="3">Western Australian Fishing Industry Council</td><td colspan="2">WAFIC responded on 10 September 2021 requesting clarity on timing clarity regarding timing (duration of temporary storage) [REQUEST 001] and the associated risks to the marine environment and commercial fishing [REQUEST 002] of Santos’ proposal to temporarily store some equipment on the sea floor prior to retrieval during full field decommissioning.

WAFIC sent a follow up email on 6 October 2021 seeking an update. Santos responded on 18 October 2021 advising:

[REQUEST 001] The equipment planned for temporary storage was connected to the DTM and MWAs. Santos advised it proposed to disconnect the equipment when the DTM and MWAs are removed and will be temporarily stored/wet parked until full field decommissioning, which is planned to commence in Q3/Q4 2024. Santos advised these decommissioning activities would be subject to either a separate EP or a further revision to the Cessation of Production EP.

[REQUEST 002] Santos did not envisage any additional risk or impact to the marine environment or commercial fishing as the equipment is currently in the water column and will be laid on the seabed and stabilised after disconnection from the DTM and MWAs. The production risers will be capped before being placed on the seabed. Additionally, all equipment currently related to the MEFF field was marked on nautical maps, which also show cautionary zones around the area.

WAFIC responded on 26 October 2021 thanking Santos for the clarification and advised at the time of response it had no additional comments relating the Revision of Mutineer-Exeter Cessation of Operations Environment Plan.

WAFIC was provided additional information via email on 22 November 2021 advising there had been a change to planned activities as previously consulted, specifically that flowlines would not be subject to additional flushing with chemically treated seawater, based on an assessment of historical flushing records and further engineering studies that have been undertaken.

WAFIC was provided additional information via email on 8 December 2021 advising that there had been a change to the Operational Area for proposed activities. WAFIC was provided the updated coordinates and a figure showing the updated Operational Area in relation to Commonwealth and State marine reserves, ports and offshore equipment. For comparison purposes, Santos also provided the initial Operational Area as shown in the information sheet sent previously to WAFIC.

WAFIC was also provided an update on Santos’ decision to consult additional commercial fishery licence holders and the relevant WA Government department, DPIRD, following a further assessment of DPIRD FishCube data in planning for the EP.

Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.</td></tr>
<tr><th>Assessment of the merits of objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(ii))</th><th>Statement of response, or proposed response, to the objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(iii))</th></tr>
<tr><td>[REQUEST 001] Santos has considered WAFIC’s request for information timing (duration of temporary storage) for equipment</td><td>Santos responded to WAFIC and acknowledged the request.</td></tr>
</table>

Stakeholder	Stakeholder Consultation Summary (OPGGS(E) Regulation 16 (b)(i))	
	that Santos plans to temporarily store on the sea floor prior to full field decommissioning.	
	[REQUEST 002] Santos has considered WAFIC's request for information about associated risks to the marine environment and commercial fish from equipment that Santos plans to temporarily store on the sea floor prior to full field decommissioning.	Santos responded to WAFIC and acknowledged the request.
Commercial fisheries – State Managed		
Mackerel Managed Fishery (Area 2)	Licence holders in the Mackerel Managed Fishery were provided the consultation package via letter on 22 November 2021, following further assessment of DPIRD FishCube data in planning for the EP that licence holders may be impacted. Licence holders were advised that DPIRD and WAFIC were being provided an update based on this assessment. Licence holders were also advised in the same letter that there had been a change to planned activities, specifically that flowlines would not be subject to additional flushing with chemically treated seawater, based on an assessment of historical flushing records and further engineering studies that have been undertaken. Licence holders were provided additional information via letter on 16 December 2021 advising that there had been a change to the Operational Area for proposed activities. Licence holders provided the updated coordinates and a figure showing the updated Operational Area in relation to Commonwealth and State marine reserves, ports and offshore equipment. For comparison purposes, Santos also provided the initial Operational Area as shown in the information sheet sent previously to the licence holders. No formal responses have been received from licence holders. All listed fisheries are described in **Section 5.2.5**, and potential impact to fisheries, fish habitat and commercial fishers are discussed in **Section 8**. Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.	
	Assessment of the merits of objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(ii))	**Statement of response, or proposed response, to the objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(iii))**
	No assessment required.	No response required.
Pilbara Trawl Interim Managed Fishery	Licence holders in the Pilbara Trawl Interim Managed Fishery were provided the consultation package via letter on 31 August 2021, as well as a map showing the location of the operational area relevant to the fishery.	

<table>
<tr><th>Stakeholder</th><th colspan="2">Stakeholder Consultation Summary (OPGGS(E) Regulation 16 (b)(i))</th></tr>
<tr><td rowspan="3"></td><td colspan="2">Licence holders in the Pilbara Trawl Interim Managed Fishery were provided additional information via letter on 22 November 2021 advising that there had been a change to planned activities as previously consulted, specifically that flowlines would not be subject to additional flushing with chemically treated seawater, based on an assessment of historical flushing records and further engineering studies that have been undertaken.
Licence holders were provided additional information via letter on 10 December 2021 advising that there had been a change to the Operational Area for proposed activities. Licence holders provided the updated coordinates and a figure showing the updated Operational Area in relation to Commonwealth and State marine reserves, ports and offshore equipment. For comparison purposes, Santos also provided the initial Operational Area as shown in the information sheet sent previously to the licence holders.
No formal responses have been received from licence holders.
All listed fisheries are described in Section 5.2.5, and potential impact to fisheries, fish habitat and commercial fishers are discussed in Section 8.
Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.</td></tr>
<tr><td>Assessment of the merits of objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(ii))</td><td>Statement of response, or proposed response, to the objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(iii))</td></tr>
<tr><td>No assessment required.</td><td>No response required.</td></tr>
<tr><td colspan="3">Other industry</td></tr>
<tr><td>Finder Energy</td><td colspan="2">Equinor was provided the consultation package via email on 31 August 2021.
Equinor responded on 1 September 2021 advising it had transferred the WA-542-P permit to Finder Energy and was no longer a stakeholder in the area.
Santos provided the consultation package to Finder Energy via email on 4 September 2021.
Finder Energy was provided additional information via email on 22 November 2021 advising that there had been a change to planned activities as previously consulted, specifically that flowlines would not be subject to additional flushing with chemically treated seawater, based on an assessment of historical flushing records and further engineering studies that have been undertaken.
No formal response has been received from Finder Energy.
Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.</td></tr>
</table>

Stakeholder	Stakeholder Consultation Summary (OPGGS(E) Regulation 16 (b)(i))	
	Assessment of the merits of objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(ii))	**Statement of response, or proposed response, to the objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(iii))**
	No assessment required.	No response required.
Woodside	Woodside was provided the consultation package via email on 31 August 2021. No formal response has been received from Woodside. Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.	
	Assessment of the merits of objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(ii))	**Statement of response, or proposed response, to the objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(iii))**
	No assessment required.	No response required.
Other stakeholders		
Australian Marine Oil Spill Centre	AMOSC was provided the consultation package via email on 31 August 2021. AMOSC was provided additional information via email on 22 November 2021 advising that there had been a change to planned activities as previously consulted, specifically that flowlines would not be subject to additional flushing with chemically treated seawater, based on an assessment of historical flushing records and further engineering studies that have been undertaken. AMOSC was provided additional information via email on 8 December 2021 advising that there had been a change to the Operational Area for proposed activities. AMOSC was provided the updated coordinates and a figure showing the updated Operational Area in relation to Commonwealth and State marine reserves, ports and offshore equipment. For comparison purposes, Santos also provided the initial Operational Area as shown in the information sheet sent previously to AMOSC. No formal response has been received from AMOSC. This stakeholder also receives Santos' Quarterly Consultation Update for WA. Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.	
	Assessment of the merits of objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(ii))	**Statement of response, or proposed response, to the objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(iii))**

Stakeholder	Stakeholder Consultation Summary (OPGGS(E) Regulation 16 (b)(i))	
	No assessment required.	No response required.

Table 6-4: Consultation summary for decommissioning

<table>
<tr><th>Stakeholder</th><th colspan="2">Stakeholder Consultation Summary (OPGGS(E) Regulation 16 (b)(i))</th></tr>
<tr><th colspan="3">Commonwealth departments/agencies</th></tr>
<tr><td rowspan="3">Australian Border Force (ABF) - Maritime Border Command</td><td colspan="2">ABF was provided the consultation package via email on 1 June 2022.
No formal response has been received from ABF.
This stakeholder also receives Santos’ Quarterly Consultation Update for WA.
Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.</td></tr>
<tr><th>Assessment of the merits of objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(ii))</th><th>Statement of response, or proposed response, to the objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(iii))</th></tr>
<tr><td>No assessment required.</td><td>No response required.</td></tr>
<tr><td>Australian Fisheries Management Authority (AFMA)</td><td colspan="2">AFMA was provided the consultation package via email on 1 June 2022.
AFMA responded on 6 July 2022 and provided the following feedback:
+ AFMA had no specific comment on proposed activities. [INFORMATION 001]
+ AFMA said it was important to consult operators with an entitlement to fish in the area, which could be done through relevant fishing associations or directly with operators. [REQUEST 001]
+ AFMA provided advice on how to identify relevant fishing associations. [INFORMATION 002]
+ AFMA provided advice on how to obtain individual licence holder contact details. [INFORMATION 003]
Santos responded to AFMA on 7 July 2022 and addressed the matters raised in its feedback of 6 July 2022 (refer assessment of stakeholder objections and claims below).
This stakeholder also receives Santos’ Quarterly Consultation Update for WA.
This stakeholder is listed as a recipient of Santos’ Quarterly Consultation Update for WA.</td></tr>
</table>

Stakeholder	Stakeholder Consultation Summary (OPGGS(E) Regulation 16 (b)(i))	
	Assessment of the merits of objections and claims (OPGGS(E) Regulation 16 (b)(ii)), information and requests	**Statement of response, or proposed response, to the objections and claims (OPGGS(E) Regulation 16 (b)(iii)), and information and requests**
	[INFORMATION 001] Santos notes that AFMA has no specific comment about proposed activities.	Santos responded to AFMA and acknowledged its advice.
	[REQUEST 001] Santos confirmed that there had been no historic effort by fishers in overlapping Commonwealth fisheries and that relevant fishing representative organisations had been provided the consultation package.	Santos responded to AFMA and acknowledged its request.
	[INFORMATION 002] Santos notes AFMA's advice on how to identify relevant fishing associations.	Santos responded to AFMA and acknowledged its advice.
	[INFORMATION 003] Santos notes AFMA's advice on how to obtain individual licence holder contact details.	Santos responded to AFMA and acknowledged its advice.
Australian Hydrographic Office (AHO)	AHO was provided the consultation package via email on 1 June 2022. AHO responded on 2 June 2022 via an auto generated email confirming that Santos' information had been received and logged for processing. AHO notification requirements, as requested by AMSA (maritime safety) (refer this table), are addressed **Table 10-7**. This stakeholder also receives Santos' Quarterly Consultation Update for WA. Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future	
	Assessment of the merits of objections and claims (OPGGS(E) Regulation 16 (b)(ii)), information and requests	**Statement of response, or proposed response, to the objections and claims (OPGGS(E) Regulation 16 (b)(iii)), and information and requests**
	No assessment required.	No response required.
Australian Maritime Safety Authority (AMSA) – maritime safety	AMSA was provided the consultation package via email 1 June 2022. AMSA responded by email on 7 June 2022 requesting timely and relevant Maritime Safety Information is promulgated for the area and nature of operations as follows: + Contact the AHO at datacentre@hydro.gov.au no less than four weeks before operations, with details relevant to the operations.	

Stakeholder	Stakeholder Consultation Summary (OPGGS(E) Regulation 16 (b)(i))	
	The AHO will promulgate the appropriate Notice to Mariners, which will ensure other vessels receive information on activities. **[REQUEST 001]** + Notify AMSA's Joint Rescue Coordination Centre (JRCC) by email rccaus@amsa.gov.au for promulgation of radio-navigation warnings at least 24-48 hours before operations commence. The JRCC will require vessel details (including name, callsign and Maritime Mobile Service Identity (MMSI)), satellite communications details (including INMARSAT-C and satellite telephone numbers), area of operation, requested clearance from other vessels and any other information that may contribute to safety at sea. JRCC will also need to be advised when operations start and end. **[REQUEST 002]** + Provide updates to both the Australian Hydrographic Office and the JRCC on progress and, importantly, any changes to the intended operations. **[REQUEST 003]** + Exhibit appropriate lights and shapes to reflect the nature of operations –we remind vessels of their obligation to comply with the International Rules for Preventing Collisions at Sea (COLREGs), in particular, the use of appropriate lights and shapes to reflect the nature of your operations (e.g., restricted in the ability to manoeuvre). Vessels should also ensure their navigation status is set correctly in the ship's Automatic Identification System (AIS) unit. **[REQUEST 004]** + To obtain a vessel traffic plot showing AIS traffic data for your area of interest, please visit AMSA's spatial data gateway and Spatial@AMSA portal to download digital data sets and maps. **[INFORMATION 001]** Santos responded to AMSA on 24 June 2022 and addressed the matters raised in its feedback of 7 June 2022 (refer assessment of stakeholder objections and claims below). This stakeholder also receives Santos' Quarterly Consultation Update for WA. Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.	
	Assessment of the merits of objections and claims (OPGGS(E) Regulation 16 (b)(ii)), information and requests	**Statement of response, or proposed response, to the objections and claims (OPGGS(E) Regulation 16 (b)(iii)), and information and requests**
	[REQUEST 001] Santos will notify the AHO no less than four weeks before operations commence where practicable. Notification requirements are addressed in Table 10-7Table 10-7	Santos responded to AMSA confirming the notifications requirements would be addressed in the EP.
	[REQUEST 002] Santos will notify AMSA's JRCC at least 24–48 hours before operations commence for each activity and advise when operations start and end. Notification requirements are addressed in **Table 10-7.**	Santos responded to AMSA confirming the notifications requirements would be addressed in the EP.

Stakeholder	Stakeholder Consultation Summary (OPGGS(E) Regulation 16 (b)(i))	
	[REQUEST 003] Santos will notify both AHO and AMSA's JRCC on any changes to the intended operations. Notification requirements are addressed in **Table 10-7.**	Santos responded to AMSA confirming the notifications requirements would be addressed in the EP.
	[REQUEST 004] Santos noted the advice on obligations to comply with COLREGs, in particular, the use of appropriate lights and shapes to reflect the nature of operations and this is addressed in **Table 10-2**.	Santos responded to AMSA and noted the information provided.
	[INFORMATION 001] Santos notes the information provided on traffic data.	Santos responded to AMSA and noted the information provided.
Australian Maritime Safety Authority (AMSA) – marine pollution	AMSA (marine pollution) was provided the consultation package via email on 1 June 2022. No formal response has been received from AMSA (marine pollution). Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.	
	Assessment of the merits of objections and claims (OPGGS(E) Regulation 16 (b)(ii)), information and requests	**Statement of response, or proposed response, to the objections and claims (OPGGS(E) Regulation 16 (b)(iii)), and information and requests**
	No assessment required.	No response required.
Department of Climate Change, Energy, the Environment and Water–Biosecurity (DCCEEW) – marine pests	DCCEEW (marine pests) was provided the consultation package via email on 1 June 2022. The consultation package was re-sent on 21June 2022 as it may not have been received due to a mail error. Consultation information was re-sent via email to DAWE on 21 June 2022. No formal response has been received from DAWE (marine pests). This stakeholder also receives Santos' Quarterly Consultation Update for WA. Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.	
	Assessment of the merits of objections and claims (OPGGS(E) Regulation 16 (b)(ii)), information and requests	**Statement of response, or proposed response, to the objections and claims (OPGGS(E) Regulation 16 (b)(iii)), and information and requests**

Stakeholder	Stakeholder Consultation Summary (OPGGS(E) Regulation 16 (b)(i))	
	No assessment required.	No response required.
Department of Climate Change, Energy, the Environment and Water (DCCEEW) – fisheries	DCCEEW (vessels, aircraft and personnel) was provided the consultation package via email on 1 June 2022. No formal response has been received from DAWE (vessels, aircraft and personnel). This stakeholder also receives Santos' Quarterly Consultation Update for WA. Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.	
	Assessment of the merits of objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(ii))	**Statement of response, or proposed response, to the objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(iii))**
	No assessment required.	No response required.
Department of Climate Change, Energy, the Environment and Water – Biosecurity (DCCEEW) – vessels, aircraft and personnel	DCCEEW (fisheries) was provided the consultation package via email on 1 June 2022. No formal response has been received from DCCEEW (fisheries). This stakeholder also receives Santos' Quarterly Consultation Update for WA. Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.	
	Assessment of the merits of objections and claims (OPGGS(E) Regulation 16 (b)(ii)), information and requests	**Statement of response, or proposed response, to the objections and claims (OPGGS(E) Regulation 16 (b)(iii)), and information and requests**
	No assessment required.	No response required.
Department of Industry, Science, Energy and Resources (DISER)	DISER was provided the consultation package via email on 1 June 2022. No formal response has been received from DISER. This stakeholder also receives Santos' Quarterly Consultation Update for WA. Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.	
	Assessment of the merits of objections and claims (OPGGS(E) Regulation 16 (b)(ii)), information and requests	**Statement of response, or proposed response, to the objections and claims (OPGGS(E) Regulation 16 (b)(iii)), and information and requests**

<table>
<tr><th>Stakeholder</th><th colspan="2">Stakeholder Consultation Summary (OPGGS(E) Regulation 16 (b)(i))</th></tr>
<tr><td></td><td>No assessment required.</td><td>No response required.</td></tr>
<tr><td rowspan="4">Director of National Parks (DNP)</td><td colspan="2">DNP was provided the consultation package via email on 1 June 2022.
DNP responded by email on 28 June 2022 and provided the following feedback:
+ No authorisations are required from the DNP. [INFORMATION 001]
+ A Sea Dumping permit may be required for proposed activities. [INFORMATION 002]
+ DNP requested Santos to consider the NOPSEMA Guidance Note Petroleum Activities and Australian Marine Parks (N-04750-GN1785 A620236, 03/06/2020) in preparing the Environment Plan. [REQUEST 001]
+ DNP requested Santos to consider the North-West Marine Parks Network Management Plan (2018) and Australian Marine Parks Science Atlas in preparing the Environment Plan. [REQUEST 002]
+ DNP requested to be notified if a marine pollution event occurred within a marine park nor was likely to impact on a marine park. DNP provided contact details for marine pollution notification. [REQUEST 003]
Santos responded to DNP on 5 July 2022 and addressed the matters raised in its feedback of 28 June 2022 (refer assessment of stakeholder objections and claims below).
This stakeholder also receives Santos' Quarterly Consultation Update for WA.
Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.</td></tr>
<tr><td>Assessment of the merits of objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(ii))</td><td>Statement of response, or proposed response, to the objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(iii))</td></tr>
<tr><td>[INFORMATION 001] Santos notes no authorisations are required from the DNP.</td><td>Santos responded to DNP and acknowledged its advice.</td></tr>
<tr><td>[INFORMATION 002] Santos notes DNP's advice on Sea Dumping permissions and confirmed it had been in contact with DAWE (Sea Dumping branch) as part of planning activities for the decommissioning of the MEFF Field. Santos confirmed it would continue to consult with DAWE (Sea Dumping branch) on the matter of sea dumping permits as they may be relevant to the MEFF Field future decommissioning, such that the application of the Environmental Protection (Sea Dumping) Act 1981 is met.</td><td>Santos responded to DNP and acknowledged its advice.</td></tr>
</table>

Stakeholder	Stakeholder Consultation Summary (OPGGS(E) Regulation 16 (b)(i))	
	[REQUEST 001] Santos has considered NOPSEMA Guidance Note Petroleum Activities and Australian Marine Parks (N-04750-GN1785 A620236, 03/06/2020). Santos has identified the relevant Australian Marine Parks and their values (**Section 5.2.3.1**).	Santos responded to DNP and confirmed it has followed the NOPSEMA guidance note in preparation of the EP.
	[INFORMATION 002] Santos has considered information within the Australian Marine Parks North-West Marine Parks Network Management Plan (2018) and Australian Marine Parks Science Atlas. Refer to **Section 5.2.3.1**.	Santos responded to DNP and acknowledged its advice.
	[REQUEST 003] Santos has addressed DNP emergency notification requirements in **Table 10-7** of the EP and Section 7 of the OPEP.	Santos responded to DNP the OPEP for the activity includes DNPs notification requirements. These can be found in Section 7 of the OPEP.
WA Government departments/agencies		
Department of Biodiversity and Conservation Attractions (DBCA)	DBCA was provided the consultation package via email on 1 June 2022. DBCA responded by email on 7 June 2022 and confirmed it had no comment on proposed activities in relation to its responsibilities under the *Conservation and Land Management Act 1984* and *Biodiversity Conservation Act 2016*, based on Santos consultation information and other readily available information. Santos responded by email on 7 June 2022 and acknowledged its advice. This stakeholder also receives Santos' Quarterly Consultation Update for WA. Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.	
	Assessment of the merits of objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(ii))	**Statement of response, or proposed response, to the objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(iii))**
	No assessment required.	No response required.
WA Department of Mines, Industry	DMIRS was provided the consultation package via email on 1 June 2022. No formal response has been received from DMIRS.	

<table>
<tr><th>Stakeholder</th><th colspan="2">Stakeholder Consultation Summary (OPGGS(E) Regulation 16 (b)(i))</th></tr>
<tr><td rowspan="3">Regulation and Safety (DMIRS)</td><td colspan="2">Santos notes previous advice from DMIRS for pre-start and cessation of activity notifications. This commitment is included in Table 8-4.
This stakeholder also receives Santos’ Quarterly Consultation Update for WA.
Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.</td></tr>
<tr><th>Assessment of the merits of objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(ii))</th><th>Statement of response, or proposed response, to the objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(iii))</th></tr>
<tr><td>No assessment required.</td><td>No response required.</td></tr>
<tr><td rowspan="3">Department of Primary Industries & Regional Development (DPIRD)</td><td colspan="2">DPIRD was provided the consultation package via email on 1 June 2022.
No formal response has been received from DPIRD.
This stakeholder also receives Santos’ Quarterly Consultation Update for WA.
Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.</td></tr>
<tr><th>Assessment of the merits of objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(ii))</th><th>Statement of response, or proposed response, to the objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(iii))</th></tr>
<tr><td>No assessment required.</td><td>No response required.</td></tr>
<tr><td>Department of Transport (DoT)</td><td colspan="2">DoT was provided the consultation package via email on 1 June 2022.
DoT responded by email on 14 June 2022 requesting that it be consulted in accordance with the Department’s Offshore Petroleum Industry Guidance Note – Marine Oil Pollution: Response and Consultation Arrangements (July 2020) if there is any risk of a spill impacting State waters from proposed activities. [REQUEST 001]
Santos responded by email on 23 June 2022 and provided a final draft of the OPEP for feedback. Santos advised that the oil spill risks for decommissioning were the same as the Mutineer, Exeter, Fletcher, Finucane Cessation of Production OPEP previously reviewed by DoT, with the exception of the Oiled Wildlife Response (OWR) section and related content which had been updated to reflect the recently released WA OWR Plan by DBCA.
DoT responded by email on 13 July 2022 advising it would review and respond to Santos if it had any queries.
This stakeholder also receives Santos’ Quarterly Consultation Update for WA.</td></tr>
</table>

Stakeholder	Stakeholder Consultation Summary (OPGGS(E) Regulation 16 (b)(i))	
	Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.	
	Assessment of the merits of objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(ii))	**Statement of response, or proposed response, to the objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(iii))**
	[REQUEST 001] Santos has provided a copy of the OPEP for proposed activities.	DoT responded by email on 13 July 2022 advising it would review and respond to Santos if it had any queries.
Industry Bodies		
Australian Petroleum Production & Exploration Association (APPEA)	APPEA was provided the consultation package via email on 1 June 2021. No formal response has been received from APPEA. Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.	
	Assessment of the merits of objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(ii))	**Statement of response, or proposed response, to the objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(iii))**
	No assessment required.	No response required.
Australian Southern Bluefin Tuna Industry Association (ASBTIA)	ASBTIA was provided the consultation package via email on 1 June 2022. No formal response has been received from ASBTIA. This stakeholder also receives Santos' Quarterly Consultation Update for WA. Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.	
	Assessment of the merits of objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(ii))	**Statement of response, or proposed response, to the objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(iii))**
	No assessment required.	No response required.
	CFA was provided the consultation package via email on 1 June 2022.	

<table>
<tr><th>Stakeholder</th><th colspan="2">Stakeholder Consultation Summary (OPGGS(E) Regulation 16 (b)(i))</th></tr>
<tr><td rowspan="4">Commonwealth Fisheries Association (CFA)</td><td colspan="2">CFA responded by email on 2 June 2022 and provided the following response:
+ CFA advised that it did not have the resources to respond on behalf of members. [INFORMATION 001]
+ CFA requested Santos liaise directly with identified affected fisheries. [REQUEST 001]
Santos responded by email on 2 June 2022 requesting a meeting to discuss CFA’s feedback and guidance on fishery engagement.
Santos met by phone with CFA on 3 June 2022 to discuss engagement with CFA and fishers in Commonwealth-managed fisheries.
Santos responded to CFA on 5 July 2022 and addressed the matters raised in its feedback of 2 June 2022 and meeting of 3 June 2022 (refer assessment of stakeholder objections and claims below).
This stakeholder also receives Santos’ Quarterly Consultation Update for WA.
Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.</td></tr>
<tr><th>Assessment of the merits of objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(ii))</th><th>Statement of response, or proposed response, to the objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(iii))</th></tr>
<tr><td>[INFORMATION 001] Santos acknowledged CFA’s advice that it did not have sufficient resources to engage member companies.</td><td>Santos responded to CFA and acknowledged its advice.</td></tr>
<tr><td>[REQUEST 001] Santos confirmed that individual licence holders had not been consulted as proposed activities were not expected to impact fishers given the MEFF location and historical effort by fishers. Santos also confirmed that it had provided the consultation packed to representative organisations for information and did not expect CFA to engage member companies where no impacts to fishers were expected.</td><td>Santos responded to CFA’s request and provided greater clarity on expected impacts to fishers and fishery consultation.</td></tr>
<tr><td>Marine Tourism WA (MTWA)</td><td colspan="2">MTWA was provided the consultation package via email on 1 June 2022.
No formal response has been received from MTWA.
This stakeholder also receives Santos’ Quarterly Consultation Update for WA.
Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.</td></tr>
</table>

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<tr><th>Stakeholder</th><th colspan="2">Stakeholder Consultation Summary (OPGGS(E) Regulation 16 (b)(i))</th></tr>
<tr><td rowspan="2"></td><td>Assessment of the merits of objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(ii))</td><td>Statement of response, or proposed response, to the objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(iii))</td></tr>
<tr><td>No assessment required.</td><td>No response required.</td></tr>
<tr><td rowspan="3">Pearl Producers Association (PPA)</td><td colspan="2">PPA was provided the consultation package via email on 1 June 2022.
No formal response has been received from MTWA.
This stakeholder also receives Santos’ Quarterly Consultation Update for WA.
Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.</td></tr>
<tr><td>Assessment of the merits of objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(ii))</td><td>Statement of response, or proposed response, to the objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(iii))</td></tr>
<tr><td>No assessment required.</td><td>No response required.</td></tr>
<tr><td>Recfishwest</td><td colspan="2">Recfishwest was provided the consultation package via email on 1 June 2022.
Recfishwest responded on 17 June 2022 by way of a letter emailed to Santos and provided the following response:
+ An overview of Recfishwest’s role in ensuring high quality recreational fishing experiences are maintained and enjoyed for all in the community. [INFORMATION 001]
+ An overview of health, well-being, and economic contribution that recreational fishing makes to Western Australia and its regional communities. [INFORMATION 002]
+ An overview of target fish species of interest to recreational fishers. [INFORMATION 003]
+ Advice that the MEFF region is infrequently visited by recreational fishers. [INFORMATION 004]
+ Recfishwest does not object to the steps being taken by Santos to address potential concerns held by recreational fishers. [INFORMATION 005]
+ Recfishwest requested to be consulted on future exploration activities, irrespective of distance from the shore and that all charts are updated so that recreational fishers can locate the areas. [REQUEST 001]
Santos responded to Recfishwest on 24 June 2022 and addressed the matters raised in its feedback of 17 June 2022 (refer assessment of stakeholder objections and claims below).
This stakeholder also receives Santos’ Quarterly Consultation Update for WA.</td></tr>
</table>

Stakeholder	Stakeholder Consultation Summary (OPGGS(E) Regulation 16 (b)(i))	
	Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.	
	Assessment of the merits of objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(ii))	**Statement of response, or proposed response, to the objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(iii))**
	[INFORMATION 001] Santos notes feedback from Recfishwest on its advocacy role for recreational fishing in Western Australia.	Santos responded to Recfishwest and acknowledged its feedback.
	[INFORMATION 002] Santos notes feedback from Recfishwest on the health, well-being, and economic contribution that recreational fishing makes to Western Australia and its regional communities.	Santos responded to Recfishwest and acknowledged its feedback.
	[INFORMATION 003] Santos notes feedback from Recfishwest on target fish species of interest to recreational fishers.	Santos responded to Recfishwest and acknowledged its feedback.
	[INFORMATION 004] Santos notes feedback from Recfishwest on target fish species of interest to recreational fishers.	Santos responded to Recfishwest and acknowledged its feedback.
	[INFORMATION 005] Santos notes that Recfishwest does not object to the steps being taken by Santos to address potential concerns held by recreational fishers.	Santos responded to Recfishwest and acknowledged its feedback.
	[REQUEST 001] Santos sought clarification from Recfishwest on its feedback with respect to exploration activities.	Santos responded to Recfishwest and acknowledged its feedback.
Tuna Australia	Tuna Australia was provided the consultation package via email on 1 June 2022. No formal response has been received from MTWA. This stakeholder also receives Santos' Quarterly Consultation Update for WA. Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.	
	Assessment of the merits of objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(ii))	**Statement of response, or proposed response, to the objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(iii))**

<table>
<tr><th>Stakeholder</th><th colspan="2">Stakeholder Consultation Summary (OPGGS(E) Regulation 16 (b)(i))</th></tr>
<tr><td></td><td>No assessment required.</td><td>No response required.</td></tr>
<tr><td rowspan="4">Western Australian Fishing Industry Council (WAFIC)</td><td colspan="2">WAFIC was provided the consultation package via email on 1 June 2022.
WAFIC responded by email on 4 July 2022, advising Santos it had developed a decommissioning policy which was currently under review. [INFORMATION 001]
WAFIC requested the following information:
+ The expected volume and impacts of the release of residual hydrocarbons.
+ Confirmation that infrastructure proposed to be left in situ was clean and free of toxic substances.
Santos responded by email on 5 July 2022 and addressed the matters raised in its feedback of 17 June 2022 (refer assessment of stakeholder objections and claims below).
This stakeholder also receives Santos' Quarterly Consultation Update for WA.
Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.</td></tr>
<tr><th>Assessment of the merits of objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(ii))</th><th>Statement of response, or proposed response, to the objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(iii))</th></tr>
<tr><td>[REQUEST 001] Santos confirmed that it flushed the subsea system to industry standard in 2018 before the FPSO departed the field, adding that the cut and recovery of subsea equipment would result in the release of residual hydrocarbons to the water column (at 30 - 40ppm within approximately 2238m^3 of treated seawater) with the potential for residual entrapped hydrocarbons in the carcass of the flexible flowlines. Santos noted that cut and recovery was an industry standard technique to allow removal of equipment, and that discharges from cut sections would result in full discharge to the water column but the discharge would occur gradually during the recovery as the assets are cut and lifted through the water column.</td><td>Santos responded to WAFIC and responded to the request.</td></tr>
<tr><td>[REQUEST 002] Santos confirmed that none of the infrastructure proposed to remain had ever been in contact with produced fluids</td><td>Santos responded to WAFIC and responded to the request.</td></tr>
</table>

Stakeholder	Stakeholder Consultation Summary (OPGGS(E) Regulation 16 (b)(i))	
	or hydrocarbons. Santos provided details on the composition of the proposed remaining infrastructure: + 6 x fully buried anchors – 98% steel (with an Iron content in the order of 97%, and the remaining percentage made up by a combination of other trace elements (e.g. Carbon, Manganese, Aluminium, Vanadium, Niobium, Titanium, etc.), and epoxy based paint (estimated under 5kg per anchor). + 6 x anchor chains lengths (partially buried) – the anchors, chains and shackles are made entirely of steel with the chains and shackles being chain grade RQ3. + 2 x epoxy coated, steel gravity bases made up of approximately 218t of steel, 10t of concrete, 850kg of anode, 376kg of cured epoxy coating and 200g of plastic (within 2 ball valves at the top of each gravity base buoyancy tank)) + 2 x ballast modules made up of approximately 7t steel, 45t concrete and 41kg of cured epoxy coating Santos advised WAFIC that it considered that it is ALARP and acceptable to leave this infrastructure in situ.	
Commercial fisheries – State Managed		
Mackerel Managed Fishery (Area 2)	Licence holders were provided the consultation package via mail on 1 June 2022. A reminder letter was sent on 11 July 2022 inviting feedback. No formal response has been received from licence holders. Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.	
	Assessment of the merits of objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(ii))	**Statement of response, or proposed response, to the objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(iii))**
	No assessment required.	No response required.
	Licence holders were provided the consultation package via mail on 1 June 2022.	

<table>
<tr><th>Stakeholder</th><th colspan="2">Stakeholder Consultation Summary (OPGGS(E) Regulation 16 (b)(i))</th></tr>
<tr><td rowspan="3">Pilbara Trawl Interim Managed Fishery</td><td colspan="2">A reminder letter was sent on 11 July 2022 inviting feedback.
No formal response has been received from licence holders.
Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.</td></tr>
<tr><th>Assessment of the merits of objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(ii))</th><th>Statement of response, or proposed response, to the objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(iii))</th></tr>
<tr><td>No assessment required.</td><td>No response required.</td></tr>
<tr><th colspan="3">Other industry</th></tr>
<tr><td rowspan="3">Finder Energy</td><td colspan="2">Finder Energy was provided the consultation package via email on 1 June 2022.
Finder Energy responded by email on 2 June 2022 and advised it had no comments on proposed activities.
Santos responded by email on 3 June 2022 thanking Finder Energy for its feedback.
Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.</td></tr>
<tr><th>Assessment of the merits of objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(ii))</th><th>Statement of response, or proposed response, to the objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(iii))</th></tr>
<tr><td>No assessment required.</td><td>No response required.</td></tr>
<tr><td rowspan="3">Woodside Energy</td><td colspan="2">Woodside Energy was provided the consultation package via email on 1 June 2022.
No formal response has been received from Woodside Energy.
Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.</td></tr>
<tr><th>Assessment of the merits of objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(ii))</th><th>Statement of response, or proposed response, to the objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(iii))</th></tr>
<tr><td>No assessment required.</td><td>No response required.</td></tr>
<tr><th colspan="3">Other stakeholders</th></tr>
</table>

<table>
<tr><th>Stakeholder</th><th colspan="2">Stakeholder Consultation Summary (OPGGS(E) Regulation 16 (b)(i))</th></tr>
<tr><td rowspan="3">Australian Marine Oil Spill Centre (AMOSC)</td><td colspan="2">AMOSC was provided the consultation package via email on 1 June 2022.
No formal response has been received from AMOSC.
This stakeholder also receives Santos’ Quarterly Consultation Update for WA.
Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.</td></tr>
<tr><td>Assessment of the merits of objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(ii))</td><td>Statement of response, or proposed response, to the objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(iii))</td></tr>
<tr><td>No assessment required.</td><td>No response required.</td></tr>
<tr><td rowspan="3">Pilbara Development Commission (PDC)</td><td colspan="2">PDC was provided the consultation package via email on 1 June 2022.
No formal response has been received from PDC.
This stakeholder also receives Santos’ Quarterly Consultation Update for WA.
Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.</td></tr>
<tr><td>Assessment of the merits of objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(ii))</td><td>Statement of response, or proposed response, to the objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(iii))</td></tr>
<tr><td>No assessment required.</td><td>No response required.</td></tr>
<tr><td rowspan="3">City of Karratha (CK)</td><td colspan="2">CK was provided the consultation package via email on 1 June 2022.
No formal response has been received from CK.
This stakeholder also receives Santos’ Quarterly Consultation Update for WA.
Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.</td></tr>
<tr><td>Assessment of the merits of objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(ii))</td><td>Statement of response, or proposed response, to the objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(iii))</td></tr>
<tr><td>No assessment required.</td><td>No response required.</td></tr>
</table>

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<table>
<tr><th>Stakeholder</th><th colspan="2">Stakeholder Consultation Summary (OPGGS(E) Regulation 16 (b)(i))</th></tr>
<tr><td rowspan="3">Karratha and Districts Chamber of Commerce and Industry (KDCCI)</td><td colspan="2">KDCCI was provided the consultation package via email on 1 June 2022.
No formal response has been received from KDCCI.
This stakeholder also receives Santos’ Quarterly Consultation Update for WA.
Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.</td></tr>
<tr><td>Assessment of the merits of objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(ii))</td><td>Statement of response, or proposed response, to the objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(iii))</td></tr>
<tr><td>No assessment required.</td><td>No response required.</td></tr>
</table>

6.5 Ongoing consultation

Stakeholder consultation for this activity will be ongoing and Santos will work with stakeholders before, during and after the activity. Should new stakeholders be identified, they will be added to the stakeholder database and included in all future correspondence as required, including activity-specific notifications.

Santos, as a marine user, understands there will be the need to interact and communicate with other marine users to ensure mutual and individual stakeholder goals are met. Santos has identified the need for ongoing engagement with the fishing industry, as committed to in **Section 10.11**.

To this end, Santos commits to the following ongoing stakeholder consultation process:

1. Before commencing the activity, Santos will notify all relevant stakeholders listed, or as revised, in **Table 10-7**. The notification will include information about activity timing, vessel movements and vessel details.
2. Upon completing the activity, Santos will provide a cessation notification to the relevant stakeholders listed, or as revised, in **Table 10-7**. The final cessation notification will advise stakeholders that the activity has ended.
3. Santos' Quarterly Consultation Update (**Section 6.6**) will include the MEFF decommissioning activities. This consultation will cease once the activity has ended.

Up to date knowledge of stakeholders will be managed as described in **Section 10.12**.

Where practicable and if available, Santos will endeavour to use the WAFIC consultation services to help distribute activity notifications to relevant commercial fishers.

Santos will assess any additional stakeholder objections or claims in accordance with **Section 6.4**.

6.6 Quarterly consultation update

Activities covered under this EP will be included in Santos' Quarterly Consultation Update until they can be listed as a 'completed activity', with updates scheduled for around March, June, September and December annually.

The Quarterly Consultation Update is circulated to a broad group of Santos' stakeholders, including many of the stakeholders identified in **Table 6-1** and **Table 6-2**.

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 to the satisfaction of both parties and keep any consultation on file during and post acceptance of an EP.

Activities covered under this EP will be included in Santos' Quarterly Consultation Update until they can be listed as a 'completed activity', with updates scheduled for around March, June, September and December annually.

The Quarterly Consultation Update is circulated to a broad group of Santos' stakeholders, including many of the stakeholders identified in **Table 6-1** and **Table 6-2**.

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 to the satisfaction of both parties and keep any consultation on file during and post acceptance of an EP.

6.7 Addressing consultation feedback

Santos' Consultation Coordinator is available before, during and after the activity to ensure opportunities for stakeholders to provide feedback are available.

Santos will maintain records of all stakeholder consultation related this this EP and activity.

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7. 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 will or may 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.

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

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

+ terminology used
+ 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' Offshore Division Environmental Hazard Identification and Assessment Guideline* (EA-91-IG-00004_5).

The outcome of the impact and risk assessment process is detailed in **Sections 8** and **9**.

7.1 Impact and risk assessment terminology

Common terms applied during the impact and risk assessment process and used in this EP are defined in **Table 7-1**. For a more comprehensive listing of the terms and definitions used in environmental impact and risk assessment, refer to Santos' Offshore Division Environmental Hazard Identification and Assessment Procedure (EA-91-IG-00004_5).

Table 7-1: 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 lifecycle 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[3].
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.
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.

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

Name	Definition
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.

7.2 Summary of the environmental impact and risk assessment approach

7.2.1 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 7-1**. The forum used to perform 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).

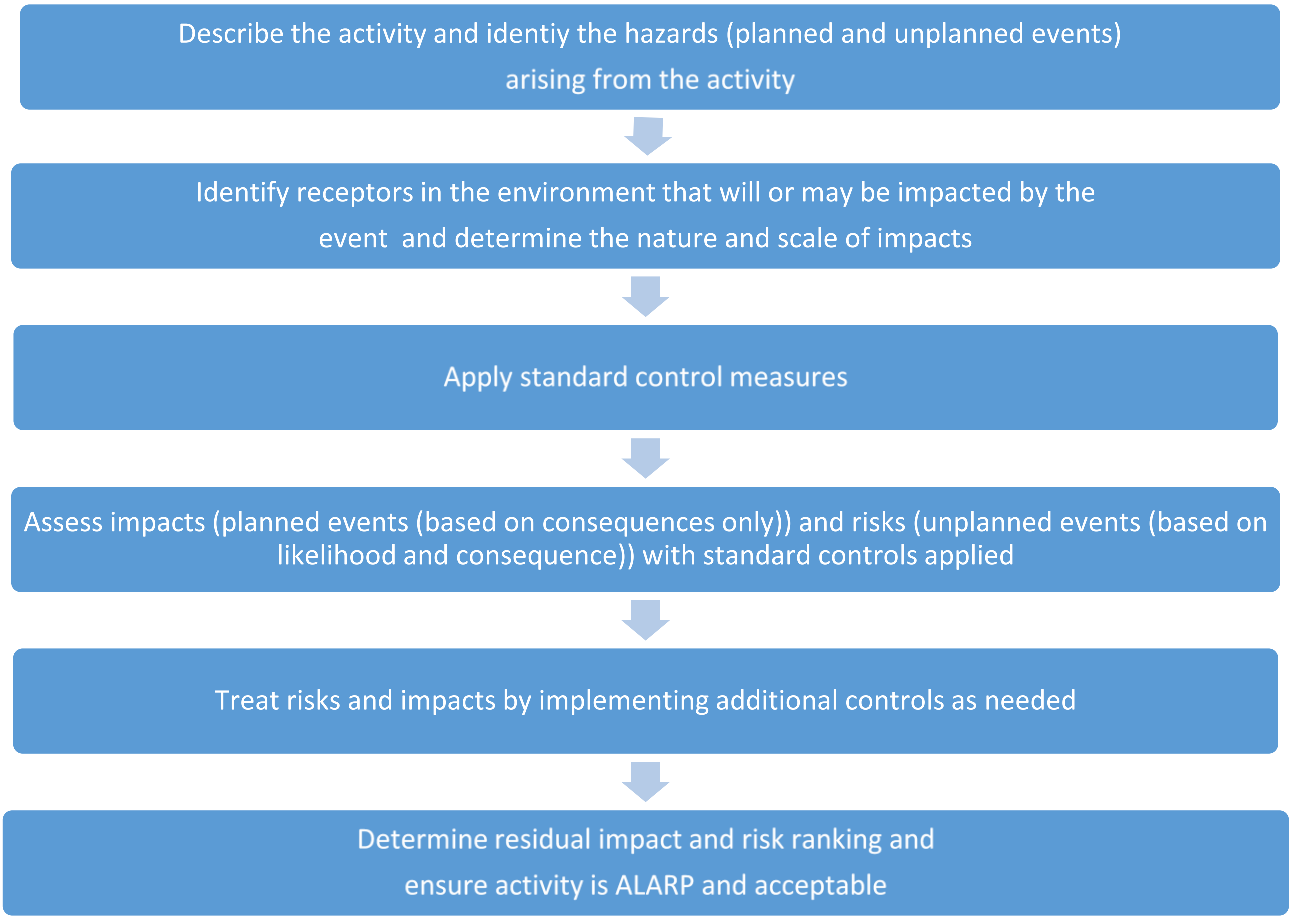

Figure 7-1 Environmental impact and risk assessment process

Santos' Environmental Hazard Identification and Assessment Guideline (EA-91-IG-00004) includes consideration of the key areas in an impact and risk assessment, being:

- 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 Safety Management System requirements
- principles of ecologically sustainable development (ESD)
- Santos' acceptable levels of impact and risk.

These factors are considered in environmental impact and risk assessment workshops in which environmental hazards are identified and assessed (ENVID workshop). The workshop involves participants from Santos' Health, Safety and Environment (HSE), Project and Spill Response departments and specialist environmental consultants.

7.2.2 Describe the activities and hazards (planned and unplanned events)

A description of the activity is required in order to determine the planned events that will take place and the credible unplanned events that may occur. The location, timing and scope of the activity must be described to determine the impacts from planned events, and the impacts and risks from unplanned events since these have a bearing upon the EMBA, by the activity.

The outcome of this assessment is detailed in the relevant sub-sections of **Sections 8** and **9**.

7.2.3 Identify receptors and determine nature and scale of impacts

A description of the environment (natural and socio-economic) within which hazards from the activity will, or may occur, is required. This constitutes a crucial stage of the risk assessment, as an understanding of the environment that will or may be affected is required to determine the type and consequence of impacts from the activity being assessed. The environment must be understood with respect to the spatial and temporal limits of the activity and key resources at risk that will or could be impacted by planned and unplanned events. Santos has developed a Values and Sensitivities of the Marine and Coastal Environment (EA-00-RI-10062, **Appendix D**) reference document that describes the existing environment that may be affected by Santos' activities and is reviewed and updated annually.

Where the existing environment is being reviewed for regulatory approvals, a comparison shall be made against the Values and Sensitivities of the Marine and Coastal Environment (EA-00-RI-10062). A new protected matters search is required to ensure a thorough understanding of the existing environment to ensure all risks are assessed.

The extent of actual impacts from each planned activity or risks from each unplanned activity, are assessed using, where required, modelling (e.g., hydrocarbon spills) and scientific reports. The duration of the event is also described including the potential duration of any impacts should they occur. Receptors identified as potentially occurring within impacted area(s) are detailed in **Section 5** and **Appendix D**.

7.3 Describe the environmental performance outcomes and control measures

For each planned and unplanned event, a set of Environmental Performance Outcome(s), Control Measures, Environmental Performance Standards and Measurement Criteria are identified. The definitions of the performance outcomes, control measures, standards and measurement criteria must be consistent with the OPGGS(E)R 2009, and the NOPSEMA EP Content Requirements Guidance Note (NOPSEMA, 2019).

For any hazard, additional controls, must also be considered and either accepted for use or rejected based on whether the standard controls reduce impacts and risks to levels that are ALARP and acceptable (refer **Sections 7.5** and **7.6**).

Controls are allocated in order of preference according to **Figure 7-2**.

Control	Effectiveness	Example
Eliminate		*Removal of the risk.* Refueling of vessels at port eliminates the risks of an offshore refueling.
Substitute		*Change the risk for a lower one.* The use of low-toxicity chemicals that perform the same task as a more toxic additive.
Engineering		*Engineer out the risk.* The use of oil-in-water separator to minimise the volume of oil discharged.
Isolation		*Isolate people or the environment from the risk.* The use of bunding for containment of bulk liquid materials.
Administrative		*Provide instructions or training to people to lower the risk.* The use of Job Hazard Analysis to assess and minimise the environmental risks of an activity.
Protective		*Use of protective equipment.* Containment and recovery of spilt hydrocarbons.

Figure 7-2: Hierarchy of controls

7.4 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/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.

The consequence level of the impact is then determined for each planned and unplanned event using the Santos Environment Consequence Descriptors (**Appendix G**).

These detailed environmental consequence descriptions are based on the consequence of the impact to relevant receptors in the categories of:

- threatened/migratory/local fauna
- physical environment/habitat
- threatened ecological communities
- protected areas
- socio-economic receptors.

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

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 (**Table 7-2**).

Table 7-2: Summary environmental consequence descriptors

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

For unplanned events, the consequence level of the impact is combined with the likelihood of the impact occurring (**Table 7-3**), to determine a residual risk ranking using the corporate Santos risk matrix (**Table 7-4**). For oil spill events, potential impacts to environmental receptors are assessed where they occur within the EMBA using results from modelling.

Table 7-3: 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 7-4: 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

7.5 Evaluate 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 ALARP. This process relies on demonstrating that further potential control measures would require a disproportionate level of cost/effort in order to reduce the level of impact or risk. If this cannot be demonstrated, then further control measures are adopted. The level of detail included within the ALARP assessment is based upon 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'.

7.6 Evaluate 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.
+ 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 Environment, Health and Safety Policy.
+ Performance standards are consistent with industry standards and best practice guidance (e.g., National Biofouling Management Guidance Guidelines for the Petroleum Production and Exploration Industry (Marine Pest Sectoral Committee, 2018)).
+ Performance outcomes and standards are consistent with stakeholder expectations.
+ Performance standards have been demonstrated to reduce the impact or risk to ALARP.
+ The consequence and risks associated with the proposed activity are not inconsistent with the outcomes of relevant principles of ecologically sustainable development (ESD) under the EPBC Act (**Table 7-5**).

Table 7-5: Activity Relevant Principles of Ecologically Sustainable Development

No.	ESD Principle	Relevance
(a)	decision-making processes should effectively integrate both long-term and short-term economic, environmental, social and equitable considerations	Santos' environmental impact and risk assessment determines impact consequence levels considering the duration and extent of the impact, receptor recovery time and the effect of the impact at a population, ecosystem, or industry level. The Santos Environment Consequence Descriptors highlights the integration of long-term and short-term environmental, and socio-economic considerations (**Appendix G – Santos Environment Consequence Descriptors**). The assessment of impact consequence levels for the proposed activity simultaneously assesses of the activity's potential implications against this principle. Additional assessment of this principle in relation to acceptability will not be conducted.

No.	ESD Principle	Relevance
(b)	if there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation	For planned activities, assessment of this ESD principle is inherent in Santos' environmental impact and risk assessment process, as Santos does not proceed with activities if the consequence of a planned event is ranked III (Moderate) or above. For unplanned events, if the residual risk is ranked between Medium and Very High, an assessment against this principle is required. If the residual risk is Medium to Very High and there is significant scientific uncertainty associated with the aspect, additional assessment against this principle is required.
(c)	the principle of inter-generational equity—that the present generation should ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations	For planned activities, assessment of this ESD principle is inherent in Santos' environmental impact and risk assessment process, as Santos does not proceed with activities if the consequence of a planned event is ranked III (Moderate). For an unplanned event, if the residual risk is ranked between Medium and Very High, an assessment against this principle is required. The assessment of this principle is implemented through further details on ALARP assessment highlighting assurance that potential impacts and risks are managed, and the environment is maintained for the benefit of future generations. Evaluation of the importance and relevance of stakeholder interest for this principle, if triggered, is fundamental in demonstrating that the environment is maintained for the benefit of future generations.
(d)	the conservation of biological diversity and ecological integrity should be a fundamental consideration in decision-making	Evaluate if there is the potential to affect biological diversity and ecological integrity.
(e)	improved valuation, pricing and incentive mechanisms should be promoted	This principle refers to activities which involve valuation, pricing and/or incentive mechanisms for the production, delivery, distribution or consumption of goods and services, especially those that are derived from natural or social capital or from ecological services. This principle is not relevant to the proposed activity as the proposed activity does not involve the production, delivery, distribution or consumption of goods and services.

8. Environmental risk and impact assessment for planned activities

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.

An ENVID workshop (as described in **Section 7**) for planned activities was held in August 2021 for floating asset removal activities (to inform the previously accepted MEFF CoP EP (Rev 4)), and in February 2022 for seabed asset removal and abandonment in situ activities (included as part of this EP revision (Rev 5)). This workshop identified potential sources of environmental impact associated with the planned activities for this activity. The consequence rankings resulting from the environmental assessments are summarised in **Table 8-1**. A comprehensive risk and impact assessment for each of the planned events, and subsequent control measures proposed by Santos to reduce the risk and impacts to ALARP and acceptable levels are details in the following subsections.

Table 8-1: Summary of the consequence level rankings for hazards associated with planned events

EP Section	Hazard	Activity / Planned Event	Consequence Ranking
8.1	Interaction with other marine users (cessation phase activities, removal activities and equipment left in situ)	Physical presence of vessels and ROVs for surveys, barrier testing, floating and seabed asset removal and other activities. Continued presence of seabed assets abandoned in situ.	I – Negligible
8.2	Seabed and benthic habitat disturbance	Floating asset removal, wet storage of equipment until future decommissioning. Sand and / or grout bags to provide stabilisation to end of disconnected, flowlines and umbilicals at the seabed. Sediment grab samples for environmental analysis. Deburial of seabed assets and seabed asset removal. Continued presence of seabed assets abandoned in situ.	II – Minor
8.3	Light emissions	Light spill from artificial lighting on vessels. Underwater light from ROV activities.	I – Negligible
8.4	Noise emissions	Vessel and ROV activities including equipment positioning, cutting activities, marine growth removal and removal of equipment.	II – Minor

EP Section	Hazard	Activity / Planned Event	Consequence Ranking
		Helicopter activities.	
8.5	Atmospheric emissions	Vessel and helicopter engine and equipment fuel combustion.	I – Negligible
8.6	Operational discharges	Sewage and grey water disposal; putrescible waste disposal; desalination brine disposal; cooling water disposal; boiler blowdown water; deck drainage disposal; bilge water disposal. Potential impacts may also occur outside of the operational area as a result of decommissioning activities, such as during towing of the DTM and MWAs and transport of seabed assets via vessel to the port of landing, and the associated onshore disposal aspect.	II – Minor
8.7	Planned chemical and hydrocarbon discharges	During barrier testing activities there may be release of small amounts of barrier testing fluids (such as hydraulic fluid, MEG or methanol) and potential residual hydrocarbons. There may be potential for minor discharge from ROV or tooling hydraulics (typically mineral oil) during subsea operations. Leak testing fluid discharge for barrier testing and flowline testing. Some OIW may be discharged when risers are cut or disconnected. There may be a small release of production riser contents during pressure bleed off prior to cutting, if required. Treated seawater, OIW and residual hydrocarbons may be released during disconnection and removal of seabed equipment. Scale inhibitor, hydraulic control fluid and glycol discharges during disconnection and removal of control systems. Santos does not anticipate any other contaminants (e.g. NORM and mercury).	II – Minor
8.8	Degradation of abandoned seabed equipment	Degradation and corrosion of mooring chains and anchors , gravity bases and concrete ballast.	I – Negligible
8.9	Contingency spill response operations	Light emissions.	I – Negligible
		Noise emissions.	I – Negligible
		Atmospheric emissions.	I – Negligible
		Operational discharges and waste.	I – Negligible
		Physical presence and disturbance.	II – Minor
		Chemical dispersant application.	II – Minor
		Disruption to other users of marine and coastal areas and townships.	II – Minor

8.1 Interaction with other marine users

8.1.1 Description of event

Event	The physical presence of vessels and ROVs involved with: + cessation phase activities in **Section 4.5** + floating asset removal as outlined in **Section 4.6** + seabed equipment removal activities as outlined in **Section 4.7** as well as the presence of the following equipment: + on the seabed (wells, pipelines, flowlines, umbilicals, jumpers, trees, mooring systems, etc), buoyant (submerged) equipment such as the DTM and MWAs and the associated safety exclusion zones, + wet-stored equipment, + towing / removal of the DTM and MWA's from the operational area; and + continued presence of abandoned in situ seabed equipment (e.g., 2 x gravity bases and concrete ballast, 6 x deeply buried mooring anchors and their associated chains) has the potential to locally disrupt the activities of other marine users. Note: Unplanned marine interaction with other marine users that may result in vessel collisions are addressed in **Section 9.6.** Unplanned interaction with other marine users from the ongoing presence of seabed equipment abandoned in situ are addressed in **Section 9.9**
Extent	Operational area.
Duration	For the duration of the activity, as described in **Section 4.1**.

8.1.2 Nature and scale of environmental impacts

Potential receptors: Socio-economic (commercial fishers, tourism, shipping traffic and other oil and gas activities).

Potential impacts to tourism and recreational fisheries include displacement from the area while the vessels are in the operational area.

Socio-economic

There are three Commonwealth fisheries that overlap with the operational area and are actively fished (**Section 5.2.5**). An analysis of the current fishery closures, depth range of activity, historical fishing effort data, fishing methods and consultation feedback (**Section 6**) has revealed that there is a low potential for interaction with Commonwealth commercial fisheries. None of the Commonwealth fisheries identified in **Section 5.2.5** are likely to be significantly active in the operational area; the Western Tuna and Billfish Fishery is the only fishery with limited activity in the area with only five active vessels since 2005.

There are two State commercial fisheries that overlap the operational area and may also be active within the area. The Pilbara Fish Interim Trawl Managed Fishery has a Closed Area (Area 6) that overlaps the operational area. As such, this fishery is unlikely to be active in the operational area during cessation of operations and decommissioning activities. The Mackerel Managed Fishery also overlaps the operational area. Low level fishing effort from the Mackerel Managed Fishery was recorded in the southern-most part of the operational area ten years ago. Consultation with WAFIC and licence holders in both fisheries suggests that there is likely to be no direct impact to fishing operations in the area. The licence holders in this fishery have not raised any concerns during MEFF Development operations, nor in the recent stakeholder consultation.

WAFIC sought additional information regarding the wet storage of equipment during cessation of operations and floating asset removal activities and this request was closed out during the consultation process during the development of Revision 4 with no further requests from WAFIC (**Section 8.1.6**). A number of other State commercial fisheries overlap the operational area; however, disruption to these fisheries is not expected, given the typical water depths they operate in (shallower than the operational area) and the vast areas available to the fisheries.

The planned abandonment in situ of seabed equipment may have a negligible impact to the area available for commercial fishing activities in the future. The Closed Area (Area 6) of the Pilbara Fish Interim Trawl Managed Fishery, which overlaps the Operational Area, has been closed since current management arrangements for the fishery came into effect in 1998 (Gaughan and Santoro, 2021). The seabed in the operational area is relatively flat, smooth and featureless. The only bathymetric features identified were those associated with the MEFF seabed equipment (**Section 5.2.2.1**). Therefore, the operational area is unlikely to support habitat for aggregations of target species for the fishery (e.g. goldband snapper, rankin cod, bluespot emperor and threadfin bream). Santos has consulted with fishing industry bodies, WAFIC and individual fishing licence holders within the Pilbara Fish Interim Trawl Managed Fishery on the ongoing physical presence of decommissioned seabed equipment (**Section 6.4**). No queries were received from WAFIC or licence holders related to the potential interaction with marine users. Recfishwest requested to be consulted on future exploration activities [sic] and for charts to be updated so that recreational fishers can locate the areas (**Section 6.4**).

All six DTM anchors were confirmed fully buried by the 2021 in field environmental survey (GHD, 2021) and are expected to be buried at depth of between 6 to 13 m and are therefore expected to remain buried. Approximately 130 m of each mooring chain was observed as unburied (**Section 4.8.2**). Gravity bases, including the associated concrete ballast protrude approximately 5.3 m above the seabed in their current state. The locations of abandoned equipment above the mudline will be provided to the AHO for marking on charts. Therefore, the planned ongoing physical presence of the gravity bases, associated concrete ballast, anchors and mooring chains abandoned in situ would only represent a very small portion of Area 6 and will not preclude commercial trawling activities from occurring in Area 6, should that area open to trawl fishing in the future.

No trap fishing has been recorded in the operational area. The Mackerel Managed Fishery has recorded low fishing effort in the area, although no activity from this fishery has been recorded in the operational area for more than ten years. The Mackerel Managed Fishery is a line fishery, focusing on pelagic fish species in the upper water column and is not expected to interact with seabed assets abandoned in situ. Therefore, impacts to commercial fishing from the planned ongoing physical presence of seabed assets permanently abandoned in situ are expected to be negligible.

The far-north corner of the eastern-most boundary of the operational area marginally overlaps the Dampier Shipping Fairway (**Figure 5-21**) (overlap of 0.764 km^2). Impacts on shipping movements are therefore expected to be minimal. The ongoing presence of exclusion zones until decommissioning activities have been completed may cause shipping to deviate from its preferred course to avoid the area. Any equipment temporarily wet stored in the course of decommissioning will be located within the existing gazetted petroleum safety zones (PSZs). Safety exclusion zones associated with the primary vessels will be communicated through a Notice to Mariners, marine users will be aware of their presence and as such they are not expected to present any change in the navigation hazard. Existing PSZs will be revoked once decommissioning has been completed prior to title relinquishment.

The ongoing planned physical presence of seabed assets abandoned in situ is not expected to interfere with commercial shipping, given water depths are in excess of 130m and in situ items are approximately 5m above seabed

Given the distance offshore, the depths at the site and the absence of reefs, it is unlikely any recreational fishing occurs in the area. There are no tourism related activities expected to occur in the area, given the distance from nearest shore.

Unplanned interactions with other users (including the potential snag risk to commercial fishing activities) from seabed equipment abandoned in situ are addressed in **Section 9.9**.

8.1.3 Environmental performance outcomes and control measures

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

+ 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 [MEFF-EPO-01].

The control measures (CM) considered for this activity are shown in **Table 8-2**, with environmental performance standards (EPSs) and measurement criteria for the EPOs described in **Section 10.4**.

Table 8-2: Control measures evaluation for interaction with other marine users

CM reference	Control measure	Environmental benefit	Potential cost / issues	Evaluation
Standard Control Measures				
MEFF-CM-01	Maritime Notices	Ensures other marine users are aware of the presence of vessels.	Costs associated with the personnel time in issuing notifications and closing out queries and responses.	**Adopted** – Benefits considered to outweigh negligible costs. Maritime requirement to issue marine notices.
MEFF-CM-02	Santos' stakeholder consultation strategy	Santos will notify all relevant stakeholders listed, or as revised, in **Section 6** of relevant activity details prior to commencement, including activity timing, vessel movements, proposed cessation date and vessel details. Ensures other marine users, such as commercial fishers, are aware of upcoming operations so they can plan their business accordingly.	Limited additional costs to Santos. Stakeholders' time required to review consultation material and communicate with Santos.	**Adopted** – Benefits considered to outweigh negligible costs. Important control to ensure other marine users are aware of upcoming operations and potential business disruptions.
MEFF-CM-03	No fishing from project vessels	Reduce potential impacts to fisheries in the vicinity of the activity.	Negligible costs.	**Adopted** – Benefits considered to outweigh negligible costs to Santos.

CM reference	Control measure	Environmental benefit	Potential cost / issues	Evaluation
MEFF-CM-04	Existing (gazetted) PSZs established around the MEFF DTM and manifold locations	Gazetted 500 m PSZ around the MEFF DTM and manifolds prevents vessels from getting too close and causing damage to equipment of either party.	No additional costs. PSZs already gazetted.	**Adopted –** Benefits considered to outweigh no costs to Santos.
MEFF-CM-05	Safety Exclusion Zone established around primary vessels during floating and seabed asset removal activities to reduce potential for collision or interference with other marine user activities	Requested Safety Exclusion Zone around the primary vessels prevents other vessels from getting too close and causing damage to equipment of either party.	No additional costs to Santos. Other marine users may be temporarily excluded from small areas.	**Adopted** – The exclusion of other marine users is temporary. Marine users will still be able to access the operational area. Normal navigation at sea process whereby shipping vessels avoid navigational risks. Hence, the safety benefits to all marine users outweighs any potential costs.
MEFF-CM-06	Lighting will be used as required for safe work conditions and navigational purposes	Ensures the vessels are seen by other marine users. Reduces the risk of collisions with other marine users.	No additional costs to Santos. Standard requirement for vessel navigation lighting and equipment to be compliant with COLREGS / Marine Orders 30: Prevention of Collisions, and with Marine Orders 21: Safety of Navigation and Emergency Procedures.	**Adopted** – The safety benefits of having navigation and lighting equipment and procedures outweighs any cost. This is a maritime requirement.
MEFF-CM-07	Seafarer certification	Requires appropriately trained and competent personnel 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 is a legislated requirement.

CM reference	Control measure	Environmental benefit	Potential cost / issues	Evaluation
MEFF-CM-08	Identification system	Primary vessels have an Automatic Identification System to aid in their detection at sea.	Negligible costs of operating navigational equipment. Standard equipment on vessels.	**Adopted** – Benefits considered to outweigh negligible costs to Santos.
MEFF-CM-09	Constant bridge watch	Crew of the primary vessels will maintain constant bridge watch, including for third party vessels which may be approaching or enter the exclusion zone.	No additional costs.	**Adopted** – No additional costs. This is a maritime requirement.
MEFF-CM-10	Primary vessel personnel inductions	Reinforcing the importance of marine communications in the event of any potential interactions with active commercial fishers will minimise project potential to displace other marine users.	Negligible, given is standard industry practice.	**Adopted** – Benefits considered to outweigh negligible costs.
MEFF-CM-11	Tow plan	Tow plan for the towing of recovered assets from the operational area to port of landing will minimise potential to interfere with or displace other marine users.	Costs associated with developing and implementing the plan.	**Adopted –** Benefits considered to outweigh minor costs.
MEFF-CM-12	Recovery Procedures	Recovery procedures for floating and seabed asset recovery within the operational area will minimise potential to interfere with or displace other marine users.	Negligible, given is standard industry practice.	**Adopted -** Benefits considered to outweigh negligible costs.
MEFF-CM-13	As left survey	Confirms understanding of physical environment in operational area post activities.	Costs associated with personnel and operations time in conducting surveys.	**Adopted** – Benefits considered to outweigh negligible costs to Santos.

CM reference	Control measure	Environmental benefit	Potential cost / issues	Evaluation
MEFF-CM-14	Notify AHO of locations for equipment abandoned in situ for marking on navigational charts	Ensures other marine users are aware of the presence of equipment abandoned in situ.	Negligible, given is standard industry practice.	**Adopted -** Benefits considered to outweigh negligible costs.
MEFF-CM-15	Relinquish petroleum safety zone (PSZ)	Ensures other marine users are aware of access permissions.	Negligible, given is standard industry practice.	**Adopted -** Benefits considered to outweigh negligible costs.
Additional Control Measures				
N/A	Manage the timing of the operational activities to avoid peak marine user periods (e.g., fishing)	Would eliminate potential impacts to other marine users.	Not considered feasible as marine users could potentially be in the area all year round. 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 through consultation.	**Rejected** – Stakeholders and shipping in the area all year round. Cost grossly disproportionate to low socio-economic benefit, given the location of the activity has low usage by commercial fishers or areas of tourism.
N/A	Dedicated guard vessel in place during the activity to reduce potential for collision or interference with other marine users	Identifies and communicates with approaching third-party vessels to ensure exclusion (safety) zone is observed, preventing potential interaction or interference.	Significant additional cost of guard vessel for the duration of activities/campaigns.	**Rejected** – Cost grossly disproportionate to benefit, given the location of the activity has low usage by commercial fishers and does not overlap with any commercial shipping lanes or areas of tourism.
N/A	Avoidance of other active marine users, where safe to do so	The primary vessels don't have the ability to avoid other vessels under own propulsion when on station for project activities, in the unlikely event	Additional costs as the primary vessels will need to be stationary and not able to move from position. If move from position is	**Rejected** – Not feasible as the primary vessel needs to be stationary. However, primary controls to avoid other marine

CM reference	Control measure	Environmental benefit	Potential cost / issues	Evaluation
		interaction with marine user requires a primary vessel to avoid other user. Note, primary controls around stakeholder engagement and navigational lighting will suffice for this control to not be implemented.	required, this may delay the activity.	users is thorough stakeholder engagement.
N/A	Eliminate the use of vessels	Would eliminate potential impacts to other marine users.	Not considered feasible as vessels are the only form of transport that can undertake the activities.	**Rejected –** Not feasible as vessels are required to complete the activities.
N/A	Do not recover and tow floating assets from the MEFF field to port of landing	Would eliminate the potential impacts to other users of the marine environment from towing activities.	Santos has committed to removing all floating assets from the MEFF field. Towing is the preferred method to remove the DTM from the operational area. Lifting the DTM onto a vessel in field would be a significantly more hazardous operation and would require use of a larger vessel with similar or greater impacts on other users of the marine environment. Towing may be required for removing the MWAs from the operational area.	**Rejected** – Santos is committed to removing the floating assets from the MEFF Field. Towing of floating assets has been assessed to be the safest method of removing recovered assets from the Title area and has negligible additional impact compared to towing.
N/A	Do not recover and remove seabed assets identified for removal from the	Would eliminate the potential impacts to other users of the marine environment from transporting	Removal of selected seabed assets is a requirement of Santos'	**Rejected** – Removal of seabed assets proposed for removal is a

CM reference	Control measure	Environmental benefit	Potential cost / issues	Evaluation
	MEFF field to port of landing	recovered seabed assets.	decommissioning of the MEFF Field.	requirement of Santos' decommissioning of the MEFF Field. Transport of recovered equipment is expected to have a negligible additional impact on other users of the marine environment.

8.1.4 Environmental impact assessment

Receptor	Consequence Level
Interaction with other marine users	
Threatened, migratory or local fauna	Not applicable – related to socio-economic receptors only.
Physical environment or habitat	
Threatened ecological communities	
Protected areas	
Socio-economic receptors	The impact of the vessel operations during IMMR and decommissioning activities, or the ongoing presence of seabed equipment on socio-economic receptors is considered to be I (Negligible) due to the fact that: + the operational area is largely not within an AMSA defined shipping fairway (eastern-most boundary of the operational area marginally overlaps the Dampier Shipping Fairway), + tourism activities are not expected to occur in the operational area, given the water depth, lack of seafloor features and distance from shore + the operational area is not extensively fished – commercially, traditionally or recreationally + EP 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 + other operators may have vessels traversing the region that will need to avoid the operational area to access exploration and development sites. Any interaction would be temporary and other operators' vessels can go around the operational area. + The planned continued presence of seabed equipment in situ is not expected to significantly impact other marine users or fishery resources and is unlikely to result in changes in distribution and abundance of fish species outside the operational area. The ongoing physical presence of seabed equipment abandoned in situ will not preclude commercial trawling activities from occurring in Area 6 of the Pilbara Fish interim Trawl Managed Fishery, should that area open to trawl fishing in the future. + During the preparation of this EP revision Santos consulted with WAFIC and invited feedback from individual fishing licence holders within the Pilbara Fish Interim Trawl Managed Fishery regards the ongoing physical presence of decommissioned seabed equipment (**Section 6.4).**
Overall worst-case consequence	I – Negligible

8.1.5 Demonstration of as low as reasonably practicable

Vessels are required for IMMR activities, ROV surveys, floating and seabed asset removal and other related activities. The presence of seabed equipment in offshore fields is normal industry practice. The management of impacts, including interactions with other marine users, is well established, understood and regulated. Given the remote offshore location, recreational and tourism activities are not expected to occur in the area. Impacts to commercial fishing activities are not expected during cessation or decommissioning activities, and the planned abandonment of equipment in situ will not preclude trawl fishers from operating in the Closed Area (Area 6) should that area become open to trawl fishing in the future. Towing is considered a standard maritime activity, and the adopted controls are effective in reducing the impacts and risks from towing floating assets on other marine users. There is little uncertainty associated with the vessel and ROV activities in relation to this aspect. No objections or concerns were raised by relevant stakeholders regarding the activity.

Stakeholders have been informed of the proposed decommissioning activity. Ongoing consultation, along with Notice to Mariners issued via Santos' notifications to Australian Hydrographic Service AHS before commencing in-field campaigns and for the locations of seabed assets abandoned in situ upon completion of the field decommissioning to minimise the risk of interference with other marine users. The DTM currently sits at 30 m depth, to minimise risk as a navigation hazard.

With the controls adopted, the assessed residual consequence for this impact is negligible. Additional control measures were considered but rejected, since the associated cost / effort was grossly disproportionate to any benefit as detailed above. Therefore, impact is considered to be ALARP.

8.1.6 Acceptability evaluation

Is the consequence ranked as I (Negligible) or II (Minor)?	Yes – maximum consequence from interaction with or impact on other marine users 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 ESD?	Yes – activity evaluated in accordance with Santos' Environmental Hazard Identification and Assessment Procedure (EA-91-IG-00004_5), which considers principles of ESD. The consequence against this aspect is I (Negligible) and therefore does not affect the outcomes of the principles of ecologically sustainable development as per **Table 7-5**.
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.

Are risks and impacts consistent with Santos' Environmental, Health and Safety Policy?	Yes – aligns with Santos' Environmental, Health and Safety Policy.
Are risks and impacts consistent with stakeholder expectations? **Related to cessation phase and floating asset removal activities**	Yes – WAFIC requested further information regarding timing (duration of temporary wet storage) and the associated risks to the marine environment and commercial fishing. Santos responded to these requests made during consultation (**Table 6-3**), advising the equipment planned for temporary wet storage is connected to the DTM and MWAs. As per **Table 6-3** Santos proposed to disconnect the equipment when the DTM and MWAs are removed and, if these are not removed, these will be temporarily stored / wet parked until full field decommissioning, which is planned to commence in Q3 / Q4 2024. Santos does not envisage any additional risk or impact to the marine environment or commercial fishing as the equipment is currently in the water column and will be laid on the seabed and stabilised after disconnection from the DTM and MWAs. The production risers will be capped before being placed on the seabed. Additionally, all equipment currently related to the MEFF field was marked on nautical maps, which also show cautionary zones around the area. Santos considers these requests have been addressed.
Are risks and impacts consistent with stakeholder expectations? **Related to seabed equipment removal and abandonment in situ activities**	Yes Recfishwest requested charts be updated. Santos notes that this is already managed through environmental performance standard MEFF-CM-14 (**Section 10.4).** AMSA requested its maritime safety notification requirements which are addressed in **Table 10-7**.
Are performance standards such that the impact or risk is considered to be ALARP?	Yes – see ALARP above.

The presence of the vessels and seabed equipment, towing of floating assets and removal of seabed equipment during decommissioning and abandonment of select seabed equipment in situ is not expected to significantly affect other marine users, including commercial fishing operations or shipping traffic, given the following:

+ small existing (gazetted) PSZs established around the MEFF DTM and manifold locations in relation to the wider areas for shipping transit and navigation. The PSZ's will be relinquished on completion of decommissioning activities.
+ short duration of the activity, depending on weather, equipment and operational issues:
  - approximately 14 days for IMMR activities
  - approximately 45 to 90 days for floating asset removal activities
  - short-term, multiple campaigns over approximately 12 months for seabed asset removal and preparation for leaving in situ activities

- seabed assets abandoned in situ will be marked on navigational charts outcomes of stakeholder engagement did not identify any concerns by relevant stakeholders.

Therefore, the impacts on marine users is considered ALARP and acceptable.

8.2 Seabed and benthic habitat disturbance

8.2.1 Description of event

Event	Potential seabed disturbance (temporary) may occur in the operational area as a result of: + floating asset removal + wet storage of equipment until future decommissioning + sand and / or grout bags to provide stabilisation to end of disconnected risers, flowlines and umbilicals at the seabed + IMMR activities during the cessation phase + environmental sediment sampling conducted during IMMR campaigns + localised seabed disturbance if required, to provide for activities such as installing plugs / caps + deburial of seabed assets, where required, and seabed asset removal + continued presence of abandoned seabed equipment. During cessation phase IMMR activities, floating and seabed asset removal activities seabed disturbance may potentially occur in the operational area due to ROV activities, temporary wet parking of equipment, such as risers, and deburial of seabed assets where required to facilitate recovery. There will be no anchoring of primary vessels or support vessels within the operational area during cessation or decommissioning phase activities. Physical impacts from the continued presence of seabed equipment are discussed further in **Section 8.8**.
Extent	All planned seabed disturbance will occur within the operational area. Seabed disturbance from wet storage of equipment during floating asset removal activities will be limited to an area within the existing DTM mooring anchor pattern. Seabed disturbance from environmental sampling as an IMMR type activity is estimated to be up to 1 m² per grab sample. Seabed disturbance from deburial (where required) and removal activities during decommissioning is expected to be predominantly localised creating a sediment plume that settles within the lay corridor (i.e. 5-10 m either side of the assets)**.** The sediment plume may be distributed by currents which is expected to rapidly disperse and be temporary in nature.
Duration	For the duration of the activity, as described in **Section 4.1**.

8.2.2 Nature and scale of environmental impacts

<u>Potential receptors:</u> Benthic habitats and fauna.

Activities may disturb seabed and benthic habitat through:

+ direct physical disturbance of an area of seabed habitat, including benthic fauna, of up to around 200 m² per riser (including sand / grout bags required for stabilisation) if wet-stored until future decommissioning
+ direct physical disturbance of an area of seabed habitat, including benthic fauna, of up to around 100 m² per mooring chain for the six DTM mooring chains if wet-stored during the floating asset removal campaign until future decommissioning
+ direct physical disturbance of an area of seabed habitat, including benthic fauna, of up to around 1 m² per grab sediment sample
+ direct physical disturbance of an area of seabed habitat, including benthic fauna, of up to around 16 m² per ROV basket placement on the seabed
+ direct physical disturbance of an area of seabed habitat, including benthic fauna, limited to within the lay corridor (5-10 m either side of the asset) during deburial (where required to

ensure load safety during removal activities) and removal of seabed assets direct physical disturbance of an area of seabed habitat, including benthic fauna, limited to the footprint and general vicinity around abandoned seabed equipment (gravity bases, associated concrete ballast and DTM mooring chains)

+ indirect disturbance to benthic habitats and associated marine fauna by sedimentation
+ increased turbidity of the near-seabed water column.

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

+ soft sediments and benthic fauna.

Physical environment

The cessation of production and decommissioning activities described in **Section 8.2.1** will inevitably result in localised impact (direct and indirect) to benthic habitat (and associated fauna) in the operational area.

Impacts may occur from direct disturbance to the seabed or from elevated turbidity in the water column, which has the potential for slight and short-term impacts to benthic fauna through clogging of respiratory and feeding parts of filter-feeding organisms.

Localised scouring or burial of abandoned equipment is expected to occur. Physical impacts to the seabed from the continued presence of seabed equipment may impact on sediment-burrowing infauna and surface epifauna invertebrates, particularly filter feeders. Impacts are expected to be intermittent with ocean currents and localised to the footprint and general vicinity around the abandoned equipment.

The operational area does not contain any significant or unique areas of benthic habitat. As described in **Section 5.2.2**, the benthic habitats within the operational area are primarily low relief unconsolidated (high volume) calcareous silty fine sand. The only bathymetric features identified were those associated with existing Santos petroleum production equipment linked to the MEFF operations and previous drilling campaigns (Neptune Geomatics, 2011).

The potential impacts of seabed disturbance caused by the planned activities are considered minor due to the following:

+ Although the Ancient Coastline at 125m Depth Contour KEF is present in the southern-most portion of the operational area (**Section 5.2.3**, **Figure 5-7**), no known sensitive features associated with the KEF have been observed in the operational area and wet-stored equipment will be located close to its original location, away from the KEF. No seabed assets overlap with the KEF. No known sensitive seabed features (e.g., reefs, canyons, shipwrecks) or benthic primary producer habitat (e.g. areas of hard corals, seagrass, macroalgae or mangroves) are present in the operational area.
+ Depressions on the seabed left by the placement of risers, DTM mooring chains and wet-stored equipment are expected to infill as a result of movement of sediments by water currents and by the deposition of detrital matter. Given the nature of the habitat and associated benthic communities (**Section 5.2.2**), recolonisation would also be expected to be rapid.
+ Any temporary turbidity and sedimentation associated with the placement and retrieval of wet-stored equipment, environmental sediment grab sampling, seabed asset deburial and removal activities is not considered likely to cause a significant environmental impact, including to the ancient coastline KEF, given the high background levels of natural sediment

movement in the area, the minor disturbance caused by the activity and the short duration of the activity.

+ Benthic habitats in the MEFF field are largely bare sediments with associated sparse assemblages of filter- and deposit-feeders. This habitat type and associated biota are very widely represented in the region and not of conservation significance. The field is in approximately 130-160 m water depth and insufficient light reaches the seabed to support photosynthetic organisms such as zooxanthellate corals, seagrasses and macroalgae. Given the widespread representation of these communities and the localised and intermitted physical disturbance, negligible impacts are expected to occur as a result of the continued presence of seabed equipment in situ.

8.2.3 Environmental performance outcomes and control measures

EPOs relating to this event include:

+ Seabed disturbance is limited to planned activities and defined locations within the operational area [MEFF-EPO-02].

The control measures considered for this activity are shown in **Table 8-3** with EPSs and measurement criteria for the EPOs described in **Section 10.4**.

Table 8-3: Control measures evaluation for seabed disturbance

CM reference	Control measure	Environmental benefit	Potential cost / issues	Evaluation
Standard Control Measures				
MEFF-CM-16	Pre- and post-floating asset removal seabed ROV surveys of wet storage locations	Provides baseline and confirms understanding of physical environment in operational area pre and post activities.	Costs associated with personnel and operations time in conducting surveys.	**Adopted** – Benefits considered to outweigh negligible costs to Santos.
MEFF-CM-17	Wet storage positioning	Wet storage within the existing DTM PSZ limits the potential for environmental impacts.	Negligible costs of acquiring and operating ultra-short baseline / low baseline to position equipment that is wet-stored.	**Adopted** – Benefits considered to outweigh negligible costs to Santos.
MEFF-CM-18	Sediment sampling and analysis plan will be developed if sediment sampling is conducted as part of IMMR campaigns	Sediment sampling methods and locations outlined within a sampling and analysis plan. Ensures effective delivery of sediment sampling program.	Costs associated with personnel time in developing plan.	**Adopted** – Benefits considered to outweigh costs and is a legislated requirement.
MEFF-CM-19	ROV assessment of substrate at	Ensures no hard substrate communities impacted as a result of	Costs associated with personnel and operations time in	**Adopted** – Benefits considered to outweigh costs.

CM reference	Control measure	Environmental benefit	Potential cost / issues	Evaluation
	sediment sampling locations	environmental sediment sampling.	conducting surveys.	
MEFF-CM-13	As left survey	Confirms understanding of physical environment in operational area post activities.	Costs associated with personnel and operations time in conducting surveys.	**Adopted** – Benefits considered to outweigh costs to Santos.
Additional Control Measures				
N/A	No removal of floating and seabed assets	Would eliminate the seabed disturbance caused by removal of floating and seabed assets.	Removal of floating and seabed assets is a requirement of Santos' decommissioning of the MEFF Field.	**Rejected** – As removal of floating and seabed assets is a requirement of Santos' decommissioning of the MEFF Field.
N/A	No wet storage of equipment on the seabed	Would eliminate the seabed disturbance caused by wet storage.	Not considered as wet storage is required for some equipment prior to decommissioning campaigns, or in the event of issues during removal of floating assets.	**Rejected** – Not feasible. Wet storage is required for some equipment and as a contingency if equipment planned for removal cannot be removed during the floating asset removal campaign. Impact of seabed disturbance is low, given the lack of sensitive receptors.
N/A	No deburial of seabed assets prior to removal	Reduction of seabed disturbance and sediment plume during seabed asset removal activities.	Option cannot be ruled out due to safety concerns; the recovery load may be too great without deburial.	**Rejected** – Deburial may be required to reduce recovery loads to enable safe recovery of equipment. Seabed disturbance will occur without deburial activities, as sediment will be disturbed if buried assets are lifted prior to deburial. Deburial will be minimised as much as practicable.

8.2.4 Environmental impact assessment

Receptor	Consequence Level
Seabed disturbance	
Threatened, migratory or local fauna	No sensitive seabed features are known to occur within the operational area. The areas of seabed that will be impacted are expected to be characterised by homogenous, flat, featureless soft sediment, predominately comprised of sand with small rubble / shell fragments. These sediments are un-vegetated and likely to have sparse benthic and epi-benthic communities with low biodiversity (refer to **Section 5.2.2**). Marine invertebrates may inhabit soft sediments and can contribute to the diet of some fauna. The area of soft sediment habitat that is potentially impacted is small compared to the amount of habitat available and therefore the disturbance is not expected to affect prey availability, or protected fauna species. Habitat modification is identified as a potential threat to a number of marine fauna species in relevant recovery plans and conservation advice (**Table 5-10**). However, the area of disturbance has not been identified as a habitat that supports any protected species. Impacts will be temporary, and the area potentially impacted is small compared to the size of the areas used by these species for foraging. Therefore, no long-term impacts to these species are expected. No decrease in local population size, area of occupancy of species, loss or disruption of critical habitat or disruption to the breeding cycle of any of these protected matters is expected. Given the small-scale area of the activity, minor and short-term nature of direct and 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 considered to be II (Minor).
Physical environment or habitat	Impacts may occur from direct disturbance to the seabed or from elevated turbidity in the water column, which has the potential for slight and short-term impacts to benthic fauna through clogging of respiratory and feeding parts of filter-feeding organisms. The area of physical environment and habitat that will be impacted during the proposed activities is small compared to the area of similar habitat in the wider environment and is expected to re-establish following disturbance. Given the widespread representation of these communities and the localised physical disturbance, long-term or significant impacts to habitat values or ecosystem function are not expected. Impacts to the physical environment or habitat are assessed as II (Minor).
Threatened ecological communities	Not applicable – No threatened ecological communities are identified in the area where seabed disturbance could occur.
Protected areas	Not applicable – No Protected Areas are identified in the area where seabed disturbance could occur.
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	II – Minor

8.2.5 Demonstration of as low as reasonably practicable

The presence of seabed equipment in offshore fields is normal industry practice. The planned activities will cause some disturbance of the seabed and associated fauna / habitats as well as short-term and localised turbidity. With regards to the continued presence of abandoned seabed equipment, any scouring and turbidity is also likely to be localised and seasonal. The planned activities will take place in an area that has been previously disturbed. Given the remote offshore location, the sparse habitats in the operational area and the absence of significant fishing effort in the area, no sensitive environmental receptors will be affected. There is little uncertainty associated with this aspect. A stakeholder request for further information regarding timing, location and duration of wet storage, and potential environmental impacts, was addressed by Santos with no further requests from the stakeholder.

All practicable control measures have been reviewed (**Section 8.2.3**) and those adopted are considered appropriate to manage the impacts such that the residual consequence is assessed to be minor and cannot be reduced further. The proposed management controls for seabed disturbance are in accordance with Santos' risk management criteria and are considered appropriate to manage the risk to ALARP.

8.2.6 Acceptability evaluation

Is the consequence ranked as I (Negligible) or II (Minor)	Yes – maximum consequence from seabed disturbance is II (Minor).
Is further information required in the consequence assessment?	No – potential impacts and risks are well understood through the information available.
Are risks and impacts consistent with the principles of ESD?	Yes – activity evaluated in accordance with Santos' Environmental Hazard Identification and Assessment Procedure (EA-91-IG-00004_5), which considers principles of ESD. The consequence against this aspect is II (Minor) and therefore does not affect the outcomes of the principles of ecologically sustainable development as per **Table 7-5**.
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.
Are risks and impacts consistent with Santos' Environmental, Health and Safety Policy?	Yes – aligns with Santos' Environmental, Health and Safety Policy.

Are risks and impacts consistent with stakeholder expectations? **Related to cessation phase and floating asset removal activities**	Yes – WAFIC requested further information regarding timing (duration of temporary wet storage) and the associated risks to the marine environment and commercial fishing. Santos responded to these requests made during consultation (**Table 6-3**), advising the equipment planned for temporary wet storage is connected to the DTM and MWAs. As per (**Table 6-3**) Santos proposed to disconnect the equipment when the DTM and MWAs are removed and, if these are not removed, these will be temporarily stored / wet parked until full field decommissioning, which is planned to commence in Q3 / Q4 2024. Santos does not envisage any additional risk or impact to the marine environment or commercial fishing as the equipment is currently in the water column and will be laid on the seabed and stabilised after disconnection from the DTM and MWAs. The production risers will be capped before being placed on the seabed. Additionally, all equipment currently related to the MEFF field was marked on nautical maps, which also show cautionary zones around the area. Santos considers these requests have been addressed.
Are risks and impacts consistent with stakeholder expectations? **Related to seabed equipment removal and abandonment in situ activities**	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 Minor (II). With the control measures in place, including compliance with industry standards and legislation, no significant impacts are expected. Therefore, the impacts of seabed and benthic habitat disturbance considered ALARP and environmentally acceptable.

8.3 Light emissions

8.3.1 Description of the event

Event	Light emissions will occur as a result of: + vessel operations + ROV operations. Vessels will routinely have external lighting to facilitate navigation and safe operations at night. Lighting typically consists of bright white (i.e. metal halide, halogen, fluorescent) lights, and are not dissimilar to other offshore activities in the region, including fishing and shipping. The ROV will be used during the activity and it will require the use of spot lighting while it is underwater working. Lighting will typically consist of bright white (i.e. metal halide, halogen, fluorescent) lights.
Extent	The light assessment boundary of 20 km from the source will be used as the extent of light exposure in accordance with National Light Pollution Guidelines for Wildlife (Commonwealth of Australia, 2020).
Duration	Navigational and safety lighting will be required on a 24-hour basis for the duration of the activity as described in **Section 4.1**.

8.3.2 Nature and scale of environmental impacts

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

Continuous lighting emanating from the same location for an extended period of time may result in alterations to fauna behaviour. The combination of colour, intensity, closeness, direction and persistence of a light source are key factors in determining the magnitude of environmental impact (EPA, 2010). Disturbance may include the following:

+ Seabirds may either be attracted by the light source itself or indirectly due to marine fauna prey (such as fish and invertebrates) being attracted to light.
+ Marine turtles and turtle hatchlings may be misoriented and disoriented by lights.
+ Fish and zooplankton may be directly or indirectly attracted to lights.

According to the National Light Pollution Guidelines for Wildlife, a 20 km threshold provides a precautionary limit based on observed effects of sky glow on marine turtle hatchlings, demonstrated to occur at 15 to 18 km from the light source and fledgling seabirds grounded in response to artificial light 15 km away. The intensity and extent of light glow, and the potential to result in biological impact, will depend on the light source itself, including the number, intensity, spectral output and position of individual lights at the source. The effect of light glow may occur at distances greater than 20 km for some species and under certain environmental conditions (Commonwealth of Australia, 2020).

Marine mammals

As described in **Section 5.2.4**, the pygmy blue whale distribution BIA overlaps the operational area. However, cetaceans and other marine mammals are not known to be significantly attracted to light sources at sea. Cetaceans predominantly use acoustic senses to monitor their environment rather than visual cues (Simmonds *et al*., 2004). Therefore, impacts are considered unlikely.

Marine turtles

The operational area does not intersect any BIAs for marine turtles (**Table 5-9**). The closest BIA for marine turtles (an interesting buffer BIA for the green turtle) lies more than 60 km away, and the nearest turtle nesting beach is more than 120 km away, at Dampier Archipelago, including Delambre Island and Hauy Island. However, it is possible individuals may traverse the operational area.

Marine turtles are particularly sensitive to artificial lighting, which is known to disrupt breeding adult turtles, post-emergent hatchlings and hatchlings dispersing in nearshore waters (Limpus, 1971; Salmon *et al.*, 1992; Limpus, 2007, 2008a, 2008b, 2009a, 2009b; Wilson *et al*., 2018).

The Recovery Plan for Marine Turtles in Australia: 2017–2027 (Commonwealth of Australia, 2017) highlights artificial light as one of several threats to marine turtles. The recovery 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
+ 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 and Rich, 2016, in EPA, 2010). This disruption can occur because hatchlings orient themselves to the lowest-elevation light horizon and away from high silhouettes when moving from the nest to the sea. When the direction of the lowest elevation light horizon is not clear, hatchlings move towards the brightest, lowest horizon (Limpus & Kamrowski, 2013).

However, given the distance to the nearest turtle nesting beach is more than 120 km away (Dampier Archipelago), light from the vessel will not be visible and therefore impacts to nesting females, emerging hatchlings and internesting females are not credible. At these distances post-dispersal hatchings will be well dispersed, so the potential for them to drift through the operational area is reduced compared to nearshore areas adjacent to nesting beaches.

The National Light Pollution Guidelines states that a 20 km buffer (based on sky glow) to important habitat for turtles should be applied when considering possible impacts (Commonwealth of Australia, 2020). However, the demonstrated impacts on which this buffer is based were in response to light emissions associated with a liquefied natural gas plant. Although details around the individual light sources of the case study and the light sources on the vessels are unknown, it is expected that light emissions associated with vessels will be notably lower compared to a liquefied natural gas plant. Given the operational area is located greater than 60 km away from the nearest turtle nesting BIA, light emissions will not be visible. Experienced nesting females are unlikely to be disturbed by light, but first-time nesters may be disturbed by light when they are selecting their first nesting beach (Pendoley, 2014). Given the closest nesting BIA is greater than 60 km from the operational area, nesting females should not be disorientated by light emissions. Furthermore, once in the water, turtle hatchlings orientate by wave fronts and do not appear to rely on visual cues (Pendoley, 2014); therefore, light emissions should not cause disorientation at that distance (i.e. greater than 20 km).

Impacts to turtles from operational activity lighting are expected to be restricted to localised attraction and temporary disorientation of individuals passing through the area, but with no long-term or residual impact due to the activity's relatively short-term nature (i.e. approximately 14 days for IMMR activities, approximately 45 to 90 days for floating asset removal, approximately 12 months cumulative duration, likely over multiple campaigns, for seabed asset removal and preparation for leaving equipment in situ, depending on weather delays and operational downtime), and the unlikely presence of hatchlings due to the distance from the nearest shorelines. It is considered that the activity will not compromise the objectives as set out in the marine turtle recovery plan and that the impact of lighting associated with the activity to turtles is negligible.

Sharks, Fish and Rays

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 (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. Lighting impacts may increase the risk of predation to these fish species. Shaw *et al.* (2002), in a similar light trap study, noted that juvenile tunas (Scombridae) and jacks (Carangidae), which are highly predatory, may have been preying upon concentrations of zooplankton attracted to the light field of the platforms. This could potentially lead to increased predation rates compared to unlit areas.

However, the low level of light emitted from a vessel is unlikely to lead to large-scale changes in species abundance or distribution. Impacts to transient fish will therefore be limited to short-term behavioural effects, with no decrease in local population size or area of occupancy of species nor loss or disruption of critical habitat or disruption to breeding cycles.

A localised increase in fish activity as a result of vessel lighting is expected to occur as a result of the activity.

Birds (seabirds / shorebirds)

Lighting from vessels may result in behavioural impacts to seabirds including terns and shearwaters. However, as activities will be for a relatively short duration, the consequence is considered negligible.

Studies conducted between 1992 and 2002 in the North Sea confirmed that artificial light was the reason birds were attracted to, and accumulated around, illuminated offshore equipment (Marquenie *et al*., 2008) and that lighting can attract birds from large catchment areas (Wiese *et al*., 2001). Birds may either be attracted by the light source itself or indirectly as structures in deep-water environments tend to attract marine life at all trophic levels, creating food sources and shelter for seabirds. The light from vessels may also provide enhanced capability for seabirds to forage at night.

Light potentially impacts breeding seabirds in the operational area in much the same way as it does marine turtles, though is species-dependent, and some seabirds may not be expected to experience any impact at all due to their diurnal behaviour (such as terns). Disoriented adult birds may not be able to return to their nests to relieve their mates or feed their young. Fledglings are particularly vulnerable to light through misorientation and disorientation when departing the colony for the first time.

The operational area does not overlap any BIAs for seabirds; therefore, the location of the operational area should not significantly impact seabird behaviour, given the large distances typically covered by breeding individuals.

8.3.3 Environmental performance outcomes and control measures

EPOs relating to this event include:

+ Reduce impacts to marine fauna from lighting on vessels through limiting lighting to that required by safety and navigational lighting requirements [MEFF-EPO-03].

The control measures considered for this activity are shown in **Table 8-4** with EPSs and measurement criteria for the EPOs described in **Section 10.4**.

Table 8-4: Control measures evaluation for light emissions

CM reference	Control measure	Environmental benefit	Potential cost / issues	Evaluation
Standard Control Measures				
MEFF-CM-06	Lighting will be used as required for safe work conditions and navigational purposes only	Light spill from unnecessary lighting reduced, even further lowering likelihood of impacts to the fauna from vessel lighting. 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, thus reducing the potential impacts to fauna.	No additional costs associated with implementing control.	**Accepted** – Cost is considered acceptable for the benefit that may be realised from this control.
Additional Control Measures				
N/A	Manage the timing of the activity to avoid sensitive periods at the location (e.g. turtle nesting / hatching).	Reduce risk of impacts from light emissions during environmentally sensitive periods for listed marine fauna (e.g. turtle nesting / hatching).	The operational area is not located in an area that is likely to cause impact to turtle nesting or hatching and therefore timing the activity to avoid this would not change the potential environmental impacts.	**Rejected** – Given the minimal risk of impacts to listed marine species (e.g. turtles) occurring due to lighting, the financial and environmental costs of extending the activity duration are deemed grossly disproportionate to low environmental benefits.

CM reference	Control measure	Environmental benefit	Potential cost / issues	Evaluation
N/A	Use of shrouding on external lights	Reduce potential for impacts on turtles from light emissions during hours of darkness when light sources are more apparent and potential impacts are greatest.	Cost associated with retro fitting external lighting with shrouding / shielding. Can only be done for lighting that does not impact on navigational requirements or safety.	**Rejected** – Given the minimal risk of impacts to listed marine species (e.g. turtles) occurring due to lighting, the financial costs of retrofitting external lighting are deemed grossly disproportionate to the low environmental benefits.
N/A	Use of dark, matt surfaces to reduce sky glow across all activities	Reduce potential for impacts on turtles from light emissions during hours of darkness when light sources are more apparent and potential impacts are greatest.	Additional cost to repaint vessel surfaces.	**Rejected –** Given the minimal risk of impacts to listed marine species (e.g. turtles) occurring due to lighting, the financial costs of repainting vessels surfaces are deemed grossly disproportionate to low environmental benefits.
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 vessels in area of low sensitivity. Navigational lighting colours are stipulated by law.	**Rejected** – Given the minimal risk of impacts to listed marine species (e.g., turtles) occurring due to lighting, the financial costs of replacing lighting types on vessels are deemed grossly disproportionate to low environmental benefits.

CM reference	Control measure	Environmental benefit	Potential cost / issues	Evaluation
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 impacts are greatest.	Would double duration of activity, increase impacts or potential impacts in other areas, including increase in waste, air emissions, risk of vessel collision, etc. A minimal level of artificial lighting will still be required on-board the vessels on a 24-hour basis for safety reasons.	**Rejected** – Given the minimal risk of impacts to turtles occurring, the financial and environmental costs by requiring all works to be undertaken during daylight hours only are not considered appropriate, given the extended duration of the activity that would occur.

8.3.4 Environmental impact assessment

Receptor	Consequence Level
Light Emissions	
Threatened, migratory or local fauna	Sensitive receptors that may be impacted by light emissions in the same location for an extended period of time include fish at the surface, marine turtles and seabirds. Impacts to marine fauna are expected to be restricted to localised attraction and temporary disorientation but with no long-term or residual impact and no decrease in local population size, area of occupancy of species or loss or disruption of critical habitat / disruption to the breeding cycle. The potential impacts are therefore considered to be I (Negligible).
Physical environment or habitat	Not applicable – No impacts to physical environments and / or habitats from light emissions are expected.
Threatened ecological communities	Not applicable – No threatened ecological communities identified in the area over which light emissions are expected.
Protected areas	Not applicable – No protected areas are identified in the area over which light emissions are expected.
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

8.3.5 Demonstration of as low as reasonably practicable

With the described controls, the consequence of artificial light on marine fauna and seabirds is considered negligible, with insignificant impacts to ecological function. No population level impacts are expected and the consequence is considered environmentally acceptable. A minimum level of artificial lighting is required for operational and navigational safety during the activity, including to alert other marine users of the activity. There are also minimum light requirements that will be necessary to provide safe working conditions. Limiting or excluding night-time operations would resulting in the activity taking around twice as long to complete. This would increase the period of time the operational area would need to be avoided by other marine users and the volume of waste, vessel discharges and emissions produced.

As the operational area is located more than 120 km from the nearest turtle nesting beaches (Dampier Archipelago), vessel light emissions will not be visible from the beaches. The operational area does not overlap any BIAs for seabirds; therefore, the location of the operational area should not significantly impact seabird behaviour, given the large distances typically covered by breeding individuals.

The activity will not compromise the objectives as set out in the Recovery Plan for Marine Turtles in Australia (Commonwealth of Australia, 2017), the Draft Wildlife Conservation Plan for Seabirds (Commonwealth of Australia, 2019) or the National Light Pollution Guidelines for Wildlife (Commonwealth of Australia, 2020), as biologically important behaviours of nesting turtle and seabird adults and emerging / dispersing hatchlings can continue, given the distance from the nearest nesting beaches. The assessed residual consequence for this impact is negligible and cannot be reduced further.

Additional control measures were considered but rejected since the associated cost or effort was grossly disproportionate to any benefit, as detailed in **Section 8.3.3**. Given lighting on the vessels will be consistent with industry standards, will result in negligible consequences, the use of 24-hour per day artificial lighting at an intensity to allow work to proceed safely is considered ALARP and acceptable.

8.3.6 Acceptability evaluation

Is the consequence ranked as I or II?	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 ESD?	Yes – activity evaluated in accordance with Santos' Environmental Hazard Identification and Assessment Procedure (EA-91-IG-00004_5) which considers principles of ecologically sustainable development. The consequence against this aspect is I (Negligible) and therefore does not affect the outcomes of the principles of ecologically sustainable development as per **Table 7-5.**
Are risks and impacts consistent with relevant legislation, international agreements and conventions, guidelines and codes of practice (including species recovery plans, threat abatement plans, conservation advice and Australian Marine Park zoning objectives)?	Yes – management consistent with International Convention of the *Safety of Life at Sea (SOLAS) 1974 and the Navigation Act 2012* and will not compromise the objectives set out in relevant species recovery plans, conservation management plans and management actions set out in **Table 5-10**.
Are risks and impacts consistent with Santos' Environment, Health and Safety Policy?	Yes – aligns with Santos' Environment, Health and Safety Policy.
Are risks and impacts consistent with stakeholder expectations? **Related to cessation phase and floating asset removal activities**	Yes – no concerns raised.
Are risks and impacts consistent with stakeholder expectations?	Yes – no concerns raised.

Related to seabed equipment removal and abandonment in situ activities)	
Are performance standards such that the impact or risk is considered to be ALARP?	Yes – see ALARP.

Artificial lighting is required 24-hours a day for operational and navigational safety during the activity. 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 individual fauna that may be present in the operational area during the activity.

The Recovery Plan for Marine Turtles in Australia (Commonwealth of Australia, 2017) specifies the following priority action for the turtles in relation to light pollution:

+ Artificial light within or adjacent to habitat critical to the survival of marine turtles will be managed such that marine turtles are not displaced from these habitats.

The operational area does not overlap any BIAs for turtles. Significant impacts are not expected on fauna, including nesting turtles or hatchlings, and will not cause turtles to be displaced from these habitats.

The operational area does not overlap any BIAs for seabirds; therefore, the proposed activities with the operational area should not significantly impact seabird behaviour, given the large distances typically covered by breeding individuals.

The potential consequence of light emissions on receptors is assessed as Negligible (I). With the control measures in place, including compliance with navigational safety legislation, no significant impacts are expected. Therefore, the impacts of light emissions to the receiving environment are ALARP and considered environmentally acceptable.

8.4 Noise emissions

8.4.1 Description of the event

Event	Potential impacts from noise emissions may occur in the operational area from: + vessel activities + ROV activities including marine growth removal subsea and ROV sonar + helicopter activities + equipment positioning using low baseline or ultra-short baseline + subsea cutting tools (such as diamond wire saw, hydraulic shear cutter, super grinder or multi cutters) used during riser disconnection, DTM and MWA mooring chain and tether disconnection and rigid flowline removal (if cut and lift methodology is adopted) + Deburial equipment (such as mass flow excavators, ROV-mounted suction pump or water jet) + Recovery equipment (such as mechanical pipe grabs, cranes or winches)
Extent	Impacts from all potential noise sources will be localised. This is based on: + noise from ROV operations being limited to when ROVs are operating within the operational area + vessel using main engines and bow thrusters to maintain position will become inaudible above background noise within around 1 km + noise from helicopters being limited to when they are transiting over the operational area. + noise from subsea cutting tools will be limited to when subsea cutting tools are operating + noise from deburial and recovery equipment will be limited to when they are operating in the operational area Cumulative effects from the activity and from other activities conducted in the vicinity are not expected.
Duration	For the duration of the activity, as described in **Section 4.1**.

8.4.1.1 Noise generated by 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 vessels, the noisiest anticipated activity is when the vessel uses thrusters to maintain its position. Whilst there is no direct studies or data for underwater noise relating to a PLV operating on DP, the PLV is likely to have similar DP thruster power as a MODU. McCauley (1998) reported noise levels generated by a semi submersible rig, during non-drilling periods the typical broadband level encountered was approximately 113 dB (rms) re 1 µPa@125 m with various tones from the machinery observable in the noise spectra. Studies undertaken in the Arctic on different MODU types (including semi-submersible and drill ships) indicate that noise levels dropped to 117 dB re 1 µPa within 1 km of the MODU and are much lower than those for large commercial vessels operating at normal speeds (Austin et al., 2018).

McCauley (1998) measured underwater sound pressure levels equivalent to around 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). McCauley (1998) also measured underwater sound levels from the Pacific Ariki, a 64 m long support vessel with 8000 HP (6000 kW) main engines during calm conditions in the Timor Sea in 110 m of water while transiting at 11 knots, and found the distance to 120 dB re 1 µPa to be around 1 km. More recently, Koessler and McPherson (2020) modelled underwater sound levels from an offshore support vessel (OSV) in 90 m of water, with underwater SPL of 183 dB re 1 µPa @ 1 m whilst operating all three thrusters. The modelling indicated that thruster noise dropped below 120 dB re 1 µPa within 4 to 5 km. 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. inspection and maintenance activities will typically require the vessel to be moving slowly at around four knots.

8.4.1.2 Noise generated by helicopters

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, with sound penetrating water at angles less than 13°. The noise from the flyover of a Bell 214 helicopter (stated to be a noisy model) has been recorded underwater (Richardson *et al.*, 1995). The sound source was 162 dB re 1 µPa @ 1 m at its peak and had frequency of 155 Hz.

8.4.1.3 Noise generated by remote operated vehicles operations

As underwater sound levels are dependent on the primary (noisiest) sound source rather than being strictly additive, and since ROV operations will be undertaken from a vessel, they will make little contribution to the overall noise emissions associated with vessel activities, as described above and are not risk assessed further. The ROV will not be equipped with multi-beam echo sounder, side scan sonar or sub bottom profiling sensors.

8.4.1.4 Noise generated by positioning equipment

A low baseline or ultra-short baseline transponder may be temporarily attached on equipment that is being lowered to or positioned on the seabed. Transponders typically emit pulses of medium frequency sound, generally within the range 21 to 31 kHz. The estimated sound pressure level (SPL) would be 180 to 206 dB re 1 µPa at 1 m (Jiménez-Arranz *et al.*, 2017). Transmissions are not continuous but consist of short ‘chirps’ with a duration that ranges from 3 to 40 milliseconds. A DP compatibility transponder / beacon may also be deployed temporarily on the seabed. All transponders / beacons will be recovered to vessel deck after each deployment.

8.4.1.5 Noise generated by subsea cutting and deburial tools

The subsea cutting of seabed assets using a subsea cutting tool may generate underwater noise. Similarly, deburial equipment (such as mass flow excavators, ROV-mounted suction pump or water jet) may generate underwater noise if required during the activity.

Twachtman et al. (2004) studied the operations and socio-economic impact of non-explosive removal of offshore structures, including noise, and concluded that mechanical cutting and abrasive water jet, as well as diamond wire cutting methods, are generally considered harmless to marine life and the environment. Similarly, Pangerc et al. (2016) described the underwater sound measurement data during an underwater diamond wire cutting of a 32-inch conductor (10 m above seabed in around 80 m depth) and found the sound radiated from the diamond wire cutting of the conductor was not easily discernible above the background noise at the closest recorder located 100 m from the source. The sound that could be associated with the diamond wire cutting was primarily detectable above the background noise at the higher acoustic frequencies (above around 5 kHz) (Pangerc et. al., 2016) above the hearing range of low frequency cetaceans.

As underwater sound levels are dependent on the primary (noisiest) sound source rather than being strictly additive, and since cutting or deburial operations will be undertaken using an ROV or directly from a vessel, they will make little contribution to the overall noise emissions associated with vessel activities as described above and are not risk assessed further.

8.4.2 Nature and scale of environmental impacts

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

The operational area, including a 20 km buffer, overlaps three BIAs, outlined in **Table 8-5**.

Table 8-5: Summary of biologically important areas that overlap the operational area (including 20 km buffer)

Location	BIA				
	Internesting BIA	Migration BIA	Foraging BIA	Breeding BIA	Distribution
Operational area	-	Pygmy blue whale	Whale shark	-	Pygmy blue whale

The use of sound in the underwater environment is important for marine animals, particularly cetaceans, to navigate, communicate and forage effectively, along with turtles, sharks, rays and other fish, for a range of functions such as social interaction, foraging and orientation. Underwater noise may impact on marine fauna through:

+ attraction to the noise source
+ increased stress levels
+ disruption to underwater acoustic cues
+ localised avoidance
+ disturbance, leading to behavioural changes or displacement from areas
+ masking or interference with other biologically important sounds such as communication or echolocation
+ physical injury to hearing or other organs
+ indirectly by inducing behavioural and physiological changes in predator or prey species.

The nature and scale of impacts must be considered in the context of the ambient noise environment. Ambient underwater noise levels are dependent on location, and are often dominated by local wind noise, waves, biological noise and ship traffic. Wind speed and seabed conditions have a clear influence on the ambient noise level. Existing anthropogenic underwater noise sources in the region of the proposed activity include shipping, small vessel traffic, and petroleum-production activities.

Marine fauna respond variably when exposed to underwater noise from anthropogenic sources, with effects dependent on a number of factors, including distance from the sound source, water depth and bathymetry, the animal's hearing sensitivity, type and duration of sound exposure and the animal's activity at time of exposure. Broadly, the effects of sound on marine fauna can be categorised as:

+ Acoustic masking – anthropogenic sounds may interfere with, or mask, biological signals, therefore reducing the communication and perceptual space of an individual. Auditory masking impacts may occur when there is a reduction in audibility for one sound (signal) caused by the presence of another sound (noise). For this to occur the noise must be loud enough and have a similar frequency to the signal and both signal and noise must occur at the same time.
+ Behavioural response – behavioural impacts will depend on the audible frequency range of each potential receptor in relation to the frequency of the noise, as marine animals will only

respond to acoustic signals they can detect, as well as the intensity of the noise. The intensity of behavioural responses of marine mammals to sound exposure ranges from subtle responses, which may be difficult to observe and have little implications for the affected animal, to obvious responses, such as avoidance or panic reactions. The context in which the sound is received by an animal affects the nature and extent of responses to a stimulus. The threshold for elicitation of behavioural responses depends on received sound level, as well as multiple contextual factors such as the activity, state of animals exposed to different sounds, the nature and novelty of a sound, spatial relations between a sound source and receiving animals, and the gender, age and reproductive status of the receiving animal.

+ Physiological impacts - auditory threshold shift (temporary and permanent hearing loss) – marine fauna exposed to intense sound may experience a loss of hearing sensitivity, or even potentially mortal injury. Hearing loss may be in the form of a temporary threshold shift (TTS) from which an animal recovers within minutes or hours, or a permanent threshold shift (PTS) from which the animal does not recover.

Available threshold criteria associated with behavioural and physiological impacts for sensitive receptors have been derived from a number of sources (NMFS, 2018; NMFS, 2014; Popper *et al.*, 2014). These criteria have been compared with measured and predicted sound levels for different sound sources to assess potential impacts.

8.4.2.1 Marine mammals

No known aggregation, resting, breeding or feeding areas for cetaceans lie close to the operational area. However, cetaceans may travel through the area; the distribution BIA for the pygmy blue whale overlaps the operational area and the migration BIA for this species is located around 18 km away from the operational area at its closest point. Additionally, the recovery plan for blue whales list noise interference as a potential threat. Pygmy blue whales are low-frequency cetaceans. Low (baleen whales) and high-frequency (toothed whales except porpoises) cetaceans may also frequent the operational area.

To better reflect the auditory similarities between phylogenetically closely related species, but also significant differences between species groups among the marine mammals, Southall *et al.* (2019) assigned the extant marine mammal species to functional hearing groups based on their hearing capabilities and sound production.

Exposure to impulsive noise may be more hazardous to hearing than continuous (non-impulsive) noise. For marine mammals, National Marine Fisheries Service (NMFS) issued a Technical Guidance document that provides acoustic thresholds for the onset of TTS and PTS in marine mammal hearing for all sound sources (NMFS, 2018). Southall *et al.* (2019) published an updated set of criteria for onset of TTS and PTS in marine mammals. While the authors propose a new nomenclature and classification for the marine mammal functional hearing groups, the proposed thresholds and weighting functions for exposure to underwater sound do not differ in effect from those proposed by NMFS (2018). These thresholds that detail receptor noise impacts and behavioural response for continuous noise (vessels) and impulsive noises, along with the new nomenclature and classifications for marine mammals, are summarised in **Table 8-6** and **Table 8-7**.

Behavioural reactions to acoustic exposure are generally more variable, context-dependent, and less predictable than the effects of noise exposure on hearing or physiology. Hence, it is difficult to determine thresholds for behavioural response in individual cetaceans as the way they respond often varies (Nowacek *et al.*, 2004; Gomez *et al.*, 2016; Southall *et al.*, 2019) and is influenced by both biological and environmental factors such as age, sex and the activity at the time. Observed disturbance responses to anthropogenic sound in cetaceans include altered swimming direction; increased swimming speed including pronounced ‘startle’ reactions; changes to surfacing, breathing and diving patterns; avoidance of the sound source area and other behavioural changes.

For non-impulsive noise, NMFS currently uses step function (all-or-none) threshold of 120 dB re 1 µPa SPL (unweighted) to assess and regulate noise-induced behavioural impacts for marine mammals (NOAA, 2019), while for impulsive noise, NMFS uses step function thresholds of 160 dB re 1 µPa SPL (unweighted) (NOAA, 2018; NOAA, 2019). The behavioural disturbance threshold criteria applied summates the most recent scientific literature on the impacts of sound on marine mammal hearing, considered the most relevant to this activity.

Table 8-6: Continuous noise: acoustic effects of continuous noise on low-frequency cetaceans: unweighted sound pressure level and SEL_{24h} thresholds

Hearing Group	NOAA (2019)	NMFS (2018); Southall *et al.* (2019)	
	Behaviour	PTS onset thresholds (received level)	TTS onset thresholds (received level)
	SPL (Lp; dB re 1 µPa)	Weighted SEL24h (LE,24h; dB re 1 µPa2·s)	Weighted SEL24h (LE,24h; dB re 1 µPa2·s)
Low-frequency cetaceans	120	199	179
High-frequency cetaceans	120	198	178
Very High-frequency cetaceans	120	173	153

L_e denotes cumulative exposure over a 24 hour period and has a reference value of 1 µPa^{2}s

Table 8-7: Impulsive noise: unweighted sound pressure level, SEL_{24h} and PK thresholds for acoustic effects on marine mammals

Hearing Group	NOAA (2019)	NMFS (2018); Southall *et al.* (2019)			
	Behaviour	PTS Onset Thresholds (Received Level)		TTS Onset Thresholds (Received Level)	
	SPL (Lp; dB re 1 µPa)	Weighted SEL24h (LE,24h; dB re 1 µPa2·s)	PK (Lpk; dB re 1 µPa)	Weighted SEL24h (LE,24h; dB re 1 µPa2·s)	PK (Lpk; dB re 1 µPa)
Low-frequency cetaceans	160	183	219	168	213
High-frequency cetaceans	160	185	230	170	224
Very High-frequency cetaceans	160	155	202	140	196

Potential impacts from vessels

Auditory masking impacts may occur when there is a reduction in audibility for one sound (signal) caused by the presence of another sound (noise). For this to occur the noise must be loud enough and have a similar frequency to the signal, and both signal and noise must occur at the same time. Therefore, the closer the whale is to the vessel, and the more overlap there is with their vocalisation frequencies, the higher the probability of masking. The potential for masking and communication impacts is therefore classified as high near the vessel (within tens of metres), moderate within hundreds to low thousands of metres (Clark *et al*., 2009).

There is a potential for auditory masking impacts to whales due to vessel noise, however, impacts are considered temporary and localised because the individual and the vessels will be almost constantly moving and therefore no single area will be impacted for any length of time.

Noise from the project vessels would likely exceed PTS thresholds at the source for very high-frequency cetaceans, whilst noise from projects vessels is not expected to be above PTS thresholds for low-frequency or high-frequency cetaceans at any time. Noise from project vessels would likely exceed TTS thresholds for up to hundreds of meters from the source. However, since marine mammals are transient in the operational area, which lacks aggregating habitat such as resting or calving areas, individuals are expected to pass through the operational area, potentially showing localised avoidance via behavioural responses (see below). PTS to very high-frequency cetaceans is unlikely as individuals will likely show avoidance before getting within range, individuals are therefore not expected to remain within the vicinity of the noise source for the duration (24 hours, **Table 8-6**) required to exceed PTS. Underwater noise generated by vessels (continuous noise) does not have the intensity and characteristics likely to cause physiological damage in marine fauna (Nedwell & Edwards, 2004; Hatch & Southall, 2009). For TTS, individuals would need to pass within hundreds of metres of the project vessels during operations. This would result in a temporary impact to a low proportion of the migrating population.

Based on the field measurements and studies discussed in **Section 8.4.1**, the distance from the source to the behavioural threshold for cetaceans (120 dB re 1 µPa) is estimated to be 5 km.

In addition to levels where PTS and TSS impacts are observed there have been observations of marine mammals reacting to aircraft and other anthropogenic impacts, specifically:

+ 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.

This is relevant to understanding the potential impacts of helicopter operations within the operational area.

8.4.2.2 Marine turtles

As described in **Table 5-9**, there are no BIAs for marine turtles within proximity to the operational area. The nearest BIA is more than 60 km away. However, individual marine turtles may pass through the operational area.

The Recovery Plan for Marine Turtles in Australia (Commonwealth of Australia, 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 equipment as sources of chronic (continuous) noise in the marine environment, exposure to which may lead to avoidance of important turtle habitat.

Finneran *et al.* (2017) presented revised thresholds for sea turtle injury and hearing impairment (TTS and PTS). Their rationale is that sea turtles have best sensitivity at low frequencies and are known to have poor auditory sensitivity (Bartol & Ketten, 2006; Dow Piniak *et al.*, 2012; Martin *et al.*, 2012). Accordingly, TTS and PTS thresholds for turtles are likely more similar to those of fishes than to marine mammals (Popper *et al.*, 2014).

Studies show behavioural responses occur to received sound levels of around 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. Based on the limited data regarding noise levels that illicit a behavioural response in turtles, the lower level of 166 dB re 1 µPa level drawn from National Science Foundation (2011) is typically applied, both in Australia and by NMFS, as the threshold level at which behavioural disturbance could occur. The recommended criteria for impulsive and continuous sound sources are shown in **Table 8-8** and **Table 8-9**.

Table 8-8: Acoustic effects of continuous noise on sea turtles

Potential Marine Fauna Receptor	Popper *et al.* (2014)		Finneran *et al.* (2017) Weighted SEL_{24h} ($LE_{,24h}$; dB re 1 µPa^2·s)	
	Masking	Behaviour	PTS onset threshold	TTS onset threshold
Marine Turtle	(N) High (I) High (F) Moderate	(N) High (I) Moderate (F) Low	220	200

Note: Relative risk (high, moderate, low) is given for animals at three distances from the source defined in relative terms as near (N) – tens of metres, intermediate (I) – hundreds of metres, and far (F) – thousands of metres.

Table 8-9: Acoustic effects of impulsive noise on sea turtles: unweighted SPL, SEL24h, and PK thresholds

NFS (2011)	Moein *et al.* (1995); McCauley *et al.* (2000b), (2000a)	Finneran *et al.* (2017)			
Behaviour		PTS onset threshold		TTS onset threshold	
SPL (L_p; dB re 1 µPa)		Weighted SEL_{24h} ($LE_{,24h}$; dB re 1 µPa^2·s)	PK (L_{pk}; dB re 1 µPa)	Weighted SEL_{24h} ($LE_{,24h}$; dB re 1 µPa^2·s)	PK (L_{pk}; dB re 1 µPa)
166	175	204	232	189	226

Potential impacts

Continuous noise sources are below PTS and TTS criteria for marine turtles. Considering the open-ocean location of the operational area, only individual turtles may be affected as they transit the area, and impacts are not considered significant based on the following:

Vessel noise is expected to be below the thresholds for PTS and TTS, given the typical size vessels used during the activity and the slow vessel speeds within the operational area, the received levels may result in behavioural impacts, but for a limited duration and will not result in significant impacts, and helicopter and ROV noise will be intermittent during the activity, and below the thresholds for behavioural impacts, PTS and TTS.

8.4.2.3 Sea snakes

There is limited information about the effects of noise on sea snakes. A current research project investigating the impacts of seismic surveys found that hearing sensitivity of sea snakes is similar to species of fish without a swim bladder (discussed below). Therefore, it is considered that there is a moderate risk in the near and intermediate distances (which extends hundreds of metres) of behavioural impacts to sea snakes, with the impacts being limited to temporary avoidance of the area.

8.4.2.4 Sharks, rays and fish

The whale shark foraging BIA overlaps the operational area. 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 groups, comprising fishes:

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

The criteria defined in Popper *et al.* (2014) for continuous (**Table 8-10**) and impulsive (**Table 8-11**) noise sources have been adopted.

Table 8-10: Continuous noise: criteria for noise exposure for fish (adapted from Popper et al., 2014)

Potential Marine Fauna Receptor	Mortality and Potentially Mortal Injury	Impairment			Behaviour
		Recoverable Injury	TTS	Masking	
Fish: No swim bladder (particle motion detection)	(N) Low (I) Low (F) Low	(N) Low (I) Low (F) Low	(N) Moderate (I) Low (F) Low	(N) High (I) High (F) Moderate	(N) Moderate (I) Moderate (F) Low
Fish: Swim bladder not involved in hearing (particle motion detection)	(N) Low (I) Low (F) Low	(N) Low (I) Low (F) Low	(N) Moderate (I) Low (F) Low	(N) High (I) High (F) Moderate	(N) Moderate (I) Moderate (F) Low
Fish: Swim bladder involved in hearing (primarily pressure detection)	(N) Low (I) Low (F) Low	170 dB SPL for 48 h	158 dB SPL for 12 h	(N) High (I) High (F) High	(N) High (I) Moderate (F) Low
Fish eggs and fish larvae	(N) Low (I) Low (F) Low	(N) Low (I) Low (F) Low	(N) Low (I) Low (F) Low	(N) High (I) Moderate (F) Low	(N) Moderate (I) Moderate (F) Low

Note: Relative risk (high, moderate, low) is given for animals at three distances from the source defined in relative terms as near (N) – tens of metres, intermediate (I) – hundreds of metres, and far (F) – thousands of metres.

Table 8-11: Impulsive noise: criteria for noise exposure for fish (adapted from Popper et al., 2014)

Potential Marine Fauna Receptor	Mortality and Potential Mortal Injury	Impairment			Behaviour
		Recoverable Injury	TTS	Masking	
Fish: No swim bladder (particle motion detection)	> 219 dB SEL_{24h} or > 213 dB PK	> 216 dB SEL_{24h} or > 213 dB PK	> 186 dB SEL_{24h}	(N) Low (I) Low (F) Low	(N) High (I) Moderate (F) Low
Fish: Swim bladder not involved in hearing (particle motion detection)	210 dB SEL_{24h} or > 207 dB PK	203 dB SEL_{24h} or > 207 dB PK	> 186 dB SEL_{24h}	(N) Low (I) Low (F) Low	(N) High (I) Moderate (F) Low
Fish: Swim bladder involved in hearing (primarily pressure detection)	207 dB SEL_{24h} or > 207 dB PK	203 dB SEL_{24h} or > 207 dB PK	186 dB SEL_{24h}	(N) Low (I) Low (F) Moderate	(N) High (I) High (F) Moderate
Fish eggs and fish larvae	> 210 dB SEL_{24h} or > 207 dB PK	(N) Moderate (I) Low (F) Low	(N) Moderate (I) Low (F) Low	(N) Low (I) Low (F) Low	(N) Moderate (I) Low (F) Low

Note: Relative risk (high, moderate, low) is given for animals at three distances from the source defined in relative terms as near (N) – tens of metres, intermediate (I) – hundreds of metres, and far (F) – thousands of metres.

Potential impacts from continuous noise

Based on criteria developed by Popper *et al.* (2014) for noise impacts on fish, vessel, helicopter and ROV noise has a low risk of resulting in mortality and a moderate risk of TTS impacts when fish are within tens of metres from the source. The most likely impacts to fish from noise will be behavioural responses. Popper *et al.* (2014) identified a moderate risk of behavioural impacts to fish in near (tens of metres) and intermediate distances (hundreds of metres) from the noise source. Masking could occur within thousands of metres under a worst-case scenario of vessel operations; however, typically any effect will be limited to within hundreds of metres.

Whale sharks could potentially be impacted from operational noise if in the 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 NWS.

Potential impacts from impulsive noise

Thresholds for PTS and recoverable injury from impulsive noise are between 207 dB PK and 213 dB PK (depending on the presence or absence of a swim bladder), and the threshold for TTS is 186 dB SELcum (Popper *et al.*, 2014). Given there is no exposure criteria for sharks and rays, the same criteria are adopted, though typically sharks and rays do not possess a swim bladder.

Individual demersal fish may be impacted in the vicinity of the activity and tuna and billfish and other mobile pelagic species may transverse the operational area. However, the operational area is not known to be an important spawning or aggregation habitat for commercially caught targeted species. Therefore, no impacts to fish stocks are expected.

8.4.2.5 Invertebrates

Underwater noise emissions from the activity are not expected to cause a change in behaviour to benthic invertebrates.

Benthic invertebrates are unlikely to be negatively impacted from noise generated from vessel operations; there is no convincing scientific evidence for any significant effects induced by non-impulsive noise in benthic invertebrates.

Plankton, including fish eggs and larvae, and pelagic invertebrates could drift into proximity to high-energy noise sources (for example, bow thrusters). However, 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.

8.4.2.6 Protected and significant areas

The operational area does not intersect any marine parks. The nearest AMP is the Montebello AMP (Multiple Use Zone – IUCN Category VI) which is located 99 km from the operational area. Due to the distance of the AMP from the operational area, impacts from noise emissions on the values of the AMP are not expected.

No recognised breeding or resting area for marine mammals, cetaceans, shark or fish species are known to occur in the operational area. However, a foraging BIA for whale sharks and a distribution BIA for the pygmy blue whale overlap the operational area (see impact assessment above).

8.4.2.7 Summary

Noise emissions associated with the activity are not expected to cause physical injury to marine fauna, particularly marine mammals. Although noise from project vessels is likely to exceed TTS thresholds for marine mammals up to hundreds of meters from the source, marine mammals are transient in the operational area, which lacks aggregating habitat such as resting or calving areas. Individuals are expected to pass through the operational area in a wide open operational area, potentially showing localised avoidance via behavioural responses.

Noise levels from the vessels, helicopters and ROV that may cause behavioural responses are expected to generally be confined to the operational area and concentrated within a radius of 5 km for vessels and a few hundred metres for helicopters and ROVs from the noise source.

Noise impacts on fish from vessel, helicopter and ROV noise has a low risk of resulting in mortality and a moderate risk of TTS impacts when fish are within tens of metres from the source. However, the operational area is not known to be an important spawning or aggregation habitat for commercially caught targeted species and any impact on recreational fishing is also expected to be minimal.

8.4.3 Environmental performance outcomes and control measures

EPOs relating to this event include:

+ no injury or mortality to EPBC Act 1999 and *WA Biodiversity Conservation Act 2016* listed fauna during activities [MEFF-EPO-04].

The control measures (CM) considered for this activity are shown in **Table 8-12** with EPSs and measurement criteria for the EPOs described in **Section 10.4**.

Table 8-12: Control measures evaluation for noise emissions

CM Reference	Control measure	Environmental benefit	Potential cost / issues	Evaluation
Standard Control Measures				
MEFF-CM-20	Procedures for interacting with marine fauna	Reduces risk of physical and behavioural impacts to marine fauna from vessel, because if they are sighted, then the vessel can slow down or move away, and helicopters can increase distances from sighted fauna if required.	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. Control drives compliance with EPBC Regulations (Part 8).
MEFF-CM-21	Vessel Planned Maintenance System (PMS) to maintain vessel DP, engines and machinery	Reduces noise emissions from the vessels because equipment is operating within its parameters.	Costs are standard for routine PMS.	**Adopted** – Benefits in reducing noise impacts.
MEFF-CM-22	Marine assurance	Ensures contracted vessels are operated, maintained and manned in accordance with industry standards (for example, Marine Orders) and regulatory requirements (this EP) and the relevant Santos procedures mentioned in this EP.	Costs are expected as part of standard procedure.	**Adopted** – Benefits in reducing noise impacts.
Additional Control Measures				
N/A	Dedicated Marine Fauna Observer on vessels[1]	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 and given that crew members will be observing for marine fauna during activities.

CM Reference	Control measure	Environmental benefit	Potential cost / issues	Evaluation
N/A	Site-specific acoustic modelling[1]	The distance at which fauna could experience behavioural impacts can be predicted and compared to literary publications. Additional management controls can then be included if required to support an ALARP justification and reduce potential impacts to marine fauna.	Additional cost to contract consultant to develop a model and produce predicted noise outputs.	**Rejected** – The cost associated with site specific modelling, outweighs any environmental benefit, and no further controls can be implemented to reduce vessel noise other than not undertaking the activity. Given the potential impacts are expected to be minor and limited to temporary and minor behavioural changes only, and noise levels from vessels and helicopters will decay rapidly; site-specific modelling will not provide additional information which would alter the current ALARP position. Also, the activity does not occur in a humpback whale resting, foraging, calving or confined migratory pathway, as described in the conservation advice.
N/A	Noise management plan[1]	Impacts are predicted to be minor (e.g., potential temporary and minor behavioural changes); therefore, a management plan, and associated management controls, will have little or no benefit in terms of outcomes; i.e., reducing impacts further.	No additional cost other than negligible personnel costs of preparing and reviewing the management plan.	**Rejected** – The activity does not occur in any resting, foraging, calving or confined migratory pathway for protected cetacean species. Therefore, the cost associated with developing a management plan outweighs the little or no benefit for a short duration activity which has a minor impact (e.g., potential temporary and minor behavioural changes).

CM Reference	Control measure	Environmental benefit	Potential cost / issues	Evaluation
N/A	Use of passive acoustic monitoring [1]	Improve detection of some sensitive receptors.	Costs of passive acoustic monitoring operators. Operational costs of shutdowns potentially prolonging the activity.	**Rejected** – Cost disproportionate to increase in environmental benefit, given the low-level behavioural response expected. Limited ability of passive acoustic monitoring to detect cetaceans would provide little benefit to the species expected to be present.
N/A	Verification of noise levels	Allow implementation of adaptive management controls should impact be greater than expected.	Costs of deploying noise monitoring equipment and processing of data.	**Rejected** – Relatively short duration of the activity (approx. 14 days IMMR, 45 to 90 days for floating asset removal and 12 months cumulative duration, likely over multiple campaigns, for seabed asset removal) would prevent noise verification being completed before the activity is finished. Cost disproportionate to increase in environmental benefit, given the rapid reduction in noise levels from vessels and the low-level behavioural response expected.
N/A	Operational activities to avoid coinciding with sensitive periods for marine fauna present in the operational area (whale shark foraging, pygmy blue whale distribution)	Reduce risk of impacts from noise emissions during environmentally sensitive periods for listed marine fauna.	High cost in moving or delaying activity schedule. The risk to all listed marine fauna cannot be reduced due to variability in timing of environmentally sensitive periods and unpredictable	**Rejected** – The operational area overlaps with very small portions of the pygmy blue whale distribution BIA and the whale shark foraging BIA, and these species could be present all year round. However, the potential impacts to whale sharks or pygmy blue whales, if they occur,

CM Reference	Control measure	Environmental benefit	Potential cost / issues	Evaluation
			presence of some species.	would be well within 500 m of the vessel and equipment (behavioural impacts within tens of metres of the vessel). With the controls in place to manage interaction with fauna within 500 m of the vessel, the potential for impact is significantly reduced. The activity will not restrict the movement of any species within the area as the BIA and the area within which they are distributed in is widespread. Cost is disproportionate to increase in environmental benefit.
N/A	Start-up of acoustic equipment and ROV equipment only when ROV in position near the seabed.	Restricts ROV noise emissions to smaller portion of water column near seabed. Reduces potential noise interactions with marine fauna.	Not possible – equipment needs to be functioning on deployment.	**Rejected** – Control not feasible.
N/A	Before commencing start-up of geophysical survey equipment in-water, the following will be completed: + A trained crew member will observe for marine mammals, whale sharks or turtles within 500 m of the vessel during daylight for 15 minutes before start-up (if no	May reduce potential for interaction of ROV with marine fauna; however, the benefit is considered limited, given there is no geophysical equipment onboard ROV other than a high frequency sonar which is outside range of marine fauna hearing. The ROV noise is not expected to be greater than that associated with vessel station keeping and operation.	Implementing control could result in survey delays with associated costs.	**Rejected** – The additional cost associated with the control exceeds the negligible environmental benefit.

CM Reference	Control measure	Environmental benefit	Potential cost / issues	Evaluation
	sightings, survey can commence) + If marine mammals, whale sharks or turtles are sighted within 500 m of the geophysical equipment before commencing survey, the operation will be delayed until the animal has moved at least 500 m away or ten minutes has passed since the last sighting + Night operations can commence if there were no more than three delays due to marine fauna in the preceding 24 hours.			

[1] As recommended in 'Approved Conservation Advice for *Megaptera novaeangliae* (humpback whale) (2015)'.

8.4.4 Environmental impact assessment

Receptor	Consequence Level
Noise Emissions	
Threatened, migratory or local fauna	While the level of noise expected from temporary and intermittent operational activities has the potential to cause physical injury to marine fauna, most species that may transit through the area are expected to demonstrate avoidance behaviour if noise levels approach those that could cause pathological effects. Avoidance behaviour is likely to be localised within the area of the activity (due to small spatial extent of elevated noise) and temporary, i.e. for the duration of the activity only. The operational area overlaps a whale shark foraging BIA, however, displacement of whale sharks is not expected. The operational area overlaps Pygmy Blue Whale BIAs. However, since pygmy blue whales show preference for water depths >500 m, only a small number of individuals are likely to be encountered transiting the operational area. Behavioural responses to vessel noise are expected to be limited to within 5 km of the vessel and are therefore not expected to reach the migration BIA (located around 18 km away at its closest point). Individuals are not expected to be displaced from foraging areas (located distant from the operational area) or from potential opportunistic foraging activities. Given the generally low level of noise expected from the vessels, helicopters and associated activities, and the relatively short duration of noise emissions, significant impacts to threatened or migratory species are not expected. Some temporary and localised behavioural response may result from the noise levels emitted, but these will not be at levels that are likely to cause mortality or injury to marine fauna or cause a decrease in local population size or area of occupancy of species. The consequence level for fauna is considered to be II – Minor.
Physical environment or habitat	Not applicable – Noise emissions will not impact the physical environment / habitats, apart from increasing ambient noise levels which is considered under other receptors.
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. The nearest protected area is the Montebello AMP, located 99 km from the operational area.
Socio-economic receptors	Noise levels are not expected to impact on socio-economic receptors due to their low activity level within the vicinity of the operational area. There are no recreation areas within the area expected to be impacted by noise. The consequence level for socio-economic receptors is I – Negligible.
Overall worst-case consequence	II – Minor

8.4.5 Demonstration of as low as reasonably practicable

The use of vessels is unavoidable if the operational activities are to proceed as required 24 hours a day. Equipment maintenance will keep the vessel noise levels to within normal operating limits, which will also aid in keeping noise emissions within the boundaries that have been risk assessed.

The vessels are also expected to produce similar noise emissions to other marine vessels that frequent or transit through the vicinity of the operational area (oil and gas industry vessels, commercial shipping). The vessels will adhere to the EPBC Regulations (Part 8) to ensure actions are undertaken to avoid marine mammals (and whale sharks) within 100 m of a vessel, and all crews will be inducted into these requirements. It is further expected that the vessels will typically emit sufficient noise for sensitive marine fauna to exhibit avoidance behaviour and move away from the activity to avoid physical impact zones.

The use of helicopters to transfer personnel to and from the vessels is necessary to allow operational activities to occur safely and effectively, with some personnel required to be rotated to and from other locations, and to provide for a rapid method of transferring to and from the vessels in the case of an emergency. 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' Protected Marine Fauna Interaction and Sighting Procedure (EA-91-11-00003). This 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 (Commonwealth of Australia, 2017) when developing these controls to minimise noise impacts on marine turtles.

Any behavioural impact caused by vessel activity noise is likely to be localised and temporary, with marine species expected to resume normal behavioural patterns in the open oceanic waters surrounding the operational area in a short timeframe with no significant impact on their normal behaviour, including during sensitive periods such as migration, nesting or foraging.

Avoiding periods of higher sensitivity such as migration or nesting periods for whales and turtles (for example) is not considered feasible. The operational area overlaps with two BIAs for fauna: pygmy blue whale distribution and whale shark foraging. Given the low potential impacts to individual fauna, there is not expected to be an impact at population level or significant impacts on migratory or breeding behaviours.

Significant impacts are not expected on fauna, including cetaceans and turtles, and the assessed residual consequence for this impact is Minor (II). Additional control measures were considered but rejected since the associated cost or effort was grossly disproportionate to any benefit (see **Section 8.4.3**). Therefore, the impact from noise associated with the activities is considered ALARP.

8.4.6 Acceptability evaluation

Is the consequence ranked as I (Negligible) or II (Minor)?	Yes – maximum consequence from noise emissions is II (Minor).
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 ESD?	Yes – activity evaluated in accordance with Santos' Environmental Hazard Identification and Assessment Procedure (EA-91-IG-00004_5), which considers principles of ESD. The consequence against this aspect is II (Minor) and therefore does not affect the outcomes of the principles of ecologically sustainable development as per **Table 7-5**.
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 – controls implemented during the activity will minimise the potential impacts to species identified in Recovery Plans as having the potential to be impacted by noise emissions. Relevant species recovery plans, conservation management plans and management actions listed in **Table 5-10**.
Are risks and impacts consistent with Santos' Environmental, Health and Safety Policy?	Yes – aligns with Santos' Environmental, Health and Safety Policy.
Are risks and impacts consistent with stakeholder expectations? **Related to cessation phase and floating asset removal activities**	Yes – no concerns raised.
Are risks and impacts consistent with stakeholder expectations? **Related to seabed equipment removal and abandonment in situ activities)**	Yes – no concerns raised.
Are performance standards such that the impact or risk is considered to be ALARP?	Yes – see ALARP above.

The activities will be conducted over a relatively short duration (approximately 14 days for IMMR activities, 45 to 90 days for floating asset removal activities and 12 months cumulative duration, likely over multiple campaigns, for seabed removal activities (dependent on weather delays and operational downtime) in a remote offshore location, with a relatively low probability of encountering significant numbers of noise sensitive fauna. The activities that will generate noise are standard offshore industry practice and the potential impacts are well documented. With the controls proposed and considering the relatively short duration and characteristics of noise types planned, the potential consequences of impacts to noise sensitive receptors in the area, including pygmy blue whales, are assessed to be Minor (II) and ALARP.

<u>Management plans and conservation advice for cetaceans</u>

The operational area intercepts BIAs for pygmy blue whales (distribution) (refer to **Figure 5-10**) and the migration corridor for this species is located around 18 km from the operational area at its closest point. The Conservation Management Plan for the Blue Whale (DoE, 2015b) discusses masking from anthropogenic noise, shipping noise and aircraft noise. Santos' Procedures for Interacting with Marine Fauna (EA-91-11-00003) drives activity compliance with EPBC Regulations (Part 8) for managing the risks of noise to cetaceans. Additionally, the activities will not displace an individual or individuals from foraging areas (located distant from the operational area) or from potential opportunistic foraging. On this basis impacts are considered acceptable.

Recovery plan for marine turtles

The Recovery Plan for Marine Turtles in Australia: 2017 to 2027 (Commonwealth of Australia, 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 equipment as sources of chronic (continuous) noise in the marine environment, exposure of which may lead to avoidance of important turtle habitat.

It specifies the following priority action related to noise, for all marine turtle stock:

+ Manage anthropogenic activities to ensure marine turtles are not displaced from identified habitat critical to the survival.

Although the operational area is distant from the nearest BIA and habitat critical to the survival of marine turtles (more than 60 km away), transiting marine turtles have the potential to occur within the operational area. However, given the relatively short duration of the activity and the proposed management measures, it is reasonable to conclude noise emissions will not affect the conservation status of marine turtles or compromise the objectives of the marine turtle recovery plan. Therefore, potential impacts are acceptable.

Summary

The controls proposed are consistent with relevant standards, including EPBC Regulations Part 8 (Vessels and Aircraft), and aligned with the applicable management actions outlined in relevant Recovery Plans and Approved Conservation Advice. No concerns from stakeholders (including fisheries) have been raised regarding noise emissions during the activity. Therefore, the Minor (II) impacts expected from noise emissions are considered environmentally acceptable.

8.5 Atmospheric emissions

8.5.1 Description of event

Event	Potential impacts from atmospheric emissions may occur in the operational area from: + operation of incinerators on vessels + operation of vessel engines, helicopters, generators, mobile and fixed plant and equipment. These emissions will include greenhouse gas (GHG) emissions, such as carbon dioxide, methane and nitrous oxide, and non-GHG emissions, such as sulphur oxides, nitrogen oxides, sulphur dioxide, particulate matter, non-methane volatile organic compounds and benzene, ethylbenzene, toluene, and xylenes. Although the vessels may use ozone-depleting substances (ODS), this will be in a closed rechargeable refrigeration system and there is no plan to release ODS to the atmosphere. Atmospheric emissions may also result from the towing of the DTM and MWAs to the port of landing, transport of other recovered seabed equipment to the port of landing and from road transport to the waste management facility. This is discussed further in Section 8.6.
Extent	Localised: The quantities of gaseous emissions are relatively small and will, under normal circumstances, quickly dissipate into the surrounding atmosphere.
Duration	Intermittent (incinerators, helicopters, mobile plant etc) to consistent (vessel engines etc) for the duration of the activity as described in **Section 4.1**.

8.5.2 Nature and scale of environmental impacts

Potential receptors: Physical environment (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 nitrogen oxides and sulphur oxides, can lead to a reduction in local air quality. GHG emissions are recognised to also contribute to the greenhouse gas emissions loading globally.

As the activity will 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. Air emissions will be similar to other vessels operating in the region for both petroleum and non-petroleum activities.

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

Potential impacts are expected to be short-term, and relate to localised reduction in air quality, limited to the immediate vicinity of the emissions release. Atmospheric emission impacts are not expected to have direct or cumulative impacts on sensitive environmental receptors or be above National Environmental Protection (Ambient Air Quality) measures.

8.5.3 Environmental performance outcomes and control measures

EPOs relating to this event include:

+ No unplanned objects, emissions or discharges to sea or air [MEFF-EPO-05].

The control measures considered for this activity are shown in **Table 8-13** with EPSs and measurement criteria for the EPOs described in **Section 10.4**.

Table 8-13: Control measures evaluation for atmospheric emissions

CM reference	Control measure	Environmental benefit	Potential cost / issues	Evaluation
Standard Control Measures				
MEFF-CM-23	Waste incineration	Reduces the potential for emissions or particulates by ensuring only permissible waste is incinerated as per International Convention for the Prevention of Pollution from Ships (MARPOL) Annex VI and Marine Order 97.	Personnel cost of maintaining waste records and training of staff.	**Adopted** – Negligible environmental impact outweighs the costs associated with transporting waste to shore for landfill.
MEFF-CM-24	Fuel oil quality	Reduces emissions through use of low sulphur fuel in accordance with Marine Order 97.	No additional costs, as this is a regulatory requirement.	**Adopted** – No additional costs.
MEFF-CM-25	International air pollution prevention certification	Ensure vessels are operating with acceptable emissions as per international standards. Ensure compliance with Australian Marine Orders as appropriate for vessel class.	No additional costs, as this is a regulatory requirement.	**Adopted** – Benefit of ensuring vessel is compliant outweighs the minimal costs and it is a legislated requirement.
MEFF-CM-26	Ozone-depleting substance handling procedures	Reduces probability of potential impacts to air quality due to ODS emissions.	Personnel cost of maintaining ODS record book or recording system.	**Adopted** – Benefit of ensuring no ODS release outweighs the minimal costs.
MEFF-CM-21	Vessel PMS to maintain vessel DP, engines and machinery	Ensure vessel is running efficiently and routine maintenance endeavours to ensure emissions are minimal.	No additional costs, is industry best practice.	**Adopted** – No additional costs.
MEFF-CM-22	Marine Assurance Standard	Reduces emissions from vessels because equipment operating within its parameters.	Cost associated with implementing procedures.	**Adopted** – Benefit of implementing procedure outweighs the minimal costs.

Santos

CM reference	Control measure	Environmental benefit	Potential cost / issues	Evaluation
Additional Control Measures				
N/A	No incineration during vessel-based operations activities	Removes all emissions associated with incineration activities during the project.	Increase in health risk from storage of wastes. Limited space available to store additional waste, additional trips to shore would be required to transport waste. 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. Incineration on the vessels (outside the 500 m PSZ) is a permitted maritime operation.
N/A	Removal of all ozone-depleting substance-containing equipment	Eliminates potential of ODS 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 refrigeration. It is noted that ODSs are rarely found on vessels.	**Rejected** – Based on cost to replace all equipment and there is only a low potential for ODS releases.
N/A	Use incinerators and engines with higher environmental efficiency	Improves air quality by more efficient burning or fuel combustion.	Significant cost in changing vessel equipment.	**Rejected –** Cost grossly disproportionate to low environmental benefit (impact rated Negligible).

CM reference	Control measure	Environmental benefit	Potential cost / issues	Evaluation
N/A	No support vessels	Reduces the emissions and GHG associated with the activity.	The primary vessels require support vessels for transfer of crew and supplies during a campaign and a vessel is also on standby to provide emergency services. Alternative transfer of supplies via helicopter is not feasible due to the size of containers being transferred.	**Rejected** – Support vessels are required to undertake the activity and no alternatives are considered feasible.
N/A	Do not recover and tow floating assets, or recover and transport the proposed seabed assets, from the MEFF field to port of landing.	Reduces the emissions and GHG associated with the activity.	Santos has committed to removing all floating assets and the proposed seabed assets from the MEFF field. The DTM and MWAs are approximately 98% steel and can be readily recycled and re-used. The recycling of floating assets will replace 'new steel', which would need to be manufactured with associated GHG emissions. The other proposed seabed assets to be recovered are mostly steel and waste management options are still being assessed.	**Rejected** – Santos is committed to removing the floating assets and the proposed seabed assets from the MEFF Field. Disposing and recycling of the DTM and MWAs, and seabed assets in accordance with local regulations provides an environmental benefit above that of eliminating emissions and GHG associated with their transport.

8.5.4 Environmental impact assessment

Receptor	Consequence Level
Atmospheric emissions	
Threatened, migratory or local fauna	Emissions from the activity are relatively small and will, under normal circumstances quickly dissipate into the surrounding atmosphere. Any potential impacts are not expected to result in a decrease in local population sizes, particularly to seabirds, or disruption to breeding cycles. The consequence of air emissions to fauna is I (Negligible).
Physical environment or habitat	The activity will occur in the open ocean and offshore waters, the combustion of fuels and rare ODS releases in such a remote location 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. Therefore, the consequence level is assessed as I (Negligible).
Threatened ecological communities	Not applicable – these receptors will not be impacted by air emissions.
Protected areas	
Socio-economic receptors	The combustion of fuels and ODS releases in these remote offshore locations will not impact on air quality in coastal towns. Similarly, the emissions from road transportation of the DTM and MWAs and seabed assets are not expected to impact air quality in 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 source. The consequence is assessed as I (Negligible).
Worst-case consequence level	I – Negligible

8.5.5 Demonstration of as low as reasonably practicable

Combustion of fossil fuels is essential to undertaking the activity to power the vessels, helicopters and equipment. Practical and reliable alternative fuel types and power sources for the vessels, helicopters and road transportation have not been identified. The use of vessels offshore and generation of atmospheric emissions are normal operations.

Implementation of a zero-incineration policy on the vessels would result in significant costs associated with the transport of waste to shore for disposal. Further transportation of the waste to shore would increase the environmental impacts and risks associated with the activities through increased vessel movements and generate greater volumes of emissions associated with the vessel movements. Additional space would also be required to store waste (including refrigerated storage) which would require larger vessels to allow for the storage, resulting in higher emissions from engine combustion and to power additional refrigeration units. Since incineration is a permitted maritime operation in accordance with Marine Order 97 (reflecting MARPOL Annex VI requirements) it is considered ALARP.

Lack of refrigeration systems (i.e., air conditioning) on-board the vessels would lead to unacceptable workplace conditions and poor food hygiene standards, limiting the vessels' ability to undertake the activities; therefore, there is no practical alternative to the use of refrigeration.

The management of vessel air emissions is well practiced and understood. Given the remote offshore location, no sensitive environmental receptors were identified. There is little uncertainty associated with this aspect. The management of air emissions is well regulated. No objections or concerns were raised by relevant stakeholders regarding atmospheric emissions.

The assessed residual consequence for this impact is Negligible (I) and cannot be reduced further. Additional control measures were considered but rejected, since the associated cost or effort was grossly disproportionate to any benefit and the offshore open environment, where atmospheric emissions dissipate rapidly in the surrounding air, is not close to sensitive receptors as detailed in **Section 8.5.3**. Therefore, the impact of the activities conducted is considered ALARP.

8.5.6 Acceptability evaluation

Is the consequence ranked as I (Negligible) or II (Minor)	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 ESD?	Yes – activity evaluated in accordance with Santos' Environmental Hazard Identification and Assessment Procedure (EA-91-IG-00004_5), which considers principles of ESD. The consequence against this aspect is I (Negligible) and therefore does not affect the outcomes of the principles of ecologically sustainable development as per **Table 7-5**.
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' Environmental, Health and Safety Policy?	Yes – aligns with Santos' Environmental Health and Safety Policy.
Are risks and impacts consistent with stakeholder expectations? **Related to cessation phase and floating asset removal activities**	Yes – no concerns raised.
Are risks and impacts consistent with stakeholder expectations? **Related to seabed equipment removal and abandonment in situ activities)**	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 Australian Marine Order standards is considered to be an appropriate management measure in this case.

The overall impacts to the atmosphere and sensitive receptors is expected to be I (Negligible) and the control measures in place effective. Therefore, the impacts from emissions generated as part of the activity are considered to be ALARP and environmentally acceptable.

8.6 Planned operational discharges

8.6.1 Description of event

Event	Potential impacts may occur in the operational area from vessel activities undertaking IMMR and decommissioning activities (floating and seabed asset removal activities). Potential impacts may also occur outside of the operational area as a result of decommissioning activities, such as during towing of the DTM and MWAs and transport of seabed assets via vessel to the port of landing, and the associated onshore disposal aspect. Planned discharges and wastes are summarised below: Operational area and vessel transport (including towing) of recovered floating and seabed assets: + sewage and grey water + food wastes + deck drainage + cooling water + bilge water + brine + ballast water + fire-fighting foam during routine testing + swarf from cutting risers and seabed assets subsea Sewage and grey water The volume of sewage, grey water and food waste is directly proportionate to the number of persons on-board the primary and support vessels. Up to 30 L to 40 L of sewage / greywater will be generated per person per day. Treated sewage will be disposed in accordance with Marine Order 96 (Marine pollution prevention – sewage) requirements. Food waste Putrescible waste is estimated to consist of around 1 L of food waste per person per day. Putrescible waste will be disposed in accordance with Marine Order 95 (Marine pollution prevention – garbage) requirements. Deck drainage Drainage water on offshore facilities consists of rainwater and seawater spray and may potentially contain small residual 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 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 **Sections 9.6** to **9.8**. 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. Bilge water While in the operational area, the vessels may discharge oily water after treatment to 15 ppm via a MARPOL-approved oily water filter system. Bilge water will be disposed in accordance with Marine Order 91 (Marine pollution prevention – oil, as appropriate to class) requirements.

	Brine Brine generated from the water supply systems on board the vessels will be discharged to the ocean at a salinity of around 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. The effluent may contain scale inhibitors such as Alpacon that controls inorganic scale formation, such as the formation of calcium carbonate and magnesium hydroxide, in water-making plants. Other water purification chemicals such as chlorine may also be added to the potable water. Other water-making plant cleaning chemicals such as Ameroyal or Saf Acid may be used and discharged to sea after completion of the cleaning process. Vessel ballast water Ballast water could potentially be discharged to the marine environment from vessel ballast tanks. Fire-fighting foam During routine testing that could occur during the activity, aqueous film-forming foam (AFFF) could be discharged from the foam tanks over each area covered by an AFFF firefighting system. It is unavoidable that some of this foam will be discharged to sea unless it is discharged within a closed bunding system. Swarf from subsea cutting activities Seabed assets, including rigid flowlines and risers, may be cut using a subsea tool, with depth in the water column to be determined. Mooring chains and tethers may be cut in close proximity to the seabed. Onshore aspect discharges/disposal Onshore disposal / recycling of floating and seabed assets may result in the following indirect environmental risks and impacts: + indirect atmospheric and GHG emissions from unavoidable onshore (road) transport and disposal or recycling activities. This is discussed further in **Section 8.5**. + discharge of minor volumes of metal swarf from cutting the assets prior to loading for road transport. + Contribution to landfill (majority of the assets are steel and planned to be recycled).
Extent	Offshore The small volumes of non-hazardous discharges may cause localised nutrient enrichment, organic and particulate loading, toxic impacts to marine fauna, thermal impacts and increased salinity in waters around discharge points and in the direction of the prevailing current. The environment that may be affected by operational discharges will likely be contained within the operational area and is predicted to be restricted to within around 100 m of the discharge point in the upper 5 m of the water column or on the seabed in the case of any swarf. Onshore Port of landing within Australia or internationally (including storage and processing areas), onshore transportation equipment (e.g. roads) and licensed waste management facilities.
Duration	During the activity, as described in **Section 4.1,** localised impacts to water and / or air quality may occur. However, water and air quality conditions will return to normal within minutes to hours of cessation of discharges.

8.6.2 Nature and scale of environmental impacts

Offshore aspects

Potential receptors: Water quality, fish (pelagic) and sharks, marine mammals, marine turtles and seabirds.

Physical environment

The discharge of small volumes of non-hazardous wastes to the marine environment will result in a localised reduction in water quality. Discharges will 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

Discharge of food waste, 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 due to nutrient inputs and bacteria activity due to organic carbon inputs. This could subsequently impact higher order predators.

However, dispersion and dilution of discharges is expected to be rapid, as the discharges are of low volume. 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 high currents, resulting in short-term changes to surface water quality within the operational area.

In a study of sewage discharge in deep ocean waters, Friligos (1985) reported no appreciable differences in the inorganic nutrient levels between the outfall area and background concentrations suggesting rapid uptake of nutrients and / or rapid dispersion in the surrounding waters. Similar studies (Parnell, 2003) concluded similar results with rapid dispersion and dilution within hours of discharge.

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

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.

Most marine species are able to tolerate short-term fluctuations in salinity in the order of 20% to 30% (Walker and 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.

Given the relatively low volume of discharge, low salinity increase and deep, open water surrounding the vessels, impact on water quality in the operational area is expected to be low.

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

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 1°C 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. 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 any offshore reefs, islands, shoals or banks, or marine parks.

Contamination from releases of bilge water

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 the 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 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.

Contamination from swarf

Metal (steel) swarf discharged during cutting of rigid flowlines, risers and other seabed assets may settle quickly to the seabed or drift with prevailing currents before settling on the seabed distant from the cutting location. Swarf discharged during cutting of mooring chains, tethers and other assets close to or on or near the seabed is expected to settle quickly to the seabed, given the close proximity to the seabed for this equipment. Discharge of swarf during cutting activities may result in minor impacts to water quality and sediment quality (e.g. through smothering), however given the very small volume of swarf expected to be discharged, any impacts would be highly localised.

Toxicity

Discharges from vessel systems may include chemicals within sewage systems, greywater, desalination, firefighting systems and residues of those used for cleaning decks.

On discharge to the marine environment, the low volumes of these types of chemicals are expected to rapidly disperse in the offshore marine environment. Hence, any potential impacts would be confined to a localised area immediately surrounding the discharge.

There may be a localised and temporary (hours) reduction in water quality in the immediate vicinity of the release. Toxicity impacts to marine fauna from the release of chemicals are unlikely to eventuate because:

- strong ocean currents result in the discharge being further diluted upon release to the marine environment, so the duration of exposure of chemicals to fauna will be minimal
- deck cleaning products planned to be released to sea will meet the criteria for not being harmful to the marine environment according to MARPOL Annex V
- other products with potential to be released to the sea meet the criteria for not being harmful to the marine environment according to MARPOL Annex V; or Gold/Silver/D or E rated through OCNS; or have a completed Santos ecotoxicological risk assessment so only environmentally acceptable products are used
- potential discharges will be intermittent and temporary within the operational area.

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 offshore waters. 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 any exposure is likely not of sufficient duration to cause a toxic effect.

Discharges may cause changes to behaviour in marine fauna (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.

Given the nature of discharged chemicals, the small volumes expect to be released to the marine environment and the nature of the marine environment within the vicinity of the operational area, the operational planned discharges are not predicted to have ecologically significant effects.

Onshore aspects

Atmospheric and greenhouse gas emissions

The onshore transport (likely by road), recycling and disposal of decommissioned assets (e.g. floating assets, risers and seabed assets) and may also result in atmospheric and GHG emissions. The disposal and recycling process is expected to require electricity purchased through the local electrical grid, which is generated by a mix of renewable and fossil fuel generation sources.

Any impacts from atmospheric emissions associated with the unavoidable onshore transport and disposal / recycling of the floating assets are expected to be short-term, and relate to localised reduction in air quality, limited to the immediate vicinity of the emissions release. Atmospheric emission impacts are not expected to have direct or cumulative impacts on sensitive environmental receptors or be above National Environmental Protection (Ambient Air Quality) measures.

Hazardous materials and waste management

Table 3-3 outlines the materials for each decommissioned asset. Key materials for recycling / disposal include:

+ floating assets: the floating assets (e.g. DTM, MWA) are predominantly steel with epoxy paint coatings and will be recycled within Australia.
+ metals: majority of decommissioned assets (e.g. xmas trees, manifolds, rigid flowlines, anode skids, pipeline crossing structures, umbilical riser bases) are predominantly steel (carbon steel and stainless steel) structures with epoxy paint coatings and aluminium and other sacrificial metal. Umbilicals and EFLs include copper and galvanised steel and tie-in and jumper spools include Inconel alloy. Metals will be recycled where possible.
+ plastics: certain decommissioned assets (e.g. rigid and flexible production risers, flexible flowlines and service lines, umbilicals, jumper spools, EFLs and HFLs) contain plastics such as nylon, polypropylene (i.e. 4LPP), polyethylene (i.e. 3LPE), polyvinylidene difluoride (PVDF), PVC, XLPE, HDPE, LLDPE, coflon, rislan, polyethylene rods, polypropylene rope, PE coated wire, hoses and tubes. HFLs are constructed primarily of plastics.
+ other materials: certain decommissioned assets (e.g. umbilicals, flexible production risers and flowlines, jumper spools) contain other materials such as fabric tapes and c-therm FPR-250 (insulation).
+ radioactive materials: the multi-phase flowmeters (MPFM) contain radioactive sources for their management systems (gamma densitometer). The radioactive source for the MPFMs in the Mutineer and Exeter booster pump manifolds is Ba-133 and in the Fletcher and Finucane

pipeline end manifolds is Cs-137. The waste materials from the flowmeters will be classified in accordance with the Australian Radiation Protection and Nuclear Safety Agency (ARPANSA) radioactive waste classification scheme and disposed of accordingly.

As per **Section 4.6.6** and **Section 4.7.7**, recovered decommissioned assets will be managed to their end fate with consideration of the waste hierarchy of reuse, repurpose, recycle and dispose.

Non-hazardous waste from recovered equipment will be transported back to shore for disposal or recycling in accordance with local regulations. Hazardous waste will be disposed of onshore at a licensed facility. Recovered equipment may be transported overseas for recycling. All waste streams will be managed in accordance with relevant legislation of the receiving jurisdiction and by suitably qualified contractors. Therefore, no impacts from general or hazardous waste materials associated with the onshore disposal of decommissioned assets are expected.

Swarf from onshore cutting

Once the recovered assets have been delivered to port, they may be cut into pieces suitable for transport to the licensed waste management facility. Cutting of the DTM and MWA's and other decommissioned assets will generate minor volumes of metal (steel) swarf. No impacts from cutting the decommissioned assets onshore are expected.

8.6.3 Environmental performance outcomes and control measures

The EPOs relating to this event include:

+ No unplanned objects, emissions or discharges to sea or air [MEFF-EPO-05].
+ Disposal of floating and seabed assets is undertaken by suitably qualified contractors at appropriately licenced waste facilities, with the final disposal of the waste streams undertaken in accordance with SMS-EXA-OS01-PD02-PD01 Waste Monitoring and Reporting [MEFF-EPO-08].

The control measures considered for this event are shown in **Table 8-14**, and EPSs and measurement criteria for the EPOs are described in **Section 10.4**.

Table 8-14: Control measures evaluation for planned operational discharges

CM reference	Control measure	Environmental benefit	Potential cost / issues	Evaluation
Standard Control Measures				
MEFF-CM-27	Waste (garbage) management procedure	Reduces probability of garbage being discharged to sea, reducing potential impacts to marine fauna. Stipulates putrescible waste disposal conditions and limitations. Provides compliance with Marine Order 95 (Marine pollution prevention – garbage).	Costs associated with pre-mobilisation audits and inspections and reporting discharge levels.	**Adopted** – Benefits of ensuring vessel is compliant outweigh the minimal costs of personnel time and it is a legislated requirement.
MEFF-CM-28	Deck cleaning product selection	Improves water quality of discharge (reduced toxicity) to the marine environment.	Personnel costs of implementing the chemical review process, potential	**Adopted** – Benefits of ensuring vessels are compliant and deck cleaning

CM reference	Control measure	Environmental benefit	Potential cost / issues	Evaluation
		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.	additional costs and delays associated with chemical substitution.	products planned to be released to sea meet MARPOL criteria.
MEFF-CM-29	General chemical management procedures	Reduces potential for inappropriate discharge of chemicals at sea through appropriate handling.	Personnel costs associated with vessel inspection and implementation of management procedures.	**Adopted** – Benefits of ensuring vessel is compliant outweigh the minimal costs of personnel time and it is a legislated requirement.
MEFF-CM-30	Chemical selection procedure	Improves water quality discharge (reduced toxicity) to the marine environment e.g. from AFFF and potable water systems.	Personnel costs of implementing the chemical review process, potential additional costs and delays associated with chemical substitution	**Adopted** – Benefits of ensuring vessels are compliant outweighs the cost.
MEFF-CM-22	Marine assurance	Vessels selected and on-boarded in accordance with the Offshore Marine Assurance Procedure (SO-91-ZH-10001) to ensure contracted vessels are operated, maintained and manned in accordance with industry standards (for example, Marine Orders) and regulatory requirements (this EP) and the relevant Santos procedures mentioned in this EP.	No additional cost.	**Adopted** – Benefits of ensuring vessel is compliant outweigh the minimal costs of personnel time and it is a legislated requirement.
MEFF-CM-31	Sewage treatment system	Reduces potential impacts of inappropriate discharge of sewage. Provides compliance with Marine Order 96 (Marine pollution prevention – sewage).	Personnel costs associated with ensuring vessel certificates are in place during vessel contracting and in pre-mobilisation audits and inspections, and in	**Adopted** – Benefits of ensuring vessel is compliant outweigh the minimal costs of personnel time and it is a legislated requirement.

CM reference	Control measure	Environmental benefit	Potential cost / issues	Evaluation
			reporting discharge levels.	
MEFF-CM-32	Oily water treatment system	Reduces potential impacts from planned discharge of oily water to the environment. Provides compliance with Marine Order 91 (Marine pollution prevention – oil).	Time and personnel costs associated with maintaining oil record book.	**Adopted** – Benefits of ensuring vessel is compliant outweigh the minimal costs of personnel time and it is a legislated requirement.
MEFF-CM-33	Onshore disposal of decommissioned assets in accordance with relevant legislative requirements	Reduced potential impacts from landfill or incorrect disposal of decommissioned assets	Costs associated with the removal and disposal of decommissioned assets	**Adopted** – It is a legislated requirement and the benefits of recycling / onshore disposal of decommissioned assets outweigh the costs (with the exception of assets proposed for abandonment in situ). .
Additional Control Measures				
N/A	Zero discharge of deck water	Would eliminate potential impacts of contaminants being discharged to sea.	Increased health and safety risks from wet deck not draining. Large amounts of water on a vessel's deck can also cause stability issues (free surface effect). 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) and increase	**Rejected** – Safety considerations outweigh the benefit, given the small volumes of contaminants. Deck drainage is a permitted maritime practice and an important safety requirement.

CM reference	Control measure	Environmental benefit	Potential cost / issues	Evaluation
			in crane movements.	
N/A	Zero discharge of bilge water	Would eliminate potential impacts of contaminants being discharged to sea from oily water.	Costs associated with containment and onshore disposal, space required for additional containment on primary vessels could create hazards for working on deck by limiting available space.	**Rejected** – Safety considerations regarding containment outweigh the environmental benefit, given the small volumes of contaminants. Discharge of treated oily water to sea is permitted maritime practice.
N/A	Zero discharge of sewage	Would eliminate potential impacts of contaminants being discharged to sea from sewage.	Costs associated with containment and onshore disposal, space required for additional containment on primary vessels could create hazards for working on deck by limiting available space.	**Rejected** – Safety considerations regarding containment outweigh the environmental benefit, given small volumes of contaminants. Discharge of treated sewage to sea is permitted maritime practice.
N/A	No discharge of food waste within the operational area	Eliminates localised nutrient enrichment, organic and particulate loading from food wastes.	Additional cost for storage of food waste or disposal onshore.	**Rejected** – Cost outweighs the benefit, given the low impact expected from planned discharges and high potential impacts from risk transfer.
N/A	Scupper plugs continuously in place to prevent deck drainage	Would eliminate potential impacts of contaminants being discharged to sea in rainwater.	Increased health and safety risks from wet deck not draining. Large amounts of water on a vessel's deck can also cause stability issues (free-surface effect).	**Rejected** – Safety considerations outweigh the benefit, given small volumes of contaminants.
N/A	Zero discharge of cooling water	Would eliminate potential impacts of cooling water (elevated temperature)	Costs associated with containment and onshore disposal, space	**Rejected** – Safety considerations outweigh the benefit,

CM reference	Control measure	Environmental benefit	Potential cost / issues	Evaluation
		being discharged to sea.	required for additional containment on primary vessels could create hazards for working on deck by limiting available space.	given small volumes of contaminants.
N/A	Restrict use of desalination plant	Would eliminate potential impacts from brine discharges by importing potable water.	Cost associated with transporting potable water. Health risks associated with limited supply of potable water.	**Rejected** – Cost outweighs the benefit, given the low impact expected from planned discharges and high potential impacts from risk transfer.
N/A	Re-design desalination plant effluent discharge system	Limited benefit to be gained given desalination brine will be diluted.	High costs associated with modifications to vessels. May not be feasible with some vessels. Salinity difference would be minimal compared to significant cost of altering the desalination plant effluent discharge system.	**Rejected** – Cost grossly disproportionate to environmental benefit. Limited benefit to be gained, given low impact. Minimal detectable change in water quality expected. Water making and brine discharge permitted maritime practice.
N/A	Zero discharge of brine water	Would eliminate potential impacts from brine discharges by storing on-board for onshore disposal.	Cost associated with transporting waste brine water, space required for additional containment on primary vessels could create hazards for working on deck by limiting available space.	**Rejected** – Cost grossly disproportionate to environmental benefit. Limited benefit to be gained, given low impact. No detectable change in water quality expected. Water making and brine discharge permitted maritime practice.
N/A	Do not test AFFF containing fire-fighting equipment on primary vessels	Would eliminate the discharge of the small quantities of AFFF.	Increased safety risk due to potentially untested AFFF system. Inability to fight fire effectively.	**Rejected** – Safety considerations outweigh the environmental benefit.

CM reference	Control measure	Environmental benefit	Potential cost / issues	Evaluation
N/A	Zero discharge of putrescible waste	Would eliminate potential impacts from putrescible waste discharges by storing on-board for onshore disposal.	Cost associated with transporting putrescible waste to shore, space required for additional containment on primary vessels could create hazards for working on deck by limiting available space. Health risks and costs associated with storage on-board and transport/disposal onshore.	**Rejected** – Cost grossly disproportionate to environmental benefit. Limited benefit to be gained, given low impact. Health risks associated with managing putrescible waste in hot weather conditions, putrescible waste discharge is a permitted maritime practice.
N/A	Do not cut risers, mooring chains and tethers and seabed assets	Eliminates the potential discharge of metal (steel) swarf to the environment.	Not performing cuts to risers, mooring chains, tethers and seabed assets would prevent the safe removal of the DTM and MWAs and seabed assets and is not considered a feasible option. Would also prevent the steel structures being cut for recycling purposes where necessary.	**Rejected** – Safety and process considerations outweigh the environmental benefit given small volumes and rapid dispersion of the discharges.

8.6.4 Environmental impact assessment

Receptor	Consequence Level
Operational Discharges	
Threatened, migratory or local fauna Physical environment or habitat	<u>Offshore aspects</u> Operational discharges from the vessels have the potential to cause a localised decrease in water quality alteration to marine fauna behaviour. Sensitive receptors that may be impacted include fish at surface, marine turtles, mammals and seabirds. Any effects on water quality are expected to be within the surface waters only and have no effect on seabed receptors. Given the distance from shorelines and that the activity will be for a relatively limited duration, impacts will be limited to short-term water quality impacts and temporary avoidance behaviour in fish, marine mammals, sharks and seabirds. Impacts to water quality will be experienced in the discharge mixing zone which will be localised and will occur only as long as the discharges occur (i.e. no sustained impacts), therefore, recovery will be measured in hours to days. Consequently, only short-term behavioural impacts are expected with no decrease in local population size, area of occupancy of species, loss or disruption of habitat critical or disruption to the breeding cycle and introduction of disease. 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 II (Minor). <u>Onshore aspects</u> Emissions associated with the onshore disposal / recycling of decommissioned assets are relatively small and will, under normal circumstances quickly dissipate into the surrounding atmosphere. The activity will occur using existing transport equipment (roads) and at existing licensed waste facilities. No land clearing is required to support onshore disposal / recycling. No impacts to threatened, migratory or local fauna are expected from disposing or recycling the assets at licensed waste facilities.
Socio-economic receptors	Not applicable – Planned operational discharges are not expected to impact on socio-economic receptors. No stakeholder concerns have been raised regarding this event.
Threatened ecological communities	Not applicable – No threatened ecological communities identified in the area over which operational discharges are expected.
Protected areas	Not applicable – No protected areas are identified in the area over which operational discharges are expected.
Overall worst-case consequence	II – Minor

8.6.5 Demonstration of as low as reasonably practicable

Vessels are required to undertake the activity. The alternative to discharging these small amounts of liquid wastes to the marine environment is to store and transport the wastes to land, where they would be disposed of in line with industry best practice. However, this would result in an increase in environmental impacts through increased fuel consumption and increased atmospheric emissions, from vessels 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 additional wastes. This method would also result in an increased risk of vessel-to-vessel collision, which could lead to a marine diesel spill. Therefore, this option would be of no net environmental benefit and would increase the risk associated with the activity, so it has not been adopted. In some cases, the containment of discharges is difficult without significant modifications to vessels (e.g. additional bunding or containment systems) presenting an increase in safety risk to personnel through the reduction in deck space, increased lifts and health hazards of storing wastes or other discharges.

The use of AFFF is required for emergency response purposes and routine testing the foam fire-fighting system is critical for maintaining emergency response capabilities on vessels. The product has been assessed through the Santos Operations Chemical Selection, Evaluation and Approval Procedure (EA-91-II-10001), ensuring potential impacts are acceptable.

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

On-board 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. The proposed management controls for planned operational discharges are considered appropriate to manage the risk to ALARP. Additional control measures were considered but rejected since the associated cost or effort was grossly disproportionate to any benefit, as detailed in **Section 8.6.3**.

No feasible alternatives to the onshore disposal / recycling for the majority of recovered decommissioned assets (e.g. floating assets manifolds, risers, umbilicals, rigid and flexible flowlines etc) have been identified. Santos is obliged to remove these assets from the MEFF Field as part of decommissioning commitments. Onshore disposal and recycling allows for the safe disposal and recycling of the floating assets, which are majority steel. Onshore disposal / recycling will only occur using suitably experienced contractors and facilities and in accordance with relevant waste legislation.

8.6.6 Acceptability evaluation

Is the consequence ranked as I (Negligible) or II (Minor)	Yes – maximum consequence from planned operational discharges is II (Minor).
Is further information required in the consequence assessment?	No – potential impacts and risks are well understood through the information available.
Are risks and impacts consistent with the principles of ESD?	Yes – activity evaluated in accordance with Santos' Environmental Hazard Identification and Assessment Procedure (EA-91-IG-00004_5), which considers principles of ESD. The consequence against this aspect is II (Minor) and therefore does not affect the outcomes of the principles of ecologically sustainable development as per **Table 7-5**.
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. Yes – onshore disposal and recycling will only be carried out in accordance with relevant waste regulations by licensed contractors and at appropriately licensed waste management facilities. Disposal / recycling will be managed in accordance with applicable requirements. For example, within Western Australia will be in accordance with legislation, such as, the Environmental Protection Act 1986.
Are risks and impacts consistent with Santos' Environmental, Health and Safety Policy?	Yes – aligns with Santos' Environmental, Health and Safety Policy.
Are risks and impacts consistent with stakeholder expectations? **Related to cessation phase and floating asset removal activities**	Yes – no concerns raised.
Are risks and impacts consistent with stakeholder expectations? **Related to seabed equipment removal and abandonment in situ activities)**	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 Australian Marine Orders requirements respectively, and is enacted by:

- Marine Order 91 (Marine pollution prevention – oil)
- Marine Order 96 (Marine pollution prevention – sewage)
- Marine Order 95 (Marine pollution prevention – garbage).

The operational discharges are not expected to significantly impact the receiving environment with management controls proposed, including compliance with all MARPOL requirements. The MARPOL standard is considered to be the most appropriate standard, given the nature and scale of the activities. These standards are internationally accepted and utilised industry-wide. Therefore, compliance with the relevant and appropriate MARPOL requirements and standards is expected to reduce the potential for environmental impacts to a level which is considered environmentally acceptable.

Disposal / recycling of decommissioned assets will be managed in accordance with applicable legislation and requirements, as such the potential for environmental impacts is expected to be reduced to a level which is considered environmentally acceptable.

8.7 Planned chemical and hydrocarbon discharges

8.7.1 Description of the event

Event	The activities that will result in the discharge of residual hydrocarbons and chemicals to the marine environment are: + field management IMMR activities + barrier testing + marine growth removal + removal of floating and seabed assets <u>Field management activities</u> Small volumes of hydraulic fluids (from the use of ROVs) and chemicals are likely to be discharged subsea during the IMMR campaigns. Worst-case discharge volumes are expected to be approximately 10 L. <u>Barrier testing</u> During barrier testing activities, there may be a requirement to release small amounts of barrier testing fluids such as water-based hydraulic oil, MEG or methanol, as well as minor amounts of residual hydrocarbons. Worst-case discharge volumes are expected to be small (approximately 25 L per test). <u>Marine growth removal</u> Small volumes (litres) of inorganic or organic acid wash chemicals (such as citric acid or sulfamic acid) may be discharged during calcareous marine growth removal if water jetting is not sufficient. <u>Removal of floating and seabed assets</u> Some residual hydrocarbons and treated seawater may be released to the marine environment during floating asset removal; e.g. when the two production risers and production umbilicals are pressure-bled and are cut from the DTM to allow for DTM removal. The 2018 flushing campaign (prior to FPSO sail away) achieved a residual hydrocarbon concentration of 30 to 40 ppm in the subsea production system. The residual hydrocarbon content of each riser is estimated to be around 1 L. However, a maximum release of approximately 50 L per riser has been estimated based on the possibility of additional hydrocarbon trapped in high points or the rough bore (**Section 4.6.2**). The estimated treated seawater discharge from disconnection of risers and flowlines during floating is approximately 2,098 m^3 (refer to **Table 4-1**). The release of residual hydrocarbons (at 30 - 40ppm) within approximately 2,238m3 of treated seawater with the potential for residual entrapped hydrocarbons in the carcass of the flexible flowlines may occur during seabed equipment removal. Some residual chemicals from the treated seawater within the production risers and umbilicals, and production chemicals (e.g. scale inhibitor, hydraulic control fluid, glycol and MEG) are also anticipated. These chemicals are OCNS rated D and/or have been previously approved for discharge to the marine environment in the MEFF Field Operations EP (ME-7000-A02-F003). Santos does not anticipate any other contaminants (e.g. NORM and mercury).

Extent	Chemicals, residual hydrocarbons and hydraulic fluids may be discharged to the marine environment from the surface or close to the seabed. Discharges will be relatively minor in volume and dissipate quickly in the open ocean marine environment. Temporary localised decline in water quality in the immediate vicinity of the discharge.
Duration	Various hydrocarbon and chemical discharges will occur intermittently for the duration of the activity and will last for minutes to several hours over the course of the IMMR and decommissioning activities as described in **Section 4.1**. The duration will be longer for umbilicals if left uncapped and wet stored during initial decommissioning activities, however the volume released will remain the same. Releases during seabed asset removal activities will be comprised of many, very small volume releases at different times rather than in a single release event.

8.7.2 Nature and scale of environmental impacts

Potential receptors: Water quality, fish (pelagic) and sharks, marine mammals, marine turtles, seabirds and socio-economic.

The potential environmental impacts from planned chemical and hydrocarbon discharges include:

+ temporary localised decline in water quality in the immediate vicinity of the discharge
+ toxicity to marine fauna.

Hydraulic fluids

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. The potential impacts of hydraulic fluid discharges near the seabed are a localised reduction in water quality and potential toxicity to benthic marine fauna associated with bare sediments or attracted / attached to seabed equipment (e.g. fish, infauna and sessile filter feeding organisms). Due to the small volumes (around 25 L per release) it is likely that any impacts to benthic fauna and water quality will be highly localised, if occurring at all.

Hydraulic fluids behave similarly to MDO when discharged in the marine environment (information about MDO is provided in **Section 9.6**). Hydraulic fluids are medium oils of light to moderate viscosity and have a relatively rapid spreading rate and, like MDO, will dissipate quickly, particularly in high sea states.

Acid wash

Inorganic or organic acids used for marine growth removal are expected to rapidly disperse in the offshore marine environment. Due to the small volumes discharged during marine growth removal, impacts to benthic fauna and water quality will be highly localised.

Treated seawater, MEG, methanol, scale inhibitor and glycol

Treated seawater will contain a biocide, likely to be similar to CRW-24830 which is a common biocide used in the offshore oil and gas industry. Although biocides typically contain a substance (quaternary ammonium chloride) which is known to be very toxic to aquatic organisms, the concentration is typically very low (less than 30%) within the biocide itself as a whole. Maximum treated seawater volumes that could be released during seabed asset removal activities are estimated to be 2,238 m^3. This is comprised of multiple volumes (largest single volume estimated to be 745 m^3). The chemical component in treated seawater is a substantially less volume; CRW-24830 at a concentration of 1700 ppm in 2,238 m^3 of treated seawater is 3.81 m^3 of chemical with the remainder being seawater.

MEG and methanol both have low toxicity, are readily biodegradable, are rated as PLONOR and E (non-CHARM) in the OCNS rankings.

Scale inhibitor is not expected to biodegrade when released to the marine environment. however, scale inhibitor is not known to bioaccumulate. Scale inhibitor and glycol both have low aquatic toxicity and the small volumes released will dilute rapidly when released to the marine environment. Scale inhibitor and glycol are rated as D (non-CHARM) in the OCNS rankings.

Therefore, it is likely that any impacts to benthic fauna and water quality will be highly localised, if occurring at all.

Residual hydrocarbons

Maximum residual hydrocarbon volumes that could be released during floating asset removal activities are estimated to be 50 L for each of the two production risers (100 L total). Maximum residual hydrocarbon volumes that could be released during seabed asset removal activities are estimated to be at a concentration of 30-40 ppm as part of the treated water discharge. This is comprised of multiple smaller volumes that will be released at different times rather than in a single release event.

The small volumes and low concentrations of residual hydrocarbon released are expected to rapidly disperse and are unlikely to impact benthic fauna and water quality in the vicinity of the release is expected to quickly return to background.

Toxicity

On discharge to the marine environment, the low volumes of chemicals and residual hydrocarbons are expected to rapidly disperse in the offshore marine environment. Hence, any potential impacts would be confined to a localised area immediately surrounding the discharge.

There may be a localised and temporary (hours) reduction in water quality in the immediate vicinity of the release. Toxicity impacts to marine fauna from the release of chemicals are unlikely to eventuate because:

+ the chemicals will have been risk assessed for their suitability for discharge using Operations Chemical Selection Evaluation and Approval Procedure (EA-91-II-10001)
+ the sensitivity of the receiving environment is considered low
+ volumes of discharges are relatively small and will be over multiple campaigns rather than simultaneously
+ strong ocean currents mean the discharge will become further diluted upon discharge, so the duration of exposure of chemicals to fauna will be minimal
+ potential discharges will be localised, intermittent and temporary within the operational area.

Santos does not anticipate any other contaminants (e.g. NORM and mercury). However, should any assets recovered to surface be of concern they will be assessed for contamination. In the case that contamination is identified, the equipment will be managed as per Santos procedures appropriate for the contamination type and level. All waste will be handled and disposed of in accordance with relevant legislation of the receiving jurisdiction.

Threatened or migratory fauna

As discussed in the sections above, the discharge extent for all planned discharges of chemicals, hydrocarbons and cutting swarf is localised. Rapid dilution of chemicals and hydrocarbons is predicted to occur within the offshore waters. 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 any exposure is likely not of sufficient duration to cause a toxic effect.

Given the nature of discharged chemicals and hydrocarbons, the small volumes that could be released to the marine environment and the nature of the marine environment within the vicinity of the operational area, the planned discharges are not predicted to have ecologically significant effects. Discharges of chemicals and hydrocarbons may cause avoidance behaviour in marine fauna. Given the nature of the discharges (localised, rapid dilution, majority are intermittent), any behavioural impacts are expected to be short-term and minimal.

8.7.3 Environmental performance outcomes and control measures

The EPOs relating to this event include:

+ No unplanned objects, emissions or discharges to sea or air [MEFF-EPO-05].

The control measures considered for this event are shown in **Table 8-15**, and EPSs and measurement criteria for the EPOs are described in **Section 10.4**.

Table 8-15: Control measures evaluation for planned chemical and hydrocarbon discharges

CM reference	Control measure	Environmental benefit	Potential cost / issues	Evaluation
Standard Control Measures				
MEFF-CM-30	Chemical selection procedure	Ensures planned discharges to sea meet the criteria for not being harmful to the marine environment according to MARPOL Annex V; or Gold/Silver/D or E rated through OCNS; or have a completed Santos ecotoxicological risk assessment so only environmentally acceptable products are used.	Personnel time associated with chemical selection, approval and procurement as per chemical selection procedure.	**Adopted** – Benefits outweigh minor costs.
MEFF-CM-34	NOPSEMA accepted WOMP for MEFF wells	Includes control measures for well integrity and well control in an accepted WOMP, that reduce the risk of discharges to the marine environment during barrier testing. The WOMP includes: + barriers in place to isolate hydrocarbons from the marine environment + inspection, monitoring and testing of barriers over the life of the well + response to increases in well integrity risk	Costs associated with personnel time in writing, reviewing and implementing the WOMP.	**Adopted** – Regulatory requirement must be adopted.

CM reference	Control measure	Environmental benefit	Potential cost / issues	Evaluation
		+ notification and reporting requirements. Effective barriers manage isolation of the reservoir from the environment, acting to eliminate hydrocarbon releases.		
MEFF-CM-35	Hazardous Materials Procedure	Ensures any NORM waste will be handled and disposed of in accordance with Federal, and State requirements.	Costs associated with implementation of the plan	**Adopted** – Benefits outweigh minor costs and is a regulatory requirement so must be adopted.
MEFF-CM-33	Onshore disposal of decommissioned assets in accordance with relevant llegislative requirements	Ensures decommissioned assets are recycled and disposed of in accordance with relevant waste management legislation applicable to the receiving jurisdiction, reducing the potential for environmental impacts.	Minimal additional costs, this is a regulatory requirement.	**Adopted** – Benefits outweigh minor costs.
Additional Control Measures				
N/A	Reduce, capture or eliminate use of chemicals and hydraulic fluid	Would eliminate or reduce the chemical and hydraulic fluid discharge to the marine environment.	Chemicals are assessed to ensure the discharge is environmentally acceptable in accordance with Operations Chemical Selection Evaluation and Approval Procedure (EA-91-II-10001). Excessive use of chemicals is restricted. Eliminating the use of chemicals and hydraulic fluid would cause safety and process issues.	**Rejected** – Safety and process considerations outweigh the environmental benefit, given small volumes and low toxicity of the discharges.
N/A	Additional flushing of subsea production	Reducing the concentration of residual hydrocarbons in the subsea system	Potentially reduces the maximum volume of residual hydrocarbons in the production risers	**Rejected** – Significant additional costs achieve little to no

CM reference	Control measure	Environmental benefit	Potential cost / issues	Evaluation
	system (risers and flowlines)	reduces the volume of residual hydrocarbons that would be released to the marine environment during asset removal.	that could be discharged. However, the 2018 flushing campaign achieved an OIW concentration measured at the FPSO of 30 to 40 ppm. This equates to an approximate residual hydrocarbon discharges detailed in **Table 3-3,** and allowing for a conservative assumption that hydrocarbon trapped in the rough bore of the flexible risers and flexible flowlines would also be released during recovery. Additional flushing will not remove the residual hydrocarbons that have migrated to high points or that is trapped in the rough bore. The environmental benefits of additional flushing are therefore negligible. There is a significant extra cost associated with contracting dedicated flushing vessels (two construction class vessels required). Around 6600 m³ to 11,050 m³ of treated seawater dosed with Hydrosure 0-3670R at a concentration of 500 ppm required. Estimated flushing time requires 24 to 74 hrs per flowline (three flowlines in total). There would also be additional	environmental benefit, given small volumes of residual hydrocarbons contained within the production system.

CM reference	Control measure	Environmental benefit	Potential cost / issues	Evaluation
			environmental risks (e.g. failure of downline during flushing, discharge of flushing returns, handling and storage of flushing chemicals, additional operational discharges from vessels, increased vessel collision risk) and indirect impacts (e.g. disposal of oil filter cartridges) to achieve overall negligible reduction in an already low volume of residual hydrocarbons.	
N/A	Do not cut risers, mooring chains and tethers and seabed assets	Eliminates the potential discharge of any contaminants to the marine environment.	Not performing cuts to risers, mooring chains and tethers and seabed assets would prevent the safe removal of assets and is not considered a feasible option.	**Rejected** – Safety and process considerations outweigh the environmental benefit, given small volumes and rapid dispersion of the discharges. In addition, decommissioning is a legal requirement.
N/A	Cap prior to recovering rigid and flexible flowlines and umbilicals (flooded)	Would reduce the volume of subsea discharges of hydrocarbons and treated seawater and the associated environmental impacts.	Will require a larger vessel or more trips to remove decommissioned assets resulting in increased costs and environmental impacts. Discharges from the rigid and flexible flowlines and umbilicals will have to be managed onboard the vessel or onshore, resulting in increased costs. Increased safety and spill risk to ocean surface from	**Rejected** – Cost outweighs the negligible environmental benefit. There are weight and safety issues associated with recovering flooded equipment and increased risk of surface hydrocarbon spills.

CM reference	Control measure	Environmental benefit	Potential cost / issues	Evaluation
			managing the discharges onboard the vessel. Costs associated with onshore disposal and associated impacts.	

8.7.4 Environmental impact assessment

Receptor	Consequence Level
Operational Discharges	
Threatened, migratory or local fauna Physical environment or habitat	Planned chemical and hydrocarbon discharges have the potential to cause a localised decrease in water quality and consequent alteration to marine fauna behaviour. Sensitive receptors that may be impacted include fish at surface, marine turtles and mammals and seabirds. Any effects on water quality are expected to be highly localised and have little to no effect on seabed receptors. Given the distance from shorelines and that the activity will be for a relatively limited duration (refer to **Section 4.1**), impacts will be limited to short-term water quality impacts and temporary avoidance behaviour in fish, marine mammals, sharks and seabirds. Impacts to water quality will be experienced in the discharge mixing zone which will be localised and will occur only as long as the discharges occur (i.e. no sustained impacts), therefore, recovery will be measured in hours to days. Discharges are not planned to occur simultaneously. Consequently, only short-term behavioural impacts are expected with no decrease in local population size, area of occupancy of species, loss or disruption of habitat critical. disruption to the breeding cycle and introduction of disease. Discharge of swarf from cutting activities may also result in localised smothering of benthic habitats. However, given the very small quantities likely to be discharged, and the lack of sensitive benthic habitats within and in proximity to the operational area, any impacts would be highly localised and temporary. Given the nature of the planned chemical, hydrocarbon and cutting 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 II (Minor).
Socio-economic receptors	Negligible - planned chemical and hydrocarbon discharges are not expected to impact fishery resources (demersal fish species) and are unlikely to result in changes in distribution and abundance of fish species outside the operational area. WAFIC raised a query regarding the expected volume and impacts of the release of residual hydrocarbons and Santos provided a response to that (**Table 6-4**), with no further concerns raised.
Threatened ecological communities	Not applicable – No threatened ecological communities identified in the area over which planned chemical or hydrocarbon discharges are expected.
Protected areas	Not applicable – No protected areas are identified in the area over which planned chemical or hydrocarbon discharges are expected.

Receptor	Consequence Level
Overall worst-case consequence	II – Minor

8.7.5 Demonstration of as low as reasonably practicable

The use of chemicals, such as methanol, to conduct testing on seabed equipment is a standard technique that is considered critical in determining the presence of leaks and equipment integrity. Alternatives to the use of methanol include freshwater. The use of freshwater in the subsea system can result in hydrate formation and introduce integrity risks; therefore, it is not considered feasible. The use of treated seawater is also an industry standard and uses chemicals that have been appropriately risk assessed under the Operations Chemical Selection Evaluation and Approval Procedure (EA-91-II-10001).

Marine growth removal is required on the DTM and MWAs as well as seabed assets so they can be safely removed from the operational area as required by legislation and regulations. Acid wash would only be used for marine growth removal if removal by mechanical means could not be achieved.

Similarly, the release of small volumes of residual hydrocarbons during floating asset and seabed asset removal cannot be avoided. An additional control of additional flushing of the subsea system (additional to the 2018 flushing campaign) with chemicals to reduce the residual hydrocarbon concentration was considered, however, the significant additional safety risks, cost and risks and impacts related to additional vessels in the field, was found to be grossly disproportionate to the negligible environmental benefit gained.

Cutting of subsea equipment, such as rigid flowlines, risers, mooring chains and tethers, with subsea cuttings tools is an industry standard technique to allow removal of equipment, with no feasible alternatives.

The controls in place to manage the volume of treated seawater and chemicals used during the activities manages the volumes released to the ocean to ALARP. The assessed residual consequence for this impact is minor and cannot be reduced further.

8.7.6 Acceptability evaluation

Is the consequence ranked as I (Negligible) or II (Minor)	Yes – maximum consequence from planned chemical and hydrocarbon discharges is II (Minor).
Is further information required in the consequence assessment?	No – potential impacts and risks are well understood through the information available.
Are risks and impacts consistent with the principles of ESD?	Yes – activity evaluated in accordance with Santos' Environmental Hazard Identification and Assessment Procedure (EA-91-IG-00004_5), which considers principles of ESD. The consequence against this aspect is II (Minor) and therefore does not affect the outcomes of the principles of ecologically sustainable development as per **Table 7-5**.
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 management and recovery plans.
Are risks and impacts consistent with Santos' Environmental, Health and Safety Policy?	Yes – aligns with Santos' Environmental, Health and Safety Policy.
Are risks and impacts consistent with stakeholder expectations? **Related to cessation phase and floating asset removal activities**	Yes – no concerns raised.
Are risks and impacts consistent with stakeholder expectations? **Related to seabed equipment removal and abandonment in situ activities**	**Yes -** WAFIC raised a query regarding the expected volume and impacts of the release of residual hydrocarbons and Santos provided a response to that (**Table 6-4**), with no further concerns raised.
Are performance standards such that the impact or risk is considered to be ALARP?	Yes – see ALARP above.

The use of hydraulic fluids, acid wash, MEG, methanol and treated seawater is unavoidable as they are required to safely complete the activities and preserve seabed equipment. The release of residual hydrocarbons during decommissioning asset removal is also unavoidable during the activity. However, water quality and benthic impacts will be highly localized to the immediate vicinity of the discharge. The operational area is not located nearby to any sensitive habitat.

The application of the chemical selection procedure is an important control for reducing the toxicity of any chemicals that may be discharged during the activities. In accordance with the procedure, CHARM-rated Gold/Silver and non-CHARM grouped E/D chemicals managed under the OCNS, or PLONOR substances listed by OSPAR, or chemicals risk assessed by Santos and deemed environmentally acceptable, will be selected.

With control measures in place to minimise the environmental impact of chemical and hydrocarbon discharges, the consequence was assessed as Minor (II) and ALARP. The managed discharges will not reduce the habitat values of the area potentially affected as described in relevant Recovery Plans or Approved Conservation Advice or be inconsistent with the strategies of these documents. No concerns have been raised regarding this event by stakeholders. Therefore, the minor impacts expected from the proposed discharges are considered to be environmentally acceptable.

8.8 Degradation of abandoned seabed equipment

8.8.1 Description of the event

Event	Potential impacts from the degradation and corrosion of abandoned seabed equipment may occur in the marine environment. from: + Degradation and corrosion of steel and concrete + degradation of minor amounts of plastics Impacts associated with the continued presence of abandoned seabed equipment on other marine users and the seabed and benthic habitats is discussed in **Section 8.1** and **Section 8.2** respectively. Impacts associated with releases of treated seawater and residual OIW on disconnection during decommissioning activities are discussed in **Section 8.7**. Corrosion and degradation of assets The materials that the equipment proposed for abandonment in situ are constructed from primarily concrete and steel and are not water soluble, although corrosion products of steel may be water soluble. The valve assemblies on the gravity bases (2 x valves on each gravity base, 4 valves in total) contain a very small amount of plastic (approximately 0.1 kg each). Most of these materials are expected to degrade into progressively smaller pieces as the equipment degrades and corrodes over long periods of time (decades to hundreds of years) (Advisian, 2022). Atteris (2021) studied the degradation processes that will affect equipment in the MEFF fields, with findings summarised below relevant to gravity bases, associated concrete ballast, mooring anchors and chains: Gravity bases and concrete ballast, mooring anchors, and chains: + It is estimated that external corrosion of the gravity bases may occur between 90 and 250 years after local cathodic protection (i.e. anode) system depletion. + The concrete in the gravity bases will gradually break down due to a combination of chloride attack and external sulfate attack. Chloride and sulfate ions in seawater can penetrate the concrete and cause chemical reactions that lead to swelling, cracking and loss of strength. The concrete ballast is not reinforced, hence spalling due to expansion of reinforcing material corrosion will not occur. The ions weaken both the cement binder as well as the cementitious material. The concrete mattress may take between 50 and 200 years to degrade. + The equipment will eventually fully corrode, and corrosion products will either be dispersed due to hydrodynamic loading during the degradation process or will sink to the seafloor. Any parts of the equipment coating system that flake off will either remain buried or be dispersed by hydrodynamic loading. + The degradation of the plastic valves has the potential to leach very minor amounts polymer additives, such as antioxidants, stabilisers and plasticisers, into the marine environment over time. Leaching from these external components has likely been ongoing since installation and will progress during the infrastructure degradation process (where the water/polymer interface occurs). + The equipment may self-bury over time, with the exception of the anchors which are already buried, due to the high weight of the concrete and steel corrosion products relative to seawater.
Extent	As equipment degrades and corrodes, larger pieces will sink or slump to the seafloor, and when fully corroded remain buried in situ or disperse due to hydrodynamic loading during the degradation process.
Duration	Degradation and corrosion of concrete and steel is estimated over decades to centuries.

8.8.2 Nature and scale of environmental impacts

Potential receptors: Water quality, benthic habitats and fauna, fish (demersal and pelagic), sharks, marine mammals, marine turtles, seabirds and socio-economic.

The potential environmental and socio-economic impacts from the degradation and corrosion of abandoned seabed equipment include:

- localised decline in water and sediment quality in the vicinity of the abandoned equipment
- toxicity to marine fauna (pelagic, demersal and benthic communities).

Steel and concrete particles:

The gravity bases, mooring chains and anchors are primarily comprised of steel, of which the main constituent is iron (approximately 96%). Iron is not considered a significant contaminant in the marine environment and is only toxic to marine organisms at high concentrations (Grimwood and Dixon, 1997).

Steel is expected to degrade into iron oxides and iron hydroxides. There are currently no trigger values for iron or its forms of hydroxide for marine water or sediment quality (DAWE 2022). Iron is not considered a significant contaminant in the marine environment (OSPAR PLONOR) and is an abundant element in marine sedimentary systems (Taylor and Macquaker, 2011).

The breakdown of steel is expected to occur over 90 – 250 years. Steel from the exposed areas of the gravity bases and mooring chains prior to any burial, may enter the water column and disperse. Any dissolved particles that enter the water column are likely to remain in low concentrations. Given such minor volumes this will not be measurable within the water column.

Elevated levels of iron may appear in the marine sediments directly adjacent to the buried DTM anchors as they corrode and degrade, however given the rate of corrosion (90 – 250 years), the fact that any contaminants would remain buried at the anchor locations, and lack of sensitive habitat, iron levels are unlikely to result in an impact greater than a localised change in sediment quality.

Similar to steel, concrete is expected to degrade into progressively smaller pieces over a similar degradation timeframe. The concrete ballast associated with the gravity bases contains ordinary Portland cement, crushed granite and natural sand. These constituents are thought to be inert in the marine environment. As the concrete degrades and flakes, it is likely to settle in the nearby sediment given it's higher density compared to seawater and is unlikely to result in an impact greater than a localised change in sediment quality.

The Atteris 2021 study predicted material breakdown outcomes for steel and concrete associated with the gravity bases and steel associated with the anchors and mooring chains and these are provided in **Table 8-16**.

Table 8-16: Estimated material breakdown outcomes of equipment proposed to be left in situ

Material	Lower Bound Size	Upper Bound Size	Likely Size and Event	Estimated Dispersion Characteristics
Concrete	Sand Like Particles < 1 mm	Large Pieces >50 cm In the event of an external impact,	Chunks < 10 cm x 10 cm x 10 cm thickness	Any exposed pieces are likely to remain within the local area and be incorporated into the seabed due to the

Material	Lower Bound Size	Upper Bound Size	Likely Size and Event	Estimated Dispersion Characteristics
	Abrasion and self-erosion due to seabed mobility and movement may form sand like particles from both the cement and sand aggregate.	movement due to extreme or environmental loading events, large sections of the concrete may break away.	Cracking of the concrete due to chloride and sulfite attack is the most likely degradation mechanism.	significantly higher density than seawater (SG ~ 2.40 - 3.04). Larger pieces are likely to erode into small particles and aggregate.
Structural Steel	Small Corrosion Particles < 1 mm Steel corrosion products can be abraded off the structure by seabed movement.	Pieces of Heavily Corroded Steel < 15 cm Heavily corroded pieces of steel may be released from the structure by impacts or uneven corrosion. Sections are likely to independently corrode in their new location.	Small and Moderate Flakes < 5 cm Dislodgement likely to be caused by abrasion, environmental loading, weight of marine growth and marine fauna activity.	Any exposed sections are likely to remain in the immediate area and be incorporated into the seabed due to the significantly higher density than seawater (SG ~5.11 for carbon steels, SG ~3 for Aluminium) varies based on chemical composition). A portion of the metals may remain dissolved and be incorporated into local marine life.

Epoxy coatings:

Volumes of epoxy coating the anchors and gravity bases is minor (**Section 4.8.1** and **Section 4.8.2**). Released volumes from the buried anchors will remain buried as the infrastructure corrodes and degrades. Coating from the exposed areas of the gravity bases, prior to any burial, may enter the water column and disperse, however given such minor volumes this will not be measurable. The release of epoxy coating, given the minor volumes are unlikely to result in an impact greater than a temporary localised change in water quality and localised change in sediment quality within the operational area.

Plastics:

The plastics associated with the valves on the gravity bases may include polymer additives, such as antioxidants, stabilisers and plasticisers. Assuming full degradation of the valves, approximately 0.4 kg of plastics may degrade into macro and microplastics and disperse in the marine environment, potentially setting in the surrounding sediment or dispersing widely in the water column and will not be measurable. Polymers/additives are expected to continue to leach very slowly and disperse rapidly in the water column and will not be measurable. Impacts to sediment are not expected from leaching given the gravity bases are unlikely to bury.

Anodes:

Anodes present on the gravity bases consist primarily of aluminium with minor amounts of zinc, indium and other trace elements such as copper, silicon, iron and cadmium. As the anodes degrade, degradation products such as aluminium oxide, cooper oxide and zinc hydroxide may be released to the marine environment. Whilst copper oxide and zinc hydroxide are considered toxic to aquatic life, only very minor amounts of the degradation products are expected to be released slowly over the degradation timeframe and rapidly in the water column. Such minor volumes will not be measurable. Aluminium oxide, copper oxide and zinc hydroxide are found naturally within the marine environment.

Filter and deposit feeding epifauna and infauna and demersal fishes may ingest corrosion and degradation by-products. Due to the low toxicity of iron, the minor qualities of other toxicants from plastics, steel, concrete, anodes and epoxy paint coatings and the slow release rate, any impacts to water and sediment quality and the associated benthic communities and demersal fishes are expected to be localised and minor. The benthic communities are widespread and are not considered to be of particular conservation significance.

Other 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 as materials degrade and corrode and the transient movement of fauna, such that any exposure is likely not of sufficient duration to cause a toxic effect.

Given the relatively minor volumes, long degradation and corrosions durations, rapid dilution, nature of the marine environment within the vicinity of the equipment under consideration for abandonment in situ and transient nature of threatened or migratory fauna, the expected by-products are not predicted to have ecologically significant effects. Avoidance behaviour in marine fauna is also not expected.

8.8.3 Environmental performance outcomes and control measures

The EPOs relating to this event include:

+ No unplanned objects, emissions or discharges to sea or air [MEFF-EPO-05].

The control measures considered for this event are shown in **Table 8-17**, and EPSs and measurement criteria for the EPOs are described in **Section 10.4**.

Table 8-17: Control measures evaluation for degradation of abandoned seabed equipment in situ

CM reference	Control measure	Environmental benefit	Potential cost / issues	Evaluation
Standard Control Measures				
MEFF-CM-13	As left survey	Confirms understanding of physical environment in operational area post activities.	Costs associated with personnel and operations time in conducting surveys.	**Adopted** – Benefits considered to outweigh costs to Santos.
MEFF-CM-36	Sea dumping permit	Ensure compliance with legislation that assesses environmental risks and impacts associated with permanent abandonment of equipment at sea.	Minimal additional costs, this is a regulatory requirement.	**Adopted** – Legal requirement.
Additional Control Measures				

CM reference	Control measure	Environmental benefit	Potential cost / issues	Evaluation
N/A	Monitoring for degradation / dispersal of materials	Awareness of degradation levels to inform environmental risk assessment.	Significant costs associated with monitoring campaign.	**Rejected** – The degradation timeline for the gravity bases, concrete ballast, mooring chains and anchors is expected to proceed very slowly through auto-oxidation, i.e. degradation will release material among seabed sediments over the course of hundreds to thousands of years. Given the small amount of plastics, slow release of other degradation products and low risk that metal corrosion causes toxicity to marine organisms, there is little benefit in monitoring.m Monitoring is not expected to provide any useful data given the long degradation timelines.

8.8.4 Environmental impact assessment

Receptor	Consequence Level
Continued presence of seabed equipment	
Threatened, migratory or local fauna Physical environment or habitat	The degradation and corrosion of abandoned seabed assets has the potential to cause impacts from a reduction in water and sediment quality affecting benthic communities and other marine fauna. Given the relatively minor volumes, long degradation and corrosion durations, rapid dilution, nature of the marine environment within the vicinity of the equipment under consideration for abandonment in situ and transient nature of threatened or migratory fauna, the expected releases are not predicted to have ecologically significant effects. Avoidance behaviour in marine fauna is also not expected. The impacts from degradation of plastics and leaching of chemicals over the degradation timeframes are variable between different marine fauna groups, and within different life stages of an individual group, and not limited to the

Receptor	Consequence Level
	operational area. The long periods for degradation (decades to centuries), very small volume of plastics (approximately 0.4 kg) and dilution will aid in reducing the risk of impacts to marine fauna, however negligible impacts may occur to individuals but is unlikely to cause significant impacts at a population scale. The Recovery Plan for Marine Turtles in Australia (Commonwealth of Australia, 2017) identifies ingestion of marine debris as a threat to marine turtle population. Understanding the threat posed by marine debris is identified in the Recovery Plan as a priority action for the NWS green turtle stock. The Recovery Plan identifies the long-term recovery objective for marine turtles in Australia as: *to minimise anthropogenic threats to allow for the conservation status of marine turtles to improve so that they can be removed from the EPBC Act threatened species list.* However, given that microplastics and degradation products are not expected to accumulate in densities required for ecological effects, including bioaccumulation and biomagnification, impacts to turtle populations are not expected. The nearest biologically important area or habitat critical to the survival of marine turtles is located more than 35 km from the operational area. Microplastics and degradation products are expected to be widely dispersed below concentrations expected to cause impacts if they reach these areas. Therefore, the abandonment in situ of the gravity bases, concrete ballast, mooring chains and anchors is unlikely to compromise the objectives of the Marine Turtle Recovery Plan. As such, impacts to threatened, migratory or local fauna from corrosion and degradation by-products including plastics, are expected to be I (Negligible).
Socio-economic receptors	I (Negligible) – The risk of impacting on fisheries (commercially, traditionally or recreationally) from corrosion and degradation by-products, is considered negligible due to the relatively minor volumes, long release durations, rapid dilution and limited fishing effort, as discussed in **Section 8.1**, in the operational area. WAFIC raised a query seeking Confirmation that infrastructure proposed to be left in situ was clean and free of toxic substances. Santos confirmed that none of the infrastructure proposed to remain had ever been in contact with produced fluids or hydrocarbons and provided details on the composition of infrastructure proposed to be left in situ (Table 6-4) and no further concerns were raised.
Threatened ecological communities	Not applicable – No threatened ecological communities identified in the area over which the potential impacts from the continued presence of seabed equipment are expected.
Protected areas	Not applicable – No protected areas are identified in the area over which the potential impacts from the continued presence of seabed equipment are expected.
Overall worst-case consequence	Negligible (I)

8.8.5 Demonstration of as low as reasonably practicable

As discussed in **Section 3**, the results from the comparative environmental impact assessment (CEIA) demonstrates that the abandonment in situ alternative will result in equal or better environmental outcomes compared to full removal, which is required by NOPSEMA's Section 572 Maintenance and Removal of Property policy (NOPSEMA 2020).

The release of corrosion and degradation by-products will be localised and impacts to receptors are considered negligible and environmentally acceptable.

Additional control measures were assessed, such as monitoring for plastics degradation / dispersal, and corrosion rates of abandoned seabed equipment but were not adopted due to there being limited to no environmental benefits. Additionally, the very small quantities of degradation products released over long time periods will not be measurable.

Santos will engage with DCCEEW regarding the application of the Environment Protection (Sea Dumping) Act 1981 for the permanent abandonment of equipment left in situ and will comply with requirements under the Act.

Therefore, the controls in place to manage the degradation of abandoned seabed equipment is considered ALARP. The assessed residual consequence for this impact is negligible and cannot be reduced further.

8.8.6 Acceptability evaluation

Is the consequence ranked as I (Negligible) or II (Minor)	Yes – maximum consequence from continued presence of seabed equipment 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 ESD?	Yes – activity evaluated in accordance with Santos' Environmental Hazard Identification and Assessment Procedure (EA-91-IG-00004_5), which considers principles of ESD. The consequence for this aspect is I (Negligible) and therefore does not affect the outcomes of the principles of ecologically sustainable development as per **Table 7-5**. However, Santos acknowledges that the seabed equipment abandoned in situ will be present for approximately 90 to 250 years before it fully degrades. Therefore, Santos has completed the following assessment against the principle of inter-generational equity—that the present generation should ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations: + The risk assessment demonstrates that the degradation of abandoned seabed equipment will not adversely impact the health, diversity and productivity of the environment for the benefit of future generations. Any impacts are expected to be negligible and acceptable for both the short-term and the long-term.
Are risks and impacts consistent with relevant legislation, international agreements and conventions, guidelines and codes of practice (including species recovery plans, threat abatement plans, conservation advice and Australian Marine Park zoning objectives)?	Yes – Consistent with relevant species recovery plans, conservation management plans and management actions set out in **Table 5-10,** including but not limited to: + The Recovery Plan for Marine Turtles in Australia (Commonwealth of Australia, 2017) + The Threat Abatement Plan for the Impacts of Marine Debris on Vertebrate Wildlife of

	Australia's Coasts and Oceans (Commonwealth of Australia, 2018b) Consistent with the National Plastics Plan (DAWE, 2021), which recognises the issue of microplastics in the marine environment and includes supporting global action to address marine plastic debris, including the implementation of the Threat Abatement Plan for the impacts of marine debris on the vertebrate wildlife of Australia's coasts and oceans. Consistent with international agreements and guidelines including: + Annex I(2) of the 1996 London Protocol to the convention on the prevention of marine pollution by dumping of waste and other matter + IMO Resolution A.672 (16) Guidelines and Standards for the Removal of Offshore Installations and Structures on the Continental Shelf and in the Exclusive Economic Zone. Consistency with these plans and guidelines is discussed further below.
Are risks and impacts consistent with stakeholder expectations? **Related to cessation phase and floating asset removal activities**	Yes – aligns with Santos' Environmental, Health and Safety Policy.
Are risks and impacts consistent with stakeholder expectations? **Related to seabed equipment removal and abandonment in situ activities**	Yes – WAFIC raised a query seeking Confirmation that infrastructure proposed to be left in situ was clean and free of toxic substances. Santos confirmed that none of the infrastructure proposed to remain had ever been in contact with produced fluids or hydrocarbons and provided details on the composition of infrastructure proposed to be left in situ (Table 6-4) and no further concerns were raised. Recfishwest requested charts be updated and this is managed through environmental performance standard MEFF-CM-14 (**Section 10.4).** AMSA requested its maritime safety notification requirements which are addressed in **Table 10-7**.
Are performance standards such that the impact or risk is considered to be ALARP?	Yes – see ALARP above.

With control measures in place to minimise the environmental impact from degradation and corrosion of abandoned seabed equipment, the consequence was assessed as Negligible (I) and ALARP. The corrosion and degradation of abandoned equipment, including a very small volume of plastics (approximately 0.4 kg), is not expected to significantly reduce the habitat values of the area potentially affected as described in relevant Recovery Plans or Approved Conservation Advice, or be inconsistent with the strategies of these documents, including the objectives of the Marine Turtle Recovery Plan for Australia, Threat Abatement Plan for the Impacts of Marine Debris on Vertebrate Wildlife of Australia's Coasts and Oceans, Annex I(2) of the 1996 London Protocol or IMO Resolution

A.672 (16) Guidelines and Standards for the Removal of Offshore Installations and Structures on the Continental Shelf and in the Exclusive Economic Zone.

The Recovery Plan for Marine Turtles in Australia (Commonwealth of Australia, 2017) identifies ingestion of marine debris as a threat to marine turtle population. Understanding the threat posed by marine debris is identified in the Recovery Plan as a priority action for the NWS green turtle stock. The Recovery Plan identifies the long-term recovery objective for marine turtles in Australia as:

> *"to minimise anthropogenic threats to allow for the conservation status of marine turtles to improve so that they can be removed from the EPBC Act threatened species list*."

The Threat Abatement Plan for the impacts of Marine Debris on Vertebrate Wildlife of Australia's Coasts and Oceans (Commonwealth of Australia, 2018b) identifies the risk of entanglement in, or ingestion of, plastics as a key threatening process for several marine species protected under the EPBC Act. This plan was made under section 270A of the EPBC Act and states the following as objectives:

> *"Understand the scale of impacts from marine plastic and microplastic on key species, ecological communities, and locations."*

A key action to achieve this objective is to build understanding related to plastic and microplastic pollution.

The assessment of the potential impacts and risks from degradation of abandoned seabed equipment has considered the potential risks from plastics and microplastics to the marine environment, including marine turtles and other vertebrate marine fauna. The assessment demonstrates that the long periods for degradation (90-250 years), limited volume of plastics (approximately 0.4 kg) and dilution will aid in reducing the risk of impacts to marine fauna, however negligible impacts may occur to individuals but is unlikely to cause significant impacts at a population scale. Therefore, the activity is not inconsistent with the objectives and actions of the Recovery Plan for Marine Turtles in Australia (Commonwealth of Australia, 2017) and the Threat Abatement Plan for the impacts of Marine Debris on Vertebrate Wildlife of Australia's Coasts and Oceans (Commonwealth of Australia, 2018b).

The degradation of abandoned seabed equipment is not inconsistent with the Principles of ESD.

The degradation of abandoned seabed equipment is not inconsistent with IMO Resolution A.672 (16) Guidelines and Standards for the Removal of Offshore Installations and Structures on the Continental Shelf and in the Exclusive Economic Zone. The assessment is detailed in **Table 8-18**.

Table 8-18: Assessment Against IMO Resolution A.672 (16) Guidelines and Standards for the Removal of Offshore Installations and Structures on the Continental Shelf and in the Exclusive Economic Zone:

IMO Resolution A.672 (16) Guidelines and Standards for the Removal of Offshore Installations and Structures on the Continental Shelf and in the Exclusive Economic Zone	Assessment
The rate of deterioration of the material and its present and possible future effect on the marine environment	In the short-term, no corrosion of the seabed equipment is expected until well after anode depletion. The DTM anchors will remain buried. All abandoned seabed equipment is expected to remain stable and at its current as left location. Therefore, the potential for any impacts in the short-term is

IMO Resolution A.672 (16) Guidelines and Standards for the Removal of Offshore Installations and Structures on the Continental Shelf and in the Exclusive Economic Zone	Assessment
	limited to the ongoing physical presence of the abandoned infrastructure. Corrosion is predicted to begin in the medium to long term (90-250 years). Microplastics and degradation products are expected to be widely dispersed below concentrations expected to cause population level impacts if they reach important areas such as BIAs or habitat critical for the survival of a species. Microplastics and degradation products are not expected to accumulate in densities required for ecological effects, including bioaccumulation and biomagnification. Therefore, long-term impacts are considered negligible. Significant impacts are not expected.
The potential effect on the marine environment, including living resources	The risk assessment demonstrates that the abandonment in situ of seabed equipment is not expected to result in serious and/or irreversible environmental damage. The existing environment, including the seabed and associated habitat in the MEFF field is well understood (**Section 5**). Therefore, although time frames for degradation processes are uncertain (although are likely to be long), there is a level of scientific certainty in the risk assessment relating to the existing environment and potential impacts from the degradation of seabed equipment.
The risk that the material will shift from its position at some future time	All abandoned seabed equipment is expected to remain at its as left location until it has completely degraded.

Annex I(2) of the 1996 London Protocol to the convention on the prevention of marine pollution by dumping of waste and other matter (update to London Convention and Protocol 1972) describes that material capable of creating floating debris or otherwise contributes to the pollution of the marine environment has to be removed. The risk assessment for the degradation of abandoned seabed equipment acknowledges that over the degradation timeframe (90 to 250 years) some plastics and microplastics will be released into the marine environment and contribute (albeit in a very minor way) to the overall load of plastics and microplastics in the marine environment. However, assuming full degradation of the plastics associated with the valves of the gravity bases, only approximately 0.4 kg of plastics will be released into the marine environment. Any such plastics are expected to be buoyant and disperse widely, below concentrations expected to cause population level impacts if they reach these sensitive areas (e.g. habitat critical to the survival of marine turtles). Additionally, the CEIA (**Section 3.4.2** and **Appendix C**) demonstrates that the abandonment in situ alternative will result in equal or better environmental outcomes compared to full removal, which is required by NOPSEMA's Section 572 Maintenance and Removal of Property policy. The degradation of abandoned seabed equipment is therefore not inconsistent with Annex I(2) of the 1996 London Protocol.

Additional controls were considered and rejected (**Section 8.8.3**). Therefore, the negligible impacts expected from the degradation and corrosion of abandoned seabed equipment are considered to be environmentally acceptable.

8.9 Spill response operations

The spill response strategies that may be adopted in the event of a hydrocarbon spill have been identified in the MEFF Decommissioning OPEP (9885-650-PLN-0002) for worst-credible LOWC and marine diesel spills. Potential impacts arising from the implementation of the following spill response operations or actions were assessed.

Santos' environmental assessment identified potential sources of environmental impacts associated with contingency spill response operations for this activity. The results of the environmental assessment are summarised in **Table 8-1**. A comprehensive risk and impact assessment for each of the contingency spill response operations, and subsequent control measures proposed by Santos to reduce the risk and impacts to ALARP and acceptable levels, are detailed in the following sub-sections.

8.9.1 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 this EP and the OPEP. Spill response will be under the direction of the relevant Controlling Agency, as defined in Section 4 of the OPEP, which may be Santos, another agency or both. 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 provided in Section 6 of the OPEP and comprise: + source control + monitor and evaluate + mechanical dispersion + shoreline protection and deflection + shoreline clean-up + oiled wildlife response + scientific monitoring + 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. Spill response could occur anywhere within the MEVA for the worst-case spill scenarios. Some strategies will be concentrated in the vicinity of sensitive receptors in coastal waters and along shorelines.
Duration	The spill response effort as a whole will exceed the duration of the worst-case spill, due to persistence of the oil in the environment and the requirement to remove this oil and/or monitor impacts and recovery to sensitive receptors. The OPEP provides further detail the duration of specific response strategies.

8.9.2 Nature and scale of environmental impacts and risks for the activities

Light emissions	
Spill response activities will involve the use of vessels, which are required, at a minimum, to display navigational lighting. Vessels may operate close 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.	
Potential receptors:	Fauna (including threatened, migratory or local fauna) Protected areas
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 (**Table 5-8**), have been identified as key fauna susceptible to lighting impacts. **Section 8.3** provides further detail about 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 the Montebello Islands, Barrow Island, the Muiron Islands, and Ningaloo area, 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 disorientation of newly hatched turtles, which may increase the hatchling mortality rate. 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.	
Acoustic disturbance	
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).	
Potential receptors:	Fauna (including threatened, migratory or local fauna) Protected areas Socio-economic receptors
Underwater noise from the use of vessels may impact marine fauna, such as fish (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 mask communication or echolocation used by cetaceans. **Section 8.4** provides further detail on these impacts from vessels and helicopters. Cetaceans have been identified as the key concern for vessel noise within the MEVA. The humpback migration and resting BIA and the pygmy blue whale migration, foraging and distribution BIAs are all within the MEVA. 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 Montebello AMP. 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. As a consequence of impacts to fauna (including shorebirds, marine mammals, fish and sharks), noise has the potential to impact supported industries such as tourism and commercial fishing and recreational values of marine parks.	
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, such as carbon dioxide, methane and nitrous oxide, along with non-GHGs such as sulphur oxides and nitrogen oxides (NOx). Emissions will result in a localised decrease in air quality.	
Potential receptors:	Fauna (including threatened, migratory or local fauna) Physical environment or habitat (air quality) Socio-economic receptors
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. Emissions may occur in protected areas and/or areas where tourism is important; however, the scale of the impact relative to potential oil spill impacts is not considered great.	
Operational discharges and waste	
Operational discharges 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 + 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 + creation, storage, transport and disposal of oily waste and contaminated organics.	
Potential receptors:	Fauna (including threatened, migratory or local fauna) Physical environment or habitat Protected areas Socio-economic receptors
Operational discharges from vessels may create a localised and temporary reduction in marine water quality. Effects include nutrient enrichment, toxicity, turbidity, and temperature and salinity increases, as detailed in **Section 8.6**. Vessel discharges may occur in shallower coastal waters during spill response activities than that described in **Section 8.6**. Discharge could potentially occur adjacent to marine habitats, such as corals, seagrass and macroalgae, and in protected areas (i.e., receptors anywhere within the MEVA), which support a more diverse faunal community; however, discharges are still expected to be localised and temporary. 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. Disturbance may also impact cultural values of an area. 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. Disturbance may also impact cultural values of an area. 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, 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 9.2** 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 socio-economic values and industry (e.g., tourism, fisheries).

Disruption to other users of marine and coastal areas and townships:	
Spill response activities may involve the use of vessels, equipment and vehicles and the establishment of temporary camps in areas used by the general public or industry. The mobilisation of spill response personnel into an affected area may also place increased demands on local accommodation and other businesses.	
Potential receptors:	Socio-economic receptors
The use of vessels in the nearshore and offshore environment and the undertaking of spill response activities at shoreline locations may exclude 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.	

8.9.3 Environmental performance and control measures

The control measures considered for this activity are shown in **Table 8-19**. However, EPOs, EPSs and measurement criteria for these spill response control measures are provided within the relevant strategy sections of the OPEP.

Table 8-19: Control measure evaluation for spill response operations

Control measure	Environmental benefit	Potential cost / issues	Evaluation
Competent Incident Management Team and oil spill responder personnel	Ensures spill response strategy selection and operational activities consider the potential for additional environmental impacts.	Personnel and operational costs associated with maintaining competent Incident Management 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.
Spill response activities selected on basis of a NEBA	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.
Noise and atmospheric emissions			
Vessels and aircraft compliant with Santos' 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).

Control measure	Environmental benefit	Potential cost / issues	Evaluation
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).
Operational discharges and waste			
Vessels meet applicable 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).
Vessels meet applicable 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).
Ballast Water Management Plan	Improve quality of water discharged to marine environment to ALARP. Reduce risk of introduced marine species.	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			
Vessels and aircraft compliant with Santos' 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
Oil Spill Response 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.
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.
Soil profile assessment prior to earthworks	Reduce habitat disruption and erosion.	Operational costs associated with soil profile assessment.	**Adopted** – Considered a standard control.
Pre-cleaning and inspection of equipment (quarantine)	Prevent introduction of invasive species.	Operational costs associated with response plan.	**Adopted** – Considered a standard control.
Use of Heritage Advisor if spill response activities overlap with potential areas of cultural significance	Reduce disturbance to culturally significant sites.	No cost/issue associated with this control measure.	**Adopted** – Considered a standard control to be adopted by the relevant Control Agency.

Control measure	Environmental benefit	Potential cost / issues	Evaluation
Adhere to WA Oiled Wildlife Response Plan and Pilbara Regional Oiled Wildlife Response Plan	Oiled wildlife hazing, capture, handling and rehabilitation meet minimum standards as outlined within the WA Oiled Wildlife Response Plan.	Operational costs associated with response plan.	**Adopted** – Considered a standard control to be adopted by the relevant Control Agency.
Disruption to other users of marine and coastal areas and townships			
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.
Utility resource assessment and support to be conducted if activity is of significant size in comparison to the size of the coastal community	Reduces potential impact due to higher utility demands causing disruptions to local community.	No cost / issue associated with this control measure.	**Adopted** – Considered a standard control.
Accommodation assessment	Reduces strain on accommodation.	No cost / issue associated with this control measure.	**Adopted** – Considered a standard control.
Transport Management Plan	Reduces potential for traffic disruptions.	No cost / issue associated with this control measure.	**Adopted** – Considered a standard control for large-scale deployment in highly populated areas.

8.9.4 Environmental impact assessment

Receptor	Consequence Level
Spill Response Operations – Light Emissions	
Threatened, migratory or local fauna	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 Negligible (I). 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 (I).
Physical environment or habitat	
Threatened ecological communities	
Protected areas	

Receptor	Consequence Level
Socio-economic receptors	These species are likely to be values of the protected area they occur in (e.g., Montebello Islands, Barrow Island, Ningaloo, etc), and the impact to the protected area from light is also considered Negligible (I). 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 (I).
Overall worst-case consequence level	I – Negligible
Spill Response Operations – Acoustic Disturbance	
Threatened, migratory or local fauna	The receptors 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 (I). 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, the Muiron Islands, Lowendal Islands, Dampier Archipelago 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 (I). 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 (I).
Physical environment or habitat	
Threatened ecological communities	
Protected areas	
Socio-economic receptors	
Overall worst-case consequence level	I – Negligible
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 (I). 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 (I).
Physical environment or habitat	
Threatened ecological communities	
Protected areas	
Socio-economic receptors	
Overall worst-case consequence level	I – Negligible

Receptor	Consequence Level
Spill Response Operations – Operational Discharges and Waste	
Threatened, migratory or local fauna Physical environment or habitat Threatened ecological communities Protected areas Socio-economic receptors	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 have the potential to impact supported industries, such as tourism and commercial fishing; however, as impacts to fauna are considered Negligible (I), any indirect impacts on socio-economic receptors will also be Negligible (I). 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 (I) 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 (I) 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' appointed waste management contractor, and dedicated waste containment areas will prevent the spreading or leaching of hydrocarbon contamination. The consequence of sewerage discharges is therefore ranked as Negligible (I) in terms of impacts to habitats, fauna or protected area values.
Overall worst-case consequence level	I – 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 (I). 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

Receptor	Consequence Level
	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 (II), 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 (II) 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 (II). 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 (II).
Overall worst-case consequence level	II – Minor
Spill Response Operations – Disruption to Other Users of Marine and Coastal Areas and Townships	
Socio-economic receptors	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 (II).
Overall worst-case consequence level	II – Minor

8.9.5 Demonstration of as low as reasonably practicable

A 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 Environmental Team Leader will be responsible for reviewing the priority receptors and selected response strategies identified in this EP 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 to 2027 (Commonwealth of Australia, 2017) and approved conservation advices for other threatened fauna (**Table 5-10**) relevant to spill responses for the activities to minimise noise and light impacts on cetaceans, sharks, marine turtles, seabirds and shorebirds. 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 **Section 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 **Sections 8.3**, **8.4**, **8.5** and **8.6** will reduce potential impacts to marine fauna, which 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, the impact of the activities conducted are acceptable and ALARP.

8.9.6 Acceptability evaluation

Is the consequence ranked as I or II?	Yes – maximum consequence is II (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 ESD?	Yes – activity evaluated in accordance with Santos' Environmental Hazard Identification and Assessment Procedure (EA-91-IG-00004_5) which considers principles of ecologically sustainable development. The consequence against this aspect is II (Minor) and therefore does not affect the outcomes of the principles of ecologically sustainable development as per **Table 7-5**
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 and strategic objectives of nearby reserves (Montebello AMP and the Argo-Rowley Terrace AMP) are met. Consistent with relevant species recovery plans, conservation management plans and management actions set out in **Table 5-10**.
Are risks and impacts consistent with Santos' Environment, Health and Safety Policy?	Yes – aligns with Santos' Environment, Health and Safety Policy.
Are risks and impacts consistent with stakeholder expectations? **Related to cessation phase and floating asset removal activities**	Yes – no concerns raised.
Are risks and impacts consistent with stakeholder expectations? **Related to seabed equipment removal and abandonment in situ activities)**	Yes – no concerns raised.
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 (II) and ALARP. The controls used during spill response activities are therefore considered to reduce additional impacts to an acceptable level.

9. Environmental risk 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.

An ENVID workshop for unplanned events was held in September 2021, with a further workshop for loss of well control and hotspot consequence assessment also held in September 2021 once oil spill modelling was received. The outcomes of the workshops were reviewed in February 2022 and still deemed applicable to the full decommissioning scope. These workshops identified potential sources of environmental risks associated with unplanned events for this activity. The results of the environmental assessment are summarised in **Table 9-1**. 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 unplanned events that were considered to not be a credible scenario and are not discussed further in this section are:

- catastrophic loss of wellhead integrity
- hydrocarbon spill due to vessel grounding.

External forces may impact wellhead and subsea trees of the MEFF subsea wells. However, an external force impact resulting in a catastrophic loss of wellhead integrity is not considered credible, as the worst-case failure mechanism as a result of an external force impact is stress cracking at the bend point of the subsea tree or wellhead. This scenario is discussed in **Section 9.7**.

Vessel grounding could 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 9-1: Summary of the risk assessment ranking for unplanned activities

EP Section Reference	Event	Consequence	Likelihood	Residual Risk Level
9.1	Release of solid objects	II (Minor)	D (Occasional)	Low
9.2	Introduction of invasive marine species	III (Moderate)	C (Possible)	Low
9.3	Marine fauna interaction	II (Minor)	C (Possible)	Low
9.4	Non-hydrocarbon and chemical releases	I (Negligible)	D (Occasional)	Low
9.6	Hydrocarbon release (marine diesel oil)	III (Moderate)	B (Unlikely)	Low
9.7	Hydrocarbon release (loss of well control)	III (Moderate)	A (Remote)	Very Low
9.8	Minor hydrocarbon releases (surface and subsurface)	I (Negligible)	D (Occasional)	Low
9.9	Interactions with other marine users (equipment left in situ)	I Negligible	B (Unlikely)	Very Low

9.1 Release of solid objects

9.1.1 Description of event

Event	Solid objects, such as those listed below, can be accidentally released to the marine environment, and potentially impact on sensitive receptors: + non-hazardous solid wastes, such as paper and packaging + hazardous solid wastes, such as batteries, fluorescent tubes and aerosol cans + equipment and materials, such as hard hats, tools or equipment parts + DTM or a MWA loses buoyancy and descends to the seabed during recovery or tow operations + dropped equipment to the seabed during floating asset and seabed asset recovery. Release of these objects may occur as a result of overfull and/or uncovered bins, incorrectly disposed items or spills during transfers of waste, or dropped objects/lost equipment.
Extent	The event will only occur within the operational area, and all non-buoyant 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 and impacts may occur until the solid degrades. Floating assets and seabed assets selected for removal will be recovered and removed from the operational area as part of the activity.

9.1.2 Nature and scale of environmental impacts

Potential receptors: Physical environment (benthic habitats), threatened or migratory fauna (marine mammals, marine reptiles, sharks and rays, fish and birds), and socio-economic receptors (commercial fishing, tourism and recreation).

Physical environment

Objects accidentally dropped to the seabed could occur during the activity, such as the transfer and 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 area in which it was dropped. In the unlikely event the DTM loses buoyancy and descends to the seabed or seabed equipment being recovered is dropped to the seabed, disturbance to benthic habitat would occur, the area of which will be confined to the footprint of the equipment.

In the highly unlikely event that the DTM or MWA is lost to the seabed during towing, Santos would undertake a risk assessment on optimal recovery options in accordance with applicable legislative requirements. A potential recovery method could involve cutting into smaller more manageable pieces on the seabed to be recovered to surface. A tow plan will be developed that will consider environmentally sensitive sea areas (ESSA) and areas to be avoided (ATBA). Seabed assets recovered for removal are not expected be towed.

The seabed within the operational area is a primarily soft sediments with little epifauna, this habitat type is widely distributed and well represented in the NWS 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. Although the Ancient Coastline at 125 m Depth Contour KEF is present in the southern-most portion of the operational area (**Section 5.2.3**, **Figure 5-7**), no known sensitive features associated with the KEF have been observed in the operational area and therefore impacts to the KEF are unlikely.

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 six to 12 months, based on previous surveys (URS, 2010).

Small buoyant dropped objects have the potential to be transported by marine currents and may impact on reefs, islands, shoals and banks within the region. The DTM and MWAs are tethered to the seabed and if dropped, would remain in the operational area close to their original location. 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 9.4**.

Threatened, migratory or local fauna

Solids such as plastics have the potential to harm marine fauna through entanglement or ingestion. Two BIAs overlap the operational area, pygmy blue whale distribution and whale shark foraging and, therefore, these receptors may be present. Other threatened and migratory marine fauna such as turtles and seabirds may also be present in low numbers within the operational area.

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 to 2027 (Commonwealth of Australia, 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 (Derraik, 2002). Marine debris has been highlighted as a threat to marine turtles, humpback whales and whale sharks in the relevant Recovery Plans and Approved Conservation Advice (**Table 5-10**). 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 solid objects (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.

The recovery plans and approved conservation advice 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, which Santos implements through adherence to MARPOL.

Socio-economic receptors

Tourism activities, such as snorkelling, diving, surfing and recreational fishing are not expected to occur in the operational area, given the water depth, lack of seafloor features and distance from shore. Although dropped solid objects have potential to float to nearby areas used for tourism or recreational purposes solid non-hydrocarbon releases are not expected to occur frequently or to a scale that may cause significant pollution that would impact the socio-economic values of these areas. Impacts to socioeconomic receptors could occur should debris interfere with other marine users or their equipment (for example, fishing nets).

9.1.3 Environmental performance outcomes and control measures

The EPOs relating to this event include:

+ No unplanned objects, emissions or discharges to sea or air [MEFF-EPO-05].

The control measures for this event are shown in **Table 9-2**, and the EPSs and measurement criteria for the EPOs are described in **Section 10.4**.

Table 9-2: Control measure evaluation for the unplanned release of solid objects

CM reference	Control measure	Environmental benefit	Potential cost / Issues	Evaluation
Standard Controls				
MEFF-CM-37	Dropped object prevention procedures	Impacts to environment are reduced by preventing dropped objects and by retrieving dropped objects unless the environmental consequences are negligible or there are risks to safety. Minimises drop risk during lifting operations. Ensures lifting equipment certified and inspected.	Personnel costs involved in implementing procedures and in incident reporting.	**Adopted** – Benefits of ensuring procedures are followed and measures implemented outweigh cost to Santos.
MEFF-CM-27	Waste (Garbage) Management Procedure	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 vessels are compliant outweighs the minimal costs of personnel time and it is a legislated requirement.
MEFF-CM-22	Marine assurance	Reduces probability of release of solid objects as a result of failure of vessel equipment because equipment operating within its parameters.	Cost associated with implementing procedures.	**Adopted** – Benefit of implementing procedure outweighs the minimal costs.

CM reference	Control measure	Environmental benefit	Potential cost / Issues	Evaluation
MEFF-CM-12	Recovery Procedure	Assist with recovering assets in a manner to prevent them drifting away.	Cost associated with implementing procedures.	**Adopted** – Benefit of implementing procedure outweighs the minimal costs.
MEFF-CM-11	Tow plan	Tow plan for the towing of recovered assets from the operational area to port of landing will minimise potential to interfere with or displace other marine users.	Costs associated with developing and implementing the plan.	**Adopted –** Benefits considered to outweigh minor costs.
MEFF-CM-38	NOPSEMA accepted MEFF Field Safety Case Addendum	Reduces the probability of releasing the assets during recovery to vessel from their current as installed position and during removal from the operational area.	Costs associated with developing and implementing the Safety Case Addendum.	**Adopted –** Benefits considered to outweigh minor costs.
Additional Controls				
N/A	Eliminate lifting in field	Reduces the risk release of non-hydrocarbon solid to the marine environment due to dropped object.	Eliminating lifting would require vessels storing more equipment and supplies on-board, and/or additional trips to shore. Vessels will not have enough deck space to store all required equipment, materials, supplies needed for the duration of the activity. Lifting also required to recover equipment for removal from the operational area.	**Rejected** – Not feasible to eliminate lifting in the field.
N/A	Do not recover and tow floating assets from the MEFF field to port of landing.	Eliminates the potential impacts from dropping or sinking the DTM or MWAs during recovery and tow.	Santos has committed to recovering and removing all floating assets from the MEFF field. Floating assets may sink at a later date if not removed and cause seabed disturbance.	**Rejected –** Santos is committed to recovering and removing the floating assets from the MEFF Field. Removal of floating assets reduces the risk of them sinking to seabed in field at a later date.

CM reference	Control measure	Environmental benefit	Potential cost / Issues	Evaluation
N/A	Do not recover and remove seabed assets from the MEFF field to port of landing.	Eliminates the potential impacts from dropping or sinking to the seabed during recovery.	Removal of assets proposed for removal is a requirement of Santos' decommissioning of the MEFF Field.	**Rejected** - Removal of assets is a requirement of Santos' decommissioning of the MEFF Field.

9.1.4 Environmental impact assessment

Description	
Receptors	Physical environment (benthic habitats) Threatened, migratory or local fauna (marine mammals, marine reptiles, sharks and rays, fish and birds) Socio-economic receptors (tourism and recreation)
Consequence	II – Minor

Physical environment

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 in which it was dropped. In the unlikely event the DTM loses buoyancy and descends to the seabed or seabed equipment being recovered is dropped to the seabed, disturbance to benthic habitat would occur, the area of which will be confined to the footprint of the dropped equipment. Any area of the seabed impacted through dropped objects would be expected to recover.

Buoyant dropped objects have the potential to smother benthic habitats and could wash up on island beaches. It is considered that the application of management measures will effectively prevent this impact occurring on a 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 and rays, fish and birds)

In the event of a dropped object, the quantities would be limited. The release could cause localised impacts to water quality and the benthic environment if the solid can degrade, leading to localised impacts on flora and fauna. Ingestion of solid wastes by marine fauna could occur in small quantities. Only small volumes of non-hydrocarbon solids would be generated during the activity, as a result, any accidental loss to the environment would be small in size. Any impacts would be restricted to a small number of individuals, if any. Relevant recovery plans and conservation advice have identified marine debris as a potential threat. There is a Threat Abatement Plan for the Impacts of Marine Debris on the Vertebrate Wildlife of Australia's Coasts and Oceans (DoEE, 2018). As such there is the potential for impacts only to a small proportion of a local population with no consequences for conservation status or reproductive success of cetaceans, marine turtles or fish species that may occur in the area.

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 is not expected to result in a decrease of the local population size. Therefore, the consequence is Minor (II).

Socio-economic receptors (tourism and recreation)

Impacts to tourism and recreation have the potential to occur through buoyant objects floating into areas used for these activities, adversely impacting tourism and recreation 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. Therefore, the consequence is Negligible (I).

Description	
Likelihood	D – Occasional
Control measures proposed ensure the risk of dropped objects, lost equipment or release of solid objects to the environment has been minimised. Given the controls in place, the likelihood of releasing solid objects to the environment resulting in a minor consequence is considered Occasional (D).	
Residual Risk	The residual risk associated with this event is **Low**.

9.1.5 Demonstration of as low as reasonably practicable

Solid waste will be generated during the activity and lifting operations and vessel operations are required as part of the activity. Equipment loss and dropped objects, which might occur during equipment recovery or vessel transfers in the field will be managed through lifting and transfer procedures and equipment management. The potential loss of recovered assets during recovery and towing will be managed through a recovery procedure and floating assets tow plan. The control measures proposed reduce the risk of dropped objects to a residual risk level that is Low and cannot be reduced further. There are no reasonably practicable additional control measures identified that would reduce the chance of a loss of solid objects.

Therefore, it is considered the impact of the activities conducted is ALARP.

9.1.6 Acceptability evaluation

Is the risk ranked between Very Low to Medium?	Yes – residual risk is ranked 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 ESD?	Yes – activity evaluated in accordance with Santos' Environmental Hazard Identification and Assessment Procedure (EA-91-IG-00004_5), which considers principles of ESD. The residual risk for this aspect is Low and therefore does not affect the outcomes of the principles of ecologically sustainable development as per **Table 7-5**.
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. Consistent with relevant species recovery plans, conservation management plans and management actions set out in **Table 5-10**.
Are risks and impacts consistent with Santos' Environment, Health and Safety Policy?	Yes – aligns with Santos' Environment, Health and Safety Policy.
Are risks and impacts consistent with stakeholder expectations? **Related to cessation phase and floating asset removal activities**	Yes – no concerns raised.
Are risks and impacts consistent with stakeholder expectations? **Related to seabed equipment removal and abandonment in situ activities)**	Yes – no concerns raised.
Are performance standards such that the impact or risk is considered to be ALARP?	Yes – see ALARP above.

The handling solid objects, recovery of assets and towing of floating assets is standard industry and maritime practice and the potential impacts are well understood. This aspect will be managed consistent with relevant legislation, regulations and guidelines and the residual risks are low and ALARP.

The control measures proposed are consistent with applicable actions described in the relevant Recovery Plans and Approved Conservation Advice and no stakeholder concerns have been raised regarding this event.

With the control measures in place to prevent accidental releases or loss of floating assets during recovery and towing and the negligible impacts predicted from these types of solids, the low risk of solid objects dropped to the environment is considered environmentally acceptable.

9.2 Introduction of invasive marine species

9.2.1 Description of event

Aspect	Introduction of invasive marine species may occur due to matters such as: + biofouling on primary or support vessels and external/internal (e.g., sea chests, seawater systems) niches + biofouling on equipment that is routinely submerged in water (e.g., ROVs) + discharge of high-risk ballast water + cross contamination between vessels + marine growth removal (on deck or subsea) + towing/transport of DTM/MWAs out of operational area. Once established, IMSs 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).

9.2.2 Nature and scale of environmental impacts

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

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 (DAWE, 2019). The majority of climatically compatible IMS to the NWS 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 (DAWE, 2019; 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
+ reduction of coastal aesthetics.

The above impacts can result in flow-on detrimental effects to fisheries, 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 around 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, 2003). 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
- 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 limited by the operational area occurring in relatively deep, 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).

The DTM and MWAs are considered to pose a very low risk of IMS. The DTM is located around 30 m below the sea surface and the MWAs are around 82 m below the sea surface. IMS are unlikely to establish at these water depths. Additionally, the DTM and MWAs have not routinely come into contact with vessels, limiting the potential for IMS transmission from a vessel to the DTM or MWAs. The DTM and MWAs will be subject to marine growth removal prior to being rigged for towing or lifted on vessel/barge for removal from the operational area. Santos engaged Biofouling Solutions Limited to undertake a desktop-based assessment of the likelihood of IMS species of concerns on the DTM. The assessment concluded that there were no species of concern present on the DTM/MWAs (Biofouling Solutions, 2021).

Seabed assets are located in water depths between 130 m to 160 m. IMS are unlikely to establish in these water depths. Given that the seabed assets have not come into contact with any vessels, and the water depths they are located in, they are considered to pose no risk of IMS.

9.2.3 Environmental performance outcomes and control measures

The EPO relating to this event is:

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

The control measures for this event are shown in **Table 9-3**, and the EPSs and measurement criteria for this EPO are described in **Section 10.4**.

Table 9-3: Control measure evaluation for unplanned introduction of invasive marine species

CM reference	Control measure	Environmental benefit	Potential cost / issues	Evaluation
Standard Controls				
MEFF-CM-39	Implementation of the management controls in the Santos Invasive Marine Species Management	The risk of introducing IMS is reduced due to assessment procedure and management of ballast water.	Personnel costs involved in risk assessing vessels in accordance with the Invasive Marine Species Management Plan. Costs associating	**Adopted** – Minimal personnel costs and potential delays or costs to project are considered outweighed by the benefits of reducing the risk of IMS.

CM reference	Control measure	Environmental benefit	Potential cost / issues	Evaluation
	Plan (IMSMP) (EA-00-RI-10172)		with reducing the vessel risk to 'low' (for example, 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.	
MEFF-CM-40	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 availability 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.
Additional Controls				
N/A	Contract vessels only operating 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. Potential significant costs and delay in activity schedule by only contracting vessels working in State/National waters.	**Rejected** – Not feasible.
N/A	Mandatory dry docking of vessels prior to entering field to clean vessel or equipment and remove biofouling	Ensure 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.

CM reference	Control measure	Environmental benefit	Potential cost / issues	Evaluation
N/A	Zero discharge of ballast water	Would reduce the potential for IMS by implementation of no ballast water exchange policy on vessels.	Ballast water exchange required on the vessels for stability.	**Rejected** – On the basis that ballast water exchange is a safety-critical activity for marine operations.
N/A	No removal of marine growth from floating assets	May reduce the potential for IMS dispersal in the highly unlikely event IMS were present on floating assets and marine growth removal transferred IMS to an area where they could colonise (i.e., out of the operational area).	Marine growth removal is required in order for floating assets to be inspected, maintained and removed safely.	**Rejected** – Marine growth removal is required for the safe inspection, maintenance and removal of floating assets.
N/A	Conduct IMS survey or risk assessment of seabed equipment prior to removal	Would confirm the presence / absence of IMS species and inform the removal / handling activities to minimise potential spread of IMS.	Costs associated with conducting an infield survey or risk assessment	**Rejected** – Low risk of IMS for the following reasons: Equipment is located on the seabed in water depths of 130-160 m, known to be too deep for IMS establishment; Low vessel interactions in the area; ROV's and other vessels that have been conducting operational / IMMR activities have passed the IMS assurance activities prior to mobilisation; IMS risk assessment for floating assets removal activities did not detect any IMS on floating assets, which are present higher in the water column than seabed equipment.

9.2.4 Environmental impact assessment

<table>
<tr><th colspan="2">Consequence Level</th></tr>
<tr><td>Receptors</td><td>Physical environment (benthic habitats)
Threatened, migratory and local fauna (marine mammals, marine reptiles, sharks, fish and rays)
Socio-economic receptors (fisheries, tourism and recreation)</td></tr>
<tr><td>Consequence</td><td>III – Moderate</td></tr>
<tr><td colspan="2">Ballast water is responsible for 20 to 30% of all marine pest incursions into Australian waters. However, research indicates 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, 2003). IMS, if successfully established, can outcompete native species for food or space, prey on native species or change the nature of the environment and can subsequently impact on fisheries or aquaculture.
If an IMS is introduced, the species has been known to colonise areas outside of the areas to which it is introduced. In the event an invasive marine species is introduced into the operational area, given the lack of diversity and extensiveness of similar benthic habitat in the region, there would only be a minor reduction in the physical environment. No threatened ecological communities are present in the area that could be affected. The overall consequence level was assessed as Moderate, this also takes into consideration the distance of the activity to protected areas and the requirements of the North-West MPNMP which applies adjacent to the operational area which requires that vessel ballast water exchange is completed in accordance with the Australian Ballast Water Management Requirements.</td></tr>
<tr><td>Likelihood</td><td>C – Possible</td></tr>
<tr><td colspan="2">The pathways for IMS introduction are well known, consequently, standard preventive measures are proposed.
The ability for invasive marine species to colonise a habitat depends on a number of environmental conditions. It has been found that highly disturbed environments (such as marinas) are more susceptible to colonisation than open water environments where the number of dilutions and the degree of dispersal are high (Paulay et al., 2002). Given the depth of the operational area (130 to 160 m) creating an unfavourable habitat for colonisation (i.e., light limiting and low habitat biodiversity with sparse epibiota) and distance from shallow coastal habitats, there is a very low likelihood IMS would be able to survive translocation and subsequently establish and colonise.
Given the dispersive open-ocean environment of the operational area, the successful translocation to surrounding shallower habitats 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 (A).</td></tr>
<tr><td>Residual Risk</td><td>The residual risk associated with this event is Low.</td></tr>
</table>

9.2.5 Demonstration of as low as reasonably practicable

There are no alternatives to the use of vessels in order to undertake the activity. The risks from IMS are well understood with the additional desktop-based assessment undertaken by Biofouling Solutions for the likelihood of presence of IMS on the floating equipment, and with the proposed control measures, the activities are considered to comply with relevant regulations and guidelines. 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, and a vessel biosecurity risk assessment in accordance with the Invasive Marine Species Management Plan (EA-00-RI-10172) will be undertaken to demonstrate the vessels are low risk so 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 NWS 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 the *Aquatic Resources Management Act 2016* 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.

9.2.6 Acceptability evaluation

Is the risk ranked between Very 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 ESD?	Yes – activity evaluated in accordance with Santos' Environmental Hazard Identification and Assessment Procedure (EA-91-IG-00004_5), which considers principles of ESD. The residual risk for this aspect is Low and therefore does not affect the outcomes of the principles of ecologically sustainable development as per **Table 7-5**.
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*, National Biofouling Management Guidance for the Petroleum Production and Exploration Industry (Marine Pest Sectoral Committee, 2018) and the *Aquatic Resources Management Act 2016*.
Are risks and impacts consistent with Santos' Environment, Health and Safety Policy?	Yes – aligns with Santos' Environment, Health and Safety Policy.
Are risks and impacts consistent with stakeholder expectations? **Related to cessation phase and floating asset removal activities**	Yes – Santos will follow advice of DCCEEW to ensure vessels present low level biosecurity risk.
Are risks and impacts consistent with stakeholder expectations? **Related to seabed equipment removal and abandonment in situ activities)**	Yes – no concerns raised.
Are performance standards such that the impact or risk is considered to be ALARP?	Yes – see ALARP above.

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

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

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

9.3 Marine fauna interactions

9.3.1 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. There is the potential for fauna to become entangled in the trailing lines/chains of the DTM or MWAs if they are being towed. Fauna strike may also occur from helicopters during take-off and landing.
Extent	Within the operational area, in the immediate vicinity of the vessels and helicopters, while moving.
Duration	Intermittent, when vessels are in the MEFF field completing general inspection activities or floating asset removal activities.

9.3.2 Nature and scale of environmental impacts

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

Movement of the vessels, including towing of the DTM and MWAs if the option of lifting these onto a vessel or barge is not feasible, in the operational area introduces the potential for interaction with marine fauna present at the same location during the activity. Marine fauna in surface waters that could be most at risk from vessel collision or entanglement include marine mammals, marine turtles and whale sharks. As summarised in **Table 5-9**, the operational area overlaps BIAs for whale shark (foraging) and pygmy blue whale (distribution).

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 5-10**). Incidents with marine fauna are recorded and reported by Santos as described in **Section 10.10**.

<u>Marine mammals and sharks/rays</u>

The Approved Conservation Advice for *Rhincodon typus* (whale shark) (TSSC, 2015a) recognises vessel strike as one of the threats to the recovery of whale sharks. Whale sharks aggregate at the Ningaloo coast between March and June each year. Whale sharks are at risk from vessel strikes when feeding at the surface or in shallow waters (where options to dive are limited). The operational area overlaps the whale shark foraging BIA (**Figure 5-9** and **Table 5-9**); therefore, individuals may be encountered during operational activities. However, the whale shark presence within the operational area is not expected to comprise significant numbers, given 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.

Pygmy blue, sei, Bryde's, orca and/or fin whales may also transit through the operational area, although it is outside the blue whale migration corridor in the region. Given the water depths in the operational area, it is unlikely there will be significant numbers of these species encountered during the activity.

The worst potential impact from vessel collision or entanglement would be mortality or serious injury of an individual. Collisions between vessels and cetaceans are most frequent on continental shelf areas where high vessel traffic and cetacean habitat occur simultaneously (WDCS, 2006). 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, 2006), 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, 2006). 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).

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 the most severe and lethal injuries to cetaceans are caused by vessels travelling at 14 knots or faster.

Marine turtles

Turtle/vessel interactions arising from increased vessel traffic is recognised as one of a number of key threats to marine turtles in the Recovery Plan for Marine Turtles (Commonwealth of Australia, 2017). It is likely only low numbers of marine turtles may be transient within the operational area due to the distance (more than 60 km) to the nearest BIA.

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 (Commonwealth of Australia, 2017). However, turtles appear to be more vulnerable to vessel strike in areas of high urban population where incidents of pleasure crafts are higher. Given the relatively low human population density of the NWS coastline, WA turtle populations are not considered to be the most affected Australian turtle populations by vessel strike.

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 5.2.4**). However, the operational area is distant from any BIA for birds.

The number of helicopter flights required to support the activities 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.

9.3.3 Environmental performance outcomes

The EPO relating to this event is:

+ No injury or mortality to *EPBC Act 1999 and WA Biodiversity Conservation Act 2016* listed fauna during activities [MEF-EPO-04].

The control measures for this event are shown in **Table 9-4**, and the EPSs and measurement criteria for this EPO are described in **Section 10.4**.

Table 9-4: Control measure evaluation for marine fauna interaction

CM reference	Control measure	Environmental benefit	Potential cost / issues	Evaluation
Standard Controls				
MEFF-CM-20	Procedures for interacting with marine fauna	Reduces risk of physical and behavioural impacts to marine fauna from vessels and helicopters. If marine fauna are sighted, vessels can slow down or move away, and helicopters can increase distances from sighted fauna if required.	Operational costs to adhere to marine fauna interaction restrictions, such as vessel and helicopter 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. Control measure ensures compliance with Part 8 of the EPBC Regulations.
MEFF-CM-09	Constant bridge watch on vessels	Monitoring of surrounding marine environment to identify potential collision risks (and reducing harm) to cetaceans and other marine fauna.	No additional cost for constant bridge watch as it is industry practice and regulated by AMSA.	**Adopted** – No additional cost, Industry practice.
MEFF-CM-11	Tow plan	The tow plan will identify a tow route that considers avoidance of environmentally sensitive sea areas (ESSA) and designated areas to be avoided (ATBA), reducing the potential for interaction with marine fauna.	Costs associated with developing and implementing the tow plan.	**Adopted –** Benefits in reducing impacts to marine fauna outweigh the costs incurred by Santos.
MEFF-CM-38	NOPSEMA accepted MEFF Field Safety Case Addendum	Shortening the trailing ropes, lines, chains and risers to as short as practicable on the DTM and	Costs associated with developing and implementing the Safety Case Addendum. Additional costs	Adopted – Benefits considered to outweigh minor costs.

CM reference	Control measure	Environmental benefit	Potential cost / issues	Evaluation
		MWAs prior to towing out of the operational area reduces the potential for fauna entanglement	associated with ROV tooling to shorten trailing lines, chains and risers on the DTM and MWAs and	
Additional Controls				
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.	High cost in moving or delaying schedule while the risk to all listed marine fauna cannot be reduced due to variability in timing of migration periods and unpredictable presence of some species.	**Rejected** – Grossly disproportionate to low incremental environmental benefit, given existing low level of risk.
N/A	Dedicated MMO on vessels (EPBC Policy Statement 2.1 Part B)	Improved ability to spot and identify marine fauna at risk of collision (that may cause harm).	Additional cost of contracting MMO.	**Rejected** – Cost disproportionate to increase in environmental benefit and would severely limit operations, which are required to occur 24 hours a day, seven days a week.
N/A	Activities will only occur during daylight hours	Reduced potential for a vessel-fauna collision occurring as activities only undertaken during daylight hours when visibility highest.	Lengthens duration of the activity as operations only continue for around ten hours per day. Increased cost due to increased activity time (more than double the cost). Lengthened schedule results in increased impacts and risks (e.g., planned emissions and discharges, interference with other marine users).	**Rejected** – Substantial additional cost due to doubling of activity duration. No overall environmental benefit as results in increased impacts and risks.
N/A	Adopt further measures to those outlined in 'EPBC Regulations	Potentially provide an additional level of protection of marine fauna.	Administrative costs to update existing procedure. Operational costs through	**Rejected** – The existing control '*procedure for interacting with marine fauna*' has been written in accordance with the EPBC

CM reference	Control measure	Environmental benefit	Potential cost / issues	Evaluation
	2000 – Part 8 Division 8.1 during peak periods of ecological sensitivity, for example, additional management considerations for vessels outlined in the Australian National Guidelines for Whale and Dolphin Watching (DoEE, 2017)		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.	Act and other relevant guidelines. A review of this procedure against the Australian National Guidelines for Whale and Dolphin watching (DoEE, 2017) found there are no additional relevant controls in the Australian National Guidelines for Whale and Dolphin Watching. Therefore, adopting this control is not ALARP.
N/A	Complete removal of all trailing lines, chains/risers from the DTM and MWAs prior to towing	Removes the hazard and hence removes the potential for fauna entanglement.	Cost, safety and technical feasibility considerations. May not be possible with ROV. May require divers. All trailing lines, ropes, risers on the DTM and MWAs will be cut as close as technically possible to the DTM/MWAs.	**Rejected** – Additional cost and safety risk is greatly disproportionate to any minor benefit gained.
N/A	Do not recover and tow floating assets from the MEFF field to port of landing	Would eliminate the potential impacts to other users of the marine environment from towing activities.	Santos has committed to removing all floating assets from the MEFF field. Towing is the preferred method to remove the DTM from the operational area. Lifting the DTM onto a vessel in field would be a significantly more hazardous operation and would require use of a larger vessel with similar or	**Rejected** – Santos is committed to removing the floating assets from the MEFF Field. Towing of floating assets has been assessed to be the safest method of removing recovered assets from the Title area and has negligible additional impact compared to towing.

CM reference	Control measure	Environmental benefit	Potential cost / issues	Evaluation
			greater impacts on other users of the marine environment. Towing may be required for removing the MWAs from the operational area.	

9.3.4 Environmental impact assessment

Description	
Receptors	Threatened or migratory fauna (marine mammals, marine turtles, sharks and rays, fish and birds)
Consequence	II – Minor
In the event of a collision or entanglement with marine fauna, there is the potential for injury or death to an individual. The number of receptors present in the operational area during the short duration of the activity is expected to be limited to a small number of transient individuals. Given the presence of the whale shark and pygmy blue whale BIAs, there may be more of these species in the vicinity, but given the distance from the nearest migration and aggregation areas, significant numbers are not expected. Boat strike and vessel disturbance are identified as potential threats to a number of marine fauna species in relevant Recovery Plan and Conservation Advice (**Table 5-10**). The above information demonstrates that with control measures in place the activity will be conducted in a manner that reduces potential impacts to ALARP and of acceptable level. There is the potential for death or injury of EPBC Act listed individual species. However, as they would represent a small proportion of the local population it is not expected that it would result in a decreased population size over what would usually occur due to natural variation, at a local or regional scale, it is expected that the loss of an individual would be a minor consequence.	
Likelihood	C – Possible
Marine turtles, marine mammals and birds, receptors are expected to be present in the operational area at various times of the year. No known aggregation areas (breeding, resting or calving) occur within the operational area and therefore concentrations of milling individuals are unlikely. Vessels will be stationary or moving very slowly while conducting activities inside the operational area, posing a low risk of collision with marine fauna. In addition, the noise generated from vessel operations will deter marine fauna from coming close to vessels. All trailing lines on the DTM will be cut as close as technically possible to the DTM, reducing the potential for entanglement during towing out of the operational area if this method is used. With controls in place ensuring the vessels are compliant with EPBC Regulations, the likelihood of a collision or entanglement with marine fauna resulting in a low consequence is considered to be Possible (C).	
Residual Risk	The residual risk associated with this event is **Low**.

9.3.5 Demonstration of as low as reasonably practicable

There are no alternatives to the use of vessels to undertake the activity. The inherent likelihood of encountering fauna in the operational area and along the tow route is limited by the short duration of the activity and the separation from areas of high surface fauna density. With relatively low vessel speeds and compliance with fauna interaction procedures, including *Regulation 8 of the EPBC*

Regulations 2000, and floating assets tow plan which will include the avoidance of ESSAs such as aggregation areas and protected areas, fauna collision or entanglement is considered very unlikely.

In the event vessels come close to EPBC Act listed marine fauna, such as whales and whale sharks, EPS have been implemented for limiting vessel operations, as well as for ensuring that the crew are aware through inductions of the risk posed by conducting the activity, in order to reduce the likelihood of a marine fauna collision to ALARP. Inductions for the crew of support vessels will include information about how to interact with cetaceans and whale sharks in accordance with the EPBC Regulations.

With the control measures adopted, the assessed residual risk for this impact is Low and cannot be reduced further. Additional control measures were considered but rejected since the associated cost or effort was grossly disproportionate to any benefit, as detailed in **Section 9.3.3**. Therefore, it is considered the impact of the activities conducted is ALARP.

9.3.6 Acceptability evaluation

Is the risk ranked between Very 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 ESD?	Yes – activity evaluated in accordance with Santos' Environmental Hazard Identification and Assessment Procedure (EA-91-IG-00004_5), which considers principles of ESD. The residual risk for this aspect is Low and therefore does not affect the outcomes of the principles of ecologically sustainable development as per **Table 7-5**.
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 (**Table 5-10**).
Are risks and impacts consistent with Santos' Environment, Health and Safety Policy?	Yes – aligns with Santos' Environment, Health and Safety Policy.
Are risks and impacts consistent with stakeholder expectations? (cessation phase and floating asset removal activities)	Yes – no concerns raised.
Are risks and impacts consistent with stakeholder expectations? (seabed equipment removal and abandonment in situ activities)	Yes – no concerns raised.
Are performance standards such that the impact or risk is considered to be ALARP?	Yes – see ALARP above.

Movement of vessels is unavoidable to undertake the activity. The possibility of vessel strike and entanglement is a well understood risk for maritime operations, including for commercial shipping and fishing.

Vessel movements, including towing of floating assets to a port of landing, will comply with all relevant maritime standards and regulations, including EPBC regulations to minimise risks to marine fauna. Application of the proposed management controls and adherence to Commonwealth and maritime regulations reduces the likelihood of vessel interactions with marine fauna. While the potential exists for a collision or entanglement to occur, it is considered unlikely. As part of Santos' reporting requirements for the activity, in the unlikely event an impact did occur in the operational area or along the tow route, it will be reported in the National Ship Strike Database (refer to **Table 10-7**).

With application of the proposed control measures, the potential impacts and risks to threatened fauna will be managed consistent with relevant recovery plans and approved conservation advice. No stakeholder concerns have been raised regarding this event. Therefore, the impact is considered to be ALARP and environmentally acceptable.

9.4 Non-hydrocarbon and chemical releases

9.4.1 Description of event

Event	Non-hydrocarbon liquids including miscellaneous chemicals and waste streams (brine, cleaning and cooling agents, stored or spent chemicals and leftover paint materials) are used or stored on-board the vessels during the activity. The presence of non-hydrocarbons liquids and chemicals represents a potential spill risk during chemical storage and handling e.g., due to tank damage, or human error. Another credible spill is due to a hose that parts when loading / offloading brine. Rupture of the pumping hose used to transfer these chemicals may occur due to dropped object, vessel motion or hose failure. An accidental release of chemicals and other non-hydrocarbon liquids into the marine environment has the potential to occur from: + vessel operations + transferring, storing or using chemicals + mechanical failure of equipment + handling and storage spills and leaks + hose or hose connection failure or leak + rupture of ROV mounted bladder during barrier testing activities + lifting – dropped objects damaging liquid vessels (containers). Accidental loss of non-hydrocarbon liquids or chemicals to the marine environment may result in impacts to water quality and hence sensitive environmental receptors.
Extent	The maximum volume of non-hydrocarbon liquids or chemicals that could be released during routine operations is likely to be small and realistically limited to the volume of individual containers (e.g., drums) stored on deck of vessels. The ROV mounted bladder will have a maximum volume of around 365 L of MEG, methanol and/or hydraulic fluid. The worst-case credible scenario, however, would be the accidental loss of contents of an ISO container, estimated to be 1 m^3. Dilution from discharges in open waters is rapid, with 1-in-1000 dilution usually occurring within 30 minutes (Costello and Read, 1994). In the event the spill is not contained on deck, a release to the marine environment would be likely to rapidly disperse and evaporate within the operational area. The environment that may be affected for non-hydrocarbon liquids or chemical release resulting in a decrease in water quality is likely to be restricted to around the vessel and predominantly contained within the operational area in which it was released.
Duration	The duration of the impact is limited to the time the released chemical/liquid takes to disperse to below toxic/harmful threshold concentrations. In the ocean, this is expected to be in the order of hours.

9.4.2 Nature and scale of environmental impacts

Potential receptors: Physical environment (water and sediment quality, benthic habitats), threatened, migratory or local fauna (marine mammals, marine reptiles, sharks and rays, fish and birds) and socio-economic receptors (commercial fishing, tourism and recreation).

Physical environment

Non-hydrocarbon liquids or chemicals released to the marine environment may lead to contamination of the water column in the vicinity of the release location. The potential impacts would most likely be highly localised and restricted to the immediate area surrounding the spill, with rapid dispersal to concentrations below impact thresholds likely to occur in the open ocean.

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 reefs, and offshore islands. There is no emergent or intertidal habitat that could be impacted by a surface spill. Owing to the water depth and location offshore, any spilled material is unlikely to reach land or affect any of benthic habitats.

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 5-9**, the operational area overlaps with BIAs for whale shark (foraging) and pygmy blue whale (distribution).

Recovery plans and conservation advices for numerous bird species identify marine pollution and contamination impacts as a threat to the species. In addition, the Recovery Plan for Marine Turtles in Australia 2017 to 2027 (Commonwealth of Australia, 2017) identifies deteriorating water quality as a threat to all species of marine turtles in Australia. These species have been identified as potentially transiting through the operational area from time to time.

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.

Socio-economic receptors

Given the localised and temporary impacts of an unplanned hazardous liquid spill, any impact to commercial fishing, tourism and recreation activities is considered unlikely.

9.4.3 Environmental performance outcomes and control measures

The EPO relating to this event is:

- No unplanned objects, emissions or discharges to sea or air [MEFF-EPO-05]

The control measures for this event are shown in **Table 9-5**, and the EPSs and measurement criteria for this EPO are described in **Section 10.4**.

Table 9-5: Control measure evaluation for hazardous liquid releases

CM reference	Control measure	Environmental benefit	Potential cost / issues	Evaluation
Standard Controls				
MEFF-CM-37	Dropped object prevention procedure	Minimises dropped object risk during vessel lifting operations that may cause secondary spill resulting in reduction in water quality. Ensures lifting equipment certified and inspected.	Cost to maintain lifting equipment and implement procedure.	**Adopted** – Benefits of ensuring procedures are followed and measures implemented outweighs costs.
MEFF-CM-41	Hazardous chemical management procedures	Reduces the risk of spills and leaks (discharges) to the sea by controlling the storage, handling and	Cost associated with permanent or temporary storage areas.	**Adopted** – Benefits of ensuring procedures are followed and measures implemented

CM reference	Control measure	Environmental benefit	Potential cost / issues	Evaluation
		clean-up of hazardous chemicals.		outweigh the costs of personnel time.
MEFF-CM-28	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.
MEFF-CM-29	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.	**Adopted –** Benefits of ensuring procedures are followed and measures implemented outweigh the costs of personnel time.
MEFF-CM-30	Chemical selection procedure	Improves water quality discharge (reduced toxicity) to the marine environment in the event of an unplanned release.	Cost associated with implementation of procedure. Range of chemicals reduced but potentially higher costs. Potential additional cost and delays of chemical substitution.	**Adopted –** Benefits of ensuring procedures are followed and measures implemented outweigh the costs of personnel time.
MEFF-CM-42	Vessel spill response plans (Shipboard Oil Pollution Emergency Plan (SOPEP)/ Shipboard Marine Pollution Emergency Plan (SMPEP))	Effective management of an accidental spill (discharge to sea) to reduce impact to the environment.	Personnel cost associated with ongoing management (spill response exercises) and implementation of plans.	**Adopted** – Benefits of ensuring response plans in place, are followed and measures implemented and that the vessels are compliant outweighs costs.
MEFF-CM-21	Vessel Planned Maintenance System to maintain	Reduces potential for unplanned releases of chemicals from the vessels because	Costs are standard for routine PMS.	**Adopted** – Benefits outweigh the cost.

CM reference	Control measure	Environmental benefit	Potential cost / issues	Evaluation
	vessel DP, engines and machinery	equipment is operating within its parameters.		
MEFF-CM-22	Marine assurance	Reduces probability of unplanned release of chemicals as a result of failure of vessel equipment because equipment operating within its parameters.	Costs are expected as part of standard procedure.	**Adopted** – Benefits outweigh the costs.

9.4.4 Environmental impact assessment

Description	
Receptors	Physical environment (water and sediment quality, benthic habitats) Threatened, migratory or local 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
In the event of a non-hydrocarbon liquid or chemical spill, the quantities of a worst-case liquid release are unlikely to be greater than 1 m³ (the size of the largest storage container). The small volumes, dilution and dispersion from natural weathering processes such as ocean currents indicate the extent of exposure will be limited in area and duration. The susceptibility of marine fauna to non-hydrocarbon liquids and chemicals depends on the type and exposure duration; however, given exposures would be limited in extent and duration, exposure to marine fauna from this hazard is not expected to result in a fauna fatality. Impacts from discharges to the marine environment to water quality would be short-term and localised, due to the nature and behaviour of the chemicals identified as being at risk of spilling, only pelagic fauna present in the immediate vicinity of the spill would likely be at risk of impact. Habitat degradation, deteriorating water quality and marine pollution are identified as potential threats to a number of marine fauna species (that may be present in the operational area) in relevant recovery plans and conservation advice (**Table 5-10**) and to matters of national environmental significance (MNES) (DoE, 2013). However, the potential non-hydrocarbon releases of liquids or chemicals are not expected to significantly impact the receiving environment with control measures proposed to prevent releases. Given a non-hydrocarbon or chemical spill would not result in a decreased population size at a local or regional scale, it is expected a spill of this nature would result in a Negligible (I) consequence.	
Likelihood	D – Occasional
A small non-hydrocarbon liquid release is unlikely to have widespread ecological effects, given the nature of the chemicals on board, the small volume that could be released, 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 non-hydrocarbon 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 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 minor consequence, is considered to be Occasional (D).	

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

9.4.5 Demonstration of as low as reasonably practicable

Non-hydrocarbon liquids and chemicals will be required to undertake the activity, so their removal from the operation is not viable. 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. Objects will need to be moved around the decks of the vessels and transferred from vessel to vessel. Control measures in place will ensure correct lifting, storage and handling procedures are followed as well as ensuring the maintenance of equipment is undertaken according to preventative management systems. No beneficial additional control measures were identified to further reduce the risk of this hazard.

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

Other management controls that have been implemented include vessel maintenance systems, chemical management procedures, spill clean-up equipment and Shipboard Marine Pollution Emergency Plan (SMPEP)/OPEPs not only to minimise the risk of an accidental release, but also to reduce the impact in the event a release does occur.

Containment of small spills from bunding, inherent in the design of vessels and from spill containment kits onboard these vessels (detailed in the SMPEP) provides a barrier to any spills reaching the marine environment. The inspection and maintenance of bunding and drainage systems and of spill response kits provides assurance that these are available to contain spills in the event of a small leak. It is considered that barriers in place to contain spills would prevent spills from reaching the marine environment and thus it is considered that there are no further controls that would offer a further benefit to the environment.

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

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

9.4.6 Acceptability evaluation

Is the risk ranked between Very Low to Medium?	Yes – maximum hazardous liquid release 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 ESD?	Yes – activity evaluated in accordance with Santos' Environmental Hazard Identification and Assessment Procedure (EA-91-IG-00004_5), which considers principles of ESD. The residual risk for this aspect is Low and therefore does not affect the outcomes of the principles of ecologically sustainable development as per **Table 7-5**.
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 94 (Marine pollution prevention – packaged harmful substances) and with relevant recovery plans and conservation advices for species that may occur in the operational area (**Table 5-10**).
Are risks and impacts consistent with Santos' Environment, Health and Safety Policy?	Yes – aligns with Santos' Environment, Health and Safety Policy.
Are risks and impacts consistent with stakeholder expectations? (cessation phase and floating asset removal activities)	Yes – no concerns raised.
Are risks and impacts consistent with stakeholder expectations? (seabed equipment removal and abandonment in situ activities)	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 non-hydrocarbon liquids and chemicals 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 low impacts predicted from a spill of this size, the environmental risk of using and handling the required chemicals is considered ALARP and environmentally acceptable.

9.5 Overview of unplanned release of hydrocarbons

There is the potential for loss of well control (subsea) resulting in a loss of light crude oil, in addition to loss of containment of marine diesel due to a vessel collision event or refuelling activities within the operational area. Light crude oil and diesel spill trajectory modelling were used to predict the potential extent of a worst-case spill event for both the MDO spills and LOWC scenarios within the operational area (GHD, 2021).

9.5.1 Spill scenario selection

9.5.1.1 Loss of well control

Santos has identified a loss of well control as the worst-case type of credible crude oil release scenario that could potentially occur during the cessation of production phase and decommissioning activities covered under this EP. Santos has undertaken a LOWC scenario review for the wells in the MEFF field, and as a result, a full bore blow out is no longer considered a credible scenario and rather, the worst-case credible scenario is stress cracking of the well head, combined with a failure of a primary barrier (Santos, November 2020). This worst-case scenario would result in a release of 1350 m^3 of light crude oil at the seabed, over 126 days (18 weeks), becoming visible on the sea surface after 49 days (seven weeks). Justification for the worst-case scenario is provided as follows:

+ For the planned scope of activities covered by this EP (**Section 4**) and the corresponding controls (**Section 8**) either:
  - they do not interfere with (or have the potential to interfere with) the established Well Barrier Envelope or;
  - the activities occur suitably distant from the wells so as to not present a hazard.
+ Note that the disconnection and decommissioning of the DTM and MWA's is sufficiently remote from the well locations such that a collision between dropped objects associated with the activities in this EP and the wells is not possible.
+ Seabed asset removal activities are expected to take place after the wells have been plugged and abandoned (P&A). After P&A activities have been completed (expected Q4 2024) it is not possible for a dropped object in the vicinity of a well to result in a LOWC as the XT's and wellheads will have been removed. Therefore, a LOWC scenario associated with the activities in this EP is not possible once P&A activities have been completed.
+ In the event that seabed asset removal activities commence prior to the completion of the P&A campaign, safe deployment / recovery zones will be designated and utilised at drill centres where wellheads are still present, such that a collision between dropped objects associated with the activities in this EP and the wells is not possible.
+ Therefore, consideration of a worst-case discharge (WCD) event (from a planned activity) that is associated with the XT being forcibly removed from the wellhead is not considered possible.
+ The most severe occurrence determined whilst assessing the activities within the scope of this EP is an unplanned event, in which a MODU or large moored vessel, working in proximity to, but not within the permit area breaks free and drifts over the location of the MEFF subsea wells. If the drifting MODU were to drag an anchor and / or anchor chains over the seabed it is possible that it / they latch onto or wrap over the subsea tree of a suspended well. Such an event could in extreme cases impart a significant force on the XT, wellhead and well architecture and was therefore assessed as a WCD potential event.
+ Typical MODU's operating in the area have an anchor chain tensile strength of approximately 1.46 x 10^6 lbs (e.g. Atwood Falcon) where as a MEFF conductor has a tensile strength of

approximately 6.98 x 10ˆ6 lbs, more than four times that of the anchor chain and neglects the additional tensile support provided by casing and tubing strings. If a MODU chain or anchor were to apply sufficient bending moment on the well, the wellhead could bend at the soft mudline until it is aligned with the direction of the pulling force. Should the force implied by the drifting MODU continue to increase above the yield strength of the chain, the chain will fail. That is, the anchor chains and pawls are not expected to have strength required to separate the wellhead and the subsea tree off the well. Thus, an anchor from a drifting MODU would not be capable of imparting sufficient load to remove the wellhead and is therefore not considered possible. However, repeated low tension strain at the wellhead because of anchor/chain entanglement could induce a fatigue load upon the wellhead. The consequence of which in the most extreme of cases could potentially lead to a cracking of the wellhead and/ or the seabed architecture. It is this scenario that has been determined for worst-case discharge scenario. This has been recognised in a more recently accepted EP (Ningaloo Vision Operations EP, (TV-00-RI-00003.01). As mentioned above, this EP's scope of activities does not plan to interfere with the established Well Barriers Envelope.

+ It follows that since the wellhead and subsea tree remain in place, an uncontrolled release of well fluids through a full bore blowout is not a possible scenario as the worst case failure mechanism as a result of this event would be stress cracking at the bend point combined with failure of a primary barrier. The estimated flow area used for the WCD modelling has been selected based on the expectation that it far exceeds the flow area/pathway resulting from any "cracks" that may result from this scenario during the 126 days it takes to control the release:
  - primary barrier breach - well fluids exit the tubing through 0.25 inch (6.35mm) equivalent diameter breach in the tubing immediately below the tubing hanger. Stress cracking failure of the production tubing resulting in a crack over 7.5% of the circumference, 1 mm wide (0.25 inch equivalent diameter).
  - secondary barrier breach - well fluids are released to the environment through 0.54 inch equivalent diameter breach in the wellhead. Stress cracking failure of the wellhead resulting in a crack over 15% of the circumference, 1 mm wide (0.54 inch equivalent diameter).
+ Note that the worst-case estimated crack size has been used throughout the 126 days discharge period, (no gradual increase in crack size over time), however the load imparted by the entangled MODU would not be applied for the duration of the WCD period. i.e. Its presence would be quickly noted with the chain likely to be cut away within 1-2 weeks of the event occurring.
+ The assumptions for the WCD flow model are based on the SCSSV being in the open position, however the SCSSV on all MEFF wells have been closed and tested to a leak rate of less than 400 cm^3/min (0.6m^3/d) as per API allowable leak-off rate thus highlighting the conservativeness total fluid leak rate of average 110.7m^3/d (90% water cut) presented in this WCD scenario. Importantly, the field SCSSVs cannot be re-opened without the direct application of hydraulic pressure to the SCSSC control-chamber which is not currently possible. To that end, the above estimate is considered appropriately conservative to model the WCD for this scenario.
+ The primary barrier referred to in the stress cracking of the wellhead is a breach in the production tubing immediately below the tubing hanger. The full hydrocarbon leak path would be as follows:
  - oil flows through the production tubing from the reservoir to surface-controlled subsurface safety valve (SCSSV).

  - oil flows past the SCSSV (modelled very conservatively as a full bore flow path, no restriction although the SCSSV's are closed and hydraulic pressure is not available in the field to open them).
  - oil flows through production tubing up to the tubing hanger in the subsea tree.
  - primary barrier breach - well fluids exit the tubing through a breach in the tubing immediately below the tubing hanger.
  - secondary barrier breach - well fluids are released to the environment through a breach in the wellhead.
+ Near virgin reservoir pressures (~100 psi depletion) were assumed in this calculation to accommodate field shut in duration.
+ No pressure depletion over the WCD period was assumed to support a worst case scenario.
+ The WCD flow rate was calculated using industry recognised Petroleum Experts Prosper software calibrated to field data.

9.5.1.2 Vessel collision

It is considered credible that a release of MDO to the marine environment could occur from a collision between the activity primary vessels and an errant third-party vessel. Such events could have sufficient impact to result in the rupture of a diesel tank leading to a loss of integrity. This is considered credible, given the diesel tanks may not be protected or double-hulled, and fuel tank ruptures resulting in a hydrocarbon release have occurred before within the maritime industry.

The AMSA (2015) Technical Guidelines for Preparing Contingency Plans for Marine and Coastal Facilities recommend that the spill scenario for modelling and impact assessment should be based on the largest single fuel tank volume. The specific vessels to undertake the activities are yet to be confirmed; however, a review of available vessels indicated that the largest single fuel tank is likely to be up to 550 m^3 in capacity. Although the likely vessel's largest fuel tank will be smaller, a conservative modelled spill volume of 604 m^3 has been used for this EP.

9.5.1.3 Refuelling

A minor spill (approximately 37.5 m^3) of MDO could occur during vessel refuelling resulting in a discharge of hydrocarbons to the marine environment at the sea surface. Spills during refuelling can occur through several pathways, including fuel hose breaks, coupling failure or tank overfilling.

Spills resulting from overfilling will be contained within the vessel drains and slops tank system. In the event the refuelling hose is ruptured, the fuel bunkering activity will cease by turning off the pump, the fuel remaining in the transfer line will escape to the environment as well as fuel released prior to the transfer operation being stopped. 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 guidance provided by AMSA (2015) for a refuelling spill under continuous supervision is considered appropriate, given refuelling will be constantly supervised. The maximum credible spill volume during refuelling is calculated as: transfer rate (150 m^3/hr) × 15 minutes of flow. 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.

9.5.2 Spill modelling overview

To determine the spatial extent of impacts from potential hydrocarbon spills, modelling was completed for the vessel collision and LOWC scenarios (GHD 2021). A surface spill of MDO during refuelling is considered relatively small in comparison to a surface spill of MDO during a vessel collision. It is therefore assumed the extent of a hydrocarbon spill during refuelling would remain within the extent of the worst-case spill trajectory of diesel from a vessel collision, subsequently, modelling of a smaller spill was not conducted.

Far-field spill modelling was performed with OSCAR. The model was configured in stochastic mode to simulate a range of environmental conditions. The start dates for the stochastic simulations were staggered approximately fortnightly across five years of hydrodynamic and wind data. A total of 150 individual ‘realisations’ made up the full stochastic simulation set for the LOWC scenario, and a total of 400 simulations made up the full stochastic simulation set for the MDO scenario. For the purpose of modelling, a theoretical release location of the south-east corner of Permit WA-54-L was chosen for the MDO scenario, representing the closest point of the operational area to emergent sensitive receptors. The Mutineer-4 well location was chosen for the LOWC modelling as this well represents the worst-case discharge scenario for any MEFF subsea well.

For each set of stochastic realisations, OSCAR spatially tracked the surface oil, total submerged oil in the water column, dissolved oil and oil on shorelines. The ‘total submerged oil’ is comprised of dissolved oil and entrained oil (or droplets), and therefore provides a conservative (over) representation of the NOPSEMA (2019a) thresholds for entrained oil.

The outputs of this modelling showed a number of different possible outcomes of a spill, which were then analysed to determine the concentrations of hydrocarbon at each grid cell of the model, providing information about the probability of contact and concentration at contact of hydrocarbons across the EMBA.

A summary of the modelled maximum credible spill scenarios is provided in **Table 9-6**.

Table 9-6: Summary of maximum credible spill scenarios

Worst-case credible spill scenario	Approx. depth of spill	Hydrocarbon type	Maximum credible volume released (m³)	Release duration	Time of year
LOWC – subsea release	162 m	Light crude oil	1350	126 days	All
Surface diesel release	0 m	MDO	604	20 minutes	All

9.5.3 Hydrocarbon characteristics

9.5.3.1 Light crude oil

The hydrocarbon type for the LOWC scenario was identified by Santos as Mutineer-Exeter light crude oil (Intertek, 2005). Key physical and chemical properties of Mutineer-Exeter light crude oil from the assay report are shown in **Table 9-7**.

Oil spill modelling in OSCAR is undertaken by selecting a hydrocarbon analogue from within the SINTEF Oil Library that provides the best match to the expected (target) hydrocarbon. The Foundation for Scientific and Industrial Research at the Norwegian Institute of Technology’s (SINTEF) Vale 2013 crude oil was selected as the modelling analogue for Mutineer-Exeter light crude oil based on the following:

+ The whole crude properties for Vale 2013 are generally well aligned with Mutineer-Exeter, with the exception of a lower boiling point and a higher viscosity.
+ The reported asphaltene content for Vale 2013 provides an exact match to Mutineer-Exeter.
+ The distillation curve (**Figure 9-1**) for Vale 2013 provides a close match to Mutineer-Exeter.

The characteristics of Mutineer-Exeter and Vale 2013 crude oil are presented in **Table 9-7**. The distillation curves of both oils are provided in **Figure 9-1**.

The distillation curve is derived from laboratory tests to determine the percentage of hydrocarbon evaporated (recovered) when heated to various temperatures (or ‘cuts’). Lighter oil components evaporate under lower temperatures, whereas heavier oil components have a greater tendency to remain in liquid state, requiring higher temperatures to evaporate. This is analogous to oil weathering in the marine environment, whereby lighter components have a higher tendency to evaporate, dissolve or decay, and heavier components tend to persist as liquid hydrocarbon for extended durations. The distillation curve therefore provides a reasonable prediction of the relative proportions of hydrocarbon components that will have rapid rates of weathering and the relative proportions that will persist.

The comparison of the distillation curves match well up to 60% mass recovered. Beyond this point, Vale 2013 requires higher temperatures to recover the same proportion of oil as Mutineer – Exeter. This is indicative of a greater proportion of more persistent components within Vale 2013, thereby rendering it as a conservative analogue selection for this modelling assessment.

Table 9-7: Properties of Mutineer-Exeter light crude oil (GHD, 2021)

Parameter	Mutineer-Exeter	Vale 2013 crude oil
API Gravity	43.4	42
Specific Gravity	0.8091	0.816
Wax Content (%)	3	3.26
Pour Point (ºC)	12	-9
Asphaltene (%)	0.03	0.03
Viscosity (cSt)	3.027 (@ 20ºC)	37 (@13ºC)

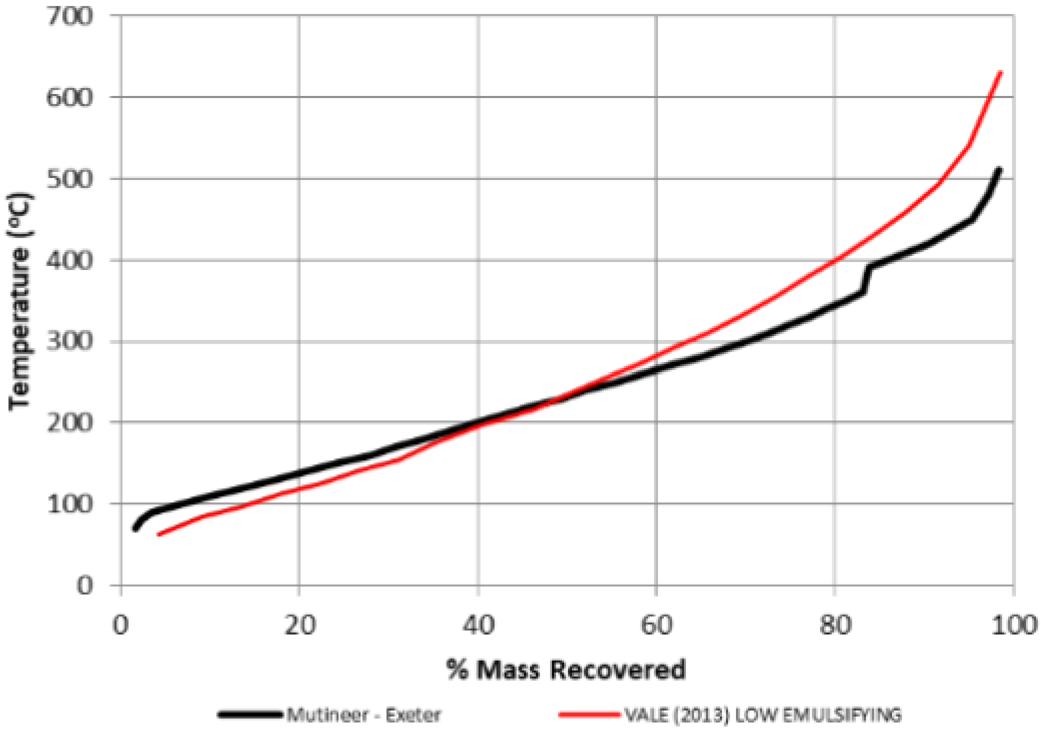

Figure 9-1: Comparison of distillation curves for Mutineer-Exeter and Vale 2013 crude oils

9.5.3.1.1 Light crude oil weathering

Evaporation is the primary weathering mechanism for Vale 2013. Under low wind speeds of 1 m/s, around 55% of the surface slick is predicted to evaporate after five days (120 hours) while wind-driven dispersion into the water column is negligible. Under moderate wind speeds of 5 m/s, around 60% of the surface slick evaporates after five days, while a further approximately 18% is dispersed into the water column and the surface slick makes up the remaining approximately 22%. High wind speeds of 10 m/s are predicted to rapidly (after 48 hours) disperse (45%) and evaporate (55%) the oil with no surface slick remaining. These are shown in **Figure 9-2**.

Vale 2013 has a high tendency for emulsion formation, with peak water contents in the surface slick stabilising at 76% after 72 hours for low winds (1 m/s), while this occurs much more rapidly (within six to 12 hours) under moderate (5 m/s) and high (10 m/s) wind speeds. The predicted changes in viscosity of the surface oil slick due to weathering are presented in **Figure 9-3**.

Peak viscosities of the surface slick within the first five days of weathering ranged from 2100 cP (for the low wind scenario) to 4000 cP (for the moderate wind scenario), with additional increases to viscosity predicted to occur as the surface slick continues to weather. Similarly, the pour point increases over the first five days of weathering, with peak pour points ranging from 30°C for the low wind scenario to 36°C for the high wind scenario. The relatively high pour point of the weathered oil would suggest a tendency for Vale 2013 to begin to solidify or 'gel' once the pour point exceeds environmental temperatures. This process would be aided by the moderate wax content within the oil that would form a waxy network structure (wax content of 3% for fresh oil, but wax would be a higher proportion of the weathered oil). It is therefore likely weathered oil stranded on shorelines would be present as a waxy, solidified residue.

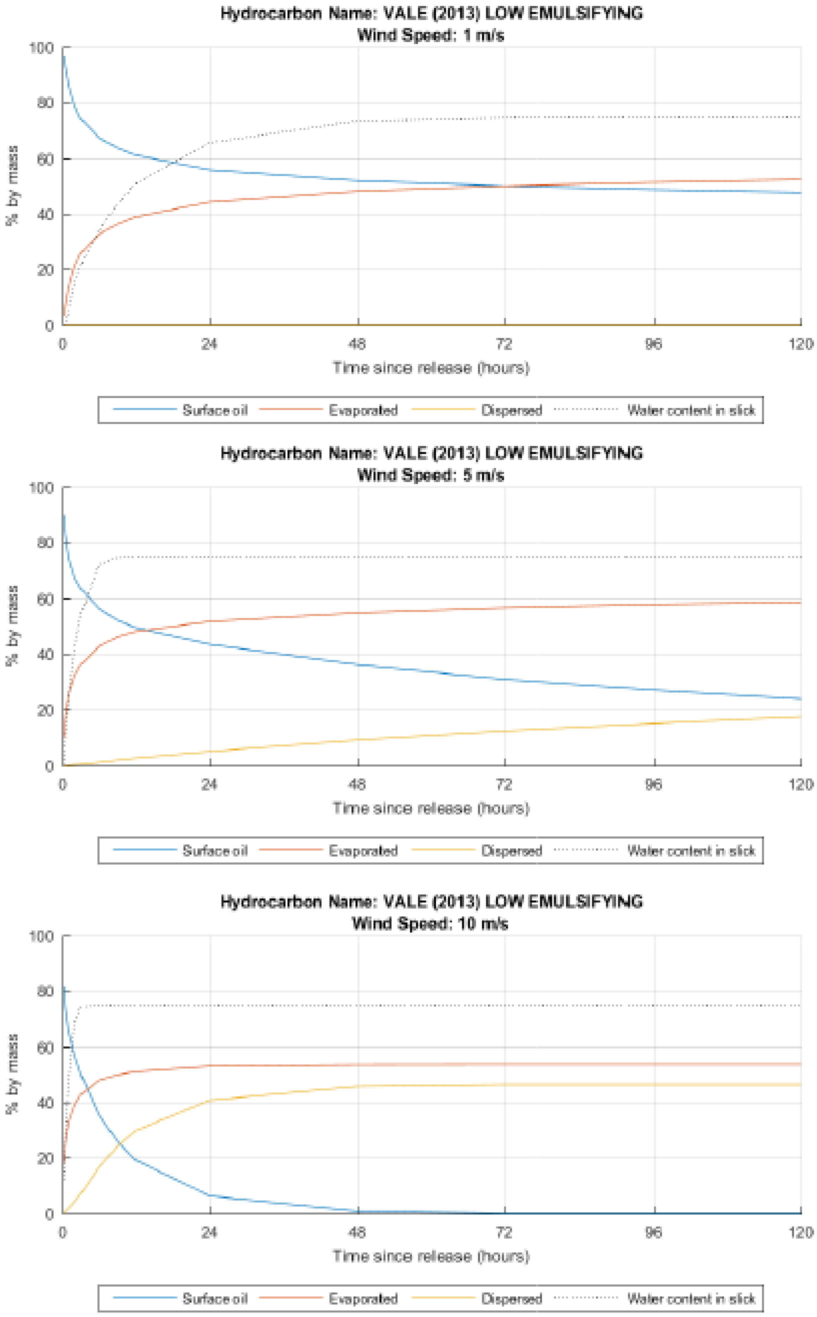

Figure 9-2: Simulated weathering of the SINTEF Vale 2013 hydrocarbon for constant wind speeds of 1 m/s (top), 5 m/s (middle) and 10 m/s (bottom) (GHD, 2021)

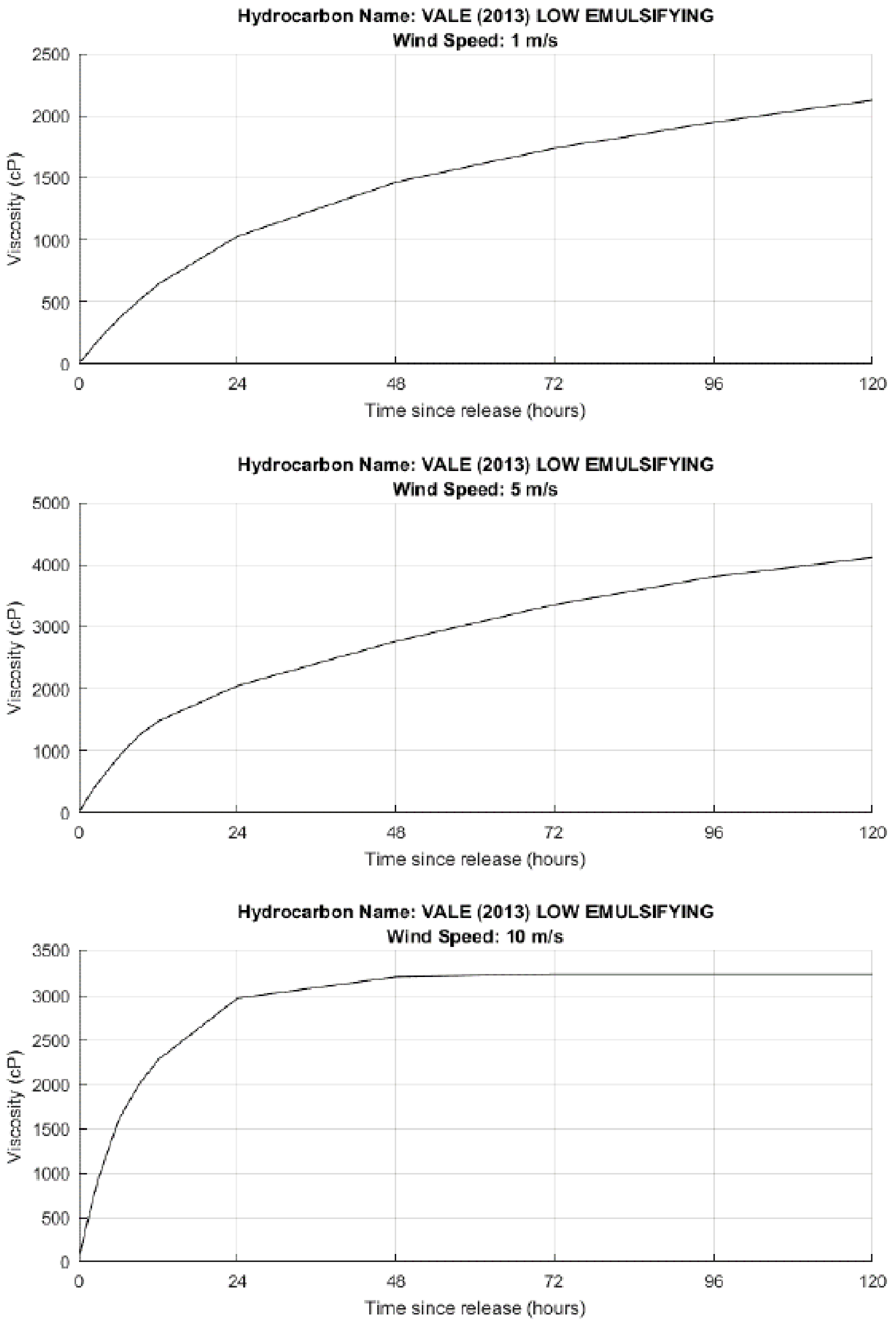

Figure 9-3: Simulated change in viscosity of the SINTEF Vale 2013 hydrocarbon for constant wind speeds of 1 m/s (top), 5 m/s (middle) and 10 m/s (bottom)

9.5.3.2 Marine diesel

International Tanker Owners Pollution Federation (2011) and 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.

- 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.

A surface release of 604 m³ of diesel was modelled from the vessel. Upon release, the diesel is forecast to spread rapidly out to a thin film on the sea surface, and evaporation is forecast to remove around 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 (GHD, 2021).

A summary of the representative characteristics of diesel, as assessed in this EP, is provided in **Table 9-8**.

Table 9-8: Summary of diesel characteristics (GHD, 2021)

Parameter	Diesel
API Gravity	36.4
Specific Gravity	0.843
Wax content (%)	0.05
Pour Point (ºC)	Less than -36
Asphaltene (%)	Less than 0.05
viscosity (cSt)	3.9 (@ 20ºC)

9.5.3.2.1 Marine diesel weathering

A preliminary analysis of hydrocarbon weathering for marine diesel was undertaken with the SINTEF oil weathering model (OWM) (GHD, 2021). The OWM predicts the fate of spilled hydrocarbons under steady state met-ocean conditions. OWM simulations were run for sustained wind speeds of 1 m/s (low winds), 5 m/s (moderate winds) and 10 m/s (high winds). The OWM simulations are based on 100 m³ of hydrocarbon released instantaneously onto the sea surface.

The results of the weathering analyses are presented in **Figure 9-4**. Marine diesel is a moderate weight and moderately persistent oil in the marine environment. Under low winds (1 m/s), 60% of the surface slick is predicted to remain after 120 hours (five days). Under moderate winds (5 m/s), 40% of the initial surface slick is predicted to remain after 24 hours, decreasing further to around 10% after 48 hours and around 1% after 72 hours. With high winds (10 m/s), the surface slick is predicted to almost entirely evaporate (around 20 to 25%) and disperse (around 75 to 80%) after 12 hours. Marine diesel has a very low tendency for emulsion formation with only around 1% water content entrained into the surface slick after 120 hours across the three constant wind assessment conditions.

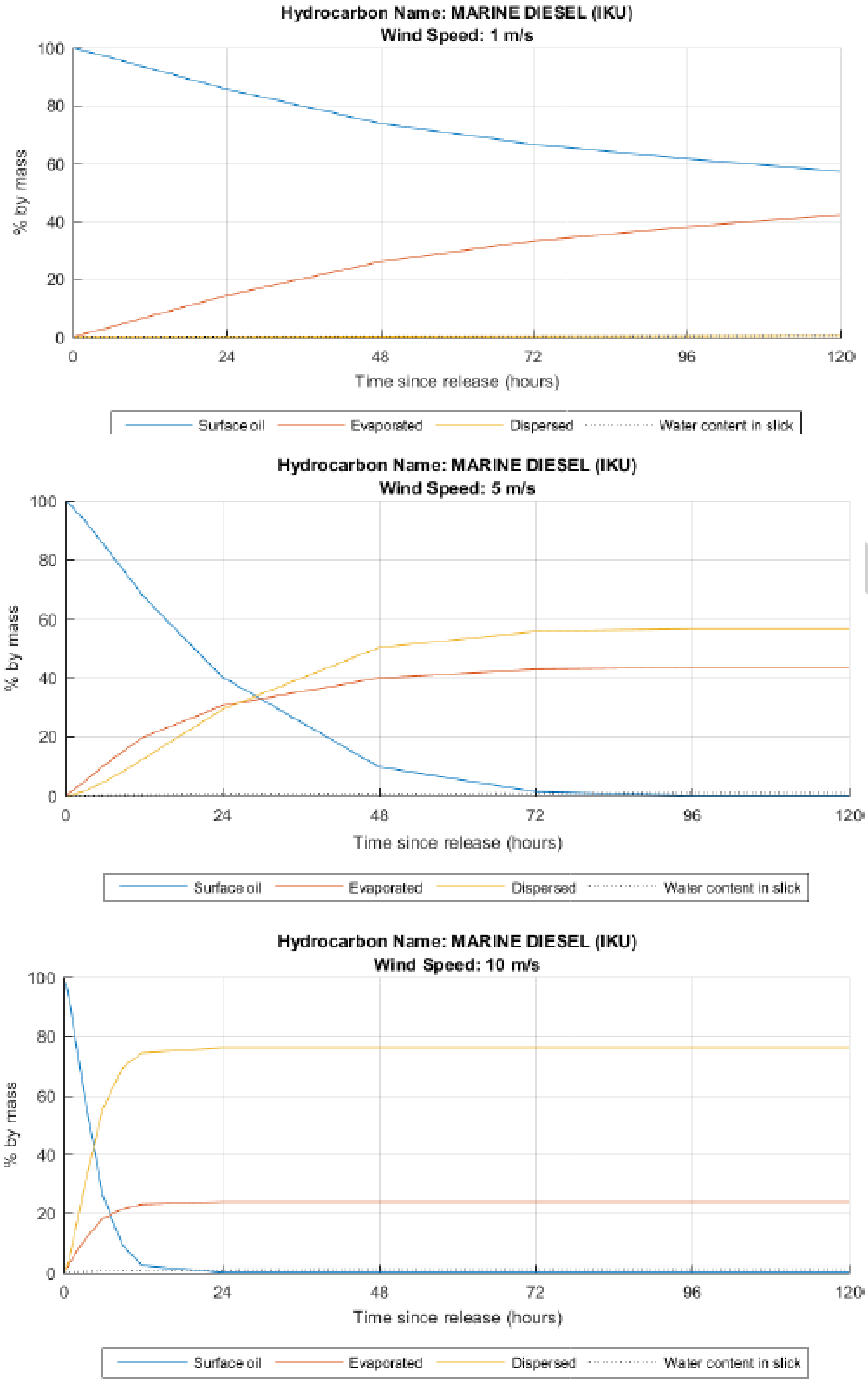

Figure 9-4: Simulated weathering of the SINTEF marine diesel (IKU) hydrocarbon for constant wind speeds of 1 m/s (top), 5 m/s (middle) and 10 m/s (bottom) (GHD, 2021)

9.5.4 Hydrocarbon exposure values

To inform the impact assessment it is important to understand the profile of the concentrations of hydrocarbons after a spill. To do this NOPSEMA recommends identifying hydrocarbon exposure values that broadly reflect the range of consequences that could occur at certain concentrations (NOPSEMA, 2019a). The exposure values that have been applied to this EP are described below.

The EMBA shown in **Figure 5-1** was identified using low exposure values. These low exposure values are not considered to be representative of a biological impact, but they are adequate for identifying the full range of environmental receptors that might be contacted by surface and/or subsurface hydrocarbons (NOPSEMA, 2019a) and a visible sheen.

To inform impact assessment, exposure values that may be representative of biological impact have also been identified. These are called ‘moderate exposure values’ (defined by the MEVA) and ‘high exposure values’ (defined by the high exposure value area) and are shown in **Figure 9-5**. Moderate and high 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.

Determining exposure values that may be representative of biological impact is complex since the degree of impact will depend on the sensitivity of the receptors contacted, the duration of the exposure and the toxicity of the hydrocarbon type making the contact. The toxicity of a hydrocarbon will also change over time, due to weathering processes altering the composition of the hydrocarbon. To identify appropriate exposure values Santos has considered the advice provided by NOPSEMA Bulletin #1 Oil Spill Modelling (NOPSEMA, April 2019) and scientific literature. The selected hydrocarbon exposure values are discussed in **Table 9-9** to **Table 9-12**. These tables explain how the exposure value is relevant to the risk evaluation and provides context on how that exposure value is used to inform response planning (which is addressed further in the OPEP).

Table 9-9: Floating hydrocarbons exposure values

Surface oil concentration (g/m²)	Exposure Value	Description
1	Low	**Risk evaluation** It is recognised a lower floating oil concentration of 1 g/m² (equivalent to a thickness of 0.001 mm or 1 ml of oil per m²) is visible as a rainbow sheen on the sea surface. Although this is lower than the exposure value 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/m² (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 to 25 g/m² (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 exposure value of 10 g/m² has been applied to impacts from surface hydrocarbons (floating oil) in this EP. Although based on birds, this hydrocarbon exposure value is also considered appropriate for turtles, sea snakes and marine mammals (NRDAMCME, 1997). This value has been used to define the MEVA. **Response planning** Contact at 10 g/m² is not specifically used for spill response planning.
50	High	**Risk evaluation** At greater thicknesses the potential for impact of surface oil to wildlife increases. All other things being equal, contact to wildlife by surface oil at 50 g/m² is expected to result in a greater impact. **Response planning** Containment and recovery effectiveness drops significantly with reduced oil thickness (McKinney *et al*., 2017; NOAA, 2014). McKinney *et al.* (2017) tested the effectiveness of various oil skimmers at various oil thicknesses. Their results showed that the oil recovery rate of skimmers dropped significantly when oil thickness was less than 50 g/m² (less than Bonn Agreement Code 4). Hence, 50 g/m² has been set as a guide for planning effective containment and recovery operations. Similarly, surface oil greater than 50 g/m² (Bonn Agreement Code 4/5 and equivalent to oil observed as discontinuous or continuous true colour) is considered to be a lower limit for effective dispersant operations and is therefore considered for planning.

Table 9-10: Shoreline hydrocarbon accumulation exposure values

Shoreline accumulation (g/m²)	Exposure Value	Description
10	Low	**Risk evaluation** An accumulated concentration of oil above 10 g/m² on shorelines is considered to represent a level of socio-economic effect (NOPSEMA, 2019b). For example, 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, 2005a, 2005b). **Response planning** Not specifically used for response planning because below the limit that can be effectively cleaned.
100	Moderate	**Risk evaluation** The impact exposure value 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 exposure value for invertebrates on hard substrates (rocky, artificial or human-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. This value has been used to define the MEVA. **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 exposure value equates to around half a cup of oil per square metre of shoreline contacted.
1000	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 9-11: Dissolved aromatic hydrocarbon exposure values

Dissolved hydrocarbons (ppb)	Exposure Value	Description
10	Low	**Risk evaluation** Dissolved aromatic hydrocarbons (DAH) include the monoaromatic hydrocarbons (compounds with a single benzene ring such as 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 severe impacts. Typically tests of toxicity done under laboratory conditions measure toxicity as proportion of test organisms affected (for example, 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-hour exposure, range between 30 ppb for sensitive species (2.5th percentile species) and 2260 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). More recently, French-McKay (2018) described in-water thresholds as 10 to 100 µg/L (equivalent to ppb). Regarding the effect of UV on PAH toxicity, French-McKay *et al*. (2018) uses the findings of Deepwater Horizon Natural Assessment (DWH NRDA) Trustees (2016) to adjust for this affect by reducing the water column exposure thresholds by ten times in the top 20 m of the water column. The dissolved hydrocarbon 10 ppb exposure value has been used to inform the EMBA within **Section 5**. An exposure value of 10 ppb is appropriate as it is concentration that could have some potential negative effect. **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).
50	Moderate	**Risk evaluation** Approximates potential toxic effects, particularly sublethal effects to sensitive species (refer to above text). Consistent with NOPSEMA (2019). This value has been used to define the MEVA. **Response planning** Encompassed by response to 10 ppb. 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 10 ppb. There is nothing different for higher exposure values.

Table 9-12: Entrained hydrocarbon exposure values

Entrained hydrocarbons (ppb)	Exposure Value	Description
10	Low	**Risk evaluation** 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 (entrained and dissolved) may account for much of the observed wide variation in reported exposure 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 2000 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 exposure value represents the very lowest concentration and corresponds generally with the lowest trigger levels for chronic exposure for entrained hydrocarbons in the Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia (2000) 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).

Entrained hydrocarbons (ppb)	Exposure Value	Description
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 dissolved from entrained oil, the higher Moderate exposure value for entrained oil over DAH (100 versus 50 ppb) is considered appropriate. This value has been used to define the MEVA. **Response planning** Encompassed by response to 10 ppb. There is nothing different for higher exposure values.

9.5.5 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 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 5.2** and **Appendix D**.
+ Identify areas of high environmental value (HEV) within the EMBA (HEVs are described in **Section 9.5.5.2**).
+ Identify and then risk-assess hot spots. Hot spots are effectively a subset of HEVs, and their determination is described in **Section 9.5.5.3**.
+ Identify priorities for protection (for consideration of spill response strategies in the OPEP).

9.5.5.1 Spill environment that may be affected

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 5.1**. To determine the potential impact to receptors within the EMBA, the MEVA is used to determine them as described in **Section 5.1**.

9.5.5.2 Areas of high environmental value

Santos has predetermined areas of HEV (**Figure 9-5**) 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.

- 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 (IUCN (1A) and sanctuary zones compared to IUCN (VI) and multiple use zones)
- listed species status and predominant habitat (surface versus subsurface)
- social values, socio-economic and heritage features (such as 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.

9.5.5.3 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)
- 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
- receive the greatest concentration or volume of oil, either floating or stranded oil, entrained oil or DAH above contact exposure values described in **Section 9.5.4**.

During the workshop, additional hotspots may be included through discretion of workshop attendees where they do not strictly meet all of the above criteria. For example, an HEV ranked 1 to 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 7**, the outcome of this is provided in **Appendix H**.

9.5.5.4 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 activity OPEP and are based on the worst-case estimate of surface oil concentration, shoreline loading and minimum contact time at exposure value concentrations:

+ Imperieuse Reef Marine Park.

The oil spill response strategies for Priority for Protection areas are undertaken within the activity OPEP.

Each protection priority will be assessed 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.

9.5.5.5 Potential hydrocarbon impact pathways

To help inform the hydrocarbon spill risk assessment receptors within the EMBA and potential impact pathways have been defined (**Table 9-13**). The potential impact pathways consider physical and chemical pathways. 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 9-13** and the information is drawn upon within the hydrocarbon risk assessment for the spill scenario. **Table 9-14** further describes the nature and scale of the hydrocarbon spills for this activity on marine fauna and socio-economic receptors found within the MEVA.

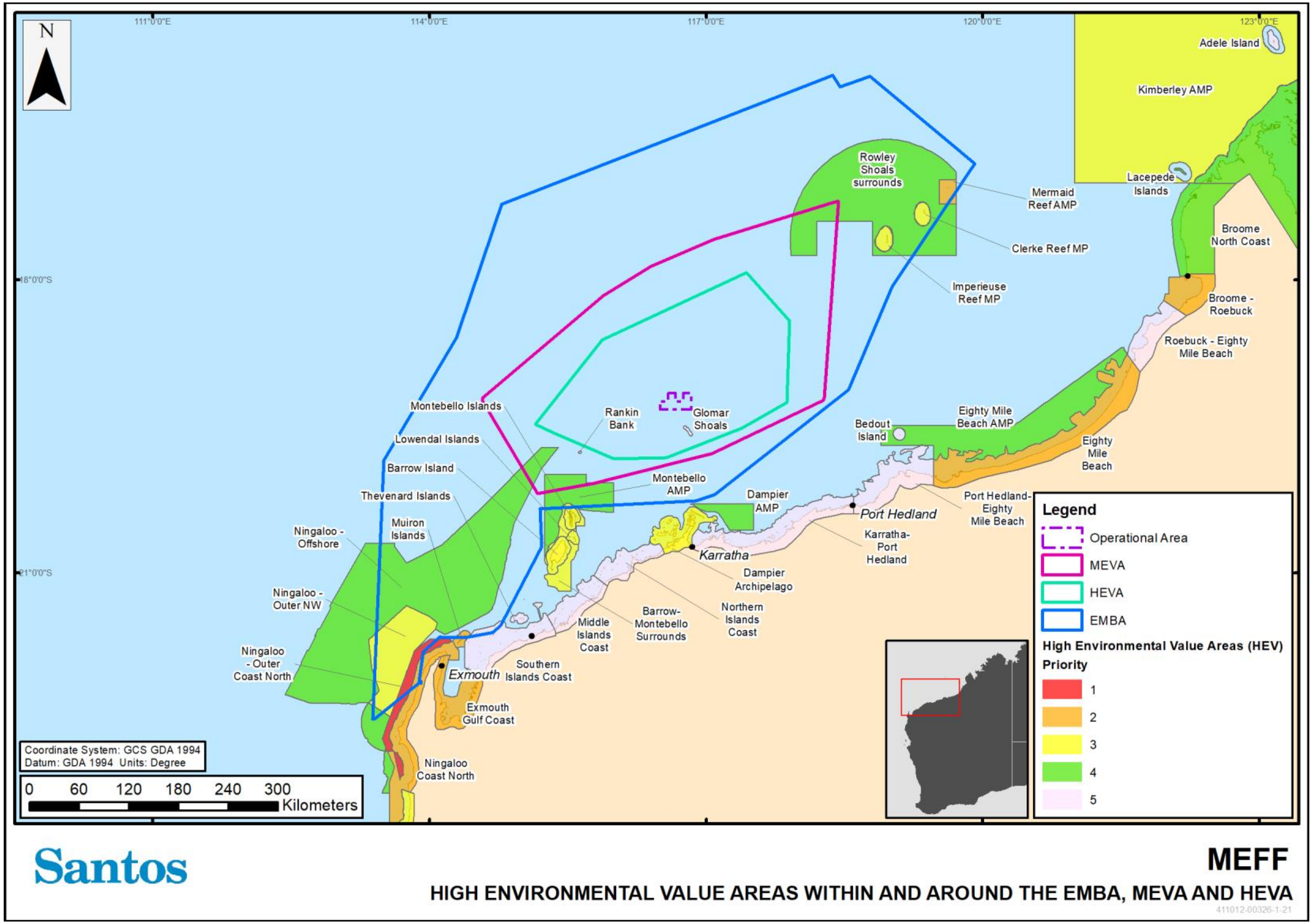

Figure 9-5: High environmental value areas within the environment that may be affected, moderate exposure value area and high exposure value area

Table 9-13: Physical and chemical pathways for hydrocarbon exposure and potential impacts to receptors

Receptor	Physical pathway	Potential impacts	Chemical pathway	Potential impacts
Rocky shorelines	Shoreline loading and attachment may result in thin and sporadic coating of hydrocarbon residues. Degree of oil coating is dependent upon the energy of the shoreline area, the type of the rock formation and continual biodegradation 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 beaches	Shoreline loading and water movement may allow hydrocarbon residue to filter down into sediments, continue to biodegrade on the surface or remobilise into surf zone. Degree of loading is dependent upon 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 platforms	Shoreline loading and water movement may allow hydrocarbon residue to filter down into sediments (e.g., within wetlands) or continue to biodegrade on the surface or remobilise into surf zone. Degree of loading is dependent upon 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
Shallow sub-tidal soft sediments	Hydrocarbon residue in the shallow waters adjacent to shorelines may settle to filter down into sediments. Degree of loading is dependent upon 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 turtles and fish. Direct impacts to infauna.	Adsorption via cellular membranes and soft tissue, ingestion, irritation/burning on contact and inhalation.	Indirect impacts to foraging habitats for turtles and fish. Direct impacts (mortality) to infauna through toxic effects and smothering.
Mangroves	Coating of root system reducing air and salt exchange. Degree of coating is dependent upon 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.
Seagrasses and macroalgae	Coating of leaves/thalli reducing light availability and gas exchange. Degree of coating depends upon 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/propagule viability.

Receptor	Physical pathway	Potential impacts	Chemical pathway	Potential impacts
Hard corals (coral reefs)	Coating of polyps, shading resulting in reduction on light availability. Degree of coating is dependent upon the metocean conditions, dilution, if 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. Reduced reproductive output. Reduced egg/larval success. Growth abnormalities.
Non-coral benthic invertebrates	Coating of adults, eggs and larvae. Degree of coating is dependent upon 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 DAH 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/larval success. Growth abnormalities. Behavioural disruption.

Receptor	Physical pathway	Potential impacts	Chemical pathway	Potential impacts
Sharks, rays and fish	Coating of adults but primarily eggs and larvae – reduced mobility and capacity for oxygen exchange.	Mortality. Oxygen debt. Starvation. Dehydration. Increased predation. Behavioural disruption.	Ingestion. External contact and adsorption across exposed skin and cellular membranes. Uptake of DAH across cellular membranes (for example, gills).	Mortality. Cell damage. Flesh taint. Reduced metabolic capacity. Reduced immune response. Disease. Reduced growth. Reduced reproductive output. Reduced egg/larval success. Growth abnormalities. Behavioural disruption.
Birds (seabirds and shorebirds)	Degree of coating is dependent upon 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, with the potential to cause secondary impacts such as: + physical restriction of flight and swimming movement + mortality + hypothermia/impairing the waterproofing of feathers + disruption to feeding/ starvation + disruption to breeding + disruption to migration.	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.

Receptor	Physical pathway	Potential impacts	Chemical pathway	Potential impacts
Marine reptiles	Degree of coating is dependent upon the energy and tidal reach of the shoreline, the type of the receptor and continual weathering of the oil.	Irritation of eyes/mouth and potential illness, which may cause secondary impacts such as: + mortality + disruption to feeding/ starvation + physical restriction + behavioural disruption.	Inhalation. Ingestion. External contact and adsorption across exposed skin and membranes.	Mortality. Cell damage, lesions. Secondary infections. Reduced metabolic capacity. Reduced immune response. Disease. Reduced growth. Reduced hatchling success. Reduced reproductive output. Growth abnormalities. Behavioural disruption.
Marine mammals	Fur damage and matting, reduced mobility and buoyancy (for applicable species). Coating of feeding apparatus in some species (baleen whales).	Irritation of eyes/mouth, damage to fur and potential illness, which may cause secondary impacts such as: + mortality + disruption to feeding/ starvation + physical restriction + behavioural disruption.	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.

Receptor	Physical pathway	Potential impacts	Chemical pathway	Potential impacts
Plankton	Coating of feeding apparatus. Reduced mobility and capacity for oxygen exchange.	Mortality. Behavioural disruption (for example, reduced mobility).	Inhalation. Ingestion. External contact.	Mortality. Impairment of biological activities (for example, feeding, respiration). Reduced mobility.
Water quality and sediment quality	Presence of hydrocarbon residue in the water, which may filter down to sediments or continue to biodegrade on the surface. Degree of loading in the water column is dependent upon the influence of wave energy and tidal range.	Impacts to flora and fauna, as discussed in rows above.	Adsorption via cellular membranes and soft tissue, ingestion, irritation/burning on contact and inhalation. Impacts to flora and fauna, as discussed in rows above.	Impacts to flora and fauna, as discussed in rows above.
Protected areas	Coating of benthic habitats, shoreline habitats and marine fauna/flora within protected areas as discussed in rows above.	Mortality, injury or behavioural disruption to marine fauna. Death or impairment of habitats within protected areas. Reduction in the quality of the marine environment within protected areas. Environmental value of protected areas is degraded.	Impacts to flora and fauna, as discussed in rows above.	Mortality, injury or behavioural disruption to marine fauna. Death or impairment of habitats within protected areas. Reduced growth of benthic habitats. Reduction in the quality of the marine environment within protected areas. Environmental value of protected areas is degraded.

Receptor	Physical pathway	Potential impacts	Chemical pathway	Potential impacts
Socio-economic environment (fisheries, tourism, shipping, defence, shipwrecks, Indigenous users, oil and gas)	Presence of hydrocarbon residue in the water, which may filter down to sediments or continue to biodegrade on the surface. Coating of benthic habitats, shoreline habitats and marine fauna/flora within protected areas as discussed in rows above.	Degradation of cultural or maritime heritage sites. Disruption to tourism, recreation or shipping activities. Reduction in resource available for commercial and recreational fisheries.	Impacts to flora, fauna and the physical environment as discussed in rows above. Commercial/recreational fish species – refer to ‘fish’ as discussed above.	Degradation of cultural or maritime heritage sites. Disruption to tourism, recreation or shipping activities. Reduction in resource available for commercial and recreational fisheries.

Table 9-14: Nature and scale of hydrocarbon spills on environment and socio-economic receptors within the moderate exposure value area

Receptor	Impacts of Hydrocarbon Spills	
	Entrained and dissolved aromatic hydrocarbons in the water column	Surface hydrocarbons
Threatened/Migratory Fauna		
Plankton (including zooplankton, fish and coral larvae)	There is potential for localised mortality of plankton due to reduced water quality and toxicity. Also, through physical contact of small oil droplets, plankton mobility, feeding and/or respiration may be impaired. Plankton could include the eggs and larvae of marine invertebrates and fish; therefore, entrained oil could impact on recruitment of invertebrate/fish species. Effects will be greatest in the upper 10 m of the water column and areas close to the spill source where hydrocarbon concentrations are likely to be highest.	Plankton utilising the sea surface layer could be impacted by floating oil.
	Plankton could include the eggs and larvae of marine invertebrates and fish and therefore impact on recruitment of invertebrate/fish species. The operational area has the potential to overlap with spawning of some fish species, given the year-round spawning of some species. In the unlikely event of a spill occurring, fish larvae may be impacted by hydrocarbons entrained in the water column. Following a hydrocarbon release a portion of the slick will rapidly evaporate and disperse in the offshore environment, reducing the concentration and toxicity of the spill. Maximum entrained oil concentrations were predicted at Glomar Shoals. Plankton utilising the sea surface layer, as well as pelagic invertebrates, could be impacted from floating oil. Exposure to entrained oils and DAHs may result in lethal or sub-lethal impacts to plankton or pelagic invertebrates through a direct contact pathway. Such contact could impair the mobility, feeding and respiration of these fauna and exchange of chemicals could occur.	
Marine mammals	Lethal or sub-lethal physical and toxic effects such as irritation of eyes/mouth and potential illness.	At risk of direct contact with surface hydrocarbons due to chance of surfacing within slick. Effects include irritation of eyes/mouth and potential illness. Surface respiration could lead to accidental ingestion of hydrocarbons or result in the coating of sensitive epidermal surfaces. Potential impact to feeding apparatus of some species (baleen whales).
	Thirteen migratory marine mammal species were identified by the PMST as occurring within the EMBA. 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 operational area and EMBA overlap with blue whale, humpback whale and dugong BIAs (**Figure 5-10** and **Figure 5-11**). For further information about environmental impacts to marine mammals from hydrocarbon exposure and increased toxicity, refer to **Table 9-13**. Other migratory marine mammals may encounter either surface or water column hydrocarbons in the EMBA. Dugongs may be particularly susceptible to surface slicks, a reduction of seagrass habitat for foraging and/or ingestion of seagrass coated with oil. Dugongs occur	

Receptor	Impacts of Hydrocarbon Spills	
	Entrained and dissolved aromatic hydrocarbons in the water column	**Surface hydrocarbons**
	throughout the shallow waters between the Pilbara offshore islands and the mainland and have been observed in the shallow waters along the east coast of Barrow Island and over the Lowendal Shelf. The EMBA overlaps a BIA for dugongs (**Figure 5-11**). Aerial surveys of dugong distribution have found that the animals occur around Barrow Island, Airlie Island, Lowendal Islands and the Montebello Islands further offshore (Prince, 2001).	
Marine reptiles	Lethal or sub-lethal physical and toxic effects such as irritation of eyes/mouth and potential illness. The Recovery Plan for Marine Turtles in Australia: 2017–2027 (CoA, 2017) highlights acute chemical discharge as one of several threats to marine turtles.	At risk of direct contact with surface hydrocarbons due to chance of surfacing within slick. Effects include irritation of eyes/mouth and potential illness. Surface respiration could lead to accidental ingestion of hydrocarbons or result in the coating of sensitive epidermal surfaces. Contact with hydrocarbons that have accumulated on shorelines particularly at nesting beaches. Oiling of eggs/hatchlings may occur. Shoreline hydrocarbons are expected to be less toxic than fresh oils due to weathering processes such as photo oxidation and biodegradation reducing the levels of lighter chain hydrocarbons which are generally more toxic.
	Seven species of threatened marine reptile were identified as possibly being impacted by a spill. Loggerhead, green, leatherback, hawksbill, flatback and Olive Ridley turtles are widely dispersed across the NWS and in the unlikely event of a hydrocarbon spill occurring, individuals traversing open water may come into contact with water column or surface hydrocarbons. The EMBA overlaps with BIAs and critical habitat for four turtle species (flatback, green, hawksbill and loggerhead) as shown in **Figure 5-12** to **Figure 5-15**:. Sea snakes are associated with the offshore reefs and banks within the EMBA, particularly those Glomar Shoals, Imperieuse and Clerke Reef within the Rowley Shoals, which are known for their abundance and diversity of seasnakes. Critical habitat including internesting habitat offshore form important nesting beaches for turtle species are present within the EMBA. However, there was no shoreline contact from surface oil above the 100 g/m² exposure value predicted for any important nesting beach. In the event of a spill, the presence of hydrocarbons on beaches would disrupt behaviour and potentially threaten turtle populations. For further detailed environmental impacts to marine reptiles from hydrocarbon exposure and increased toxicity, refer to **Table 9-13**.	

Receptor	Impacts of Hydrocarbon Spills	
	Entrained and dissolved aromatic hydrocarbons in the water column	**Surface hydrocarbons**
Birds (seabirds and shorebirds)	Lethal or sub-lethal physical and toxic effects such as irritation of eyes/mouth and potential illness. May encounter entrained hydrocarbons while diving and foraging.	Particularly vulnerable to surface slicks. As most fish survive beneath floating slicks, they will continue to attract foraging seabirds, which typically do not exhibit avoidance behaviour. Smothering can lead to reduced water proofing of feathers and ingestion while preening. In addition, direct contact with hydrocarbons can erode feathers causing chemical damage to the feather structure that subsequently affects ability to thermoregulate and maintain buoyancy on water. Shorebirds may be impacted by the presence of hydrocarbons accumulated on shorelines which may result in exposure to eggs and ingestion by foraging individuals. Shoreline hydrocarbons are expected to be less toxic than fresh oils due to weathering processes such as photo oxidation and biodegradation reducing the levels of lighter chain hydrocarbons which are generally more toxic.
	Thirty-two threatened or migratory species of seabirds and shorebirds were identified within the EMBA by the PMST (**Table 5-8**). Of these, only nine species were identified within the operational area. There were no BIAs for seabirds or shorebirds within the operational area. Migratory seabird BIAs for breeding and resting overlap with the EMBA (**Table 5-9**); therefore, species may be impacted by surface and entrained hydrocarbons while foraging (dive and skim feeding) with higher numbers expected during the breeding periods. Birds (seabirds and shorebirds) are highly susceptible to hydrocarbon spills, with impacts primarily attributed to oiling of birds at the sea surface from slicks and oil on shorelines. Given the EMBA contacts multiple areas where seabirds are known for breeding including Rowley Shoals (Imperieuse and Clerke reefs), impacts to birds may include coating by oil when floating in open water, diving into open and coastal waters to feed on fish, wading and foraging on shallow intertidal mud/sand flats and wetlands or roosting on oil affected sandy beaches. Other impacts could include behavioural impacts whereby birds avoid important nesting and migratory stop-over areas or reduced food availability if important foraging areas are impacted. For further information about environmental impacts to seabirds/shorebirds through hydrocarbon exposure and toxicity effects, refer to **Table 9-13**.	

<table>
<tr><th rowspan="2">Receptor</th><th colspan="2">Impacts of Hydrocarbon Spills</th></tr>
<tr><th>Entrained and dissolved aromatic hydrocarbons in the water column</th><th>Surface hydrocarbons</th></tr>
<tr><td rowspan="2">Sharks, rays and fish</td><td>Hydrocarbon droplets can physically affect fish, sharks and rays exposed for an extended duration (weeks to months). Smothering through coating of gills can lead to the lethal and sub-lethal effects of reduced oxygen exchange, and coating of body surfaces may lead to increased incidence of irritation and infection. Fish may also ingest hydrocarbon droplets or contaminated food, leading to reduced growth.

There is potential for localised mortality of fish eggs and larva due to reduced water quality and toxicity. Effects will be greatest in the upper 10 m of the water column and areas close to the spill source where hydrocarbon concentrations are likely to be highest; therefore, demersal fish communities (including those associated with the Ancient Coastline at 125m depth contour KEF, Continental Slope Demersal Fish Communities KEF) and Glomar Shoals may be exposed. For further information about environmental impacts to fish/sharks/rays from hydrocarbon exposure and toxicity effects, refer to Table 9-13.</td><td>While fish, sharks and rays do not generally break the sea surface, individuals may feed at the surface. For condensate/diesel spills where a slick is expected to quickly disperse and evaporate, prolonged exposure to surface hydrocarbons by fish, shark and ray species is unlikely. Due to the filter-feeding nature of whale sharks they may be susceptible to ingesting surface hydrocarbons, both fresh and weathered (tar balls) if feeding at the sea surface particularly from diesel spills.</td></tr>
<tr><td colspan="2">The NWS supports a diverse assemblage of fish, including 456 species of finfish, particularly in shallower water near the mainland and islands. Threatened species identified by the PMST include the white shark, whale shark, grey nurse shark, sawfishes (dwarf, green and narrow), giant manta ray and reef manta ray, mako sharks and oceanic white tip sharks 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. These threatened and migratory fish and sharks could be present at low densities all year round within the operational area and EMBA; however, the absence of any known feeding, resting or breeding areas means significant numbers are unlikely to be impacted if an unplanned release were to occur.

The whale shark foraging BIA is presented in Figure 5-9 and the main whale shark aggregation location (Ningaloo Marine Park) is more than 400 km southwest of the operational area. The EPBC Act-listed whale shark may occur in the EMBA, particularly off the Ningaloo coastline between March and June and is known to feed in surface waters. There is, therefore, the potential for this species to ingest oil from surface slicks with resultant damage to gills, other tissues and organs. For further information about environmental impacts to fish/sharks/rays from hydrocarbon exposure and toxicity effects, refer to Table 9-13.</td></tr>
</table>

<table>
<tr><th rowspan="2">Receptor</th><th colspan="2">Impacts of Hydrocarbon Spills</th></tr>
<tr><th>Entrained and dissolved aromatic hydrocarbons in the water column</th><th>Surface hydrocarbons</th></tr>
<tr><td colspan="3">Socio-economic</td></tr>
<tr><td rowspan="2">Commercial, recreational and traditional fisheries</td><td>Hydrocarbons in the water column can have toxic effects on fish (as outlined above) potentially reducing catch rates and rendering fish unsafe for human consumption.</td><td>In addition to the effects of entrained and DAHs, exclusion zones surrounding a spill can directly impact fisheries by restricting access for fishermen. Weathered diesel slicks may form tar balls which may result in oiling of nets and fishing equipment.</td></tr>
<tr><td colspan="2">A number of commercial fisheries operate within the EMBA (Section 5.2.5). Impacts to these fisheries from a spill may range from disruption of fishing activities caused by the physical presence of the slick, loss of (or loss of function of) coastal intertidal habitat (for example, seagrass meadows, mangrove communities, intertidal mudflats) which may provide nursery habitat for fishery species (for example, fish and crustaceans) and contact of surface and entrained hydrocarbons with the eggs and larvae of commercially important species. Exposure to entrained and DAHs could result in the accumulation of oil in fish tissues to the extent that could result in hydrocarbon taint of fish flesh. Connell and Miller (1981) compiled a summary of studies listing the exposure value concentrations at which tainting occurred for hydrocarbons. The results contained in their review indicate tainting of fish occurs when fish are exposed to ambient concentrations of 4 to 300 ppm (4000 to 300,000 ppb) of hydrocarbons in the water, for durations of 24 hours or more, with response to phenols and naphthenic acids being the strongest. Given entrained hydrocarbons are predicted to exceed the moderate threshold at some locations in the MEVA, hydrocarbon taint is possible in fish flesh. Although it is difficult to assess how long fish might be exposed for, small, less mobile fishes would be more susceptible. It is possible impacts could be detected to fisheries on a stock level, although it is more likely that natural variation in fish abundance would be on a greater scale than any impacts attributable to a hydrocarbon spill. This would most likely be the case for fisheries species that utilise shallow waters around the Barrow and Montebello Islands and could occur through direct impacts to fish or to fish habitats (for example, seagrass, coral reef, mangrove habitats).

The same negative impacts could also occur to important recreational fish species and the recreational fisheries they support although impacts to commercial fisheries could result in the additional impact of loss of income for commercial fishers.</td></tr>
<tr><td>Recreation and tourism</td><td colspan="2">A number of tourism destinations occur within the EMBA, including Ningaloo Reef (which is within a World Heritage Area, National Heritage Place and a Commonwealth Heritage Place) and offshore islands such as the Montebello Islands and Rowley Shoals. A number of areas with high diversity or which have unique ecological values are protected within AMPs. As well as reducing the visual amenity of these areas, a LOWC spill could impact the habitats and marine fauna of these areas thereby impacting the environmental values of these tourism areas. Depending upon the extent of impact, loss of revenue to coastal towns and communities could also occur.</td></tr>
</table>

Receptor	Impacts of Hydrocarbon Spills	
	Entrained and dissolved aromatic hydrocarbons in the water column	Surface hydrocarbons
Shipping	Multiple shipping fairways intersect the EMBA (**Figure 5-21**). Hydrocarbons in the water column will have no effect on shipping.	Exclusion zones surrounding a spill will reduce access for shipping vessels for the duration of the response undertaken for spill clean-up (if applicable), vessel may have to take large detours leading to potential delays and increased costs.
Defence	The level of defence activities performed in the vicinity of operational area is low, though the EMBA does overlap some of the North West Exercise Area. Interference of defence activities due to a hydrocarbon spill is expected to be minimal.	
Shipwrecks	There are a number of historic (more than 75 years old) shipwrecks within the EMBA. Shipwrecks may be of important heritage value and/or act as dive sites. Surface hydrocarbons will have no impact on shipwrecks. Hydrocarbons in the water column either as entrained oil or DAHs may extend thousands 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 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 cultures 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.	
Existing oil and gas activity	A number of oil and gas operators operate within the EMBA which encompasses the entire NWS with existing projects and equipment in place as well as continuing drilling and exploration programs. A surface slick has the potential to disrupt activity potentially halting production or exploration with associated economic impact. Exclusion zones surrounding spills will reduce access potentially resulting in delays to work schedules with possible subsequent financial implications.	
Protected Areas		
Marine parks and Commonwealth heritage areas	Protected areas are described in **Section 5.2.3**. These areas provide key habitats that support an array of marine flora and fauna along with unique natural phenomena.	
	These protected areas support all the habitats and faunal groups described above and support unique/protected habitats/marine fauna or ecological features. Impacts to the habitat/fauna receptors described above therefore have an impact on the values of these reserves which could have flow-on effects to tourism revenue for coastal communities that provide access to these marine reserves. The protected areas may also support nursery/feeding/aggregation areas for fisheries species and therefore may assist in maintaining healthy fish stocks and commercial/recreational fisheries.	
RAMSAR wetlands	No RAMSAR wetlands ae located within the EMBA.	

Receptor	Impacts of Hydrocarbon Spills	
	Entrained and dissolved aromatic hydrocarbons in the water column	Surface hydrocarbons
KEFs	KEFs overlapping the EMBA are described in **Section 5.2.3**.	
	While some features associated with the KEFs are subtidal or submerged and would not be directly contacted by a surface slick, they all may support increased productivity or abundance of marine fauna that use surface waters above the features (including plankton, pelagic invertebrates and fish, marine mammals, marine reptiles and seabirds) which may be impacted by floating oil. Impacts to these marine fauna are described above.	
Threatened ecological communities	No threatened ecological communities are located within the EMBA.	

9.5.6 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 6 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.

9.6 Hydrocarbon spill – marine diesel oil

9.6.1 Description of event

Event	Worst-credible marine diesel oil spill It is considered credible that a release of MDO to the marine environment could occur between the primary vessels, between a primary vessel and a support vessel, or between a passing third party vessel and a primary or support vessel. The worst-case environmental incident resulting from a vessel collision is the rupturing of a vessel fuel tank resulting in the release of MDO to the environment. Vessel collision could occur due to factors such as human error, poor navigation, vessel equipment failure or poor weather. A maximum credible spill volume has been determined based on technical guidance provided by AMSA (2015). This guidance states that for a vessel other than an oil tanker, the maximum credible spill from a collision can be determined from the volume of the largest single fuel tank. In reviewing the general arrangements and fuel tank capacities of typical vessels likely to be utilised, the largest single fuel tank capacity identified was no greater than around 604 m³ of MDO for support vessels. This scenario would result in a spill of diesel at the sea surface. Refuelling incident The second most significant MDO spill scenario identified is a primary vessel refuelling incident (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 guidance provided by AMSA (2015) for a refuelling spill under continuous supervision is considered appropriate, given refuelling will be constantly supervised. The maximum credible spill volume during refuelling is calculated as: transfer rate (150 m³/hr) × 15 minutes of flow giving a volume of 37.5 m³. 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. Recovery of floating assets During the recovery of the floating assets, it is a remote possibility, that the floating assets are released in an uncontrolled manner, rises to the surface and impacts a project vessel, with the potential to result in a release of marine diesel oil if the impact breached a fuel tank. For the purpose of the EP the impacts of a MDO spill of 604 m³ has been assessed as this is the largest credible MDO spill associated with the activity.
Extent	Diesel spill trajectory modelling (GHD, 2021) indicated there was some probability of a 604 m³ MDO spill extending as follows (using the moderate exposure thresholds) based on a summary from all modelling locations: + Shoreline loading above 100 g/m² was only predicted to occur at Imperieuse Reef Marine Park around 300 km northeast of the release location. + Surface oil above 10 g/m² was predicted to occur within around 300 km. + Total submerged oil above 100 ppb was predicted to occur within around 225 km. + Dissolved hydrocarbons above 50 ppb were predicted to occur within around 200 km.
Duration	A 604 m³ release of MDO was modelled for a release over half an hour, replicating the potential duration of a spill arising from a significant collision.

9.6.1.1 Stochastic spill modelling – summary of results for moderate exposure thresholds

Accumulated shoreline oil above 100 g/m²

At the moderate threshold the spatial extent of shoreline accumulation was within around 300 km to the northeast at Imperieuse Reef MP. Imperieuse Reef MP was the only receptor with shoreline accumulation above the moderate threshold of 100 g/m², specifically:

- maximum total accumulated oil of 12.4 tonnes covering a maximum length of shoreline of 11 km
- probability of contact above the moderate threshold of 0.5% and a minimum arrival time of 11.7 days.

Surface oil greater than 10 g/m²

Surface oil above the moderate threshold extends up to around 300 km from the release location. Surface oil impacts at the moderate threshold include:

- Very low (2%) contact probability was predicted at Glomar Shoals (submerged receptor), with a maximum time-averaged surface oil concentration of 217 g/m² and a minimum arrival time of 0.4 days (ten hours).
- Very low (<1%) contact probability was predicted at Montebello AMP, Rowley Shoals surrounds and Ningaloo – Offshore (all submerged receptors), with maximum time-averaged concentrations of 11 to 29 g/m² and minimum arrival times of five to seven days.

Entrained oil greater than 100 ppb

Total submerged oil at the moderate threshold, although sparsely scattered, were predicted to occur up to 225 km from the release location. Total submerged oil impacts at the moderate threshold include:

- The only receptor predicted to be contacted by total submerged oil above the moderate threshold (100 ppb) was Glomar Shoals, with a low contact probability of 2%, maximum time-averaged concentration of 450 ppb and a minimum arrive time of 0.5 days (12 hours).

Dissolved oil greater than 50 ppb

Dissolved hydrocarbons at the moderate threshold were predicted to be within around 200 km of the release site. Dissolved oil impacts at the moderate threshold include:

- The only receptor predicted to be contacted by dissolved hydrocarbons oil above the moderate threshold (50 ppb) was Glomar Shoals, with a low contact probability of 2%, maximum time-averaged concentration of 266 ppb and a minimum arrive time of 0.5 days (12 hours).

Spill modelling results for the MDO scenario are summarised in **Table 9-15**.

Table 9-15: Spill modelling results for surface release of marine diesel oil

Receptor	Receptor Type	Minimum time to contact (days)							Maximum hydrocarbon concentration							Maximum oil ashore (tonnes)	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 hydrocarbons (50 ppb)	Entrained Hydrocarbons (100 ppb)	Dissolved hydrocarbons (400 ppb)	Shoreline accumulation (1000 g/m^2)	Surface hydrocarbons (50 g/m^2)	Shoreline accumulation (100 gm^2)	Surface hydrocarbons (10 g/m^2)	Dissolved hydrocarbons (50 ppb)	Entrained Hydrocarbons (100 ppb)	Dissolved hydrocarbons (400 ppb)	Shoreline accumulation (1000 g/m^2)	Surface hydrocarbons (50 g/m^2)	Shoreline accumulation (100 g/m^2)	Shoreline accumulation (100 g/m^2)
Clerke Reef MP	Emergent	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
Imperieuse Reef MP	Emergent	11.7	NC	NC	NC	NC	NC	NC	888.9	NC	NC	NC	NC	NC	NC	12.4	11.0
Southern Islands Coast	Intertidal	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
Glomar Shoals	Submerged	NC	0.4	0.5	0.5	NC	NC	0.5	NC	217.4	265.6	449.2	NC	NC	0.5	NC	NC
Montebello MP	Submerged	NC	5.1	NC	NC	NC	NC	NC	NC	11.4	NC	NC	NC	NC	NC	NC	NC
Rowley Shoals surrounds	Submerged	NC	6.8	NC	NC	NC	NC	NC	NC	21.3	NC	NC	NC	NC	NC	NC	NC
Ningaloo – offshore	Submerged	NC	4.9	NC	NC	NC	NC	NC	NC	29.1	NC	NC	NC	NC	NC	NC	NC

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. The nature and scale of a hydrocarbon spill is described throughout this chapter for a vessel collision scenario, given smaller hydrocarbon spills (from refuelling) will impact a smaller area than a vessel collision.

Potential receptors: Plankton (including zooplankton and fish and coral larvae), Marine mammals, Marine reptiles, Seabirds and shorebirds, Shallow benthic, intertidal and shoreline habitats, Fish and sharks, Fisheries, Tourism, Protected areas, Shipping, Defence, Existing oil and gas activity and KEFs.

As a light hydrocarbon, MDO undergoes rapid spreading and evaporative loss in warm waters, indicating that a surface slick will be temporary, with around 40% of the released volume evaporating within 40 hours. The high rate of evaporation means that little MDO will become entrained and few aromatic hydrocarbons are predicted to become dissolved. A surface release of MDO 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. Potential impact pathways (physical and chemical) of hydrocarbon exposure for receptors are summarised in **Table 9-13** and potential impacts to receptors found within the EMBA are further described in **Table 9-14**.

9.6.2 Net environmental benefit analysis

Net environmental benefit analysis (NEBA) is a structured approach used by the response community and stakeholders to select spill response strategies that will effectively remove oil, are feasible to use safely in particular conditions, and will reduce the impact of an oil spill on the environment.

The NEBA process is used during pre-spill planning (strategic NEBA) and during a response (operational NEBA). A strategic NEBA is an integral part of the contingency planning process and is used to ensure response strategies for scenarios are well informed. An operational NEBA is used to ensure evolving conditions are understood, so response strategies can be adjusted as necessary to manage individual response actions and end points.

Balancing trade-offs may involve differing and conflicting priorities, values and perceptions of the importance of sensitive receptors. There is no universally accepted way to assign perceived value or importance, and it is not a quantitative process. Overall, the NEBA process provides an estimate of potential environmental effects that are sufficient to allow the parties to compare and select preferred combinations of response strategies to reduce environmental impacts to ALARP.

A strategic NEBA has been developed for all response strategies identified as applicable to credible spills identified in the OPEP related to an unplanned release of condensate, with the potential environmental benefit or potential impact to each protection priority area. This will provide information that will help to select response strategies tailored to the key environmental values within the areas of highest priority. A summary of spill response strategies is available for each of the priorities for protection and the potential impact that a response strategy has on the area’s environmental values.

This information is to be considered in the NEBA process that takes place during a spill response (i.e., an operational NEBA). An operational NEBA will also consider real-time monitoring of the effectiveness and potential impacts of a response and will also consider accessibility, feasibility and safety of responders (refer to Section 6 of the OPEP).

9.6.3 Environmental performance outcomes and control measures

The EPOs relating to this event include:

+ No loss of containment of hydrocarbon to the marine environment [MEFF-EPO-07].

The control measures applied to prevent hydrocarbon spill from refuelling and vessel collision are shown in **Table 9-16** and the EPSs and measurement criteria for this EPO are described in **Section 10.4**.

Selection of oil spill response strategies and associated performance outcomes, control measures and performance standards, 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 9-16: Control measure evaluation for hydrocarbon spill – marine diesel oil

CM reference	Control measure	Environmental benefit	Potential cost / issues	Evaluation
Standard Controls				
MEFF-CM-01	Maritime Notices	Ensures other marine users are aware of the presence of vessels.	Costs associated with the personnel time in issuing notifications and closing out queries and responses.	**Adopted** – Benefits considered to outweigh negligible costs. Maritime requirement to issue marine notices.
MEFF-CM-02	Santos' stakeholder consultation strategy	Santos will notify all relevant stakeholders listed, or as revised, in **Section 6** of relevant activity details prior to commencement, including activity timing, vessel movements, proposed cessation date and vessel details. Ensures other marine users, such as commercial fishers, are aware of upcoming operations so they can plan their business accordingly.	Limited additional costs to Santos. Stakeholders' time required to review consultation material and communicate with Santos.	**Adopted** – Benefits considered to outweigh negligible costs. Important control to ensure other marine users are aware of upcoming operations and potential business disruptions.
MEFF-CM-04	Existing (gazetted) PSZs established around the MEFF DTM and manifold locations	Gazetted 500 m PSZ around the MEFF DTM and manifold locations and reduces the potential for third-party vessel collision with the primary vessels when they are working in these PSZs.	No additional costs. PSZs already gazetted.	**Adopted** – Benefits considered to outweigh no costs to Santos.

CM reference	Control measure	Environmental benefit	Potential cost / issues	Evaluation
MEFF-CM-05	Safety Exclusion Zone established around primary vessels during floating and seabed asset removal activities, to reduce potential for collision or interference with other marine user activities	Requested Safety Exclusion Zone around the primary vessels prevents reduces the potential for vessel collision with third-party vessels.	No additional costs to Santos. Other marine users may be temporarily excluded from small areas.	**Adopted** – Befits outweigh the costs.
MEFF-CM-06	Lighting will be used as required for safe work conditions and navigational purposes	Ensures vessels meet minimum safety standards, therefore reducing potential for vessel collision events with associated diesel spill to the environment. Marine Order Part 30: Prevention of Collisions, and with Marine Order Part 21: Safety of Navigation and Emergency Procedures requires vessels to have navigational equipment to avoid collisions. Requirement of the *Navigation Act 2012*.	Costs associated with personnel time in checking vessel certifications are in place. Negligible costs of operating navigational equipment.	**Adopted** – Benefits considered to outweigh costs.
MEFF-CM-07	Seafarer Certification	Requires appropriately trained and competent personnel, in accordance with Marine Order 70, to navigate vessels to reduce interaction with other marine users. Requires appropriately trained and competent personnel to navigate vessels.	Costs associated with personnel time in obtaining qualifications.	**Adopted** – Benefits considered to outweigh costs.
MEFF-CM-24	Fuel oil quality	Use of diesel reduces the potential impacts to marine environment in the event of unplanned hydrocarbon spills or leaks during bunkering.	Additional personnel costs of ensuring vessels are using the required fuel.	**Adopted** – Benefits of ensuring procedures are followed outweighs the minimal costs of personnel time.

CM reference	Control measure	Environmental benefit	Potential cost / issues	Evaluation
MEFF-CM-42	Vessel spill response plans (SOPEP/ SMPEP)	Implements response plans on board vessels to deal with unplanned hydrocarbon releases and spills quickly and efficiently in order to reduce impacts to the marine environment.	Administrative costs of preparing documents. Generally undertaken by vessel contractor so time for Santos personal to confirm and check SOPEP/ SMPEP in place.	**Adopted** – Benefits of considered to outweigh costs.
MEFF-CM-43	Accepted OPEP	Implements response plans to deal with an unplanned hydrocarbon release quickly and efficiently in order to reduce impacts to the marine environment.	Administrative costs of preparing documents and large costs of preparing for and implementing response strategies.	**Adopted** – Regulatory requirement must be adopted.
MEFF-CM-22	Marine assurance standard	Ensures vessels meet Marine assurance standards to reduce the likelihood of unplanned discharge.	Costs associated with personnel time in checking vessel.	**Adopted** – Benefits of ensuring procedures are followed and measures implemented and that the vessels are compliant outweigh the costs. Regulatory requirement must be adopted.
MEFF-CM-21	Vessel PMS to maintain vessel DP, engines and machinery	Ensure vessel is running efficiently and routine maintenance endeavours to ensure risk of collision form vessel system failure is reduced.	No additional costs, is industry best practice.	**Adopted** – No additional costs.
MEFF-CM-44	Santos Refuelling and Chemical Transfer Standard (SO-91-IQ-00098)	Minimises risk of pollution to ALARP during hydrocarbon transfers/ vessel refuelling.	Personnel costs associated with ensuring procedures are in place and implemented during refuelling and chemical transfers.	**Adopted** – Benefits of ensuring procedures are followed and measures implemented outweigh the costs.

CM reference	Control measure	Environmental benefit	Potential cost / issues	Evaluation
MEFF-CM-45	Dynamic positioning system	Ensure vessel is running efficiently and routine maintenance endeavours to ensure risk of collision form vessel system failure is reduced.	No additional costs, is industry best practice.	**Adopted** – No additional costs.
MEFF-CM-38	NOPSEMA accepted MEFF Field Safety Case Addendum	Reduces the probability of an unplanned release of the floating assets during recovery to vessel from their current as installed position, impacting a project vessel and causing a release of marine diesel to marine environment.	Costs associated with developing and implementing the Safety Case Addendum.	**Adopted** – Benefits considered to outweigh minor costs.
Additional Controls				
N/A	Schedule activities to avoid coinciding with sensitive periods for marine fauna present in the operational area	Potential reduction in risk of a hydrocarbon spill to some sensitive receptors.	Impracticable to schedule activities to avoid all listed marine fauna due to variability in timing of environmentally sensitive periods and the constant or unpredictable presence of some species. Short duration activity (i.e., a few days) that is low risk to marine fauna.	**Rejected** – Cost is disproportionate to increase in environmental benefit.

CM reference	Control measure	Environmental benefit	Potential cost / issues	Evaluation
N/A	Zero fuel bunkering via hose	Removes spill risk from hose operations.	Cost associated with transfer of MDO via drums or containers. Not possible to modify vessels to allow additional fuel storage. Cost associated with vessel transits and risk transfer to Health and Safety issues with additional trips to port instead. Would significantly increase the schedule to include multiple trips.	**Rejected** – Storage of fuel on vessels would result in unacceptable transfer of environmental risks to occupational health and safety/ operational risks and would not eliminate risk of MDO spills to sea. Costs associated with implementing control is deemed grossly disproportionate to environmental benefit and low risk activity with standard controls in place.
N/A	Require all 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' 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.

CM reference	Control measure	Environmental benefit	Potential cost / issues	Evaluation
N/A	Dedicated resources (e.g., dedicated spill response facilities on location) in the event of loss of hydrocarbons to allow rapid response	May allow for quicker response to a spill as resources will be within proximity.	Large costs associated with a dedicated resource on location. Modelling shows limited shoreline contact.	**Rejected** – Large cost associated with dedicated resources on location deemed grossly disproportionate to very low likelihood of occurrence and high natural dispersion of MDO.
N/A	Dedicated standby vessel in field 24 hours during field activities	Reduces potential for collision or interference with other marine users.	Large costs associated with a dedicated standby vessel.	**Rejected** – Large cost associated with dedicated standby vessel which outweigh any benefits.

9.6.4 Environmental impact assessment

The below environmental impact assessment follows the risk assessment approach detailed in **Section 9.5.5**.

9.6.4.1 Identification of hotspots for consequence assessment

As described in **Section 9.5.5**, all HEVs within the MEVA and EMBA for LOWC are listed in **Table 9-17**. The values and sensitivities associated with these HEVs have been described in **Appendix D**. Further to this, **Table 9-17** filters the HEV to identify the Hot Spots where they meet the criteria (as described in **Section 9.5.5**).

Table 9-17: Identified high environmental value and hot spot receptors for surface release scenario – marine diesel oil

Receptor	HEV ranking	Exposure Threshold		Hot Spot
		Low (EMBA)	Moderate (MEVA)	
Imperieuse Reef Marine Park	3	✓	✓	Y
Clerke Reef Marine Park	3	✓	✗	N
Rowley Shoals surrounds	4	✓	✗	N
Montebello AMP	4	✓	✓	N
Offshore Ningaloo	4	✓	✓	N
Glomar Shoals	5	✓	✓	N
Southern Islands Coast	5	✓	x	N

No receptors had a contact probability of 5% or above for the medium or high exposure values. However, Imperieuse Reef MP was chosen as a hot spot due to the potential for shoreline accumulation above the moderate exposure value (100 g/m²).

Appendix H provides a simplified summary of the consequence assessment results for each of the Hot Spot areas. The consequence assessment was based on predicted contact and concentration of floating oil, accumulated oil, total submerged oil and dissolved oil. For each Hot Spot area, the consequence to the key values were assessed using the methodology described in **Section 9.5.5**.

Description	
Receptors	Physical environment – water quality, Shallow benthic, intertidal and shoreline habitats Threatened/migratory fauna – plankton, invertebrates, marine mammals, marine reptiles, sharks, rays and fish, birds (seabirds and shorebirds) Protected areas – KEFs and Marine Parks Socio-economic – commercial, recreational and traditional fisheries, recreation and tourism, oil and gas industry)
Consequence	III – Moderate
Potential impact pathways (physical and chemical) of hydrocarbon exposure for receptors are summarised in **Table 9-13** and potential impacts to receptors found within the EMBA are described in **Table 9-14**. *Threatened/migratory fauna* A surface release of MDO to the marine environment would result in a localised reduction in water quality in the upper surface waters of the water column. As a light hydrocarbon, MDO undergoes rapid spreading and evaporative loss in warm waters, indicating that a surface slick will be temporary. Under moderate winds (5 m/s), 40% of the initial surface slick is predicted to remain as surface oil after 24 hours,	

Description
decreasing further to around 10% after 48 hours and around 1% after 72 hours (GHD, 2021). The high rate of evaporation means that little MDO will become entrained and few aromatic hydrocarbons are predicted to become dissolved reducing impact to marine fauna. Surface oil, and entrained hydrocarbon in the sea surface layer, could have the physical effect of coating fauna interacting within and under the surface, including plankton, pelagic invertebrates and fishes, marine reptiles, marine mammals and seabirds, and may also affect some species through ingestion of oiled fish (as described in **Table 9-14**). The diesel EMBA overlaps breeding/foraging BIAs for a number of seabirds, including an important rookery for the red-tailed tropic bird in the Clerke Reef MP. An unplanned release of MDO is not expected to interfere with their breeding activity, but could cause slight secondary effects through ingestion after preening or ingestion of oiled fish (as described in **Table 9-13** and **Table 9-14**). The humpback whale (migration) and pygmy blue whale (distribution, migration and foraging) BIAs and whale shark foraging BIA overlap the EMBA. An unplanned release of MDO is not expected to interfere with their migration activity. There is the potential for behavioural disruption to the local population as individuals traverse the area affected with potential for coating of baleen (in whales) and ingestion of oiled prey (plankton/fish) as described in **Table 9-13** and **Table 9-14**. The EMBA overlaps internesting critical habitat BIAs for a number of turtles. Therefore, turtle behaviour could be disrupted with the potential to threaten turtle populations (as described in **Table 9-14**), particularly those at significant rookeries on the Montebello Islands. No turtle rookeries are known to occur in the Imperieuse Reef MP. Deteriorating water quality/chemical and terrestrial discharge is identified as a potential threat to turtles in the marine turtle recovery plan, and some bird and shark species (**Table 5-10**). Habitat modification, degradation and disruption, pollution and/or loss of habitat are also identified as threats to sharks, birds, cetaceans and turtles in conservation management and recovery plans. Given the location of the release, and volume of potential hydrocarbon release there is the potential for modification to or a decrease in the availability of quality habitat (shorelines/subsurface). Shoreline accumulation may present a major disruption to shoreline individuals (as described in **Table 9-14**). Volumes of accumulated hydrocarbon may result in a reduction in area available for seabirds and/or turtle species. The quality of habitat (shorelines/subsurface) may be reduced for a period, with recovery over the medium term (decades). *Physical environment and habitats* In the event of MDO release, hydrocarbons that reach nearshore environments have the potential to impact benthic coral reefs and mangrove areas which may result in a decrease in ecological values, given toxicity impacts associated with hydrocarbon exposure. The quality of habitat may be reduced for a significant period with recovery over the medium term (two to ten years). As described above, accumulated hydrocarbons on shorelines could impact marine fauna that utilize beaches such as shorebirds in the Imperieuse Reef MP, dependent upon the timing of a spill. Entrained hydrocarbon could also contact sandy beaches at high tide. Such impacts would be most likely to nesting females as they move up and down beaches or to turtle hatchlings as they emerge from nests six to eight weeks following nesting. The quality of habitat available to the turtles will be reduced, with recovery over the medium term. *Protected areas* The EMBA intersects several Marine Parks, AMPs, Commonwealth Heritage Areas and marine management areas (**Section 5.2**). Combined, these areas support all the habitats and faunal groups described above. Impacts to the habitat/fauna receptors described above therefore have an impact on the values of these reserves which could have flow-on effects to tourism revenue of coastal communities that provide access to these marine reserves. *Socio-economic receptors* There is the potential for hydrocarbons to temporarily disrupt fishing activities if the surface or entrained hydrocarbon moves through fishing areas. However, the high rate of evaporation means little MDO will become entrained and few aromatic hydrocarbons are predicted to become dissolved. It is possible there could be accumulation of oil in fish tissues to the extent that could result in hydrocarbon tainting of fish flesh. Connell and Miller (1981) compiled a summary of studies listing the exposure value concentrations at which tainting occurred for hydrocarbons. The results contained in their review indicate

Description	
tainting of fish occurs when fish are exposed to ambient concentrations of 4 to 300 ppm (4000 to 300,000 ppb) of hydrocarbons in the water, for durations of 24 hours or more, with response to phenols and naphthenic acids being the strongest. Given the volume of oil that could potentially be released, it is possible impacts could be detected to fisheries on a stock level although it is more likely that natural variation in fish abundance would be on a greater scale than any impacts attributable to a hydrocarbon spill. This would most likely be the case for fisheries species that utilise shallower waters around the Glomar Shoals and could occur through direct impacts to fish or to fish habitats (e.g., seagrass, coral reef, mangrove habitats). A number of oil and gas operators operate within the EMBA with existing projects and equipment in place as well as continuing drilling and exploration programs. An unplanned hydrocarbon release has the potential to disrupt these activities, with associated economic impact, albeit on a temporary basis. Tourism could also be affected by a spill, either from reduced water quality/shoreline oiling preventing recreational activities or reducing aesthetic appeal or from impacts to habitats and marine fauna as described in **Table 9-13** and **Table 9-14**.	
Likelihood	B – Unlikely
A worst-case hydrocarbon release resulting from a vessel collision could result in major disruption and long-term effects on the receiving environment. Impacts could decrease local populations and result in loss of critical habitats; however, recovery would be expected within decades. With the proposed control measures in place to prevent releases, any decline in local populations or degradation of habitats is considered unlikely and therefore the activity will be conducted in a manner that is considered acceptable. The likelihood of a hydrocarbon release occurring due to a vessel collision/bunkering is limited, given the set of mitigation and management controls in place. Subsequently the likelihood of a vessel collision releasing hydrocarbons to the environment resulting in a major consequence is considered to be Unlikely (b).	
Residual Risk	The residual risk associated with this hazard is **Low**.

9.6.5 Demonstration of as low as reasonably practicable

The use of vessels is integral to activity and therefore vessels and associated risks of unplanned hydrocarbon releases, cannot be completely eliminated.

Offshore refuelling is standard industry practice and oil pollution legislation (*Protection of the Sea (Prevention of Pollution from Ships) Act 1983* and MARPOL Annex I) has been developed to safeguard against the risk of a hydrocarbon spill occurring during refuelling. Other hydrocarbon types such as HFO, IFO have specifically not been selected for this activity (only diesel will be used in the operational area) to ensure potential environmental impacts are reduced to ALARP.

Recovery of floating assets will only occur in accordance with the floating asset recovery procedure and this control is effective in managing the risks of floating asset collision with a vessel during recovery. No additional controls were identified for this activity.

The combination of the standard prevention CMs (which reduce the likelihood of the event happening), floating asset recovery procedure and the spill response strategies (which may reduce the consequence) together reduce the overall hydrocarbon spill risk.

No additional controls have been identified and 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 is reduced to ALARP.

In terms of spill response activities, Santos will implement oil spill response as specified within the OPEP. A detailed ALARP assessment on the adequacy of arrangements available to support spill response strategies and CMs is presented in the OPEP.

The North-West Marine Parks Network Management Plan states that 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 of the marine parks identified with the EMBA (DNP, 2018a) without an authorisation issued by the Director, provided the actions are taken in accordance with an EP 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.

9.6.6 Acceptability evaluation

Is the risk ranked between Very Low to Medium?	Yes – 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 ESD?	Yes – activity evaluated in accordance with Santos' Environmental Hazard Identification and Assessment Procedure (EA-91-IG-00004_5), which considers principles of ESD. The residual risk for this aspect is Low and therefore does not affect the outcomes of the principles of ecologically sustainable development as per **Table 7-5**.
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 5.2**), relevant species recovery plans, conservation management plans and management actions (**Table 5-10**).
Are risks and impacts consistent with Santos' Environment, Health and Safety Policy?	Yes – aligns with Santos' Environmental Health and Safety Policy.
Are risks and impacts consistent with stakeholder expectations? (cessation phase and floating asset removal activities	Yes – no concerns raised.
Are risks and impacts consistent with stakeholder expectations? (seabed equipment removal and abandonment in situ activities	Yes – no concerns raised. DNP made a request in relation to a marine pollution event, that impacts, or is likely to impact an AMP and provided expectations on notification requirements (addressed in **Table 10-7**)
Are performance standards such that the impact or risk is considered to be ALARP?	Yes – see ALARP above.

Given the control measures in place to prevent a vessel collision and refuelling incidents and the low frequency of significant volume diesel spills that occur in the industry, the likelihood of a loss of containment event during the activity is low. The risks from diesel spills are well understood and the activities will be managed in accordance with relevant legislation and standards. The control measures proposed are consistent with applicable actions described in the relevant recovery plans and approved conservation advice and no stakeholder concerns have been raised regarding this aspect.

With the implementation of industry standard and activity-specific control measures to reduce the chance of a diesel spill event (and minimise impacts), the residual risk is assessed to be Low and ALARP. Control measures will reduce the risk of impact from MDO spill to a level that is acceptable.

9.7 Hydrocarbon spill – loss of well control

9.7.1 Description of event

Event	A loss of well control during decommissioning may occur due to the following reason: + stress cracking to a subsea tree or wellhead from an external impact (refer to **Section 9.5.1**). In the event of a LOWC, up to 1,350 m³ of light crude oil may be released as a slow leak (around 10.7 m³ per day) to the marine environment over 126 days with the most likely release points at the wellhead or subsea tree near the seabed. Worst-case credible spill scenarios were estimated to cover the possibility of a LOWC from any MEFF well under this EP. The worst-case credible spill scenario was predicted by selecting the most likely hydrocarbon flow parameters from the well to yield the credible maximum release volumes and rates (i.e., environmentally credible worst-case volume and rate) from the most credible (external force) unplanned scenario. Key parameters for input to this 'worst-case' blowout were taken from key Santos well design documents and Well Design Automation System, suitable analogues, latest reservoir models, or Santos' best estimates where information was unavailable. Quantitative hydrocarbon spill modelling was undertaken for the worst-case scenario. The LOWC worst-case discharge volumes that were used for the hydrocarbon spill modelling were based on Santos' Mutineer, Exeter, Fletcher, Finucane Worst Case Discharge Technical File Note. Rev 0, November 2020. Outputs from the modelling were used to inform the environmental impact assessment and to assist with emergency planning. The environmental consequences of a LOWC are highly variable, dependent on the characteristics of the hydrocarbon released, the dynamics of the receiving environment and the proximity of the release point to sensitive environmental receptors. Note that at the completion of P&A activities (expected Q4 2024), a LOWC during decommissioning activities covered in this EP is no longer possible (**Section 9.5.1**).
Extent	The EMBA for the worst-case hydrocarbon spill from a LOWC was defined in **Section 5.1**. For information about the extent of potential impact associated with a LOWC, refer to **Section 9.7.3**.
Duration	The worst-case duration of a LOWC is predicted as 126 days (refer to the OPEP). This is the estimated time required to drill a relief well, including 49-day initial period until the LOWC is detected on the sea surface. Hydrocarbons would persist within the environment for a longer period of time.

9.7.1.1 Stochastic spill modelling – summary of results for moderate exposure thresholds

Accumulated shoreline oil above 100 g/m²

There was no shoreline accumulation above the moderate threshold of 100 g/m² predicted for any receptor.

Surface oil greater than 10 g/m²

No sensitive receptors, including the open ocean, were predicted to be contacted by surface oil above the moderate threshold of 10 g/m².

Entrained oil greater than 100 ppb

The open ocean, within 20 km of the release location was the only receptor predicted to be contacted by entrained hydrocarbons above the moderate threshold of 100 ppb.

Dissolved oil greater than 50 ppb

The open ocean, within 40 km of the release location was the only receptor predicted to be contacted by dissolved hydrocarbons above the moderate threshold of 50 ppb.

Given the results of the stochastic modelling, not additional environmental receptor hotspots have been identified for the LOWC scenario.

9.7.2 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.

The magnitude of potential environmental impact from a light crude oil release depends on multiple factors including hydrocarbon type, release volume and rate, and ocean and weather conditions.

An assessment of the sensitive environmental receptors at risk from a condensate release has been determined based on a literature review and trajectory and fate modelling described above. **Section 5.2** includes a description of biological environment present in the operational and/or EMBA.

Potential receptors: Physical environment (water and sediment quality, shoals and banks, benthic habitats), threatened or migratory fauna (marine mammals, marine reptiles, sharks, fish, rays and birds), protected and significant areas (KEFs), socio-economic receptors (fisheries, tourism, recreation and other third-party operators).

A LOWC release to the marine environment would result in reductions in water quality for at least one model time step (around an hour) at a probability greater than 10% across the 150 individual realisations per scenario over the worst-case spatial extents of:

- entrained oil (>100 ppb) within 20 km of the release location
- dissolved oil (>50 ppb) within 40 km of the release location
- shoreline accumulation (>100 g/m^2): no contact
- Surface oil (>10 g/m^2): no contact.

The potential impact pathways (physical and chemical) of hydrocarbon exposure to relevant habitat and marine fauna receptors are summarised in **Table 9-13** and an impact assessment completed for receptors within the EMBA in **Table 9-14**.

9.7.3 Environmental impact assessment

<table>
<tr><th colspan="2">Description</th></tr>
<tr><td>Receptors</td><td>Physical environment (water and sediment quality, benthic habitats)
Threatened or migratory fauna (marine mammals, marine reptiles, sharks, rays, fish, and birds)
Protected and significant areas (KEFs)
Socio-economic receptors (fisheries, tourism and recreation)</td></tr>
<tr><td>Consequence</td><td>III – Moderate</td></tr>
<tr><td colspan="2"><u>Physical environment or habitat</u>
In the highly unlikely event of a LOWC, hydrocarbons are unlikely to reach shoreline habitats. Entrained and dissolved hydrocarbons above the moderate threshold will be restricted to within close vicinity to the release location within the operational area (20 km and 40 km respectively). Entrained and dissolved hydrocarbons may have the potential to affect water quality, threatened and migratory marine fauna and submerged features such as KEFs and shoals in the vicinity of the operational area.
<u>Threatened or migratory fauna</u>
In the highly unlikely event of a LOWC, the volume of light crude oil released would result in a reduction in water quality with the potential to impact marine fauna. Marine fauna present in the area may be potentially impacted by a spill through exposure to floating oil, entrained oil, or dissolved aromatic hydrocarbons. A description of impacts to marine fauna from exposure to condensate is provided in Table 9-14.
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 5-10). 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.
Protected areas
The EMBA from the LOWC scenario intersects the Ancient Coastline at 125 m Depth Contour KEF and Glomar Shoals (Section 5.2.3). Combined, these areas support all the habitats and faunal groups described above in Table 9-13 and Table 9-14.
<u>Socio-economic receptors</u>
There is the potential for entrained oil to temporarily disrupt fishing activities if the surface or entrained oil moves through fishing areas. Surface oil above 10 g/m² is not expected to impact any commercial fishery. Entrained and dissolved hydrocarbons above 100 ppb and 50 ppb respectively may impact on the WA Mackerel Managed Fishery, which has shown to be active in the southern extremities of the operational area within the last 10 years. In the highly unlikely event of a crude spill, fishing grounds may be temporarily closed, which would have an impact on fishermen through loss of income. Market value/ demand for fish may also be impacted due to actual or perceived tainting of catches. The significance of any decrease in market value/demand for fish may be substantial to those few individual fisheries operating in the affected areas, but it is unlikely to cause any significant long-term impact.
Impacts to tourism and recreational fishing are expected to be limited, given the lack of shoreline accumulation and relatively restricted extent of entrained and dissolved hydrocarbons. In the event of a crude oil spill, there is the potential for temporary closure of all marine-based recreational activities (including snorkeling and diving) to the risk to public health and safety.
A number of oil and gas operators operate within the EMBA with existing projects and equipment in place, as well as continuing drilling and exploration programs. A LOWC in the operational area has the potential to disrupt these activities, with associated economic impact, albeit on a temporary basis.
On the basis of the above assessment, a LOWC has the potential to impact an array of receptors. Given the extent and the presence of protected areas (including World Heritage) within the EMBA, the worst-case consequence is considered to be Moderate (III).</td></tr>
</table>

Likelihood	A – Remote
In accordance with the Santos Risk Matrix, a worst-case surface release of crude as a result of LOWC has been defined as an 'Remote' event as it 'requires exceptional circumstances and is unlikely even in the long-term'. The likelihood of a LOWC event occurring is based on industry statistics, Santos' statistics and the standard preventive control measures in place. Wells are designed with essential engineering and safety control measures to prevent a loss of containment occurring. A full-bore blowout scenario is not possible during the decommissioning phase as Santos has no plans to actively re-enter any of the MEFF wells. The worst-case credible scenario of an external force from another operator's MODU breaking mooring and dragging anchors over subsea wells and causing a LOWC through stress cracking of a subsea tree or wellhead has not happened in the Australian industry. For Offshore Operations of North Sea Standard, the frequency of well blowout for a production well (includes shut in production wells) from external causes was found to be 2.7×10^{-5} per well year. There were no records of well releases caused by external factors in the database. Frequency is based on 8 blowouts in UK, Norway and US Gulf of Mexico between 1980 and 2014 (IOGP 2019). Management controls in place to control the flow of hydrocarbons include construction design and regular inspection and maintenance. 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 a NOPSEMA-accepted WOMP, safety case, and a spill response plan (OPEP) (refer **Section 9.7.4**). These control measures are considered to reduce the risk of a loss of containment (and minimise impacts) occurring to a level that is acceptable. In accordance with the Santos Risk Matrix, given the control measures in place, the likelihood of worst-case seabed release of crude as a result of LOWC resulting in a Moderate (IV) consequence is considered to be Remote.	
Residual Risk	The residual risk associated with this event is **Very Low**.

9.7.4 Environmental performance outcomes and control measures

The EPOs relating to this hazard include:

- No loss of containment of hydrocarbon to the marine environment [MEFF-EPO-07].

The extensive planning, risk assessment of the activity and the engineering and operational control measures in place are considered to result in a very low risk of a hydrocarbon release due to LOWC occurring. The control measures considered for this activity are shown in **Table 9-18**. The EPSs and measurement criteria for the EPOs are described in **Section 10.4**.

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 9-18: Control measure evaluation for a loss of well control hydrocarbon spill

CM reference	Control measure	Environmental benefit	Potential cost / issues	Evaluation
Standard Controls				
MEFF-CM-34	NOPSEMA accepted WOMP for MEFF wells	Includes control measures for well integrity and well control in an accepted WOMP, that reduce the risk of unplanned discharges to the marine	Costs associated with personnel time in writing, reviewing and implementing the WOMP and Safety Case.	**Adopted** – Regulatory requirement must be adopted.

CM reference	Control measure	Environmental benefit	Potential cost / issues	Evaluation
		environment. The WOMP also includes: + barriers in place to isolate hydrocarbons from the marine environment + inspection, monitoring and testing of barriers over the life of the well + response to increases in well integrity risk + notification and reporting requirements. Effective barriers manage isolation of the reservoir from the environment, acting to eliminate hydrocarbon releases.		
MEFF-CM-46	Navigational charts	Wells gazetted and marked on navigational charts to minimise the risk of collision from third parties.	Negligible costs, standard industry practice.	**Adopted** – Benefits considered to outweigh negligible costs to Santos.
MEFF-CM-02	Santos stakeholder consultation strategy	Relevant stakeholders consulted/ advised of activities prior to commencement of individual inspection/ maintenance campaigns. Minimises the risk of collision from third parties.	Personnel cost and administrative costs associated with preparing material and liaising with stakeholders.	**Adopted** – Benefits considered to outweigh costs.
MEFF-CM-43	Accepted OPEP	Implements response plans to deal with an	Administrative costs of preparing documents and	**Adopted** – Regulatory requirement must

CM reference	Control measure	Environmental benefit	Potential cost / issues	Evaluation
		unplanned hydrocarbon release quickly and efficiently to reduce impacts to the marine environment.	large costs of preparing for and implementing response strategies.	be adopted.
MEFF-CM-42	Third-party agreements and contracts	Memorandums of Understanding (MoUs) for relief well drilling and contracts for source control personnel assist in controlling the flow of hydrocarbons as quickly as possible to reduce environmental impacts.	Cost of contracts and MoUs.	**Adopted** – Benefits considered to outweigh costs.
Additional Controls				
MEFF-CM-48	Implement MEFF Subsea Integrity Management Plan (ME-7000-REP-0071)	May reduce spill detection time from seven weeks (49 days) to two weeks (14 days). May result in some minor reduction of already very low shoreline accumulation (maximum ashore one tonne) and exposure to submerged hydrocarbons.	Minimal cost, plan already exists.	**Adopted** – Minimal cost, may provide small environmental benefit.
MEFF-CM-52	Designated safe deployment/recovery zones for seabed asset removal activities that commence prior to completion of the P&A campaign at drill centres where wellheads are still present	Eliminates the potential for a dropped object during seabed asset removal activities to impact a wellhead, if seabed asset removal activities commence prior to completion of the P&A campaign.	Minimal cost associated with designating and planning safe deployment/recovery zones.	**Adopted** – environmental benefit outweighs the minimal cost.
N/A	Additional (fortnightly) ROV monitoring of subsea trees, in	May reduce spill detection time from seven weeks	Vessel day rate of around $50,000 to $70,000 over the	**Rejected** – The significant cost of additional

CM reference	Control measure	Environmental benefit	Potential cost / issues	Evaluation
	addition to risk-based inspection program.	(49 days) to two weeks (14 days). May result in some minor reduction of already very low shoreline accumulation (maximum ashore one tonne) and exposure to submerged hydrocarbons.	remaining period of the EP (around 12 months) = around $1,000,000.	surveillance of the subsea trees with ROV is deemed grossly disproportionate to the low risk of an external impact to a subsea tree or wellhead. Additionally, there is little to no environmental benefit, given the predicted very low shoreline accumulation and exposure to submerged hydrocarbons.
N/A	Additional (fortnightly) surveillance over the field using aircraft or satellite imagery	May reduce spill detection time from seven weeks (49 days) to two weeks (14 days). May result in some minor reduction of already very low shoreline accumulation (maximum ashore one tonne) and exposure to submerged hydrocarbons.	Aircraft – $1 million over the remaining period of the EP (around 12 months) (assumed $26,000 per hour and 1.5 hr flight time). Satellite imagery – $260,000 (assumes average of $10,000 for one image each fortnight).	**Rejected** – The cost of additional surveillance using aircraft and/or satellite imagery is deemed grossly disproportionate to the low risk of an external impact to a subsea tree or wellhead. Furthermore, a surface sheen may be difficult to detect from either aircraft or satellite surveillance, given that surface slicks >10 g/m² are not expected. Hence there may be no befit realised.
N/A	Protection and burying of seabed equipment	Reduces the risk of external impact to subsea tree or wellhead and hence the risk of impact to sensitive receptors from a loss of hydrocarbons.	Large cost and seabed disturbance associated with protection and burying. Burying of equipment will impact inspection and maintenance campaigns and future decommissioning	**Rejected** – Large cost associated with protection and burying is grossly disproportionate compared to the risk. May also cause issues for future inspection, maintenance and

CM reference	Control measure	Environmental benefit	Potential cost / issues	Evaluation
			activities.	decommissioning campaigns.
N/A	Rock dump of seabed equipment	Reduces the risk of external impact to subsea tree or wellhead and hence the risk of impact to sensitive receptors from a loss of hydrocarbons.	Large cost and seabed disturbance associated with rock dumping. Burying of equipment will impact inspection and maintenance campaigns and future decommissioning activities.	**Rejected** – Large cost associated with rock dumping is grossly disproportionate compared to the risk. May also cause issues for future inspection, maintenance and decommissioning campaigns.
N/A	Dedicated standby or guard vessel in field 24 hours	Reduces potential for third party external damage to subsea tree or wellhead.	Large costs associated with a dedicated standby/guard vessel. May not be successful in preventing adrift MODU from impacting subsea tree/wellhead.	**Rejected** – Large cost associated with dedicated standby/guard vessel which outweigh any benefits.
N/A	Source control plan 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 organisational costs 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.

9.7.5 Demonstration of as low as reasonably practicable

The combination of the standard and additional prevention control measures (**Section 9.7.4**) (which reduce the likelihood of the event happening), and the spill response strategies (which may reduce the consequence) together reduce the hydrocarbon spill risk.

Based on the stochastic spill modelling, Santos has determined applicable source control response measures to limit the spill volume from a LOWC event to ALARP. Further detail is provided below.

Source control and detection controls

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 126 days (18 weeks) to execute. A breakdown of the key tasks and their timeframe to drill a relief well in 18 weeks have been included in Section 9 of the OPEP.

Supporting controls to allow the relief well schedule to be met include:

- rig capability register is maintained
- status of relief well tangible equipment
- APPEA MoU provides for access to other operators' rigs
- contracts and MoUs for third-party-independent well control specialist personnel are in place.

The implementation timeframe of this control is key to its effectiveness. Additional controls were considered to reduce the timeframe for detection; however, all were rejected based on no environmental benefit realised for significant additional cost. A full-bore well blowout is not considered a credible scenario for the cessation of operations phase, and no shoreline accumulation above threshold levels is predicted.

Spill mitigation controls

Santos considers that through the selection of appropriate spill response strategies, development of spill response controls and maintenance of preparedness arrangements and resources to implement these controls, spill risk is mitigated to ALARP. Preparedness spill response controls are outlined in **Table 9-18** while those that would be implemented in the event of a spill are outlined within the OPEP.

9.7.6 Acceptability evaluation

Is the risk ranked between Very Low and Medium?	Yes – maximum credible hydrocarbon spill volume (light crude oil from a LOWC) residual risk is ranked as Very Low.
Is further information required in the consequence assessment?	Yes – hydrocarbon spill modelling results were used to determine consequence and risk.
Are risks and impacts consistent with the principles of ESD?	Yes – activity evaluated in accordance with Santos' Environmental Hazard Identification and Assessment Procedure (EA-91-IG-00004_5), which considers principles of ESD. The residual risk for this aspect is Very Low and therefore does not affect the outcomes of the principles of ecologically sustainable development as per **Table 7-5**.
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 (**Section 5**) relevant species recovery plans, conservation management plans and management actions. Management is also consistent with the zoning of the Australian marine parks, and their management plans in that risks have been reduced to ALARP, e.g., implementation of spill response activities will limit impacts, thereby conserving the marine park values which includes RAMSAR wetlands and other habitats critical to the diversity and value of the protected areas.
Are risks and impacts consistent with Santos' Environment, Health and Safety Policy?	Yes – aligns with Santos' Environment, Health and Safety Policy.
Are risks and impacts consistent with stakeholder expectations? (cessation phase and floating asset removal activities	Yes – no concerns raised.
Are risks and impacts consistent with stakeholder expectations? (seabed equipment removal and abandonment in situ activities	Yes – no concerns raised. DNP made a request in relation to a marine pollution event, that impacts, or is likely to impact an AMP and provided expectations on notification requirements (addressed in **Table 10-7**)
Are performance standards such that the impact or risk is considered to be ALARP?	Yes – see ALARP above.

The likelihood of a LOWC event during the activity is unlikely when considering industry statistics, Santos' statistics and the preventative controls in place. Wells are designed with essential engineering and safety control measures to prevent a LOWC incident occurring. 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 WOMP, MEFF Integrity Management Plan and a spill response plan (OPEP). In accordance with Santos' risk assessment process, the residual risk is considered to be ALARP. The proposed control measures will reduce the risk of impacts from a LOWC to a level that is considered acceptable.

9.8 Minor hydrocarbon release (surface and subsea)

9.8.1 Description of event

Event	Causes for accident hydrocarbon releases (other than diesel release from a vessel collision or bunkering, and LOWC) include: + hydraulic fluids, lubricant oils and (stored) waste oils + ROV failure (including oil seal, hydraulic system hose and quick disconnect system failures) or loss of contents of ROV mounted bladder (MEG, methanol or hydraulic fluid) + loss of primary containment (drums, tanks, intermediate bulk containers [IBCs], etc) due to handling, storage and dropped objects (e.g., swinging load during lifting activities) + vessel pipework failure or rupture, hydraulic hose failure, inadequate bunding + lifting – dropped objects damaging diesel equipment (hoses, pipes, tanks, etc) + rupture or leak from a flowline, service line or umbilical during floating asset removal + subsea cutting and deburial equipment failure (hydraulic system seals, hoses etc.) The vessels main engines and equipment such as pumps, cranes, winches, power packs and generators require MDO for fuel and a variety of hydraulic fluids and lubricating oils for efficient operation and maintenance of moving parts. These products are present within the equipment and also held in storage containers and tanks on the vessels. Small hydrocarbon leaks could occur from loss of primary containment due to handling, storage and dropped objects (during lifting activities). Volumes are likely to be small and limited to the volume of individual containers (e.g., IBC, 44-gallon drums) stored on the deck of vessels. The credible spill for this scenario is considered to be the loss of an IBC (1 m^3) during transfer from a support vessel to a primary vessel. Equipment deployed overboard during activities (e.g., ROV operations, subsea cutting and deburial) can result in unplanned discharges (of hydraulic fluids) directly to the marine environment due to equipment failure, equipment interactions with the vessel thrusters and/or accidental contact with subsea equipment. The largest credible hydrocarbon spill from ROV operations would be an accidental release of around 365 L of hydraulic fluid from the deployed ROV-mounted bladder. Minor accidental loss of other hydrocarbon-based liquids (e.g., used lubricating oils, cooking oil, and hydraulic oil) to the marine environment could also occur via tank pipework failure or rupture, hydraulic hose failure, inadequate bunding and/or storage, insufficient fastening or inadequate handling which could result in impacts to water quality and hence sensitive environmental receptors. Potential discharge fluids from a rupture or leak from a flowline, service line, or umbilical include treated seawater (including corrosion inhibitor) and residual reservoir hydrocarbons (in the flowlines). Records confirm that flushing activities undertaken prior to the departure of the FPSO achieved an OIW concentration of 30 to 40 ppm (**Section 4.6.2**). At a residual concentration of 40 ppm, the expected maximum volume of hydrocarbon in the subsea production system is estimated to be 84 L (**Table 4-1**). The subsea equipment is not over-pressured. Therefore, any fluids leaked would contain no more than 300 ppm oil in water. Hence, the volume of residual hydrocarbons released to the marine environment would be low.
Extent	The relative low volumes are expected to rapidly disperse into the marine environment. Below toxic/harmful threshold concentrations are expected to occur at short distances from the hydrocarbon release point. In the event of a worst-case spill, potential impacts beyond the operational area are not expected.
Duration	Potentially toxic/harmful threshold concentrations limited to a very short period immediately following release.

9.8.2 Nature and scale of environmental impacts

Potential receptors: Physical environment (water and sediment quality, benthic habitats), threatened, migratory or local fauna (marine mammals, marine reptiles, sharks and rays, fish and birds), and socio-economic receptors (commercial fishing).

Physical environment

Hydraulic fluids and lubricating fluids behave similarly to MDO when spilt in the marine environment (for information about MDO behaviour in the marine environment refer to **Section 9.5.3**). 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, although lubricating oils are more viscous and so the spreading rate of a spill of these oils would be slightly slower.

Physical environment

Minor volumes of hydrocarbons released to the marine environment may lead to contamination of the water column in the vicinity of the vessels. The potential impacts would most likely be highly localised and restricted to the immediate area surrounding the spill, with rapid dispersal to concentrations below impact thresholds likely to occur in the open ocean.

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. There is no emergent or intertidal habitat that could be impacted by a surface spill and spilled hydrocarbons at minor volumes are unlikely to reach shorelines.

Threatened migratory or local fauna

The minor and short-term changes to water quality that may result are not predicted to impact on marine fauna (e.g., pelagic fish and sharks, marine mammals, marine reptiles and seabirds). As summarised in **Table 5-9**, the BIA for pygmy blue whales (distribution) and whale shark (foraging) overlap the operational area; therefore, these receptors may be present. A number of Recovery Plans and Conservation Advice for threatened and migratory species that may occur within the operational area (**Table 5-10**) identify marine pollution and deteriorating water quality (chemical discharge) as a threat to the species.

Small hydrocarbon spills are unlikely to have an ecological effect on threatened or migratory fauna, given the small volumes that could be released, and the open ocean environment. Physical coating of marine fauna or lethal/sub-lethal toxicity effects from any accidentally released hydrocarbons, is considered unlikely, given the expected low concentrations and short exposure times.

Socio-economic receptors

Given the historically limited commercial fishing effort in the operational area and the fact that the only recently active (in the last ten years) fishery is the Mackerel Managed Fishery which targets pelagic species, impacts to commercial fishing are not expected. The small volumes of hydrocarbons are expected to disperse rapidly and no impacts to commercial fisheries species are expected.

9.8.3 Environmental performance outcomes and control measures

The EPOs relating to this event include:

- No loss of containment of hydrocarbon to the marine environment [MEFF-EPO-07].

The control measures considered for this event are shown in **Table 9-19**, and EPSs and measurement criteria for the EPOs are described in **Section 10.4**.

Table 9-19: Control measure evaluation for minor release of hydrocarbons

CM reference	Control measure	Environmental benefit	Potential cost / issues	Evaluation
Standard Controls				

CM reference	Control measure	Environmental benefit	Potential cost / issues	Evaluation
MEFF-CM-41	Hazardous chemical management procedures	Reduces the risk of spills and leaks (discharges) to sea by controlling the storage, handling and clean-up.	Personnel cost associated with implementation of procedures and permanent or temporary storage areas.	**Adopted** – Benefits of ensuring procedures are followed and measures implemented outweigh costs.
MEFF-CM-29	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.
MEFF-CM-30	Chemical selection procedure	Reduced toxicity to marine environment through ensuring only environmentally acceptable chemicals discharged to sea.	Potential additional cost and delays of chemical substitution.	**Adopted –** Benefits of ensuring procedures are followed outweighs costs.
MEFF-CM-49	Maritime Dangerous Goods Code	Dangerous goods managed in accordance with International Maritime Dangerous Goods Code to reduce the risk of an environmental incident, such as an accidental release to sea or unintended chemical reaction.	Cost associated with implementation of code/procedure.	**Adopted –** Benefits of ensuring procedures are followed and measures implemented outweigh costs.
MEFF-CM-50	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.
MEFF-CM-43	Accepted OPEP	Implements response plan to deal with an unplanned hydrocarbon spills	Personnel and administrative costs associated with preparing documents, ongoing management	**Adopted** – Regulatory requirement must be adopted.

CM reference	Control measure	Environmental benefit	Potential cost / issues	Evaluation
		quickly and efficiently in order to reduce impacts to the marine environment.	(spill response exercises) and implementation of OPEP.	
MEFF-CM-42	Vessel spill response plans (SOPEP/ SMPEP)	Effective management of an accidental spill (discharge to sea) to reduce impact to the environment.	Personnel cost associated with ongoing management (spill response exercises) and implementation of plans.	**Adopted** – Benefits of ensuring response plans in place, are followed and measures implemented and that the vessels are compliant outweighs costs.
MEFF-CM-51	Deck drainage control measures	Reduces the risk of spills and leaks (discharges) to sea through use of scupper plugs or equivalent deck drainage control measures available where chemicals and hydrocarbons are stored and frequently handled.	Additional personnel costs of ensuring procedures in place and followed.	**Adopted** – Benefits of ensuring procedures are followed outweigh costs.

9.8.4 Environmental impact assessment

Description	
Receptors	Physical environment (water and sediment quality, benthic habitats) Threatened, migratory or local fauna (marine mammals, marine reptiles, sharks, fish, rays and birds) Socio-economic receptors (commercial fishing)
Consequence	I – Negligible
In the event of a minor hydrocarbon spill, the quantities would be limited to around 1 m³ for the loss of the contents of an IBC, or 50 L for ROV, subsea cutting tool or deburial tool hydraulic fluid. The small volumes, dilution and dispersion from natural weathering processes such as ocean currents are such that spills will be limited in area and duration. The number of receptors present at the activity location are expected to be limited to a small number of transient individuals. The susceptibility of marine fauna to hydrocarbons depends on hydrocarbon type and exposure duration; however, given exposures would be limited in extent and duration, exposure to marine fauna from this hazard is considered to be low. The small volumes of worst-case discharges are such that the impacts to receptors will decline rapidly with time and distance at the sea surface. Rapid dilution at depth would also result in the impacts to receptors declining rapidly with time and distance. Deteriorating water quality and marine pollution are identified as potential threats to a number of marine fauna species in relevant recovery plans and conservation advice (**Table 5-10**) and to MNES (DoE, 2013). With control measures in place, the activity will be conducted in a manner that reduces potential impacts to ALARP and an acceptable level. Toxic impacts are not expected to the benthic community due to the water depths. Near the sea surface, fish are able to detect and avoid contact with surface slicks and as a result, fish mortalities rarely occur in open waters from surface spills (Kennish, 1997; Scholz *et al*., 1992). Pelagic fish species are therefore generally not highly susceptible to impacts from hydrocarbon spills. In offshore waters near to the release point, pelagic fish are at risk of exposure to the more toxic aromatic components of the hydrocarbons. Pelagic fish in offshore waters are highly mobile and comprise species such as tunas, sharks and mackerel. Due to their mobility, it is unlikely pelagic fish would be exposed to toxic components for long periods in this spill scenario. The more toxic components would also rapidly evaporate and concentrations would significantly diminish with distance from the spill site, limiting the potential area of impact. The potential minor hydrocarbon releases are not expected to significantly impact the receiving environment with control measures proposed to prevent releases; therefore, the activity will be conducted in a manner that is considered acceptable. Given a small hydrocarbon spill would not result in a decreased population size at a local or regional scale or long-term reduction to water and sediment quality, it is expected a spill of this nature would result in a Negligible (I) consequence.	
Likelihood	D – Occasional
A small hydrocarbon liquid release has reduced likelihood due to a number of controls being in place, which include: + the control measures in place to prevent spills + the procedures in place to clean up a spill. Consequently, the likelihood of releasing minor volumes of hydrocarbons to the environment, is considered Occasional (D).	
Residual Risk	The residual risk associated with this event is **Low**.

9.8.5 Demonstration of as low as reasonably practicable

Storage and use of hydraulic and lubricating oils/fluids for equipment and machinery, including for ROV, subsea cutting and deburial operations, are required to undertake the activity, so their removal from the activity is not viable. A thorough set of control measures have been proposed to ensure the risks of minor hydrocarbons spills and leaks occurring and subsequent impacts are minimised. The resulting impacts to marine fauna that could potentially result from a spill of this size would be negligible, with potential impacts restricted to a small number of individuals within a localised area. The assessed residual risk for this impact is low and cannot be reduced further. Therefore, it is considered the impact of the activities conducted is ALARP.

9.8.6 Acceptability evaluation

Is the risk ranked between Very Low and Medium?	Yes – maximum minor hydrocarbon spill 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 ESD?	Yes – activity evaluated in accordance with Santos' Environmental Hazard Identification and Assessment Procedure (EA-91-IG-00004_5) which considers principles of ecologically sustainable development. The residual risk for this aspect is Low and therefore does not affect the outcomes of the principles of ecologically sustainable development as per **Table 7-5**.
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 SOLAS 1974 and *Navigation Act 2012*, Marine Order 91 (Marine pollution prevention – oil) and with relevant recovery plans and conservation advices for species that may occur in the operational area (**Table 5-10**).
Are risks and impacts consistent with Santos' Environment, Health and Safety Policy?	Yes – aligns with Santos' Environment, Health and Safety Policy.
Are risks and impacts consistent with stakeholder expectations? (cessation phase and floating asset removal activities	Yes – no concerns raised.
Are risks and impacts consistent with stakeholder expectations? (seabed equipment removal and abandonment in situ activities	Yes – no concerns raised. DNP made a request in relation to a marine pollution event, that impacts, or is likely to impact an AMP and provided expectations on notification requirements (addressed in **Table 10-7**)
Are performance standards such that the impact or risk is considered to be ALARP?	Yes – see ALARP above.

With the control measures in place to prevent the accidental release of minor volumes of hydrocarbons, and potential social and environmental impacts and risk well understood and considered low, the environmental risk associated with a minor hydrocarbon release is considered acceptable.

9.9 Interaction with other marine users (equipment left in situ)

9.9.1 Description of event

Event	Interaction with other marine users may occur as a result of: + the continued presence of seabed assets (two x gravity bases, and associated anchor chains) abandoned in situ above the seabed. The physical presence of the seabed equipment abandoned in situ on or above the seabed may interfere with third party activities including: + current and future commercial fishing activities (accidental damage to fishing equipment such as trawl and trap fishing gear) + future petroleum activities + future commercial shipping activities
Extent	Operational area.
Duration	The potential effects may occur until equipment degrades (many decades)

9.9.2 Nature and scale of environmental impacts

Potential receptors: Socio-economic (commercial fishers, shipping traffic and other oil and gas activities).

Commercial fisheries

There is potential for the abandoned in situ seabed equipment to pose a snag risk to commercial fisheries.

As described **in Section 8.1.2**, none of the Commonwealth fisheries identified in **Section 5.2.5** are likely to be significantly active in the operational area; the Western Tuna and Billfish Fishery is the only fishery with limited activity in the area with only five active vessels since 2005.

There are two State commercial fisheries that overlap the operational area and may be active within the area. The Pilbara Fish Interim Trawl Managed Fishery has a Closed Area (Area 6) that overlaps the operational area. No trap fishing has been recorded in the operational area. The Mackerel Managed Fishery also overlaps the operational area. Low level fishing effort from the Mackerel Managed Fishery was recorded in the southern-most part of the operational area more than ten years ago. The Mackerel Managed Fishery is a line fishery, focusing on pelagic fish species in the upper water column and is not expected to interact with seabed assets abandoned in situ.

All six DTM anchors were confirmed fully buried by the 2021 in field environmental survey (GHD, 2021) and are expected to be buried at depth of between 6 to 13 m and are therefore expected to remain buried. Approximately 130 m of each mooring chain was observed as unburied (**Section 4.8.2**). The buried anchors and exposed lengths of anchor chains are not considered to pose a snag risk to any commercial fishing activities. The gravity bases protrude approximately 5.3 m above the seabed (including concrete ballast) (**Table 3-3**).The gravity bases and associated concrete ballast may pose a potential snag hazard for commercial fishers operating in the Pilbara Fish Interim Trawl Managed Fishery should the closed area (Area 6) become open to trawl fishing at a future time. The Closed Area (Area 6), which overlaps the Operational Area, has been closed since current management arrangements for the fishery came into effect in 1998 (Gaughan and Santoro, 2021).

Santos has consulted with fishing industry bodies, WAFIC and individual fishing licence holders within the Pilbara Fish Interim Trawl Managed Fishery on the ongoing physical presence of decommissioned seabed equipment (**Table 6-4**). The ongoing physical presence of the gravity bases, anchors and anchor chains abandoned in situ will not preclude commercial trawling activities from occurring in Area 6, should that area open to trawl fishing in the future.

Commercial fishing vessels operating in the Pilbara Fish Interim Trawl Managed Fishery are likely to be equipped with one or more echosounders and GPS plotters. Echo sounders detect strong target strength seabed obstacles such as the gravity bases. Given the water depth of the operational area, the trawl gear in approximately 130 m to 160 m of water may reside some 250 to 300 m astern of the vessel, so there would be sufficient time and room to manoeuvre to avoid the obstacle. GPS plotters accurately show the vessels position relative to marked seabed infrastructure and allow trawlers to plan their routes to safety avoid the obstacle.

Further, a review of the historical fishing vessel incident data from AMSA Monthly Domestic Vessel Incident Reporting Database (2 year data set) and Australian Transport Safety Bureau (ATSB) Marine Safety Investigations Reports (1982-2020) shows that there are no reported fishing vessel incidents confirmed as related to offshore oil and gas infrastructure in Australia.

In the unlikely event of snagging, potential consequences are financial loss to commercial fishers either through lost fishing time or damages to, and losses of, fishing gear (Rouse et. al., 2020). Studies of historical snag incidents in the UK have found that vessel damage or loss occurred less than 0.5% of the time, with one capsize resulting in fatalities/injuries occurring in the UK between 1989 and 2016 (Rouse et. al., 2020), equating to 0.06% of incidents.

Future interactions with the fisheries and seabed equipment left in situ are not expected given the locations of remaining equipment above the mudline being provided to the AHO for marking on charts. Additionally, the seabed in the operational area is relatively flat, smooth and featureless. The only bathymetric features identified were those associated with the MEFF seabed equipment (**Section 5.2.2.1**). Therefore, the operational area is unlikely to support habitat for aggregations of target species for the fishery (e.g. goldband snapper, rankin cod, bluespot emperor and threadfin bream).Therefore, impacts to commercial fishing from unplanned events such as snagging the seabed equipment permanently abandoned in situ are expected to be negligible.

Commercial shipping

The far-north corner of the eastern-most boundary of the operational area marginally overlaps the Dampier Shipping Fairway (**Figure 5-21**) (overlap of 0.764 km^2). Impacts on shipping movements are therefore expected to be minimal. The ongoing physical presence of seabed assets abandoned in situ is not expected to interfere with commercial shipping, given water depths are in excess of 130m and in situ items would only protrude approximately 3 m above the seabed in water depths in excess of 100m.

Petroleum industry

The presence of the equipment on the seabed may interfere with future petroleum activities (e.g. interfere with drill rig placement). However, due to the small footprint of the equipment (each of the 2 gravity bases are approximately 19m x 6m x 5.3 m high including concrete ballast) and known presence of the equipment, any such interference would be insignificant.

Given the distance offshore, the depths at the site and the absence of reefs, it is unlikely any recreational fishing occurs in the area. There are no tourism related activities expected to occur in the area, given the distance from nearest shore.

9.9.3 Environmental performance outcomes and control measures

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

+ 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 [MEFF-EPO-01].

The control measures (CM) considered for this activity are shown in **Table 9-20**, with environmental performance standards (EPSs) and measurement criteria for the EPOs described in **Section 10.4**.

Table 9-20: Control measures evaluation for interaction with other marine users

CM reference	Control measure	Environmental benefit	Potential cost / issues	Evaluation
Standard Control Measures				
MEFF-CM-14	Notify AHO of locations for equipment abandoned in situ for marking on navigational charts	Ensures other marine users are aware of the presence of equipment abandoned in situ.	Negligible, given is standard industry practice.	**Adopted -** Benefits considered to outweigh negligible costs.
Additional Control Measures				
MEFF-CM-36	Sea dumping permit	Ensure compliance with legislation that assesses environmental risks and impacts associated with permanent abandonment of equipment at sea.	Minimal additional costs, this is a regulatory requirement.	**Adopted** – Legal requirement.
N/A	Protection and burying of seabed equipment (gravity bases and concrete ballast, mooring chains)	Reduces the risk of trawl fishing gear becoming snagged on seabed assets abandoned in situ.	Costs associated with burial and seabed disturbance associated with protection and burying. Burying of equipment will result in additional environmental impacts such as direct seabed disturbance and indirect from turbidity plumes.	**Reject –** Costs associated with protection and burying is grossly disproportionate compared to the risk especially given the Operational Area is located in an area of the trawl fishery that is closed at present.

9.9.4 Environmental impact assessment

Description	
Receptors	Socio-economic receptors (commercial fishing, commercial shipping, petroleum industry)
Consequence	I – Negligible
Threatened, migratory or local fauna	Not applicable – related to socio-economic receptors only.
Physical environment or habitat	
Threatened ecological communities	
Protected areas	
Socio-economic receptors	The continued presence of seabed equipment in situ is not expected to significantly impact other marine users or fishery resources and is unlikely to result in changes in distribution and abundance of fish species outside the operational area. Bottom trawl fishing gear is at greatest risk of interacting with seabed assets abandoned in situ in the MEFF field if the Closed Area (Area 6) of the Pilbara Fish Interim Trawl Managed Fishery becomes open to trawl fishing in the future. Future interactions with the fishery and seabed assets left in situ are not expected given the locations of remaining equipment above the mudline being provided to the AHO for marking on charts and the use of fishery GPS plotters. Additionally, the seabed in the operational area is relatively flat, smooth and featureless. The only bathymetric features identified were those associated with the MEFF seabed equipment. Therefore, the operational area is unlikely to support habitat for aggregations of target species for the fishery. The ongoing physical presence of seabed assets abandoned in situ will not preclude commercial trawling activities from occurring in Area 6, should that area open to trawl fishing in the future. During the preparation of Revision 4A, Santos consulted with WAFIC and invited feedback from individual fishing licence holders within the Pilbara Fish Interim Trawl Managed Fishery regards the ongoing physical presence of decommissioned seabed equipment (**Table 6-4).** No response was received from licence holders and WAFICs queries related to contamination aspects which are addressed in Section 8.7.6 and Section 8.8.6. Impacts to commercial shipping expected to be negligible. The ongoing physical presence of seabed assets abandoned in situ is not expected to interfere with commercial shipping, given water depths are in excess of 130m and in situ items would only protrude approximately 3 m above the seabed. Impacts to future petroleum industry are expected to be negligible, due to the small footprint of the equipment (each of the 2 gravity bases are approximately 19m x 6m x 5.3 m high including concrete ballast) and known presence of the equipment, any such interference would be insignificant.
Likelihood	B – Unlikely
Given the operational area is not extensively fished and is in a Closed Area of the Pilbara Fish Interim Trawl Managed Fishery, and the low profile (approx. 5.3 m) of the gravity bases and water depth (130 m to 160 m); unplanned impacts to commercial fisheries are considered unlikely. The likelihood of any impact to commercial shipping or petroleum activities from the low-profile gravity bases and anchor chains is unlikely.	

Description	
With controls in place ensuring the presence of the equipment is known and marked on nautical charts, the likelihood of unplanned interaction with other marine users resulting in a negligible consequence is considered to be b-Unlikely	
Residual Risk	The residual risk associated with this event is **Very Low**

9.9.5 Demonstration of as low as reasonably practicable

The abandonment of equipment in situ will not preclude trawl fishers from operating in the Closed Area (Area 6) of the Pilbara Fish Interim Trawl Managed Fishery should that area become open to trawl fishing in the future. No objections or concerns were raised by relevant stakeholders regarding the activity in terms of this aspect.

Stakeholders have been informed of the proposed decommissioning activity and asked for feedback. Santos will notify the Australian Hydrographic Service AHS with the locations of seabed assets abandoned in situ upon completion of the field decommissioning to minimise the risk of interference with other marine users.

An additional control of engaging with DCCEEW regarding the application of the Environment Protection (Sea Dumping) Act 1981 for the permanent abandonment of equipment left in situ and complying with requirements under the Act has been adopted Additional controls of protection and burying of seabed equipment (gravity bases and concrete ballast, mooring chains) and complete removal of gravity bases were considered but rejected.

Given the seabed equipment proposed for abandonment in situ is in a Closed Area of the Pilbara Fish Interim Trawl Managed Fishery that has not been open to trawling since the current management arrangements for the fishery came into, will be marked on navigational charts and the trawl vessels are likely to be equipped with navigational equipment such as echo sounders and GPS plotters the risk of interacting with commercial fishers is very low.

With the controls adopted, the assessed residual consequence for this impact is negligible. Three additional control measures were considered with two rejected, since the associated cost / effort was grossly disproportionate to any benefit as detailed above. Therefore, impact is ALARP.

9.9.6 Acceptability evaluation

Is the consequence ranked as I (Negligible) or II (Minor)?	Yes – maximum consequence from interaction with or impact on other marine users 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 ESD?	Yes – activity evaluated in accordance with Santos' Environmental Hazard Identification and Assessment Procedure (EA-91-IG-00004_5), which considers principles of ESD. The residual impact for this aspect is Very Low and therefore does not affect the outcomes of the principles of ecologically sustainable development as per **Table 7-5**. However, Santos acknowledges that the seabed equipment abandoned in situ will be present for approximately 90 to 250 years before it fully degrades. Therefore, Santos has completed the following assessment against the principle of inter-generational equity—that the present generation should ensure that the health, diversity and productivity of the

	environment is maintained or enhanced for the benefit of future generations: + The risk assessment demonstrates that the degradation of abandoned seabed equipment will not adversely impact the health, diversity and productivity of the environment for the benefit of future generations. Any impacts are expected to be negligible and acceptable for both the short-term and the long-term.
Are risks and impacts consistent with Santos' Environmental, Health and Safety Policy?	Yes – aligns with Santos' Environmental, Health and Safety Policy.
Are risks and impacts consistent with stakeholder expectations? (seabed equipment removal activities)	Yes – no concerns raised about this aspect.
Are performance standards such that the impact or risk is considered to be ALARP?	Yes – see ALARP above

The abandonment of select seabed equipment in situ (gravity bases including concrete ballast, anchor chain and buried anchors) is not expected to significantly affect other marine users, including commercial fishing operations or shipping traffic, given the following:

- seabed assets abandoned in situ will be marked on navigational charts
- outcomes of stakeholder engagement did not identify any concerns by relevant stakeholders.

Therefore, the potential impacts on marine users is considered ALARP and acceptable.

10. 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 OPEP.

Stakeholder engagement is assessed separately for the requirements of the activities. Ongoing stakeholder management strategies are discussed in **Section 6**.

10.1 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
+ 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.

10.2 Environment, health and safety policy

Santos' Environment, Health and Safety Policy (**Appendix A**) clearly sets out Santos' 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.

10.3 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 8** and **9**). 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 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 **Section 10.12** and **Section 10.13**.

Any new, or proposed amendment to a control measure, EPSs or EPOs will be managed in accordance with the Environment Management of Change Procedure (EA-91-IQ-10001) (**Section 10.12**).

Oil spill response control measures and environmental performance standards and outcomes are listed in the OPEP.

10.4 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 10-1** for planned activities and unplanned events. Those 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.

10.4.1 Control measures and performance standards

The control measures (CM) that will be used to manage identified environmental impacts and risks and the associated statements of performance required of the control measure (i.e. EPSs) are listed in **Table 10-2**. Measurement criteria (MC) outlining how compliance with the control measure and environmental performance standard could be evidenced are also listed.

All control measures and environmental performance standard and associated measurement criteria relating to preparedness and response operations are contained within the MEFF Decommissioning OPEP (9885-650-PLN-0002).

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Table 10-1: Environmental performance outcomes

Reference	Environmental Performance Outcomes
MEFF-EPO-01	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
MEFF-EPO-02	Seabed disturbance is limited to planned activities and defined locations within the operational area
MEFF-EPO-03	Reduce impacts to marine fauna from lighting on vessels through limiting lighting to that required by safety and navigational lighting requirements
MEFF-EPO-04	No injury or mortality to *EPBC Act 1999 and WA Biodiversity Conservation Act 2016* listed fauna during activities
MEFF-EPO-05	No unplanned objects, emissions or discharges to sea or air
MEFF-EPO-06	No introduction of marine pest species
MEFF-EPO-07	No loss of containment of hydrocarbon to the marine environment
MEFF-EPO-08	Disposal of floating and seabed assets is undertaken by suitably qualified contractors at appropriately licenced waste facilities, with the final disposal of the waste streams undertaken in accordance with SMS-EXA-OS01-PD02-PD01 Waste Monitoring and Reporting.

Table 10-2: Control measures and environmental performance standards for the proposed activity (Environment Plan)

Control Measure	CM Reference	Environmental Performance Standard	EPS Reference No.	Measurement Criteria	EPO Reference No.
Maritime Notices	MEFF-CM-01	Information provided to either AMSA, Department of Defence, AHO and/or nearest port authority on primary vessel(s) arrival and departure so the maritime industry is aware of petroleum activities.	MEFF-CM-01-EPS-01	Transmittal records demonstrate notification of activity prior to the activity commencing	MEFF-EPO-01 MEFF-EPO-07
Santos' stakeholder consultation strategy	MEFF-CM-02	Santos will notify all relevant stakeholders listed, or as revised, **Table 10-7** of relevant activity details prior to commencement, including activity timing, vessel movements, proposed cessation date and vessel details.	MEFF-CM-02-EPS-01	Santos' correspondence to relevant stakeholders	MEFF-EPO-01 MEFF-EPO-07
		If any primary vessel departs and returns from the operational area, relevant maritime notices will be updated.	MEFF-CM-02-EPS-02	Santos' correspondence to relevant stakeholders	
		All correspondence with external stakeholders is recorded.	MEFF-CM-02-EPS-03	Saved consultation records	
		Santos' Consultation Coordinator is contactable before, during and after completion of the planned activity to ensure stakeholder feedback is evaluated and considered during the operational activity phases.	MEFF-CM-02-EPS-04	Consultation Coordinator contact details provided to relevant persons in all correspondence	
		Santos will not restrict commercial fishing access to the operational area, and is committed to concurrent operations where safety of either vessel is not compromised.	MEFF-CM-02-EPS-05	Incident records show nil incidents of complaints of restrictions to commercial fishing	

Control Measure	CM Reference	Environmental Performance Standard	EPS Reference No.	Measurement Criteria	EPO Reference No.
				access to the operational area, and show nil incidents of vessel safety being compromised by concurrent operations	
No fishing from project vessels	MEFF-CM-03	Personnel are prohibited from recreational fishing activities on vessels.	MEFF-CM-03-EPS-01	Induction records confirm no fishing prohibition is communicated to all personnel	MEFF-EPO-01
Petroleum safety zone established (gazetted) around MEFF DTM and manifold locations	MEFF-CM-04	A 500 m PSZ is defined around the MEFF DTM and manifold locations.	MEFF-CM-04-EPS-01	Notice to Mariners placed with AHO outlining PSZ and timeframes of the activity	MEFF-EPO-01 MEFF-EPO-07
Safety exclusion zone established around primary vessels during floating and seabed asset removal activities to reduce potential for collision or interference with other marine user activities	MEFF-CM-05	A 500 m safety exclusion zone is established around the primary vessels during the activity.	MEFF-CM-05-EPS-01	Notice to Mariners placed with AHO outlining safety exclusion zone and timeframes of the activity	MEFF-EPO-01 MEFF-EPO-07
Lighting will be used as required for safe work conditions and navigational purposes only	MEFF-CM-06	Vessel navigation lighting and equipment is compliant with COLREGS / Marine Orders 30: Prevention of Collisions, and with Marine Orders 21: Safety of Navigation and Emergency Procedures.	MEFF-CM-06-EPS-01	Offshore Vessel Inspection Database (OVID) or equivalent confirms vessel certification compliance with applicable regulations	MEFF-EPO-01 MEFF-EPO-03 MEFF-EPO-07
Seafarer certification	MEFF-CM-07	Vessel crew are trained and competent, in accordance with Flag State regulations, to navigate vessels	MEFF-CM-07-EPS-01	Training matrix	MEFF-EPO-01 MEFF-EPO-07

Control Measure	CM Reference	Environmental Performance Standard	EPS Reference No.	Measurement Criteria	EPO Reference No.
		and reduce interaction with other marine users.			
Identification system	MEFF-CM-08	Primary vessels have an Automatic Identification System to aid in their detection at sea.	MEFF-CM-08-EPS-01	Completed inspection report or statement of conformance supplied by primary vessel contractors	MEFF-EPO-01
Constant bridge watch	MEFF-CM-09	Competent crew shall maintain constant bridge-watch.	MEFF-CM-09-EPS-01	Bridge log or equivalent	MEFF-EPO-01 MEFF-EPO-04
Primary vessel personnel inductions	MEFF-CM-10	Induction materials reinforce to the Vessel Master the importance of marine communications in the event of any potential interactions with active commercial fishers.	MEFF-CM-10-EPS-01	Induction records	MEFF-EPO-01
Tow plan	MEFF-CM-11	If the recovered assets are towed, a tow plan will be prepared and developed with consideration for navigational hazards, navigational controls, required notifications, way points, applicable nautical charts, places of refuge, Environmental Sensitive Sea Area's (ESSA) and designated Area to be Avoided (ATBA).	MEFF-CM-11-EPS-01	Records confirm recovered assets towed in accordance with floating assets tow plan	MEFF-EPO-01 MEFF-EPO-04 MEFF-EPO-05
Recovery procedure	MEFF-CM-12	A recovery procedure will be developed, reviewed and issued for use prior to mobilisation to the field. Reviews will be performed to ensure that risks have been managed in accordance with ALARP principles prior to issuing procedures for us.	MEFF-CM-12.EPS-01	Records of the constructability review and HAZID are available. Records confirm floating and seabed assets recovered in	MEFF-EPO-01 MEFF-EPO-04 MEFF-EPO-05

Control Measure	CM Reference	Environmental Performance Standard	EPS Reference No.	Measurement Criteria	EPO Reference No.
				accordance with procedure.	
As left survey	MEFF-CM-13	Survey of seabed where equipment has been removed or abandoned in-situ,, including seabed adjacent to equipment.	MEFF-CM-13-EPS-01	Completed survey reports with associated videos and / or photos	MEFF-EPO-02 MEFF-EPO-05
Notify AHO of locations for equipment abandoned in situ so they can be marked on navigational charts	MEFF-CM-14	Notify AHO of locations for equipment abandoned in situ so they can be marked on navigational charts.	MEFF-CM-14.EPS-01	Records demonstrate that AHO has been notified for equipment abandoned in situ.	MEFF-EPO-01
Relinquish petroleum safety zone (PSZ)	MEFF-CM-15	Relinquish PSZ after completion of seabed asset removal activities.	MEFF-CM-15.EPS-01	Records demonstrate that PSZ has been relinquished.	MEFF-EPO-01
Pre- and post-floating asset removal seabed ROV surveys of wet storage location	MEFF-CM-16	Survey of floating asset (DTM, MWA and associated componentry), including seabed adjacent to equipment completed prior to and after the floating asset removal activities.	MEFF-CM-16-EPS-01	Completed survey reports with associated videos and / or photos	MEFF-EPO-02
Wet storage positioning	MEFF-CM-17	Equipment that is temporarily wet stored until future decommissioning campaign will be located close to original DTM position (19° 16' 33.5" S; 116° 36' 45.6" E, and wholly within the footprint of the existing mooring anchor pattern.	MEFF-CM-17-EPS-01	Record of wet-stored equipment position	MEFF-EPO-02
Sediment sampling and analysis plan	MEFF-CM-18	If sediment sampling is required during IMMR campaigns, sediment sampling methods and locations will be outlined within a sampling and analysis plan.	MEFF-CM-18-EPS-01	Sampling and analysis plan	MEFF-EPO-02

Control Measure	CM Reference	Environmental Performance Standard	EPS Reference No.	Measurement Criteria	EPO Reference No.
ROV assessment of substrate at sediment sampling locations	MEFF-CM-19	No hard substrate communities impacted as a result of environmental sediment sampling.	MEFF-CM-19-EPS-01	Completed survey reports with associated videos and / or photos	MEFF-EPO-02
Procedures for interacting with marine fauna	MEFF-CM-20	Vessels comply with Santos' 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.	MEFF-CM-20-EPS-01	Conformance checked on receipt of marine fauna sighting datasheets Completed vessel statement of conformance	MEFF-EPO-04
		Any vessel strikes with cetaceans will be reported in the National Ship Strike Database.	MEFF-CM-20-EPS-02	Conformance checked on Santos' receipt of incident report	MEFF-EPO-04
		Helicopter contractor procedures comply with Santos' Protected Marine Fauna Interaction and Sighting Procedure (EA-91-11-00003), which ensures compliance with Part 8 of the Environment Protection and Biodiversity Conservation Regulations 2000, which includes controls for minimising interaction with marine fauna.	MEFF-CM-20-EPS-03	Helicopter contractor procedures align with Santos' Protected Marine Fauna Interaction and Sighting Procedure (EA-91-11-00003)	MEFF-EPO-04
Vessel Planned Maintenance System to maintain vessel DP, engines and machinery	MEFF-CM-21	Documented maintenance program is in place for equipment on vessels that provides a status on the maintenance of equipment.	MEFF-CM-21-EPS-01	Vessel daily/weekly records OVID or equivalent CMMS records	MEFF-EPO-04 MEFF-EPO-05 MEFF-EPO-07

Control Measure	CM Reference	Environmental Performance Standard	EPS Reference No.	Measurement Criteria	EPO Reference No.
Marine assurance	MEFF-CM-22	Vessels selected and on-boarded in accordance with the Offshore Marine Assurance Procedure (SO-91-ZH-10001) to ensure contracted vessels are operated, maintained and manned in accordance with industry standards (for example, Marine Orders) and regulatory requirements (this EP) and the relevant Santos procedures mentioned in this EP.	MEFF-CM-22-EPS-01	Completed documentation in accordance with procedure	MEFF-EPO-04 MEFF-EPO-05 MEFF-EPO-07
Waste incineration	MEFF-CM-23	Waste incineration managed in accordance with MARPOL Annex VI.	MEFF-CM-23-EPS-01	Waste records verified by Santos Offshore Representative	MEFF-EPO-05
				OVID report	
				Incineration records	
				Marine assurance inspections	
Fuel oil quality	MEFF-CM-24	MARPOL-compliant fuel oil will be used during the activity.	MEFF-CM-24-EPS-01	Fuel bunkering records and / or relevant purchase records	MEFF-EPO-05 MEFF-EPO-07
International air pollution prevention certification	MEFF-CM-25	Pursuant to MARPOL Annex VI primary vessels and support vessel(s) will maintain a current International Air Pollution Prevention (IAPP) Certificate as relevant to vessel class which certifies that measures to prevent ODS emissions, and reduce nitrogen oxides, sulphur oxides and incineration emissions during the activity are in place.	MEFF-CM-25-EPS-01	OVID or equivalent confirms current international air pollution prevention (IAPP) certificate	MEFF-EPO-05

Control Measure	CM Reference	Environmental Performance Standard	EPS Reference No.	Measurement Criteria	EPO Reference No.
Ozone-depleting substance handling procedures	MEFF-CM-26	ODS managed in accordance with MARPOL Annex VI to reduce the risk of an accidental release of ODS to air.	MEFF-CM-26-EPS-01	OVID or equivalent confirms completed ODS record book or recording system	MEFF-EPO-05
Waste (garbage) management procedure	MEFF-CM-27	Waste management procedure implemented to reduce the risk of unplanned release of waste to sea. The procedure includes standards for: + bin types + lids and covers + waste segregation + bin storage.	MEFF-CM-27-EPS-01	Completed Santos Offshore Representative inspection checklist Marine assurance inspections	MEFF-EPO-05
		No waste (garbage) discharged to sea, unless the waste is food waste disposed in accordance with MARPOL Annex V.	MEFF-CM-27-EPS-02	Completed garbage disposal record book or recording system verified by Santos Offshore Representative Marine assurance inspections	MEFF-EPO-05
		Pursuant to MARPOL Annex V, placards displayed to notify personnel of waste disposal restrictions.	MEFF-CM-27-EPS-03	Completed Santos Offshore Representative inspection checklist Marine assurance inspections	MEFF-EPO-05
Deck cleaning product selection	MEFF-CM-28	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.	MEFF-CM-28-EPS-01	SDS and product supplier supplementary data as required	MEFF-EPO-05

Control Measure	CM Reference	Environmental Performance Standard	EPS Reference No.	Measurement Criteria	EPO Reference No.
General chemical management procedures	MEFF-CM-29	Safety datasheet (SDS) available for all chemicals to aid in the process of hazard identification and chemical management.	MEFF-CM-29-EPS-01	Contractor's routine inspection of the chemical storage / SDSs verified by onsite inspection by either Santos Offshore Representative or Marine Assurance Inspection	MEFF-EPO-05 MEFF-EPO-07
		Chemicals managed in accordance with SDS in relation to safe handling and storage, spill-response and emergency procedures, and disposal considerations.	MEFF-CM-29-EPS-02	Contractor's chemical management procedures verified by onsite inspection – by either Santos Offshore Representative or Marine Assurance Inspection	
Chemical selection procedure	MEFF-CM-30	Products with potential to be released to the sea meet the criteria for not being harmful to the marine environment according to MARPOL Annex V; or Gold/Silver/D or E rated through OCNS; or have a completed Santos ecotoxicological risk assessment so only environmentally acceptable products are used. The selection criteria for chemical preference through the risk assessment process as outlined Santos Operations Chemical Selection, Evaluation and Approval Procedure (EA-91-II-10001) is low aquatic toxicity (e.g., EC50/LC50 > 100 mg/L), low bioaccumulation	MEFF-CM-30-EPS-01	Completed Santos risk assessments show chemicals selected are acceptable as per Santos Operations Chemical Selection, Evaluation and Approval Procedure (EA-91-II-10001)	MEFF-EPO-05 MEFF-EPO-07

Control Measure	CM Reference	Environmental Performance Standard	EPS Reference No.	Measurement Criteria	EPO Reference No.
		potential (e.g., Log Pow <3) and readily biodegradable (e.g., >60 in 28 days OECD 306).			
Sewage treatment system	MEFF-CM-31	Pursuant to MARPOL Annex VI, vessel(s) have a current International Sewage Pollution Prevention (ISPP) Certificate which certifies that required measures to reduce impacts from sewage disposal are in place (as applicable to vessel class).	MEFF-CM-31-EPS-01	OVID or equivalent confirms current International Sewage Pollution Prevention (ISPP) Certificate	MEFF-EPO-05
		Sewage discharged in accordance with MARPOL Annex IV.	MEFF-CM-31-EPS-02	Completed Santos Offshore Representative inspection checklist	
				Sewage discharge records	
		Preventive maintenance on sewage treatment equipment is completed as scheduled.	MEFF-CM-31-EPS-	OVID or equivalent confirms current International Sewage Pollution Prevention Certificate	
Oily water treatment system	MEFF-CM-32	Oily mixtures (bilge water) only discharged to sea in accordance with MARPOL Annex I.	MEFF-CM-32-EPS-01	Completed Santos Offshore Representative inspection checklist	MEFF-EPO-05
				Oil record book or log where available	
		Preventative maintenance on oil filtering equipment completed as scheduled.	MEFF-CM-32-EPS-02	Maintenance records or evidence of maintenance in operational reports where available	

Control Measure	CM Reference	Environmental Performance Standard	EPS Reference No.	Measurement Criteria	EPO Reference No.
		Pursuant to MARPOL Annex I, vessel(s) will have an International Oil Pollution Prevention (IOPP) Certificate which certifies that required measures to reduce impacts of planned oil discharges are in place.	MEFF-CM-32-EPS-03	OVID or equivalent confirms current International Oil Pollution Prevention (IOPP) Certificate	
Onshore disposal of decommissioned assets in accordance with relevant legislative requirements	MEFF-CM-33	Decommissioned assets are disposed of or recycled using suitably qualified contractors at appropriately licenced waste facilities, in accordance with relevant legislation of the receiving jurisdiction.	MEFF-CM-33-EPS-01	Transport and disposal / recycling contracts and waste receipts.	MEFF-EPO-05 MEFF-EPO-08
NOSPEMA accepted WOMP for MEFF wells	MEFF-CM-34	A NOPSEMA-accepted WOMP in place that includes control measures for well integrity to reduce the risk of an unplanned release of hydrocarbons.	MEFF-CM-34-EPS-01	NOPSEMA-accepted WOMP	MEFF-EPO-07
			MEFF-CM-34-EPS-02	Incident records confirm no breach of containment	
Hazardous materials procedure	MEFF-CM-35	If NORM contamination is identified during decommissioning, the equipment will be managed as per Santos procedures appropriate for the contamination type and level. All waste will be handled and disposed of in accordance with Federal and State requirements.	MEFF-CM-35-EPS-01	Records show that any NORM contamination identified is managed in accordance with Santos procedures.	MEFF-EPO-07
Sea dumping permit	MEFF-CM-36	Santos engages with DCCEEW regarding the application of the Environment Protection (Sea	MEFF-CM-36-EPS-01	Records demonstrate DCCEEW has been engaged on the application of the Environment Protection	MEFF-EPO-02 MEFF-EPO-05

Control Measure	CM Reference	Environmental Performance Standard	EPS Reference No.	Measurement Criteria	EPO Reference No.
		Dumping) Act 1981 and will comply with requirements under the Act.		(Sea Dumping) Act 1981 relevant to the decommissioning of the MEFF Field.	
			MEFF-CM-36-EPS-02	Application for a sea dumping permit, if required.	
Dropped object prevention procedures	MEFF-CM-37	Vessel Safety Case includes control measures for dropped objects that reduce the risk of objects entering the marine environment, specifically: + lifting equipment certification and inspection + lifting crew competencies + lift procedures + preventative maintenance on cranes.	MEFF-CM-37-EPS-01	NOPSEMA-accepted Safety Case Completed Santos Offshore Representative inspection checklist Details contained in incident documents	MEFF-EPO-05
		Lifting operations managed in accordance with vessel work instructions or procedures.	MEFF-CM-37-EPS-02	Vessel work instructions or procedures	
		Objects dropped overboard are recovered (if possible) 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.	MEFF-CM-37-EPS-03	Fate of dropped objects detailed in incident documents	
NOSPEMA accepted MEFF Field Safety Case Addendum	MEFF-CM-38	DTM recovered to vessel in accordance with:	MEFF-CM-38-EPS-01	Recovery in accordance with NOPSEMA accepted	MEFF-EPO-05 MEFF-EPO-07

Control Measure	CM Reference	Environmental Performance Standard	EPS Reference No.	Measurement Criteria	EPO Reference No.
		+ risers cut sequencing over a series of steps + mooring chains disconnection sequencing over a series of steps + the use of support lines from the DTM to the vessel and/or tug to prevent the DTM from drifting away. The MWA's will be recovered to vessel in accordance with: + the use of support lines connecting the MWAs to the vessel/and or tug prior to final release, that enables suitable vessel offset as the MWAs rise to surface and prevent the MWAs from drifting away + The final release of the MWA from the gravity base will be performed to enable a controlled release to surface. This may be achieved by cutting a single line connected to the gravity base using an ROV.		MEFF Field Safety Case Addendum	
		Prior to towing, length of all trailing ropes and lines from the DTM and MWAs will be shortened to as short as practicable.	MEFF-CM-38-EPS-02	Towing preparations in accordance with NOPSEMA accepted MEFF Field Safety Case Addendum	MEFF-EPO-04
		Connection points (towing points) on the towed equipment will be inspected during the install of the towing gear to confirm suitability for tow as detailed in the MEFF Field Safety Case Addendum.	MEFF-CM-38-EPS-03	Towing preparations in accordance with NOPSEMA accepted MEFF Field Safety Case Addendum	MEFF-EPO-01 MEFF-EPO-04 MEFF-EPO-05

Control Measure	CM Reference	Environmental Performance Standard	EPS Reference No.	Measurement Criteria	EPO Reference No.
Implementation of the management controls in the Santos IMSMP	MEFF-CM-39	Vessels are managed to low risk in accordance with the Santos IMSMP (EA-00-RI-10172) prior to movement or transit into or within the invasive marine species management zone, which requires: + assessment of applicable vessels using the IMSMP risk assessment + the management of immersible equipment to low risk.	MEFF-CM-39-EPS-01	Completed risk assessment demonstrating equipment and vessels are 'low risk'	MEFF-EPO-06
		Pursuant to the *Biosecurity Act 2015* and Australian Ballast Water Management Requirements 2017, primary and support vessels carrying ballast water and engaged in international voyages shall manage ballast water so marine pest species are not introduced.	MEFF-CM-39-EPS-02	Records show ballast water management is implemented Completed ballast water record book or log is verified by Santos Offshore Representative	
		Vessels receive entry clearance from DCCEEW (Seaports) as necessary (or as applicable to their location and movements).	MEFF-CM-39-EPS-03	Records show a complete Questionnaire for Biosecurity Exemptions for Biosecurity Control Determination issued to Seaports at least one month in advance where practicable	
Anti-foulant system	MEFF-CM-40	Vessel anti-foulant system maintained in compliance with International Convention on the Control of Harmful Anti-fouling Systems on Ships, where applicable.	MEFF-CM-40-EPS-01	OVID or equivalent confirms current International Anti-Fouling System Certificate	MEFF-EPO-06

Control Measure	CM Reference	Environmental Performance Standard	EPS Reference No.	Measurement Criteria	EPO Reference No.
Hazardous chemical management procedures	MEFF-CM-41	For hazardous chemicals including hydrocarbons, the following standards apply to reduce the risk of an accidental release to sea: + Storage containers closed when the product is not being used. + Storage containers managed in a manner that provides for secondary containment in the event of a spill or leak. + Storage containers labelled with the technical product name as per the SDS. + Spills and leaks to deck, excluding storage bunds and drip trays, immediately cleaned up. + Storage bunds and drip trays do not contain free flowing volumes of liquid. + Spill response equipment readily available.	MEFF-CM-41-EPS-01	Contractor's routine inspection of the chemical storage/ SDSs verified by onsite inspection – by either Santos Offshore Representative or Marine Assurance Inspection Contractor's chemical management procedures. Verified by onsite inspection – by either Santos Offshore Representative or Marine Assurance Inspection	MEFF-EPO-05 MEFF-EPO-07
Vessel spill response plans (SOPEP/SMPEP)	MEFF-CM-42	Vessels have current and implemented a SOPEP, or SMPEP, pursuant to MARPOL Annex I.	MEFF-CM-42-EPS-01	Approved SOPEP or SMPEP	MEFF-EPO-05 MEFF-EPO-07
		SOPEP or SMPEP spill response exercises conducted not less often than every three months to ensure personnel are prepared.	MEFF-CM-42-EPS-02	Spill exercise records or evidence of a spill exercise in an operational report	
Accepted OPEP	MEFF-CM-43	In the event of a hydrocarbon spill to sea, the Santos OPEP requirements	MEFF-CM-43-EPS-01	Incident report	MEFF-EPO-07

Control Measure	CM Reference	Environmental Performance Standard	EPS Reference No.	Measurement Criteria	EPO Reference No.
		are implemented to mitigate environmental impacts.			
Santos Refuelling and Chemical Transfer Standard (SO-91-IQ-00098)	MEFF-CM-44	Bunkering activities follow the requirements of the Santos Refuelling and Chemical Transfer Standard (SO-91-IQ-00098) which includes key requirements to prevent spills to the environment such as: + when bunkering activities can occur + roles and responsibilities + dry-break couplings and breakaway couplings used + bunkering activity communication requirements + bunker hose undergoes hydrostatic leak testing.	MEFF-CM-44-EPS-01	Completed bunkering checklist Spill details contained in incident documentation	MEFF-EPO-07
Dynamic positioning system	MEFF-CM-45	For vessels equipped with Dynamic Positioning (DP) equipment design, redundancy, equipment maintenance and operation in accordance with the IMCA Guideline for the Design and Operation of Dynamically Positioned Vessels.	MEFF-CM-45-EPS-01	Records of annual DP trials	MEFF-EPO-07
		DP trials to ensure correct operation.	MEFF-CM-45-EPS-02	Record of field entry DP trials	
Navigational charts	MEFF-CM-46	Wells gazetted and marked on navigational charts to minimise the risk of collision from third parties.	MEFF-CM-46-EPS-01	Wells and DTM currently marked on navigational charts	MEFF-EPO-07

Control Measure	CM Reference	Environmental Performance Standard	EPS Reference No.	Measurement Criteria	EPO Reference No.
Third-party agreements and contracts	MEFF-CM-47	APPEA Mutual Aid MoU for relief well drilling. Contracts/MoUs for source control personnel.	MEFF-CM-47-EPS-01	Documentation of MoUs, AMOSC/Oil Spill Response Limited and Wild Well Control contracts and third-party agreements	MEFF-EPO-07
Implement MEFF Subsea Integrity Management Plan (ME-7000-REP-0071)	MEFF-CM-48	MEFF subsea systems integrity is maintained and demonstrated in compliance with the MEFF Subsea Integrity Management Plan (ME-7000-REP-0071), including: + risk-based inspection program + triggered inspections in response to natural events such as cyclones or reported third-party interference or damage.	MEFF-CM-48-EPS-01	Integrity inspection reports	MEFF-EPO-07
Maritime Dangerous Goods Code	MEFF-CM-49	Dangerous goods managed in accordance with International Maritime Dangerous Goods Code to reduce the risk of an environmental incident, such as an accidental release to sea or unintended chemical reaction.	MEFF-CM-49-EPS-01	Completed Multimodal Dangerous Goods Form for transfers	MEFF-EPO-07
				Completed Santos Offshore Representative inspection checklist	
ROV inspection and maintenance procedures	MEFF-CM-50	Preventative maintenance on ROV completed as scheduled to reduce the risk of hydraulic fluid releases to sea.	MEFF-CM-50-EPS-01	Maintenance records or evidence of maintenance in operational reports	MEFF-EPO-07
		ROV pre-deployment inspection completed to reduce the risk of hydraulic fluid releases to sea.	MEFF-CM-50-EPS-02	ROV pre-dive checklists	

Control Measure	CM Reference	Environmental Performance Standard	EPS Reference No.	Measurement Criteria	EPO Reference No.
Deck drainage control measures	MEFF-CM-51	Scupper plugs or equivalent deck drainage control measures available where hydrocarbons are stored and frequently handled.	MEFF-CM-51-EPS-01	Completed Santos Offshore Representative inspection checklist	MEFF-EPO-07
				Marine assurance inspection	
Designated safe deployment / recovery zones for seabed asset removal activities that commence prior to completion of the P&A campaign at drill centres where wellheads are still present	MEFF-CM-52	Seabed asset removal activities to be undertaken prior to P&A completion will only occur within the safe deployment zone to avoid potential impacts to well equipment. No lifts for SAR activities will occur outside the safe deployment zone.	MEFF-CM-52-EPS-01	Records demonstrate seabed asset removal activities, if carried out prior to P&A activities, only occur in safe deployment zone.	MEFF-EPO-07

10.5 Environmental monitoring arrangements

Santos is required to address arrangements for long-term environmental monitoring of equipment abandoned in situ (**Section 4.8**). Santos has identified the requirements that need to be satisfied when addressing arrangements for long-term monitoring in **Table 10-3**.

Table 10-3: Regulatory requirements to be met by long term monitoring arrangements

Source	Requirement
A.672(16) Guidelines and Standards for the Removal of Offshore Installations and Structures on the Continental Shelf and in the Exclusive Economic Zone (IMO 1989)	Consider any potential effect on the safety of surface or subsurface navigation, or of other uses of the sea.
	Consider the rate of deterioration of the material and its present and possible future effects on the marine environment.
	Consider the potential effect on the marine environment, including living resources.
	Consider the risk that the material will shift from its position and some future time.
Section 270 NOPSEMA Advice - Consent to Surrender Title (NOPSEMA, 2021)	Provide for the conservation and protection of natural resources.
	Make good damage to the seabed.
	The final condition of the surrender area has been delivered as described in permissioning documents and control measures to manage the impacts and risks have been effective.
	The final impacts and risks upon the environment shall be determined by comparison between initial baseline condition monitoring and survey data and the end state condition.
	Subsequent monitoring and surveys may be required based upon an assessment of risk to confirm the final condition has not changed and control measures to manage the impacts and risks remain effective. Consideration shall be given to the risks in perpetuity associated with property that is not removed.
	Performance reports shall be provided for the duration of monitoring and survey activities.

10.5.1 Confirming the conditions at the time of abandonment

Santos will undertake a survey to confirm the state and position of the equipment described in **Section 4.8** at the time of abandonment, referred to as an as left survey (**Section 4.10**). The as left survey will address several of the requirements identified in **Table 10-3** as shown in **Table 10-4**.

While the as left survey will monitor equipment, Santos has also monitored the condition of the environment at the time of abandonment. This includes:

- The historical and current activities of other users of the sea, including commercial fishing and maritime transport. The description of the environment in **Section 5** and stakeholder consultation in **Section 6** detail these activities, which are considered in the assessment of impacts and risks in **Section 8** and **Section 9**.

- The condition of environmental values in and around the MEFF field, including water quality, sediment quality, benthic habitats, and demersal fish assemblages. The description of the environment in **Section 5** details the condition of these environmental values, which are considered in the assessment of impacts and risks in **Section 8** and **Section 9**.
- Sediment sampling completed in 2014 (GHD, 2014) to validate the produced water model predictions, found no significant differences in sediment quality between sites in the vicinity of the FPSO and reference sites. Furthermore, there were no exceedances of National Assessment Guidelines for Dredging (NAGD, 2009) trigger values. Therefore, impacts to sediment quality from FPSO operations in the MEFF field had not occurred over approximately 10 years of operations.
- The most recent assessment undertook a visual survey and sediment sampling in March 2021 (GHD, 2021), which observed contaminants were generally below recognised thresholds, with the exception of antimony and lead at the Exeter facility and total recoverable hydrocarbons at the Mutineer facility. Concentrations of these contaminants exceeded the default guideline values outlined in the Australian and New Zealand guidelines for Fresh and Marine Water Quality (DAWE, 2022), but not the 'upper' guideline values at which observable toxic effects may be expected.
- The six DTM mooring anchors were confirmed as fully buried with no seabed disturbance visible at the anchor locations.
- Anchors are expected to be buried between 6 to 13 m below the seabed and therefore, will remain buried as they are below the regional scour depth (estimated to be 50 mm). Approximately 130 m of each mooring chain remains unburied (sitting on the seabed). These may self bury over time.

Table 10-4: Demonstration of how as left survey outcomes address relevant regulatory requirements

Requirements [1,2]	Relevance	As Left Survey Outcome
[1]Consider any potential effect on the safety of surface or subsurface navigation, or of other uses of the sea	This EP assesses the potential effect of equipment abandoned in situ on other users of the sea (**Section 8.1**). The as left survey will confirm the location of the equipment at the time of abandonment and verify the assumptions made in **Section 8.1**.	An as left survey will: Confirm assumptions about the equipment abandoned in situ at the time of abandonment (e.g., condition, inventory etc.).
[2]The final condition of the surrender area has been delivered as described in permissioning documents and control measures to manage the impacts and risks have been effective.	The as left survey will confirm: + The condition and location of equipment at the time of abandonment + That all equipment not permitted to be abandoned in situ has been removed + That the state of the equipment and any associated control measures are consistent with what is stated in this EP.	
[2]The final impacts and risks upon the environment shall be determined by comparison between initial baseline condition	This EP assesses the impacts and risks to the environment as the equipment abandoned in situ degrades (**Section 8.1** and **Section 8.8**). The as	

Requirements [1,2]	Relevance	As Left Survey Outcome
monitoring and survey data and the end state condition.	left survey will confirm the assumptions made in the EP about the condition of the equipment.	
[1]The rate of deterioration of the material and its present and possible future effects on the marine environment [1]The risk that the material will shift from its position at some future time	The degradation study by Atteris (2021) makes a number of assumptions about the initial state of the equipment to be abandoned in situ. The Atteris (2021) study provides the basis for Santos' considerations of the degradation of the equipment and associated environmental impacts and risks assessed in this EP(**Section 8.1** and **Section 8.8**) . The as left survey will confirm the assumptions made by Atteris (2021) about the equipment at the time of abandonment.	Confirm the assumptions made in the degradation and stability study undertaken by Atteris (2021)
[1]Consider any potential effect on the safety of surface or subsurface navigation, or of other uses of the sea	The AHO has previously been advised of the position of equipment in the MEFF fields. Santos will confirm the location of equipment abandoned in situ with AHO once equipment removal activities have been completed. AHO can them make any updates to nautical charts to show the location of the equipment abandoned in situ (**Section 8.1**).	Inform consultation with relevant persons, such as confirming the position of the equipment abandoned in situ to the AHO for inclusion on hydrographic charts.
[1]Consider the potential effect on the marine environment, including living resources [2]Provide for the conservation and protection of natural resources	This EP assesses the potential environmental impacts and risks from abandonment of equipment in situ and demonstrates that natural resources will be conserved (**Section 8.8)**. The as left survey will confirm the natural resources present at the time of abandonment, which will be used to validate the information and assumptions in the EP.	Confirm the current state of the natural resources and inform the demonstration in this EP that natural resources will be conserved and protected
[2]Make good damage to the seabed	The as left survey will confirm the state of the seabed at the time of abandonment. From this, Santos can determine: + The effectiveness of any actions undertaken to make good damage to the seabed + The extent of remaining damage to the seabed (if any).	Confirm the state of the seabed, including any damage to the seabed that Santos may be required to make good prior to surrender of the petroleum titles.

[1]A.672(16) Guidelines and Standards for the Removal of Offshore Installations and Structures on the Continental Shelf and in the Exclusive Economic Zone (IMO 1989)

[2]Section 270 NOPSEMA advice - Consent to surrender title (NOPSEMA 2021)

10.5.2 Predicting the future condition of the equipment abandoned in situ

The degradation and stability studies commissioned by Santos make predictions about the future condition of equipment abandoned in situ. The studies were undertaken by Atteris (2021). The degradation studies informed the potential environmental impacts and risks from abandonment of equipment in situ (**Section 8.8**) and considered:

- the initial state and composition of the equipment
- the degradation mechanisms that may act upon the equipment
- the protection mechanisms that mitigate degradation and the time for these mechanisms to be depleted
- the potential toxicity of the material released to the environment.

The composition of the equipment abandoned in situ consists almost entirely of steel, concrete and very minor amounts of plastic (approximately 0.4 kg) and is reliably quantified. The degradation mechanisms for these materials in the environment is well-understood, hence the predictions made in this EP are reliable.

The degradation studies help address relevant regulatory requirements as summarised in **Table 10-5**.

Table 10-5: Demonstration of how as degradation studies address relevant regulatory requirements

Requirements [1,2]	Relevance	Degradation and Stability Studies Outcome
[1]Consider any potential effect on the safety of surface or subsurface navigation, or of other uses of the sea. [1]Consider the risk that the material will shift from its position and some future time.	The degradation studies and this EP determine that the equipment does not pose a risk to other users of the sea (**Section 8.1**). Trawled fishing gear is the only other user type that was identified as potentially interacting with the equipment. Trawled fishing gear may become snagged on exposed equipment. The only active trawl fishery in the vicinity of the MEFF fields is the Pilbara trawl fishery. Large areas of the continental shelf are closed to this fishery, including the MEFF fields. There is no indication that fisheries management agencies will open areas currently closed to trawling.	Predict that all equipment is stable on the seabed. Very high energy cyclone events (100 and 1,000-year return periods) were not predicted to have any effect on the movement of equipment abandoned in situ. Equipment abandoned in situ will gradually degrade and become a component of the sediment, equipment may become progressively buried over time.
[1]Consider the rate of deterioration of the material and its present and possible future effects on the marine environment. [2]The final impacts and risks upon the environment shall be determined by comparison between initial baseline condition monitoring and survey data and the end state condition.	This EP considers the outcomes of the degradation studies in the assessment of environmental impacts and risks until the equipment is completely degraded (**Section 8.8**).	Degradation studies predict the future states that equipment abandoned in situ will progress through from its current state until it is completely degraded.
[1]Consider the potential effect on the marine environment, including living resources.	The EP considers the outcomes of the degradation studies in the assessment of environmental	Degradation studies predict the future states that equipment abandoned in situ will progress

Requirements [1,2]	Relevance	Degradation and Stability Studies Outcome
[2]The final impacts and risks upon the environment shall be determined by comparison between initial baseline condition monitoring and survey data and the end state condition.	impacts and risks to the living resources in the marine environment until the equipment is completely degraded (**Section 8.8**).	through from its current state until it is completely degraded. The studies also consider ecotoxicity effects on marine biota.

[1]A.672(16) Guidelines and Standards for the Removal of Offshore Installations and Structures on the Continental Shelf and in the Exclusive Economic Zone (IMO 1989)

[2]Section 270 NOPSEMA advice - Consent to surrender title (NOPSEMA 2021)

10.5.3 Determining if additional mitigation is required

The IMO Guidelines and Standards for the Removal of Offshore Installations and Structures on the Continental Shelf and in the Exclusive Economic Zone (IMO 1989), and Section 270 NOPSEMA Advice - Consent to Surrender Title (NOPSEMA, 2021) describe the requirements to address arrangements for long term monitoring of equipment abandoned in situ.

The degradation pathways and environmental receptors that may be impacted by equipment abandoned in situ are reliably described in the EP and supporting technical studies. As demonstrated in this EP, the material from equipment abandoned in situ does not pose unacceptable impacts or risks to the current state of the environmental receptors (**Section 8.8**). However, the current state of environmental receptors may not represent their future states, and Santos is required to demonstrate that long-term impacts and risks are managed to a level that is ALARP and acceptable.

The impact assessment identified that trawled fishing gear may have the potential to become snagged on the equipment abandoned in situ. Benthic trawls are known to interact with subsea pipelines, with free spans posing a risk of snagging otter boards on trawls (Rouse et al., 2020). The Pilbara Fish Interim Trawl Managed Fishery overlaps the MEFF fields. The current management arrangements for the fishery came into effect in the 1990's and limit trawling to several management areas north of Dampier and Port Hedland, none of which overlap with the MEFF field. Anecdotal evidence from the Western Australian Department of Fisheries suggests that the current management boundaries are very unlikely to be extended to permit the Pilbara trawl fishery to operate over this location.

All flowlines on the MEFF titles will be removed (**Section 4.7**). All six DTM mooring anchors have been confirmed as buried and have no potential to un-bury, given their expected depth below the seabed (estimated at 6 to 13 m). Only the two gravity bases extending approximately 5.3 m above the seabed (including concrete ballast) abandoned in situ would pose a potential risk to trawl gear. The only credible interaction of other users with abandoned equipment is in the event that trawl fishing was to commence. Even if trawl fishing were to commence in the Closed Area, any interaction event is considered negligible (refer **Section 8.1**). Additionally, it is standard practice for fishers using trawled gear to avoid known seabed and the position of equipment left in situ will be marked on nautical charts with locations confirmed by the "as left" survey undertaken by Santos.

Other fishing methods targeting demersal scalefish, such as lines and traps, have very little potential to interact with the equipment abandoned in situ. Fishers using these methods may reasonably be expected to target equipment abandoned in situ to benefit from the associated fish assemblages.

There are no unacceptable impacts and risks to the seabed and subsoil from the gravity bases, concrete ballast, anchors and mooring chains remaining in the field and it is considered that the seabed is remediated to enable future unrestricted access, beneficial use and re-release for future use. Impacts and risks have been demonstrated to be reduced to ALARP and acceptable levels (refer **Section 8.8 and Section 9.9**) and no long-term monitoring is warranted given the low risk to other users.

10.5.4 Environment Plan Reporting

The outcomes of the arrangements outlined in **Sections 10.5.1**, **10.5.2** and **10.5.3** will be reported to NOPSEMA as part of the end of activity EP environmental performance reporting outlined in **Table 10-7**. This reporting will include:

+ Confirming the as left condition of the equipment complies with what is permitted in the accepted Mutineer-Exeter Cessation of Production Environment Plan (9885-650-PLN-0001)
+ Consultation outcomes after the development of the EP (e.g., confirmation that AHO was advised of the location of equipment abandoned in situ)

10.6 Roles and responsibilities

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.

Key roles and environmental responsibilities for the decommissioning activity are detailed in **Table 10-6** and will be communicated to these positions before the activity commences and when any changes are made to these positions.

Table 10-6: Key personnel role and environmental responsibilities

Role	Responsibilities
During all activities	
Production Manager Asset Retirement (Onshore)	+ Ensure compliance with Santos' Environment, Health and Safety Policy. + Ensure relevant Santos Management System Standards and procedures are implemented as necessary. + Ensure adequate resources are in place to meet the requirements within the EP. + Ensure overall compliance with the EP with advice and guidance from the Santos Environmental Coordinator. + Ensure incidents and non-conformances are managed as per **Section 10.10** and **10.13** respectively. + Review information received from external sources regarding lessons learnt and non-conformances, relevant to the survey, with the project team to identify if there are actions relevant to the survey. If actions are relevant implement as per **Section 10.13**.
Santos HSE Manager (WA)	+ Ensure incident preparedness and response arrangements meet Santos and regulatory requirements. + Ensure adequate resources are in place to meet the compliance requirements within the OPEP. + Have overall responsibility for approving the OPEP.

Role	Responsibilities
	+ Notify NOPSEMA of a change in titleholder, a change in the titleholder's nominated liaison person or a change in the contact details for (as per **Section 1.6**).
Senior Stakeholder Adviser	+ Ensure relevant stakeholders are identified throughout the life of the EP. + Maintain a stakeholder contact and information database. + Maintain a Stakeholder Notification Log specific to the EP. + Maintain records of all stakeholder correspondence specific to the EP. + Before commencing the activity and on advice of Santos Project Manager or Santos Environment Coordinator, provide a notification (including Commencement, Cessation and others as required by **Table 10-7**) to all relevant stakeholders listed, or as revised, in **Table 10-7**. + Be available before, during and after the activities to ensure opportunities for stakeholders to provide feedback are available. + Prepare and distribute quarterly consultation updates to relevant stakeholders.
During IMMR campaigns	
Santos Offshore Representative	+ Be responsible for day-to-day monitoring of operations. + Interface with the Santos Production Manager – Asset Retirement) and assist the contractor in performing field campaigns in a safe and environmentally acceptable manner in accordance with this EP. + Ensure all personnel are given a full briefing on environmental sensitivities of the permit area and environmental management procedures and commitments detailed in this EP. + Ensure Santos Environment, Health and Safety Policy is applied in areas of responsibility. + Maintain clear communication between Santos and contractors on environmental issues. + Notify Santos Production Manager – Asset Retirement immediately of any changes in operations which could impact negatively on environmental performance. + Ensure incident investigations are conducted as required. + Participate in the investigation of any environmental incidents. + Be responsible for the offshore management of contractor activities and ensuring compliance with the relevant commitments (including record keeping) made in this EP. + Be offshore focal point for communications between Santos and contractor personnel. + Immediately report any incidents to the Vessel Master and the Santos Production Manager – Asset Retirement.
Santos Environmental Coordinator	+ Ensure site environmental audits are carried out as required to ensure compliance. + Ensure environmental monitoring is conducted in accordance with the Santos Management System and this EP. + Liaise with the Santos Production Manager – Asset Retirement and Offshore Field Representative to ensure compliance with all aspects of this EP. + Perform environmental education and inductions for operational personnel.

Role	Responsibilities
	+ Ensure incident investigations are conducted as per Santos Management System. + Ensure EP compliance report that covers environmental performance of the activity in this EP is prepared and submitted to NOPSEMA.
All personnel	+ Adhere to this EP. + Follow good housekeeping procedures and work practices. + Report HSE incidents, hazards or non-conformance to the Vessel Master in a timely manner. + Report sightings of marine fauna and pollution.
During cessation of operations phase (but outside of when field campaigns are occurring)	
Santos Environmental Coordinator	+ Ensure environmental monitoring is conducted in accordance with the Santos Management System and this EP. + Ensure incident investigations are conducted as per Santos Management System. + Ensure EP compliance report that covers environmental performance of the activity in this EP is prepared and submitted to NOPSEMA.
During decommissioning activities / campaigns (floating asset removal and seabed asset removal)	
Project Manager	+ Ensure compliance with Santos' Environment, Health and Safety Policy. + Ensure relevant Santos Management System Standards and procedures are implemented as necessary. + Ensure adequate resources are in place to meet the requirements within the EP and OPEP. + Ensure adequate emergency response capability is in place. + Ensure overall compliance with the EP and OPEP with advice and guidance from the Santos Environmental Coordinator / HSE Manager as necessary. + Interface with the Santos Production Manager – Asset Retirement and assist the contractor in performing field campaigns in a safe and environmentally acceptable manner in accordance with this EP. + Ensure incidents and non-conformances are managed as per **Section 10.10** and **10.13** respectively. + Review information received from external sources regarding lessons learnt and non-conformances, relevant to the survey, with the project team to identify if there are actions relevant to the survey. If actions are relevant implement as per **Section 10.13**.
Santos Offshore Representative or Company Site Representative	+ Be responsible for day-to-day monitoring of operations. + Ensure all personnel are given a full briefing on environmental sensitivities of the permit area and environmental management procedures and commitments detailed in this EP. + Ensure Santos Environment, Health and Safety Policy is applied in areas of responsibility. + Maintain clear communication between Santos and contractors on environmental issues. + Notify Santos Project Manager (Onshore) immediately of any changes in operations which could impact negatively on environmental performance.

Role	Responsibilities
	+ Ensure incident investigations are conducted as required. + Participate in the investigation of any environmental incidents. + Be responsible for the offshore management of contractor activities and ensuring compliance with the relevant commitments (including record keeping) made in this EP. + Be offshore focal point for communications between Santos and contractor personnel. + Immediately report any incidents to the Vessel Master and the Santos Project Manager (Onshore).
Santos Environmental Coordinator	+ Ensure site audits are performed as required to ensure compliance. + Ensure environmental monitoring is conducted in accordance with the Santos Management System and this EP. + Liaise with the Santos Project Manager (Onshore) and Offshore Company Site Representative to ensure compliance with all aspects of this EP. + Perform environmental education and inductions for operational personnel. + Ensure environment, health and safety incident investigations are conducted as per Santos Management System. + Ensure EP compliance report that covers environmental performance of the activity in this EP is prepared and submitted to NOPSEMA.
Senior Oil Spill Response Advisor	Have overall responsibility for: + providing upfront and ongoing guidance, framework, and direction on preparation of this OPEP + developing and maintaining arrangements and contracts for incident response support from third parties + developing and defining objectives, strategies and tactical plans for response preparedness defined in this OPEP and Incident Response Plan + undertaking assurance activities on arrangements outlined within the OPEP.

10.7 Workforce training and competency

OPGGS(E)R 2009 Requirements
Regulation 14(5)
The implementation strategy must include measures to ensure 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 each employee and contractor is aware of his or her responsibilities in relation to the EP and has appropriate training and competencies.

10.7.1 Activity inductions

All offshore personnel 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 about:

+ Santos' Environment, Health and Safety Policy
+ regulatory regime (NOPSEMA regulations)

- EPBC Act Policy Statement 2.1 and how it applies to the activity
- operating environment (e.g. nearby protected marine areas, sensitive environmental periods)
- interaction with other marine users (e.g. 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 (e.g. **Table 10-1** and **Table 10-2**)
- incident reporting and notifications
- regulatory compliance reporting
- management of change process for changes to EP activities
- oil pollution emergency response (e.g. OPEP requirements).

10.7.2 Training and competency

All offshore personnel will complete relevant training and hold qualifications and certificates for their role. Santos and its contractors are individually responsible for ensuring their personnel are qualified and trained. The systems, procedures and responsible persons will vary and will be managed through the use of online databases, staff on-boarding process and training departments etc.

Personnel qualifications and training records will be sampled before and / or during an activity. Such checks will be performed during the contracting process, facility acceptance testing, inductions, crew change and operational inspections and audits.

10.7.3 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 all personnel attend daily toolbox or pre-shift 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 etc).

10.8 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. The MEFF Decommissioning Project will be managed in accordance with Santos's Decommissioning Management Procedure (SMS-DEV-OS02-PD01) and Project Delivery Process (SMS-PRM-OS01-PS01). The Project Delivery Process (PDP) ensures Santos delivers repeatable, predictable and successful project outcomes. It is a structured, decision-driven process to identify and realise maximum value from business opportunities including robust and cost-effective decommissioning plans and decisions.

Any equipment recovered from the field during the decommissioning phase will be taken to shore for recycling, reuse or disposal in accordance with applicable legislation. Santos will record the final disposal of the various waste streams in accordance with the Waste Monitoring and Reporting procedure (SMS-EXA-OS01-PD02-PD01).

The decommissioning options presented in this EP include proposed seabed assets to be abandoned in situ. Santos are required to obtain a Sea Dumping Permit for such assets in accordance with the requirements of the Sea Dumping Act 1981 administered by DCCEEW.

10.9 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 updating the plan.

Vessels are required to have and implement incident response plans, such as an emergency response plan (ERP), Shipboard Marine Pollution Emergency Plan (SMPEP) or Shipboard Oil Pollution Emergency Plan (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 MEFF Decommissioning OPEP (9885-650-PLN-0002) 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).

10.10 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 one 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 HSE incidents and hazards will be documented in the incident management systems as appropriate. HSE incidents will be investigated in accordance with the Incident Reporting and Investigation Procedure (QE-91-IF-00002).

Environmental recordable and reportable incidents will be reported to NOPSEMA and to other regulators as required in accordance with **Table 10-7**. The incident reporting requirements will be provided to all crew on board the facilities and support vessels during the 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 EPO or EPS, that is not also a reportable incident
+ a reportable incident, for an activity, means an incident 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 7**. Of the planned and unplanned events assessed within this EP, the events identified to have a potential consequence level of Moderate or higher are:

+ introduction of invasive marine species (Moderate)
+ hydrocarbon release (marine diesel oil) (Moderate)
+ hydrocarbon release from LOWC (Moderate).

10.11 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 one 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.

10.11.1 Notifications and compliance reporting

Regulatory, other notifications and compliance reporting requirements are summarised in **Table 10-7**.

Table 10-7: Activity notification and reporting requirements

Agency	Required information	Timing	Type	Recipient
Before the Activity				
AHO Notification As requested by Defence and AMSA during consultation.	Pre-start notification.	At least four weeks before the activity commences where practicable.	Written	AHO: datacentre@hydro.gov.au
AMSA JRCC Notification as requested by AMSA during consultation.	Pre-start notification.	24 to 48 hours before the activity commences.	Written	AMSA's JRCC: rccaus@amsa.gov.au
Pilbara Ports Authority	Pre-start notification.	At least two weeks before the activity commences where practicable.	Written	Pilbara Port Authority: shipping@pilbaraports.com.au
WAFIC and commercial fishers As requested during consultation.	Pre-start notification provided to relevant commercial fishing stakeholders, as agreed with WAFIC, or relevant industry body.	At least two weeks before the activity commences where practicable.	Written	WAFIC: oilandgas@wafic.org.au
OPGGS(E) Regulation 29 & 30 – Notifications NOPSEMA must be notified that the activity is to commence.	Complete NOPSEMA's Regulation 29 Start or End of Activity Notification form prior to each campaign.	At least ten days before the campaign activity commences.	Written	NOPSEMA
During the Activity				
OPGGS(E) Regulation 26B – Recordable Incidents NOPSEMA must be notified of a breach of an EPO or EPS, in the environment plan that applies to the activity that is	Complete NOPSEMA's Recordable Environmental Incident Monthly Report form.	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

Agency	Required information	Timing	Type	Recipient
not a reportable incident.				
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, moderate to significant environmental damage.	The oral notification must contain: + all material facts and circumstances concerning the reportable incident known or by reasonable search or enquiry could be found out + 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.	As soon as practicable, and in any case not later than two 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 National Offshore Petroleum Titles Administrator
	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 + 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	Must be submitted as soon as practicable, and in any case not later than three days after the first occurrence of the reportable incident unless NOPSEMA specifies otherwise. Same report to be submitted to NOPTA within seven days after giving the written report to NOPSEMA.	Written	NOPSEMA National Offshore Petroleum Titles Administrator

Agency	Required information	Timing	Type	Recipient
	+ 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.			
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.	A detailed environmental performance report will be submitted within three months of submission of Regulation 29(2).	Written	NOPSEMA
AMSA Reporting Under the MoU between Santos and AMSA and as requested by AMSA during consultation.	Any changes to the intended operations.	As soon as practicable.	Written	AMSA's JRCC: rccaus@amsa.gov.au
	Titleholder agrees to notify AMSA of any marine pollution incident[4].	Within two hours of incident.	Oral	AMSA
	POLREP and SITREP available online (refer to OPEP).	POLREP as requested by AMSA following verbal notification. SITREP as requested by AMSA within 24 hours of request.	Written	AMSA
AHO Notification As requested during consultation.	Any changes to the intended operations.	As soon as practicable.	Written	AHO: datacentre@hydro.gov.au
Santos' commitment to include activity in Quarterly	The Quarterly Consultation Update will include the activity.	Quarterly.	Written	The Quarterly Consultation Update is circulated to a broad

[4] 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 environmental impact and risk assessment process outlined in **Section 7**.

Agency	Required information	Timing	Type	Recipient
Consultation Update until activity ends.	This consultation will cease once the activity has ended.			group of Santos' stakeholders, including many of the stakeholders identified in **Section 6.2**.
Director of National Parks Reporting Notification of the event of oil pollution within a marine park or where an oil spill response action must be taken within a marine park; or if any changes to intended operations (requested through consultation).	The DNP should be made aware of oil / gas pollution incidences which occur within a marine park or are likely to impact on a marine park as soon as possible. Notification should be provided to the 24-hour Marine Compliance Duty Officer on 0419 293 465. The notification should include: + titleholder details + time and location of the incident (including name of marine park likely to be affected) + proposed response arrangements as per the OPEP (such as dispersant, containment) + confirmation of providing access to relevant monitoring and evaluation reports when available + contact details for the response coordinator. Note that the DNP may request daily or weekly Situation Reports, depending on the scale and severity of the pollution incident.	So far as reasonably practicable prior to response action being written.	Oral and written	Director of National Parks
	Notify if details regarding the activity change and result in an overlap with or new impact to a	As soon as practicable.	Written	DNP: marineparks@awe.gov.au

Agency	Required information	Timing	Type	Recipient
	marine park.			
DPIRD Reporting If marine pests or disease are suspected this must be reported to DPIRD.	Notification of any suspected marine pests or diseases including any organism listed in the Western Australian Prevention List for Introduced Marine Pests and any other non-endemic organism that demonstrates invasive characteristics.	Within 24 hours.	Oral	DPIRD FishWatch
DCCEEW Reporting Any harm or mortality to EPBC Act listed threatened marine fauna. Marine Fauna Sighting Data.	Notification of any harm or mortality to an EPBC listed species of marine fauna whether attributable to the activity or not.	Within seven days to EPBC.permits@environment.gov.au.	Written	DCCEEW
	Marine fauna sighting data recorded in the marine fauna sighting database.	As soon as practicable, in any case no later than three months of the end of the activity.	Written	DCCEEW
Department of Biodiversity, Conservation and Attractions Reporting 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 seven days to fauna@dbca.wa.gov.au.	Written	DBCA
Australian Marine Mammal Centre Reporting 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	DCCEEW
Department of Biodiversity, Conservation and Attractions Reporting	Notification of actual or impending spillage.	As soon as practicable.	Oral or Written	DBCA Pilbara regional office

Agency	Required information	Timing	Type	Recipient
Notification of the event of a hydrocarbon release.				
Department of Transport Reporting 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 two hours.	Oral	DoT
	WA DoT POLREP and SITREP available online (refer OPEP).	As requested by DoT after verbal notification.	Written	DoT
End of Activity				
OPGGS(E) Regulation 29 – Notifications NOPSEMA must be notified that the activity is completed.	Complete NOPSEMA's Regulation 29 Start or End of Activity Notification form for both notifications.	Within ten days after cessation of each activity campaign.	Written	NOPSEMA
AHO AMSA JRCC DCCEEW DMIRS	Activity Cessation Notification.	Within ten days after cessation of each campaign.	Written	AHO: datacentre@hydro.gov.au AMSA's JRCC: rccaus@amsa.gov.au DCCEEW: Petroleum&Fisheries@agriculture.gov.au DMIRS: petroleum.environment@dmirs.wa.gov.au
AHO Notification of abandoned equipment in situ	Provide location coordinates and description of equipment abandoned in situ so they can be marked on navigational charts	On completion of the decommissioning campaign	Written	AHO: datacentre@hydro.gov.au
AHO Notification of relinquishment	Provide coordinates and description of the PSZ to be	On completion of the decommissioning campaign	Written	AHO: datacentre@hydro.gov.au

Agency	Required information	Timing	Type	Recipient
of PSZ	relinquished.			
Commercial Fishers Notification As requested during consultation.	Activity Cessation Notification provided to relevant commercial fishing stakeholders, as agreed with WAFIC or relevant industry body.	Within ten days after cessation of each campaign.	Written	WAFIC oilandgas@wafic.org.au
OPGGS(E) Regulation 14(2) & 26C – Environmental Performance NOPSEMA must be notified of the environmental performance of the activity.	Report must contain sufficient information to determine whether or not environmental performance outcomes and standards in the EP have been met.	An environmental performance report will be submitted within three months of completion of each campaign.	Written	NOPSEMA
OPGGS(E) Regulation 25A EP ends when titleholder notifies completion and the Regulator accepts the notification. NOPSEMA must be notified that the activity has ended and all EP obligations have been completed.	Notification advising NOPSEMA of end of all activities to which the EP relates and that all obligations have been completed.	Within 12 months of the final Regulation 29 (2) notification.	Written	NOPSEMA

10.11.2 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 relevant marine orders.

Santos and support vessel contractors will maintain records so 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 10-8**.

Table 10-8: Monitoring methods for emissions and discharges

Discharge/emission	Parameter	Quantitative Record	Recording frequency
Chemicals (discharged to marine environment)	Volume	Chemical Risk Assessment Volumes used will be estimated based on known inventories	For every chemical used with a fate to the marine environment
Oily water	Volume and location	Oil Record Book or equivalent report	For every discharge
Garbage (including food scraps)	Volume and location	Garbage Record Book	For every discharge
Sewage	Volume and location	Sewage Record Book	For every discharge
Ballast water	Volume and location	Ballast water record book or log	For every discharge
Unplanned discharge of solid objects	Volume	Incident report	For every discharge
Unplanned discharge of hazardous liquids	Volume	Incident report	For every discharge
Unplanned hydrocarbon release	Volume	Incident report	For every discharge

10.12 Document management

10.12.1 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' intranet. Santos' contractors are also required to maintain current versions of these documents.

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Environmental performance outcomes and standards will be measured based on the measurement criteria listed in **Table 10-2**. Such records will be maintained for a period of five years. Contractors are required to make these records available upon request.

10.12.2 Management of change

The management of change (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 about the MoC process is provided in **Figure 10-1**.

The MoC procedure also allows for the assessment of new information that may become available after EP acceptance, such as new management plans for AMPs, 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 EP”, and the MoC process is followed accordingly.

Accepted MoCs become part of the in-force EP or OPEP, are tracked on a register and are made available on Santos’ intranet. Where appropriate, the EP compliance register will be updated so CM or EPS changes are communicated to the workforce and implemented. Any MoC will be distributed to the relevant management personnel identified in **Table 10-6** and the most relevant management position will ensure the MoC is communicated and implemented, which may include crew meetings, briefings or communications as appropriate for the change.

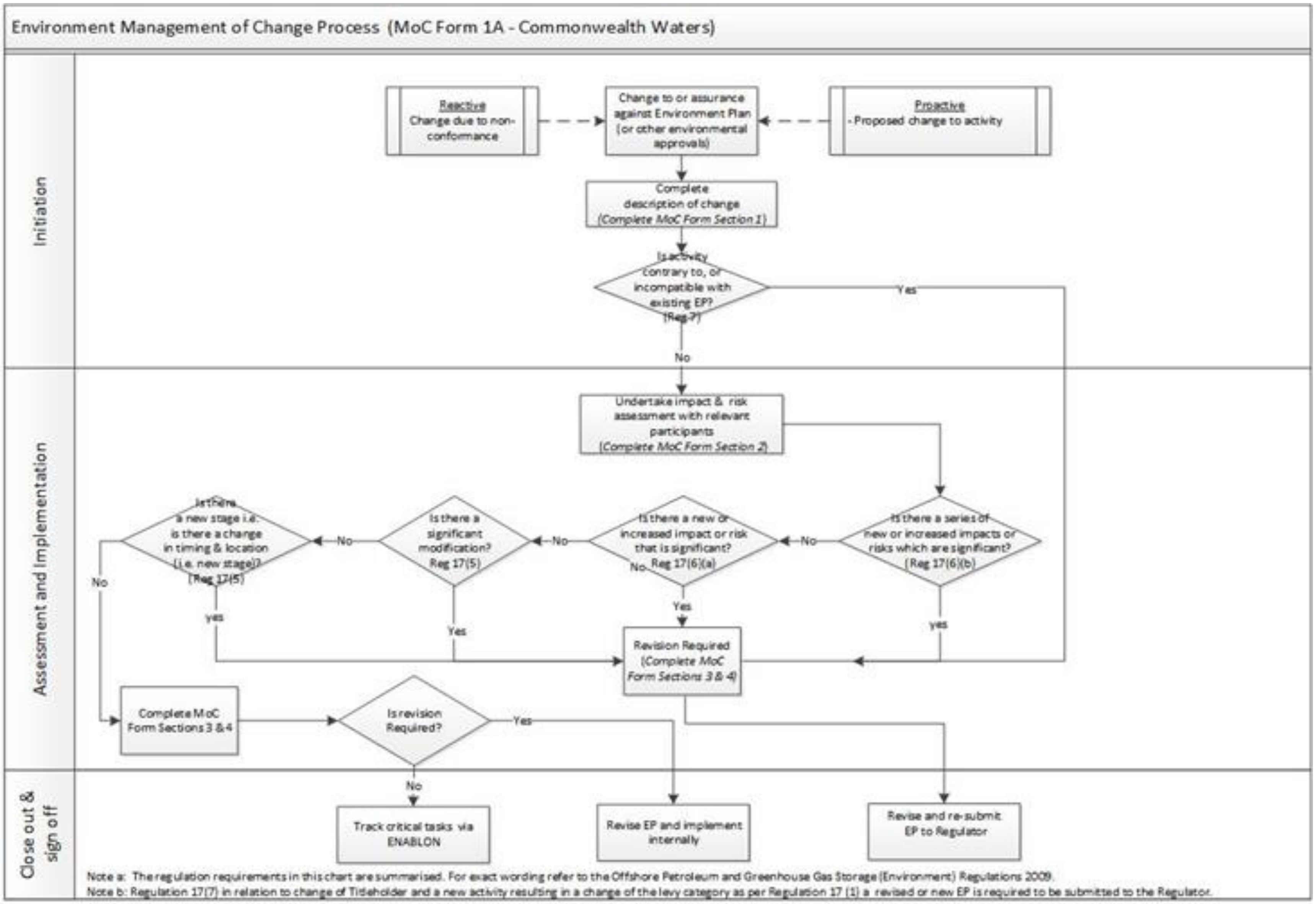

Figure 10-1: Environment management of change process

10.12.3 Reviews

This EP has assessed impacts and risk across the operational area, during any time of the year, for planned and unplanned events, given the nature of the 24/7 operations.

It is recognised that over the validity of this EP changes may occur, such as:

- legislation
- businesses conditions, activities, systems, processes and people
- industry practices
- science and technology
- societal and stakeholder expectations.

To ensure Santos maintains up-to-date knowledge of the industry, legislation and conservation advice, the following tasks are undertaken:

- Maintain membership of APPEA (Australian Petroleum Production & Exploration Association), 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.
- Undertake annual spill response exercises to check spill response arrangements and capability are adequate.
- Identify stakeholders prior to the activity commencing under this EP via the mechanisms outlined in **Section 6**.
- Review the Values and Sensitivities within the EMBA which includes completing a new EPBC Protected Matters Search, reviewing **Appendix D** against relevant legislation to capture and review any relevant updates and incorporate as required, and reviewing any recently known published relevant scientific papers.
- Subscribe to various regulator updates.
- Have regular liaison meetings with Regulators.

Through maintenance of up-to-date knowledge, these changes are identified. If the changes have an impact on the activity or risks described and assessed in this EP, the EP will be reviewed and any changes required documented in accordance with Santos' MoC procedure (**Section 10.12.2**).

10.13 Audits and reviews

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 the environmental performance outcomes and standards in the environment plan are being met.

10.13.1 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' audit schedule may be amended to accommodate operational priorities, activity risk, personnel availability or high audit demand during certain periods (for example, regulatory audits, contractor audits). Santos will determine if a vessel audit is required following contract award and vessel confirmation.

Audits will be undertaken in a manner consistent with Santos' Management Standard for Assurance (SMS MS15).

Audit scope typically includes a selection of CMs and EPSs and EPOs. However, audits may also include other parts of the EP.

Audit findings may include opportunities for improvement and non-conformances. Audit non-conformances are managed as described in **Section 10.13**.

10.13.2 Inspections

During an activity, HSE inspections (desktop or vessel based) will be conducted at least once during the activity to identify or review hazards, incidents and EP non-conformances. These inspections will also check compliance against all the EPOs and EPSs of this EP (**Table 10-1** and **Table 10-2**) and inform end of activity reporting (**Table 10-7**). Any in-field opportunities for improvement or corrective actions will be discussed during the inspection with the Vessel Master.

10.13.3 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. HSE 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.

10.13.4 Continuous improvement

Continuous improvement may result in a review of the EP, with changes applied in accordance with **Section 10.12.2**. For this EP, continuous improvement will be driven by:

+ improvements identified from the review of business-level HSE key performance indicators
+ actions arising from Santos and departmental HSE improvement plans
+ corrective actions and feedback from HSE audits and inspections, incident investigations and after-action reviews
+ opportunities for improvement and changes identified during pre-activity reviews and MoC documents
+ actions taken to address concerns and issues raised during the ongoing stakeholder management process (**Section 6**).

Identified continuous improvement opportunities will be assessed in accordance with the 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 Environment, Health and Safety Policy

Environmental Management

Santos

Policy

Our commitment

We share the community's concern for the proper care and custody of our environment for present and future generations. At Santos protecting the environment and valuing cultural heritage are an integral part of the way we do business.

Our objective is to implement best environmental practices wherever practical to do so. We are committed to demonstrating leadership in environmental management and ensuring that our actions are performed in a manner which has acceptable impact on the land, sea and air.

We will comply with all applicable environmental legislation and regulations relevant to our business.

We will promote continuous improvement in energy efficiency, greenhouse gas emission reduction and innovation to reduce our carbon footprint and energy use.

Our actions

Wherever we operate we will:

+ Maintain open community and government consultation regarding our activities and our environmental performance
+ Educate, train and encourage our workforce to conduct activities in an environmentally responsible manner
+ Identify, assess and control risks to the environment and the surrounding community in order to manage the potential for unacceptable pollution and impacts
+ Develop and implement systems to manage all activities which have the potential to affect the surrounding natural environment
+ Measure our environmental performance and set targets for continual improvement; and
+ Conduct monitoring of the surrounding natural environment thereby contributing to knowledge of natural systems and enabling any impacts to be detected.

Governance

This policy has been reviewed and endorsed by the Santos WA Energy Holdings Board of Directors and management who foresee benefits in, and take responsibility for, its successful implementation.

By accepting employment with Santos, each employee and contractor acknowledges that they are responsible for the application of this policy.

K. T. Gallagher

Kevin Gallagher
Managing Director & CEO

APPROVED 28 November 2018

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Appendix B: Legislative Framework

Australian Legislation

Commonwealth legislation	Summary	Relevant to activity?	Administering authority	Relevant aspects of the activity	EP section
Aboriginal and Torres Strait Islander Heritage Protection Act 1984	This Act provides for the preservation and protection from injury or desecration areas and objects that are of significance to Aboriginal people, under which the Minister may make a declaration to protect such areas and objects. The Act also requires the discovery of Aboriginal remains to be reported to the Minister.	Yes	Commonwealth – Department of Climate Change, Energy, the Environment and Water	There are no known sites of Aboriginal Heritage Significance within the operational area, but there are within the 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 offshore location of the activity.	**Section 5.2.3** – Protected / significant areas
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 Climate Change, Energy, the Environment and Water	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 9.2** – 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 a number of national heritage places found on the National Heritage List, within the EMBA, as identified by the Act.	**Section 5.2.3** – Protected/significant areas
Australian Maritime Safety Authority Act 1990 (AMSA Act)	This Act specifies that AMSA's 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.	Yes	AMSA	This Act applies to the use of any vessel associated with operations, and is relevant to the activity regarding the unplanned pollution from ships.	**Section 9.6** – Hydrocarbon spill – marine diesel oil

Commonwealth legislation	Summary	Relevant to activity?	Administering authority	Relevant aspects of the activity	EP section
	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.				
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; however, this has been deferred while an amendment to the Act is progressed.	Yes	Department of Primary Industries and Regional Development	Vessel movements have the potential to introduce IMS. This Act was considered during development of the Santos IMS Management Zone and IMS Management Plan (EA-00-RI-10172).	**Section 9.2** – Introduction of invasive marine species
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	**Sections 8 and 9** – 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	No	The Department of Immigration and Border Protection	This Act applies to the shipwrecks (over 75 years old) within the EMBA.	N/A

Commonwealth legislation	Summary	Relevant to activity?	Administering authority	Relevant aspects of the activity	EP section
	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.			There is no planned interaction or interference with shipwrecks, and any unplanned impacts is only expected to affect the surface waters.	
Biosecurity Act 2015 Biosecurity Regulations 2016	This Act provides the Commonwealth with powers to take measures of quarantine, and implement related programs as are necessary, to prevent the introduction of any plant, animal, organism or matter that could contain anything that could threaten Australia's native flora and fauna or natural environment. The Commonwealth's powers include powers of entry, seizure, detention and disposal. This Act includes mandatory controls on the use of seawater as ballast in ships and the declaration of sea vessels 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.	Yes	Commonwealth – Department of Climate Change, Energy, the Environment and Water	This Act applies to all internationally sources vessels operating in Australian Waters which could have the potential for the introduction of IMS and potential ballast water exchange.	**Section 9.2** – Introduction of IMS
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 1.6**
Environment Protection and Biodiversity	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	Yes	Commonwealth – Department of Climate Change, Energy, the	This Act applies to all aspects of the activity that have the potential to impact MNES. Appropriate environmental approvals	**Section 8.4** – Noise emissions **Section 0** – Light emissions

Commonwealth legislation	Summary	Relevant to activity?	Administering authority	Relevant aspects of the activity	EP section
Conservation Act 1999 EPBC Amendment Regulations 2006	through NOPSEMA's decision-making processes. This Act is the Australian Government's key piece of environmental legislation. The Act focuses on protecting MNES. AMP Management Plans were also developed under this Act.		Environment and Water	will be sought from NOPSEMA for all operations (this EP) which outlines compliance with the relevant regulations and plans under the Act. Where activities have existing approvals under the Act, these will continue to apply.	**Section 8.6** – Operational discharges **Section 0** – Planned chemical and hydrocarbon discharges **Sections 9.6**, **9.7** and **9.8** – Hydrocarbon release **Section 9.3** – Marine fauna interaction
Underwater Cultural Heritage Act 2018	This Act replaces the *Historic Shipwrecks Act 1976*, and extends protection 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		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. Numerous shipwrecks identified within EMBA.	**Sections 9.6**, **9.7** and **9.8** – Hydrocarbon release
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 Climate Change, Energy, the Environment and Water Climate Change Authority	This Act applies to the atmospheric emissions through combustion engine use to operate the vessels and MODU 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	**Section 8.5** – Atmospheric emissions

Commonwealth legislation	Summary	Relevant to activity?	Administering authority	Relevant aspects of the activity	EP section
				MARPOL Annex VI (Marine Order Part 97: Marine Pollution Prevention – Air Pollution), and require the use of low sulphur fuel.	
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 Equipment 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 Pollution), and require the use of low sulphur fuel.	**Section 8.5** – Atmospheric emissions
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	All vessel movements associated with the activity will be governed by AMSA marine safety regulations under the Act.	**Section 8.1** – Interaction with other marine users **Section 9.6** – Hydrocarbon spill – marine diesel oil
Navigation Act 2012	An Act regulating navigation and shipping including SOLAS. A number of Marine Orders enacted under this Act apply directly to offshore petroleum exploration and production activities: + Marine Order 21: Safety and Emergency Arrangements + Marine Order 27: Safety of Navigation and Radio Equipment	Yes	AMSA (operational) Department of Equipment and Regional Development Minister for Equipment and Regional Development	All vessel movements associated with the activity will be governed by marine safety regulations and Marine Orders under the Act.	**Section 8.1** – Interaction with other marine users **Section 9.6** – Hydrocarbon spill – marine diesel oil

Commonwealth legislation	Summary	Relevant to activity?	Administering authority	Relevant aspects of the activity	EP section
	+ Marine Order 30: Prevention of collisions + Marine Order 58: Safe Management of Vessels + Marine Order 70: Seafarer Certification.				
Offshore Petroleum and Greenhouse Gas Storage Act 2006 Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009	Petroleum exploration and development activities in Australia's offshore areas are subject to the environmental requirements specified in the OPGGS Act and associated Regulations. The OPGGS Act contains a broad requirement for titleholders to operate in accordance with 'good oil-field practice'. Specific environmental provisions relating to work practices essentially 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.	Yes	NOPSEMA	The activity involves cessation of production and decommissioning activities, which are petroleum activities regulated by NOPSEMA under this Act.	**Section 8.1** – Risk Assessments for Planned Events **Section 9** – Risk Assessments for Unplanned Events

Commonwealth legislation	Summary	Relevant to activity?	Administering authority	Relevant aspects of the activity	EP section
	The OPGGS Environment Regulations provide an objective based regime for the management of environmental performance for Australian offshore petroleum exploration and production activities in areas of Commonwealth jurisdiction. Key objectives of the Environment Regulations include to: + ensure operations are performed in a way that is consistent with the principles of ecologically sustainable development + adopt best practice to achieve agreed environment protection standards in industry operations + encourage industry to continuously improve its environmental performance.				
Ozone Protection and Synthetic Greenhouse Gas Management Act 1989	Regulates the manufacture, importation and use of ODSs (typically used in fire-fighting equipment and refrigerants). Applicable to the handling of any ODS.	Yes	Commonwealth – Department of Climate Change, Energy, the Environment and Water	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 8.5** – Atmospheric emissions
Protection of the Sea (Powers of Intervention) Act 1981 Protection of the Sea (Powers of Intervention) Regulations 1983	The Act authorises the Commonwealth to take measures for the purpose of protecting the sea from pollution by oil and other noxious substances discharged from ships and provides legal immunity for persons acting under an AMSA direction.	Yes	Commonwealth – Department of Equipment 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	**Section 8.1** – Interaction with other marine users **Section 8.6** – Planned operational discharges **Section 9.4** to **9.8** – Unplanned

Commonwealth legislation	Summary	Relevant to activity?	Administering authority	Relevant aspects of the activity	EP section
				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 91: Marine Pollution Prevention – Oil + Marine Order 93: Marine Pollution Prevention – Noxious Liquid Substances + Marine Order 94: Marine Pollution Prevention – Packaged Harmful Substances + Marine Order 95: Marine Pollution Prevention – Garbage + Marine Order 96: Marine Pollution Prevention – Sewage.	hydrocarbon and non-hydrocarbon/ chemical spills **Section 9.2** – Introduction of IMS
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	Yes	Commonwealth – Department of Equipment 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	**Section 8.6 –** Planned operational discharges **Section 9.4** to **9.8 –** Unplanned hydrocarbon and non-hydrocarbon/ chemical spills **Section 9.2 –** Introduction of IMS

Commonwealth legislation	Summary	Relevant to activity?	Administering authority	Relevant aspects of the activity	EP section
	Annexes I, II, III, IV, V and VI of MARPOL 73/78: + Marine Order 91: Marine Pollution Prevention – Oil + Marine Order 93: Marine Pollution Prevention – Noxious Liquid Substances + Marine Order 94: Marine Pollution Prevention – Packaged Harmful Substances + Marine Order 95: Marine Pollution Prevention – Garbage + Marine Order 96: Marine Pollution Prevention – Sewage + Marine Order 97: Marine Pollution Prevention – Air Pollution.			in place to give effect to relevant regulations of Annexes I, II, III, IV, V and VI of MARPOL 73/78: + Marine Order 91: Marine Pollution Prevention – Oil + Marine Order 93: Marine Pollution Prevention – Noxious Liquid Substances + Marine Order 94: Marine Pollution Prevention – Packaged Harmful Substances + Marine Order 95: Marine Pollution Prevention – Garbage + Marine Order 96: Marine Pollution Prevention – Sewage.	
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 may be undertaken at sea as part of the activity. Compliance with the Act reduces the risk of bunker oil pollution.	**Section 9.6** – Hydrocarbon spill – marine diesel oil
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 Equipment 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	**Section 9.2** – Introduction of IMS

Commonwealth legislation	Summary	Relevant to activity?	Administering authority	Relevant aspects of the activity	EP section
	This is enacted by Marine Order 98 (Marine Pollution – Anti-fouling Systems) 2013.			IMS/harmful impact on Australian biodiversity. This is enacted by Marine Order 98 (Marine Pollution – Anti-fouling Systems) 2013.	
Environment Protection (Sea Dumping) Act 1981	The Sea Dumping Act 1981 requires sea dumping permits to be required for particular activities and gives effect to the United Nations Convention on the Law of the Sea and the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (London Convention) and associated Protocol.	No	Commonwealth – Department of Climate Change, Energy, the Environment and Water	Not relevant for floating asset removal activities, however is applicable to abandonment in situ of proposed seabed equipment as part of decommissioning activities.	N/A
State Legislation					
Fish Resources Management Act 1994 *Fish Resources Management Regulations 1995*	This Act establishes a framework for management of fishery resources and is the nominated lead agency responsible for implementing Western Australian marine biosecurity management requirements through implementation of the *Fish Resources Management Act 1994* (FRMA 1994) and associated regulations.	Yes	Department of Primary Industries and Regional Development	Introduction of invasive marine species.	**Section 9.2** – Introduction of invasive marine species
Dangerous Goods Safety Act 2004	Act relating to the safe storage, handling and transport of dangerous goods and for related purposes.	Yes	Department of Mines, Industry Regulation and Safety	Relevant to the onshore transportation and disposal of the floating and seabed assets from the MEFF Field if they are landed and disposed of in Western Australia.	**Section 4.6.6** and **4.7.7** – Disposal

Commonwealth legislation	Summary	Relevant to activity?	Administering authority	Relevant aspects of the activity	EP section
Dangerous Goods Safety (Goods in Ports) Regulations 2007	'Goods in Ports' Regulations give legal status to the provisions of Australian Standard AS 3846 The handling and transport of dangerous cargoes in port areas. Requires classification of Dangerous Goods loads based on the International Maritime Dangerous Goods Code (IMDG) rather than ADG Code. Additional requirements are for safety management and emergency plans	Yes	Department of Mines, Industry Regulation and Safety	Relevant to the onshore transportation and disposal of the floating and seabed assets from the MEFF Field if they are landed and disposed of in Western Australia.	**Section 4.6.6** and **4.7.7** – Disposal
Dangerous Goods Safety (Storage and Handling of Non Explosives) Regulations 2007	Regulations adopt NOHSC Standard for the Storage and Handling of Workplace Dangerous Goods. Western Australia has retained a licensing system for dangerous goods. In relation to dangerous goods, 'handling' includes manufacture, process, pack, use, sell, supply, carry and disposal of dangerous goods. References to the Australian Dangerous Goods Code (the ADG Code) in the regulations relate to the 7th edition of the ADG Code.	Yes	Department of Mines, Industry Regulation and Safety	Relevant to the onshore transportation and disposal of the floating and seabed assets from the MEFF Field if they are landed and disposed of in Western Australia.	**Section 4.6.6** and **4.7.7** – Disposal
Environmental Protection Act 1986 *Environmental Protection (Controlled Waste) Regulations 2004*	Act contains measures for preventing or minimising pollution, which includes a general prohibition against pollution. Applicable areas include discharge of operational waste (sewage, galley waste) and oily water from vessels, gaseous emissions from diesel engines and ballast water exchange and discharge and controlled waste. The Act also regulates industrial emissions and discharges through a licensing process.	Yes	Department of Water and Environmental Regulation	Relevant to the onshore transportation and disposal of the floating and seabed assets from the MEFF Field if they are landed and disposed of in Western Australia.	**Section 4.6.6** and **4.7.7** – Disposal

Commonwealth legislation	Summary	Relevant to activity?	Administering authority	Relevant aspects of the activity	EP section
	The *Environmental Protection (Controlled Waste) Regulations 2004* provide for the licensing of carriers, drivers, and vehicles involved in transporting controlled waste on roads in Western Australia.				
Shipping and Pilotage Act 1967	Act relating to shipping and pilotage in and about the ports, fishing boat harbours and mooring control areas of the State.	Yes	Department of Transport	Relevant to the onshore transportation and disposal of the floating and seabed assets from the MEFF Field if they are landed and disposed of in Western Australia.	**Section 4.6.6** and **4.7.7** – Disposal
Navigable Waters Regulations 1958	Prescribes further matters on navigational safety in WA waters, use of jetties, obstruction and wrecks, berthing and mooring of vessels	Yes	Department of Transport	Relevant to the onshore transportation and disposal of the floating and seabed assets from the MEFF Field if they are landed and disposed of in Western Australia.	**Section 4.6.6** and **4.7.7** – Disposal

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, grey water, and putrescible wastes generated from support vessels and MODU. Deck drainage/deck wash-down, cooling, brine, ballast and bilge water from support vessels. Hydraulic fluid released by valve operation on seabed equipment. Various discharges from planned maintenance activities.	**Section 8.6** – 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.	Yes	Only relevant in so far as the credible spill scenario may result in impact to migratory seabirds foraging in area.	**Section 9.6** to **9.8 –** Unplanned hydrocarbon spills
Agreement Between the Government of Australia and the Government of the People's Republic of China for the Protection of Migratory Birds and Their Environment 1986 (commonly referred to as the China Australia Migratory Bird Agreement or CAMBA)	This agreement recognises the special international concern for the protection of migratory birds and birds in danger of extinction that migrate between Australia and China. Implemented in EPBC Act.	Yes	Only relevant in so far as the credible spill scenario may result in impact to migratory seabirds foraging in area.	**Section 9.6** to **9.8 –** Unplanned hydrocarbon spills
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*	No	Onshore disposal/recycling of the floating assets has been confirmed by Santos as occurring within Australia so this piece of legislation is not applicable.	**Section 6.6** – Operational discharges

International agreements and conventions	Summary	Relevant to activity?	Relevant aspects	EP section
	Waste (Regulation of Exports and Imports) Act 1989.			
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 8.4** – Noise emissions **Section 0** – Light emissions **Section 8.2** – Seabed and benthic habitat disturbance **Section 6.6** – Operational discharges **Section 9.3 –** Interaction with marine fauna **Section 9.4** to **9.8** – Unplanned releases
Convention on Oil Pollution Preparedness, Response and Co-operation 1990 (OPRC 90)	This convention comprises national arrangements for responding to oil pollution incidents from ships, offshore oil facilities, sea ports and oil handling. The convention recognises that in the event of pollution incident, prompt and effective action is essential.	Yes	In the event worse-case credible spill scenarios may enact a national arrangement for response.	**Section 9.6** to **9.8 –** Unplanned hydrocarbon spills **Section 8.9 –** Spill response operations
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 9.6** to **9.8 –** Unplanned hydrocarbon spills **Section 8.9 –** Spill response operations
International Convention for the Establishment of an International Fund for	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 agreements and conventions	Summary	Relevant to activity?	Relevant aspects	EP section
Compensation for Oil Pollution Damage (Fund 92)				
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 six Annexes, dealing respectively with oil, noxious liquid substances, harmful packaged substances, sewage, garbage and air pollution. Detailed rules are laid out as to the extent to which (if at all) such substances can be released in different sea areas. The legislation giving effect to MARPOL in Australia is the *Protection of the Sea (Prevention of Pollution from Ships) Act 1983*, the *Navigation Act 2012* and several Parts of Marine Orders made under this legislation.	Yes	Already dealt with through the *Protection of the Sea (Prevention of Pollution from Ships) Act 1983* – refer to legislation table.	N/A
International Convention for the Safety of Life at Sea 1974	This convention is generally regarded as the most important of all international treaties concerning 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 8.1** – 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	The IMO has been addressing the problem of invasive marine species in ship's ballast water since the 1980s.	Yes	Potential internationally sourced vessel operating in Australian Waters which could have the potential for	**Section 9.2** – Introduction of

International agreements and conventions	Summary	Relevant to activity?	Relevant aspects	EP section
Sediments (Ballast Water Convention) 2004	Ballast water and sediments guidelines were adopted in 1991 and the ballast water convention was adopted in 2004. Recent accession by Finland has triggered the final entry into force of these international requirements. As a result, the International Convention for the Control and Management of Ships Ballast Water and Sediment will enter into force on 8th September 2017 (IMO Briefing 22 2016). It aims to prevent the spread of harmful aquatic organisms from one region to another, by establishing standards and procedures for the management and control of ships' ballast water and sediments. Ballast Water Management systems must be approved by the Administration in accordance with this IMO Guidelines.		introduction of IMS and potential ballast water exchange.	invasive marine species
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	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 Order 91: Marine Pollution Prevention – Oil + Marine Order 93: Marine Pollution Prevention – Noxious Liquid Substances	**Section 8.6** – Operational discharges **Section 9.4** to **9.8** – Unplanned releases **Section 9.2** – Introduction of invasive marine species

International agreements and conventions	Summary	Relevant to activity?	Relevant aspects	EP section
	relating to the implementation of Part XI of the Convention in 1982, and UNCLOS in 1994.		+ Marine Order 94: Marine Pollution Prevention – Packaged Harmful Substances + Marine Order 95: Marine Pollution Prevention – Garbage + Marine Order 96: Marine Pollution Prevention – Sewage + Marine Order 97: Marine Pollution Prevention – Air Pollution.	
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 to 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. The MODU and support vessels will use diesel, which is a low sulphur fuel.	**Section 0** – Atmospheric emissions
Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter, 1972 (known as the London Protocol)	The London Convention contributes to the international control and prevention of marine pollution by prohibiting the dumping of certain hazardous materials.	No	Onshore disposal/recycling of the floating assets has been confirmed by Santos as not occurring internationally and not involving any disposal in the marine environment, so this Convention is not applicable.	**Section 6.6** – Operational discharges

Appendix C: MEFF Decommissioning Comparative Environmental Impact Assessment

Comparative Environmental Impact Assessment

MEFF Decommissioning

Santos

16 June 2022

411012-00326

Advisian
Worley Group

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PROJECT 411012-00326 - 411012-00326-001: Comparative Environmental Impact Assessment - MEFF Decommissioning

Rev	Description	Author	Review	Advisian approval	Revision date	Client approval	Approval date
A	Draft	W. Chisholm	R. Morgan	R. Morgan	02.11.21	A McGovern	30.11.21
B	Draft	W. Chisholm	R. Morgan	R. Morgan	15.12.21	A McGovern	21.01.22
C	Draft	W. Chisholm	R. Morgan	R. Morgan	04.02.22	A McGovern	25.02.22
0	Final	W. Chisholm	R. Morgan	R. Morgan	07.06.22	A McGovern	07.06.22
1	Final	W. Chisholm	R. Morgan	R. Morgan	16.06.22		

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Executive summary

Santos Ltd (Santos) is the titleholder for production licences WA-54-L, WA-26-L and WA-27-L, which cover the Mutineer, Exeter, Fletcher, and Finucane light crude oil fields, collectively referred to as MEFF fields. The fields are in water depths of 130-160 m on the North West Shelf approximately 150 km offshore from Dampier.

Santos commenced production from the MEFF fields in 2005, with production ceasing in 2018. Hydrocarbons were produced from a series of subsea wells linked by subsea pipelines via a disconnectable turret mooring (DTM) to a floating production storage and offloading unit (FPSO). Following cessation of production:

- all wells were shut in,
- the subsea production system was flushed to reduce hydrocarbons and preserved with treated seawater,
- the FPSO was removed from the field, and
- the DTM was lowered to approximately 30 m below the sea surface.

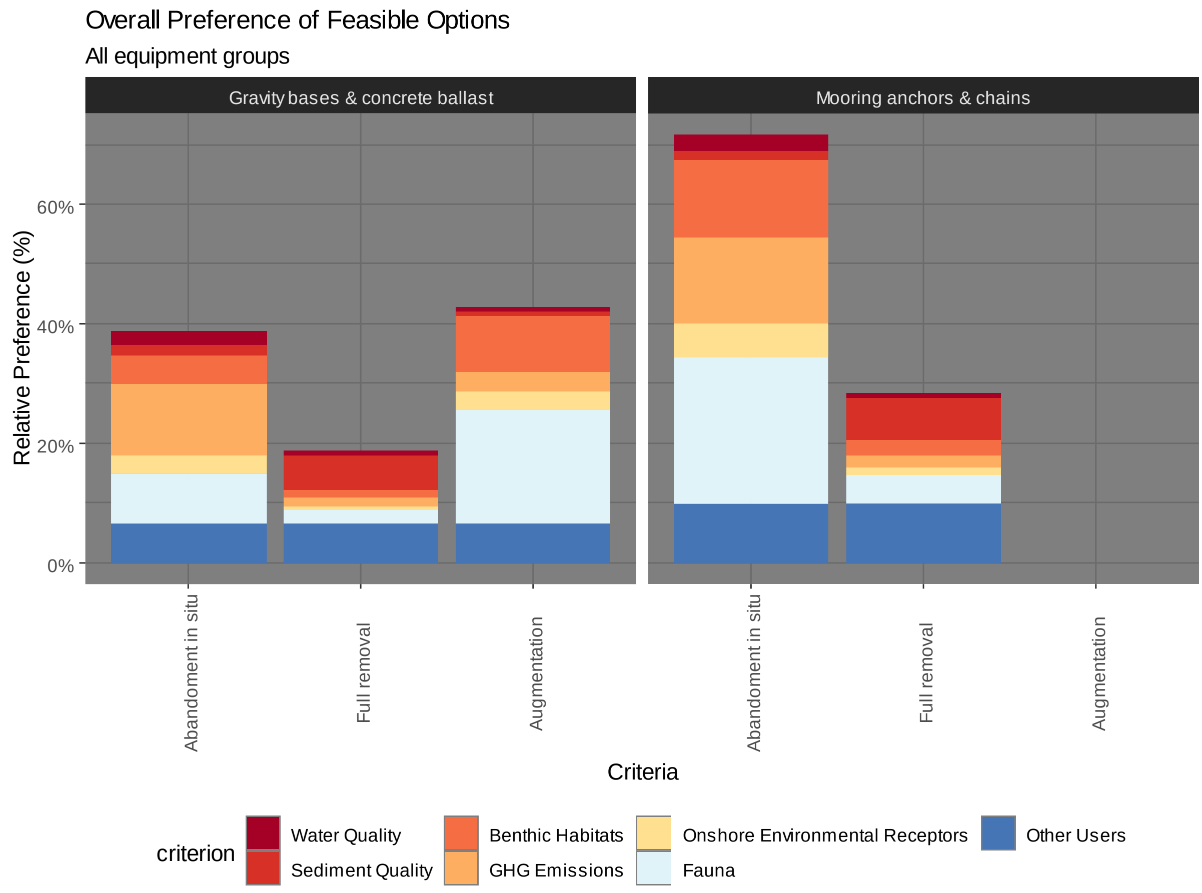
Santos is preparing to decommission the remaining equipment in the MEFF fields and is considering decommissioning options. Santos has identified two equipment groups for which alternatives to full removal are being considered – gravity bases and concrete ballast, and mooring anchors and chains. These equipment groups and the feasible decommissioning options are summarised in the table below.

Equipment Group	Full Removal	Abandonment *In Situ*	Augmentation
Gravity bases and concrete ballast	Yes	Yes	Yes
Mooring anchors and chains	Yes	Yes	No

As required by the *Section 572 Maintenance and Removal of Property* (NOPSEMA 2020), this document compares the environmental outcomes of the feasible alternatives to full removal to determine their relative environmental outcomes. The relative environmental outcomes were determined by a comparative environmental impact assessment of the feasible decommissioning options.

The comparative environmental impact assessments for each of the equipment groups was done using the analytic hierarchy process (AHP). This process identified the environmental receptors that may credibly be impacted by the feasible decommissioning options for each of the equipment groups. The AHP determined the relative weightings of each of these environmental receptors. The feasible decommissioning options for each equipment group were then compared in relation to each of the environmental receptors. These comparisons were then aggregated and weighted in accordance with the AHP. The resulting overall preferences for the feasible options are shown in the figure below. For

each of the equipment groups, an alternative to full removal was shown to yield equal or better environmental outcomes.



Acronyms and Abbreviations

Acronym/abbreviation	Definition
AHP	Analytic hierarchy process
CI	Consistency index
CO_2	Carbon dioxide
CR	Consistency ratio
DGV	Default guideline value
DP	Dynamic positioning
DP2	Dynamic positioning system - redundancy
DTM	Disconnectable turret mooring
EP	Environment plan
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
FPSO	Floating production, storage, and offtake
GHG	Greenhouse gas
GV-high	Guideline value high
IMO	International Maritime Organization
KEF	Kef Ecological Feature
MARPOL	International Convention for the Prevention of Pollution from Ships, 1973 as modified by the Protocol of 1978
MCDA	Multi-criteria decision analysis
MEFF	Mutineer, Exeter, Fletcher, and Finucane
NOPSEMA	National Offshore Petroleum Safety and Environmental Management Authority
OPGGS Act	*Offshore Petroleum and Greenhouse Gas Storage Act 2006*
OPGGS (E) Regulations	Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009
PMST	Protected Matters Search Tool
RI	Random index
ROV	Remotely operated vehicle

1 Introduction

Santos Ltd (Santos) is the titleholder for production licences WA-54-L, WA-26-L and WA-27-L, within which lie the Mutineer, Exeter, Fletcher, and Finucane light crude oil fields, collectively referred to as MEFF fields. The fields are in water depths of 130-160 m on the North West Shelf approximately 150 km offshore from Dampier (Figure 1-1).

Santos commenced production from the MEFF fields in 2005, with production ceasing in 2018. Hydrocarbons were produced from a series of subsea wells linked by subsea pipelines via a disconnectable turret mooring (DTM) to a floating production storage and offloading unit (FPSO). Following cessation of production:

- all wells were shut in,
- the subsea production system was flushed to reduce hydrocarbons and preserved with treated seawater,
- the FPSO was removed from the field, and
- the DTM was lowered to approximately 30 m below the sea surface.

Inspections and environmental sampling have been undertaken since cessation of production in accordance with the Mutineer Exeter Cessation of Production Environment Plan (EP) (9885-650-PLN-0001).

Santos is preparing to decommission the remaining equipment in the MEFF fields and is considering decommissioning options. Section 572 of the *Offshore Petroleum and Greenhouse Gas Storage Act 2006* (OPGGS Act) requires Santos to remove equipment from the MEFF fields when it is no longer in use, such as following cessation of production. The National Offshore Petroleum Safety and Environmental Management Authority's (NOPSEMA's) policy *Section 572 Maintenance and Removal of Property* (2020) provides for alternative arrangements to the removal of equipment to be accepted under the Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009 (OPGGS (E) Regulations) on the conditions that:

- the Environment Plan (EP) detailing the alternative arrangements meets the criteria for acceptance under the OPGGS (E) Regulations, and
- the EP demonstrates that the alternative arrangements are expected to result in equal, or better, environmental outcomes compared to the removal of equipment.

Santos has identified several feasible decommissioning options, including alternatives to full removal for some of the equipment in the MEFF fields. As required by the *Section 572 Maintenance and Removal of Property* (NOPSEMA 2020), this document compares the environmental outcomes of the feasible decommissioning options to determine their relative environmental outcomes. The relative environmental outcomes were determined by a comparative environmental impact assessment of the feasible decommissioning options.

The structure of this report reflects the logical arrangement of the comparative assessment process used to compare the environmental outcomes of the feasible options. The following points outline key sections of this report:

- Section 2: Identifies the equipment for which alternatives to full removal are being assessed.

- Section 3: Describes the feasible options that comprise the alternatives being considered.
- Section 4: Describes the comparative assessment methodology.
- Section 5: Compares the environmental receptors that may be impacted by the feasible options to determine their relative weightings in the assessment
- Section 6: Assesses the impacts that may be caused by the feasible options for each of the environmental receptors
- Section 7: Summarises the results of the comparative assessment.

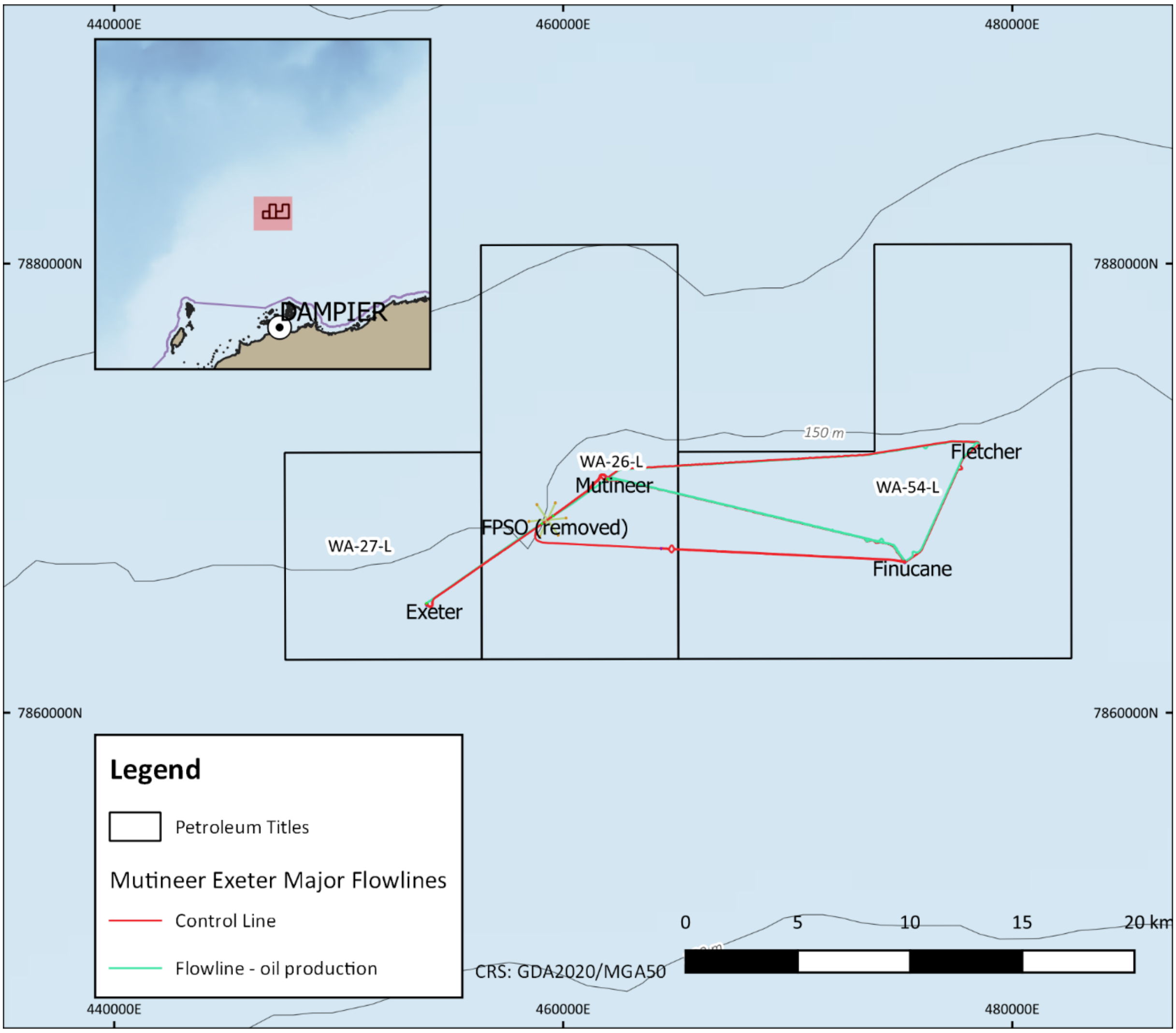


Figure 1-1 MEFF fields overview

1.1 Offshore Decommissioning Environmental Policy and Legislative Context

The *Section 572 Maintenance and Removal of Property* policy (NOPSEMA 2020) outlines NOPSEMA's interpretations of the application of Section 572 of the OPGGS Act and subsidiary regulations to decommissioning of offshore petroleum infrastructure. The following sections of the *Section 572*

Maintenance and Removal of Property policy (NOPSEMA 2020) are relevant to the decommissioning of the MEFF fields, each of which is considered below:

- removal of property (Section 1.1.1), and
- deviations from the requirements to maintain and remove property (Section 1.1.2).

1.1.1 Removal of Property

The *Section 572 Maintenance and Removal of Property* policy (NOPSEMA 2020) cites the requirements in Section 572(3) of the OPGGS Act for titleholders to remove property that is not used, or will not be used. This is the "base case" for decommissioning expressed in several of the publications that preceded the policy. Importantly, the policy states:

> "*Deviations from the property removal requirement of section 572 may be agreed to by NOPSEMA through permissioning documents. A deviation in the context of this regulatory policy includes where a titleholder intends to do something that is different from the requirement of section 572(3).*"

This prompted Santos to assess alternative options to the base case of full removal. The draft *Section 270 NOPSEMA Advice – Consent to Surrender Title* (NOPSEMA 2021) indicates that "permissioning documents" include EPs, safety cases and well operations management plans.

The *Section 572 Maintenance and Removal of Property* (2020) policy outlines the principles NOPSEMA applies when considering removal of property:

- Complete removal of all property is the base case for all offshore operations and should inform the basis for field development planning.
- All property is to be designed, installed, and operated to ensure it can be removed when it is neither used, nor to be used, unless a deviation is provided for in a permissioning document approved by NOPSEMA.
- Removal should be planned and undertaken throughout the operations authorised by the title when property is neither used, nor to be used.
- Complete removal of property must be completed while the title is still in force unless a deviation from the complete property removal requirement has been approved by NOPSEMA.
- NOPSEMA's acceptance of the activities associated with removal of property is obtained under the OPGGS (E) Regulations and the Offshore Petroleum and Greenhouse Gas Storage (Resource Management and Administration) Regulations 2011
- Where titleholders engage contractors to operate facilities, titleholders remain ultimately responsible for ensuring that adequate provisions including assurance and oversight are in place to meet the property removal requirements on titleholders.

1.1.2 Deviations from the Requirements to Maintain and to Remove Property

NOPSEMA recognises that removal of property may not always be practicable. NOPSEMA's *Section 572 Maintenance and Removal of Property* policy (2020) states that NOPSEMA must be reasonably satisfied that an EP proposing alternative arrangements meets the acceptance criteria in the OPGGS (E) Regulations. NOPSEMA must also have regard to the *Offshore Petroleum Decommissioning Guideline*

(Commonwealth of Australia, 2018), including titleholder demonstrations that the proposed alternative arrangements provide for equal or better environmental outcomes. The policy subsequently states the EP must include:

- An evaluation of the feasibility of all options, including partial and complete property removal.
- An evaluation of environmental impacts and risks of all feasible options, including complete property removal, to enable NOPSEMA to have regard to the *Australian Government Decommissioning Guideline* (Commonwealth of Australia, 2018) policy principle that deviations will provide an equal or better environmental outcome when compared to complete property removal. The evaluation of all the environmental impacts and risks of each option must include consideration of control measures necessary to manage the impacts and risks.
- Evaluation of all environmental impacts and risks within Australia's environment including, where relevant, indirect consequences that may arise from the petroleum activity of removing property from a title area.
- Where deviation/s to removal of property or relocation of property is proposed, titleholders are to address arrangements for long term monitoring and management. EPs requiring long-term monitoring for property will be subject to environmental performance reporting requirements and compliance monitoring by NOPSEMA for the duration of the monitoring program. NOPSEMA advises the Joint Authority of EPs requiring long term monitoring for property and this may be a matter taken into account when considering surrender of titles.
- Consideration of relevant persons' consultation with respect to the options being proposed.

The policy states that multi-criteria decision analysis (MCDA) may be used in an EP but notes that unless the information from the MCDA can be applied directly to the acceptance criteria of the OPGGS (E) Regulations the EP is unlikely to demonstrate that the regulatory criteria for acceptance have been met.

2 Equipment Being Considered for Abandonment In Situ

Santos' decommissioning philosophy for the MEFF field is to remove all equipment that may result in unacceptable environmental impacts. This includes impacts to receptors such as other users, marine fauna, and the physical environment. Santos considers a range of requirements in determining acceptability of impacts, such as

- consultation outcomes,
- the Australian and New Zealand Guidelines for Fresh And Marine Water Quality (Commonwealth of Australia and New Zealand Government, 2018),
- plans made under the EPBC Act, such as threat abatement plans, species recovery plans and management plans for Australian marine parks, and
- Santos' internal policies, such as a commitment to remove plastics from the sea for the MEFF project.

The MEFF field contains a range of types of equipment that was used to produce hydrocarbons. This equipment inventory, aggregated into groups, is summarised in Table 2-1. The equipment groups were identified prior to, and agreed upon during, a project framing workshop. Equipment groupings considered attributes such as spatial proximity, integration between equipment, and equipment materials. Santos has undertaken preliminary analysis of feasible decommissioning options for the equipment types within the MEFF field, which are summarised in Table 2-1.

Descriptions of the feasible options that are considered in this comparative assessment are provided in Section 3. Santos' preferred decommissioning option based on the preliminary analysis is Option 3, which is intended to remove most equipment for onshore disposal, including all equipment containing plastics. Hence, this comparative environmental impact assessment is based on Option 3. Santos determined Option 3 was its most preferred option based on the following points:

- Equipment made of materials that pose little hazard to the environment, such as steel and concrete, are abandoned *in situ*. This will preserve the environment that has developed on and around this equipment and reduce the cost and complexity of the offshore removal and onshore disposal works required.
- Most of the materials identified as environmental hazards, such as plastics and radiation sources, will be removed and disposed of onshore.

Only the equipment groups that will not be removed under Option 3 are considered in this comparative environmental impact assessment. Each of these equipment groups is described in more detail below. The feasible decommissioning options for these groups are described in Section 3. Equipment groups that will be removed have not been considered further as full removal is the base case for decommissioning and is consistent with s572 of the OPGGS Act. Santos is not proposing an alternative to full removal for this equipment, hence there is no requirement to demonstrate removal results in equal or better environmental outcomes than any alternative decommissioning options.

Table 2-1 Summary of decommissioning options considered by Santos for equipment groups within the MEFF fields. Section 3 contains descriptions of the feasible options being considered in this comparative environmental impact assessment.

Equipment Group	Option 1 (Full Removal)	Option 2 (All Remain *In Situ*)	Option 3 (Plastic Removed)	Option 4 (Rigids Remain)	Option 5 (Most *In Situ*)
12" rigid production flowlines	Full removal	Leave *in situ*	Full removal	Leave *in situ*	Leave *in situ*
2" coiled tubing well service flowlines (piggybacked to 12" rigid production flowlines)	Full removal	Leave *in situ*	Full removal	Leave *in situ*	Leave *in situ*
Flexible flowlines	Full removal	Leave *in situ*	Full removal	Full removal	Leave *in situ*
Production manifolds	Full removal	Leave *in situ*	Full removal	Leave *in situ*, flowmeters removed	Augmentation
Production manifold mudmats	Full removal	Leave *in situ*	Full removal	Leave *in situ*	Augmentation
Pipeline end manifolds	Full removal	Leave *in situ*	Full removal	Full removal	Augmentation
Rigid tie-in spools	Full removal	Leave *in situ*	Full removal	Full removal	Augmentation
Umbilicals	Full removal	Leave *in situ*	Full removal	Full removal	Leave *in situ*
Hydraulic flying leads / Electric flying leads	Full removal	Leave *in situ*	Full removal	Full removal	Full removal
Production Umbilical Distribution Units / Umbilical Termination Assemblies	Full removal	Leave *in situ*	Full removal	Full removal	Leave *in situ*

Equipment Group	Option 1 (Full Removal)	Option 2 (All Remain *In Situ*)	Option 3 (Plastic Removed)	Option 4 (Rigids Remain)	Option 5 (Most *In Situ*)
Subsea trees	Full removal	Leave *in situ*	Full removal	Full removal	Augmentation
Tree flowbases / guidebases	Full removal	Leave *in situ*	Full removal	Full removal	Augmentation
Flexible risers	Full removal	Leave *in situ*	Full removal	Full removal	Disconnect and abandon
Midwater arches	Full removal	Flood, sink and abandon	Full removal	Full removal	Flood, sink and augmentation
Midwater arch gravity bases	Full removal	Leave *in situ*	Leave *in situ*	Leave *in situ*	Augmentation
Gravity base concrete ballast modules	Full removal	Leave *in situ*	Leave *in situ*	Leave *in situ*	Augmentation
Midwater arch tether chains	Full removal	Leave *in situ*	Full removal	Full removal	Full removal
DTM spider buoy	Full removal	Flood, sink and abandon	Full removal	Full removal	Flood, sink and abandon
DTM mooring anchors and chains	Full removal	Leave *in situ*	Leave *in situ*	Leave *in situ*	Leave *in situ*
DTM mooring riser wires	Full removal	Leave *in situ*	Full removal	Full removal	Full removal
Wellheads and casings	Full removal	Leave *in situ*	Full removal	Full removal	Full removal
Umbilical riser bases	Full removal	Leave *in situ*	Full removal	Full removal	Leave *in situ*

2.1 Gravity Bases and Concrete Ballast

There are two gravity bases installed in the MEFF fields to which the mid-water arch buoys are tethered. The gravity bases are approximately 333 tonnes each and consist of steel structures with attached concrete ballast. Both are sitting on the seabed near the location of the FPSO (which has been removed). Corrosion prevention measures consist of protective epoxy paint coatings and sacrificial anodes. The gravity bases include ballast compartments which were flooded during installation.

The mid-water arch buoys will be removed as part of a campaign to remove floating equipment from the MEFF fields. There are two small ball valves on each gravity base that were part of the ballast system. Each valve contains a small quantity of plastics (approximately 100 g), which will be abandoned *in situ*.

Figure 2-1 MEFF field gravity base during installation (from GHD et al., 2021)

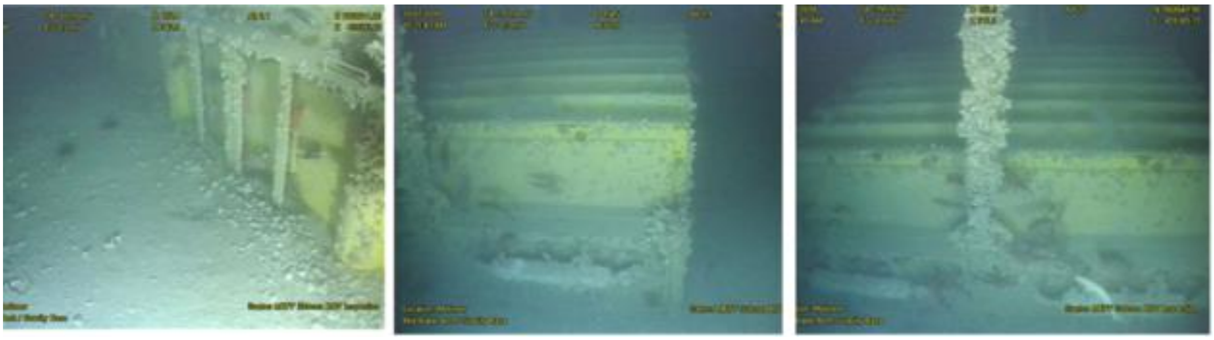


Figure 2-2 Gravity base in situ in the MEFF field (from GHD et al., 2021)

2.2 Mooring Anchors and Chains

A series of six mooring anchors with attached tether chains were installed in the MEFF fields to hold in place the spider buoy. The components of a single mooring anchor and chain are summarised in Table 2-2. The mooring layout and components arrangement are shown in Figure 2-3 and Figure 2-4 respectively. Images of the midwater sections of the mooring chains from inspection footage are shown in Figure 2-5

The anchors are entirely embedded within the seabed, with no disturbance to the seabed observed at the anchors during visual surveys in 2021. The anchors were designed to penetrate the seabed to depths between 6 and 13 m and were tensioned following installation. Chains attached to the anchors that were resting on the seabed were observed to be completely buried along approximately two thirds of their length. The portion of the chains between the anchor and the catenary leading to the spider buoy are sitting on the seabed and are assumed to be partially buried.

The spider buoy will be removed as part of a campaign to remove floating equipment from the MEFF fields. The tether chains will be laid on the seabed following disconnection from the spider buoy.

Table 2-2 Summary of mooring anchors and chains components for a single anchor

Item	Description	Length / Qty
Anchor	17 Te Vryhof Stevpris MK 5 steel anchor	1 unit
Anchor shackle	Steel anchor D shackle	1 unit
Ground chain	80 mm studless grade RQ3S steel chain	500 m length
Joining shackle	Steel D shackle	1 unit
Excursion limiter load chain	112 mm studless grade RQ3 steel chain	Approx. 225 m length
Weight chain hanger shackle	Steel D shackle	20 units
Excursion limiter weight chain	118 mm studless steel chain	10 x 27.8 m lengths
Joining shackles	Steel D shackle	1 unit
Riser wire (which will be removed)	74 mm spiral strand grade 1870 steel wire with 8 mm plastic sheath	90 m length

Item	Description	Length / Qty
Joining shackles	Steel D shackle	1 unit
Top chain (which will be removed)	84 mm grade R3S steel chain	Approx. 30 m length

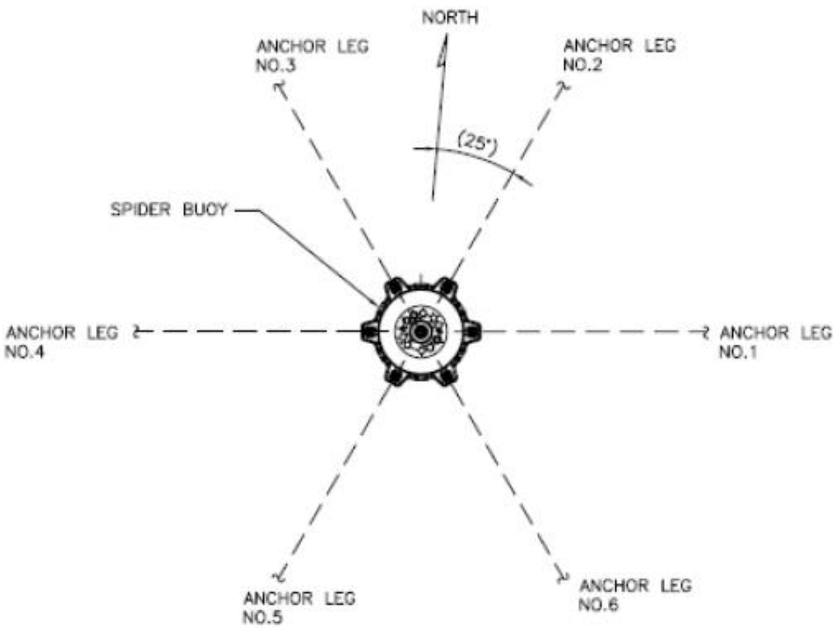


Figure 2-3 DTM mooring pattern

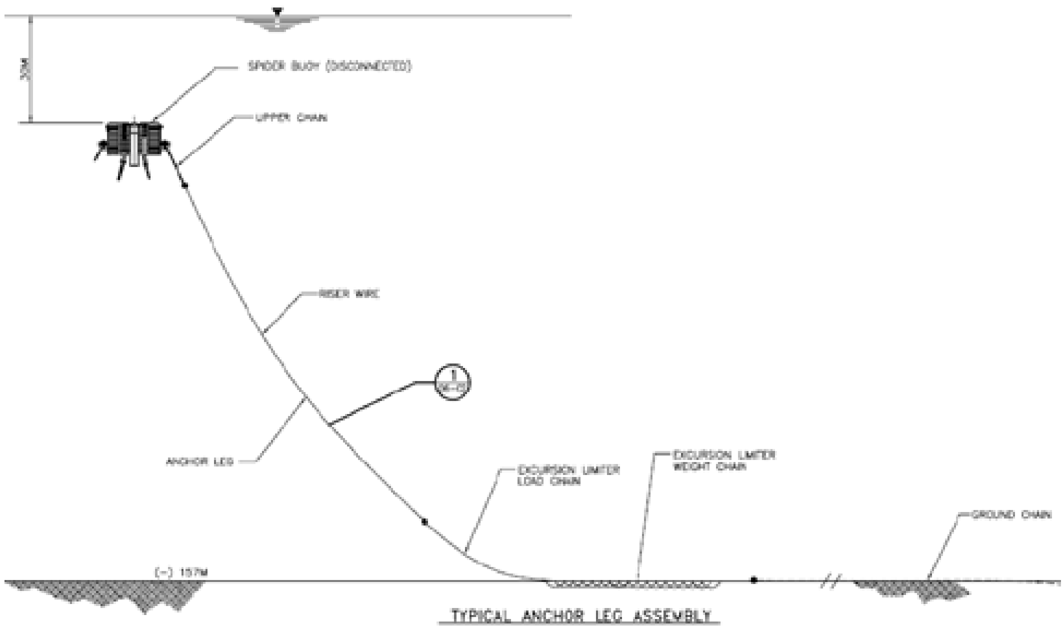


Figure 2-4 DTM Mooring Arrangement

Figure 2-5 Mid-water section of mooring tether chain within the MEFF fields (from GHD et al., 2021)

3 Feasible Decommissioning Options

The feasible decommissioning options for equipment being considered for abandonment *in situ* were identified in two steps – identification and screening.

The following decommissioning options were identified for the equipment being considered for abandonment *in situ*:

- Manage-in-situ refers to leaving the structure, in whole or in part, in-place.
- Augmentation consists of subsea construction (i.e., artificial reefs are created alongside the existing equipment to provide additional habitat complexity and ecological benefit).
- Full removal refers to the complete removal of the equipment (base case option)

Each of the options listed above were matched to equipment groups and pre-screened for technical feasibility. The options for each equipment group were assessed in a workshop with participants from Santos' environmental, health, safety and decommissioning teams, and external consultants. The decommissioning options for equipment being considered for abandonment *in situ* is summarised in Table 3-1. Note that not all options apply to all equipment groups under consideration for abandonment *in situ*.

Each of the decommissioning options is described further below. Refer to GHD et al. (2021) for further information on the identification and assessment of feasible decommissioning options.

Table 3-1 Summary of feasible decommissioning options for equipment groups

Equipment Group	Full Removal	Abandonment *In Situ*	Augmentation
Gravity bases and concrete ballast	Yes	Yes	Yes
Mooring anchors and chains	Yes	Yes	No

3.1 Full Removal

The full removal methodologies for discrete pieces of equipment consists of securing lifting lines to the equipment in the MEFF field and recovering it to the surface for disposal onshore. This method is limited by the size and weight of the equipment within the MEFF field, and some equipment is expected to be lifted as components (e.g., concrete ballast from gravity bases may be lifted separately from the steel gravity base structure). Lifting is assumed to be like the reverse of the installation process. Contingencies requiring bespoke lifting methods (e.g., construction and use of custom lifting frames) may be required, however this comparative environmental impact assessment assumes such contingencies will not be needed.

Some of the equipment in the MEFF field is partially or completely buried by sediments, which may need to be removed to lift the equipment from the seabed. Sediment removal may be accomplished by water jetting, using a mass flow excavator (MFE) or similar or dredging by a ROV. The mooring anchors are deeply embedded in the seabed. Recovery of the anchors is assumed to be done by pulling the anchors free in the opposite direction to which they were installed. Seabed intervention may be required to free the anchors, such as mass flow excavation. Removal of the anchors will result in substantial disruption of the seabed above, around and along the removal path of the anchors.

Most of the marine growth on MEFF equipment is assumed to be removed offshore and discharged to the marine environment, and the recovered equipment would be brought ashore for processing and disposal. The disposal options for equipment will be determined by the classification of the waste material. Most of the material recovered comprises steel and concrete, which is expected to be suitable for recycling or disposal in landfill facilities.

3.1.1 Vessel Specifications

Full removal of the equipment being considered would be done as part of the equipment removal campaign for the MEFF field.

Removal of the gravity bases and concrete ballast is expected to require an offshore construction support vessel with the following capabilities:

- DP2-rated dynamic positioning,
- Sufficiently rated crane with a subsea hook,
- Crane able to transfer recovered equipment to shore in port, and
- Open deck space for storage of recovered equipment.

A review of potentially suitable vessels indicated the *Seven Oceanic* (Figure 3-1) is a suitable analogue for a construction support vessel capable of full removal of equipment. Indicative vessel specifications for the *Seven Oceanic* are provided in Table 3-2. This vessel exceeds the specifications to fully remove the equipment groups being considered, but it representative of the type of vessel that may be used for the equipment removal campaign, and hence it is suitable for informing the comparative environmental impact assessment.

Recovery of the mooring chain may optionally be accomplished by an Anchor Handling Tug, depending on the recovery method. Indicative vessel specifications for the *MMA Centurion* are provided in Table 3-3 and the vessel is illustrated in Figure 3-2.

Figure 3-1 Seven Oceanic, an indicative construction support vessel

Figure 3-2 MMA Centurion, an indicative anchor handling tug

Table 3-2 Seven Oceanic vessel specifications

Length overall	157 m
Breadth	27 m
Maximum speed	17 knots
Dynamic positioning system	DP-3
Accommodation	140
Main crane	400 tonnes at 15 m

Table 3-3 MMA Centurion vessel specifications

Length overall	70 m
Breadth	17 m
Maximum speed	14 knots
Dynamic positioning system	DPS-2
Accommodation	50

3.1.2 Waste Management

The recovered equipment assumed to be offloaded, stored, and processed in or around the ports of Dampier, Onslow, or Exmouth. The area required for storing, handling, and processing equipment recovered from the field will depend on the timing of decommissioning activities. For example, decommissioning through a staggered campaign may require less area onshore as materials could be processed and storage areas freed up whilst waiting for the next part of the campaign to commence. Given the amount of material that may be recovered from the MEFF fields, it is assumed that no additional clearing of land would be required, and that storage, handling and processing of equipment would occur at existing facilities.

The processing required to prepare recovered equipment for disposal has not been subject to detailed studies yet, but is expected to consist of:

- Removal of residual marine growth,
- Removal of external coatings,
- Segregation of wastes into categories for disposal or recycling.

Steel wastes are expected to be recyclable. Other waste streams are expected to be sent to landfill. All wastes streams are assumed to be processed within Australia for this environmental impact assessment.

3.1.3 Duration

The duration of the full removal activities for the gravity bases and concrete ballast and the mooring anchors and chains is expected to require approximately 30 days, including contingency time (e.g., due to weather delays).

3.1.4 Environmental Aspects of Full Removal

The full removal option was identified as a feasible option for all the equipment groups (Table 3-1). The environmental aspects of the full removal of these equipment groups are described below.

3.1.4.1 Atmospheric Emissions

Combustion emissions from vessels (and incidental incinerator emissions) will be the principal source of atmospheric from the full removal options. Fuel sources are expected to comprise marine gas oil or marine diesel oil for main engines and diesel for stationary equipment, such as cranes. Emissions from vessel combustion engines and incinerators include carbon dioxide, carbon monoxide, oxides of nitrogen, sulphur dioxide, particulate matter, non-methane volatile organic compounds and benzene, ethylbenzene, toluene, and xylenes.

Atmospheric emissions are routinely made by vessels at sea and managed by the IMO under the International Convention for the Prevention of Pollution from Ships, 1973 as modified by the Protocol of 1978 (MARPOL) Marine Orders made under the *Navigation Act 2012*, *Protection of the Sea (Prevention of Pollution from Ships) Act 1983* and subsidiary legislation give effect to the MARPOL Convention in Commonwealth waters. Santos requires all vessels making utility discharges to comply with MARPOL requirements and Marine Order 97 (Marine pollution prevention – air pollution) 2013[1]. Santos considers meeting the requirements of this Marine Order is an appropriate control for vessel atmospheric emissions. No further controls for atmospheric emissions have been considered for the trench and bury option.

The transportation to shore, processing and disposal of the equipment recovered will also generate atmospheric emissions through transportation (e.g., trucks) and electricity consumption. These emissions are expected to be relatively small compared to the emissions from the vessel undertaking the full removal options.

Steel recovered from the removed MEFF equipment may be suitable for recycling. Recycling steel may result in a reduction of steel manufacturing, resulting in an associated reduction in GHG emissions. Note that steel recycling is likely to occur beyond Australia. Transportation of steel recovered from equipment will contribute to GHG emissions.

The full removal options are expected to generate the greatest volume of atmospheric emissions of all the feasible options given:

- The size of the vessel required for full removal,
- The duration of the full removal activity, and
- The onshore processing and disposal of equipment.

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[1] Marine Order 97 gives effect to the 0.50% by mass limit for the sulphur content of fuel oil introduced by the IMO on 1 January 2020.

3.1.4.2 Equipment Removal

Equipment removal will result in seabed disturbance through the lifting of the equipment from the seabed and seabed interventions required to secure lifting gear to the equipment. Recovery of the anchors is expected to generate the greatest seabed disturbance as the anchors are embedded within the seabed.

3.1.4.3 Physical Presence

The physical presence of the vessels undertaking full removal activities may induce behavioural changes in marine fauna, such as attraction or avoidance behaviour. The presence of the vessel may also result in the displacement of other marine users, such as commercial shipping, from the vicinity of the full removal activities. The area from which other users would be excluded is expected to be a 500 m radius around the vessel.

Controls consistent with good maritime practice would be implemented in relation to the physical presence of vessels aspect, such as:

- stakeholder consultation prior to and during removal of the pipeline,
- maintenance of the existing gazetted petroleum safety zones within the MEFF fields, and
- compliance with relevant international conventions, and Australian legislation giving effect to these conventions, such as:
  - the International Regulations for Preventing Collisions at Sea 1972,
  - the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers 1978, and
  - the International Convention for the Safety of Life at Sea 1974, and the Marine Orders giving effect to these conventions under Commonwealth law.

3.1.4.4 Utility Discharges

Utility discharges from the vessels undertaking full removal will include routine discharges such as:

- sewage,
- grey water,
- putrescible waste
- deck drainage,
- bilge water, and
- cooling water.

Utility discharges will occur continuously, or intermittently at short intervals (i.e., days), throughout the duration of the activity.

Utility discharges are routinely made by vessels at sea and managed by the International Maritime Organisation (IMO) under the MARPOL Convention. Marine Orders made under the *Navigation Act 2012*, *Protection of the Sea (Prevention of Pollution from Ships) Act 1983* and subsidiary legislation give effect to the MARPOL Convention in Commonwealth waters. Santos requires all vessels making utility discharges to comply with MARPOL requirements and associated Marine Orders, including:

- Marine Order 93 (Marine pollution prevention – noxious liquid substances) 2014,
- Marine Order 94 (Marine pollution prevention – packaged harmful substances) 2014,
- Marine Order 95 (Marine pollution prevention – garbage) 2013,
- Marine Order 96 (Marine pollution prevention – sewage) 2013, and
- Marine Order 91 (Marine pollution prevention – oil) 2014.

Santos considers meeting the requirements of the Marine Orders listed above is an appropriate control for vessel utility discharges given the environmental risk and potential impact to water quality. Santos routinely undertakes utility discharges during vessel activities in Australian waters in accordance with the requirements above. No further controls for vessel utility discharges have been considered for utility discharges from vessels.

3.1.4.5 Underwater Noise Emissions

Noise associated with vessel operation includes noise generated by vessel thrusters, engines, and propellers, as well as noise emitted onboard which is converted to underwater noise through the hull (e.g., from heavy machinery). The main source of noise emitted from vessels undertaking full removal activities will be from DP thrusters. Noise from DP thrusters is predominately generated from cavitation and typically ranges between 200 Hz and 1.2 kHz in frequency. Surveys measuring underwater noise from DP support vessels holding station reported maximum source levels of approximately 182 dB re 1 µPa at 1 m (McCauley, 1998). Similar recordings of drillships, which are substantially larger than supply vessels, recorded source levels of up to 190 dB re 1 µPa (root mean square). Levels emitted from vessels during full removal activities are expected to be no higher than these reported levels, although relatively high use of power when on DP is expected due to the currents in the MEFF fields. DP noise from the vessel undertaking full removal will be continuous for the duration of the activity.

3.1.4.6 Waste Management

The steel recovered from equipment is expected to be recycled, which delivers an environmental benefit through the re-use of a non-renewable resource. All material that cannot be recycled will be sent to a waste management facility for landfill disposal. Such facilities in Australia are regulated and managed to reduce the potential environmental impacts and risks.

3.2 Abandonment In Situ

Abandonment *in situ* of the gravity bases and concrete ballast consists of leaving these as is following disconnection and removal of the attached tethers. The ballast compartment valves will be removed from the concrete gravity bases prior to their abandonment *in situ*. This will be done as part of an equipment removal campaign.

Abandonment *in situ* of the mooring anchors and chains consists of laying the chains on the seabed within the MEFF fields. Riser wires, which form part of the mooring system, will be removed due to the plastic sheath around the wire core. This will be done as part of an equipment removal campaign.

3.2.1 Environmental Aspects of Abandonment In Situ

The abandonment *in situ* option was identified as a feasible option for all the equipment groups (Table 3-1). The environmental aspects of the abandonment *in situ* of these equipment groups are described below.

3.2.1.1 Physical Presence

Abandonment *in situ* will leave equipment on or in the seabed. This may pose a risk to trawled fishing equipment depending on the size and height of equipment above the seabed. The mooring anchors are deeply embedded within the seabed. The chains will lie on the seabed and will be partially embedded in the sediment. As such, the mooring anchors and chains pose negligible risk to trawled fishing gear following abandonment *in situ*.

The gravity bases and concrete ballast are partially embedded in the seabed due to their weight, with a portion extending above the seabed. This may pose a risk to trawled fishing gear.

The locations of all equipment abandoned *in situ* will be marked on nautical charts to enable other users to avoid the equipment. Trawl protection is not planned to be installed, as there is no recent or historical trawl fishing effort in the MEFF fields. The only active trawl fishery in the region that operates in the depth range of the MEFF fields is the Pilbara trawl fishery. This fishery is not permitted to operate in the vicinity of the MEFF fields due to limitations on where trawl fishing is permitted. The limitation for trawling in the vicinity of the MEFF fields came into force over 20 years ago.

3.2.1.2 Equipment Degradation

Degradation of equipment abandoned *in situ* will release degradation products to the sediment over a timescale of decades to centuries. Degradation products will be denser than seawater, and hence will be concentrated below and around the equipment. The materials from which the equipment is constructed (primarily concrete and steel) are not water soluble, although corrosion products of steel may be water soluble.

Atteris (2021) studied the degradation processes that will affect the gravity bases, concrete ballast, mooring anchors, and chains in the MEFF fields, with findings summarised below:

- The cathodic protection systems on the structures are forecast to deplete within the next 28 years with some of the systems already close to full depletion.
- Once the cathodic protection systems fail locally, external corrosion will begin at coating defect sites (e.g., paint defects). It is estimated that the corrosion perforation of the structural members and piping may occur between 90 and 250 years after local cathodic protection system depletion. After this time, it is likely that some structural members of the structures begin to detach from the parent structure due to corrosion.
- Internal corrosion will occur because of oxygen and nutrients entering the inside of the structural members and piping through the corrosion perforation sites. The entering mass of oxygen and nutrients is expected to be small given diffusive processes. Ongoing internal corrosion will likely be further isolated as openings become clogged with sediment. Structural members that detach are likely to fall to the seafloor and self-bury due to the high weight of the steel corrosion products.
- As the number of perforation sites increase over time, the internal corrosion of the structure will accelerate. The structure will eventually fully corrode, and corrosion product will either be

dispersed due to hydrodynamic loading during the degradation process or will sink to the seafloor. Any parts of the structure coating system that flake off will either remain buried or be dispersed by hydrodynamic loading.

- It is also possible that the structural members (where applicable) corrode to the point where they are no longer able to support the structure. In this case, it is likely that the remaining structure will buckle under its own weight and fall to the seafloor, likely self-burying due to the high weight of the steel corrosion products relative to seawater.
- Potential concrete degradation mechanisms include:
  - Spalling due to steel reinforcement corrosion (if present)
  - Chemical damage (e.g., carbonation, external sulphate attack, calcium leaching etc.)

3.3 Augmentation

Augmentation consists of installing additional artificial structures in the MEFF fields in addition to the abandonment *in situ* of equipment. The nature of the structures used to augment equipment has not yet been determined but is assumed to be like the concrete structure shown in Figure 3-3. The intent of augmentation is to provide additional complex structures that promote settlement of sessile biota and provide habitat for fishes.

Augmentation structures are assumed to be lifted into place from a construction support vessel holding station using DP. The number of structures required for augmentation are not confirmed but are assumed to be in the order of 10's of structures for all augmentation of equipment in the MEFF fields.

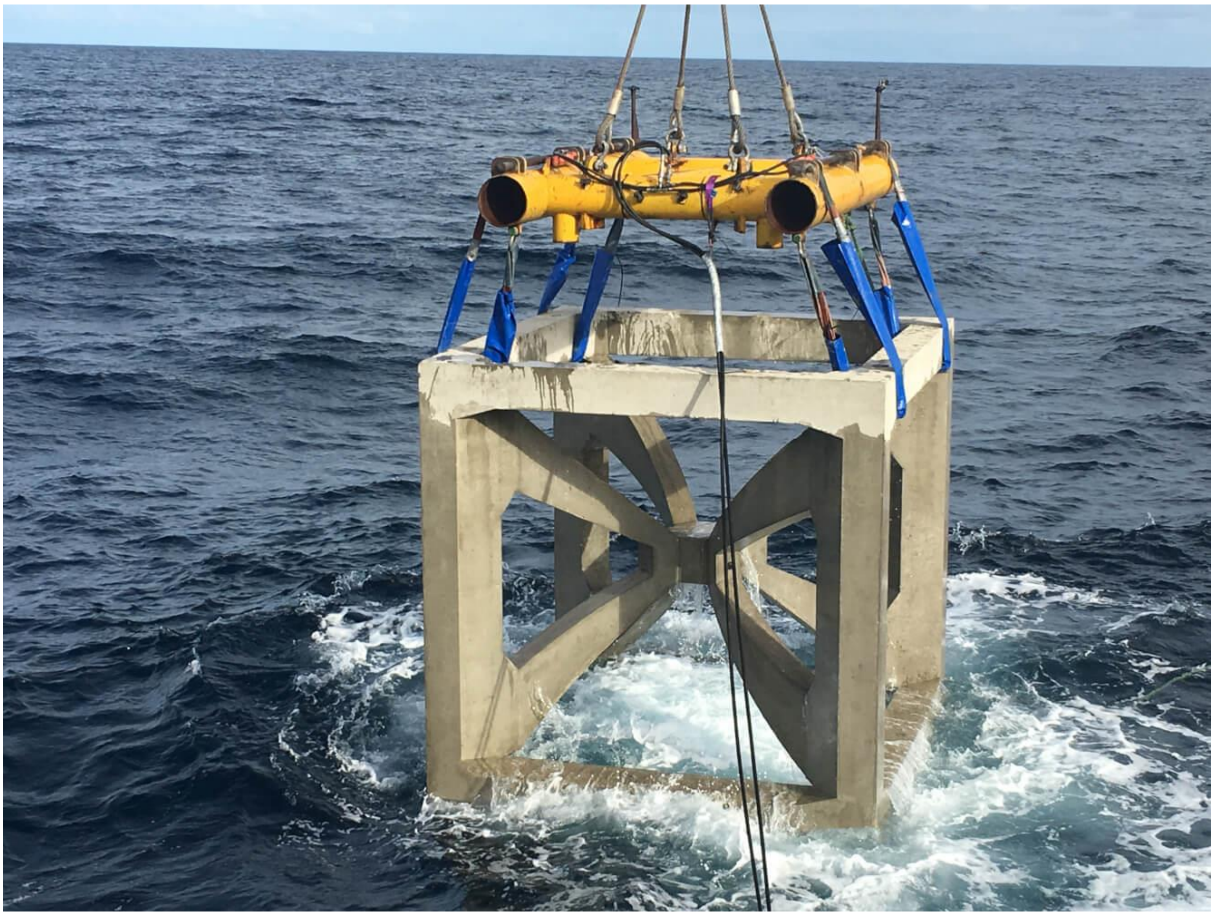

Figure 3-3 An example of a concrete structures intended for potential augmentation

3.3.1 Vessel Specifications

The installation of augmentation structures is expected to require a vessel with the following:

- Crane capable of lifting > 50 t with a submersible hook and wire,
- DP2-rated dynamic positioning, and
- Remotely operated vehicle (ROV) support.

A review of the vessels operating in the region indicated the MMA *Pinnacle* (Figure 3-4) is a suitable analogue for a construction support vessel for installing the gravity anchor structure. Indicative vessel specifications for the *Pinnacle* are provided in Table 3-4.

Figure 3-4 MMA Pinnacle, an indicative construction support vessel

Table 3-4 MMA Pinnacle vessel specifications

Length overall	88 m
Breadth	22 m
Maximum speed	11.5 knots
Dynamic positioning system	Rolls Royce DP2
Accommodation	100
Main crane	150 t at 15 m radius

3.3.2 Duration

Installation of augmentation structures is expected to require 2-3 days, including contingency time.

3.3.3 Environmental Aspects of Augmentation

Augmentation was identified as a feasible option for the gravity bases and concrete ballast only. Given the mooring anchors are embedded in the seabed, there is no exposed structures to augment and hence augmentation was determined to not be feasible for this equipment group. The environmental aspects of augmentation are described below.

3.3.3.1 Atmospheric Emissions

Like the full removal option, combustion emissions from vessels will be the principal source of atmospheric from the augmentation option. The vessel-based activities in the augmentation option are expected to require a smaller vessel and be of similar duration, although augmentation may be done as part of an equipment removal campaign. Atmospheric emissions from vessels installing augmentation will be subject to the same controls as those undertaking full removal (Section 3.1.4.1).

Augmentation is expected to consist of installing concrete and steel structures in the MEFF fields. The manufacture of the concrete and the steel, along with the transportation of the structures into the MEFF fields, will generate GHG emissions.

3.3.3.2 Augmentation Installation

The installation of augmentation structures on the seabed will result in localised seabed disturbance. The disturbance footprint will be limited to the seabed directly below the augmentation structures.

3.3.3.3 Equipment and Augmentation Degradation

The augmentation option will not remove any equipment from the environment; all equipment will be abandoned *in situ* as per the abandonment *in situ* option. Refer to Section 3.2.1.2 for a description of the equipment degradation aspect.

In addition to the equipment, the augmentation structures will also degrade *in situ*. These structures are assumed to consist largely of Portland cement, which is inert. The concrete will gradually break down due to a combination of chloride attack and external sulphate attack. Chloride and sulphate ions in seawater can penetrate the concrete and cause chemical reactions that lead to swelling, cracking and loss of strength (Atteris, 2021). The density of the concrete is much greater than seawater, hence concrete rubble from the degradation of augmentation structures will remain in the immediate vicinity of the augmentation structure. The resulting concrete rubble is expected to gradually become buried over time through natural sediment deposition.

3.3.3.4 Physical Presence

The physical presence aspect of the augmentation option will be similar in nature and scale to that of the full removal option. Refer to Section 3.1.4.3 for a description of the physical presence aspect.

3.3.3.5 Underwater Noise Emissions

The underwater noise emissions aspect of the augmentation option will be similar in nature and scale to that of the full removal option. Refer to Section 3.1.4.5 for a description of the underwater noise emissions aspect.

3.3.3.6 Utility Discharges

The utility discharges aspect of the augmentation option will be similar in nature and scale to that of the full removal option. Refer to Section 3.1.4.4 for a description of the utility discharges aspect.

4 Comparative Assessment Methodology

A comparative impact assessment of the environmental impacts of the feasible decommissioning options was undertaken using the analytic hierarchy process (AHP) for the equipment groups identified in Section 2. AHP is a multi-criteria decision analysis (MCDA) method, where the alternatives can be compared using a suite of criteria. The AHP method has been studied extensively in a range of disciplines (e.g., defence, finance, and medicine) and is supported by a wide body of literature. The comparative assessment methodology is available in more detail in Saaty (1996). A concise description of the AHP in the context of environmental impact assessment has been provided by Ramanathan (2001).

Determining the relative environmental outcomes of the feasible options for the equipment groups is a complex process that requires consideration of many factors. The AHP facilitates this by identifying these factors and making determinations about each independently. Once each of these smaller determinations has been made, they are then aggregated into a holistic summary of all the deliberations made. To facilitate the comparative assessment, each comparative impact assessment was composed into a hierarchy comprising the following elements:

- the statement of the goal,
- the environmental criteria, and
- the feasible alternatives to be considered for each equipment group.

A conceptual model of an AHP hierarchy with these elements is shown in Figure 4-1.

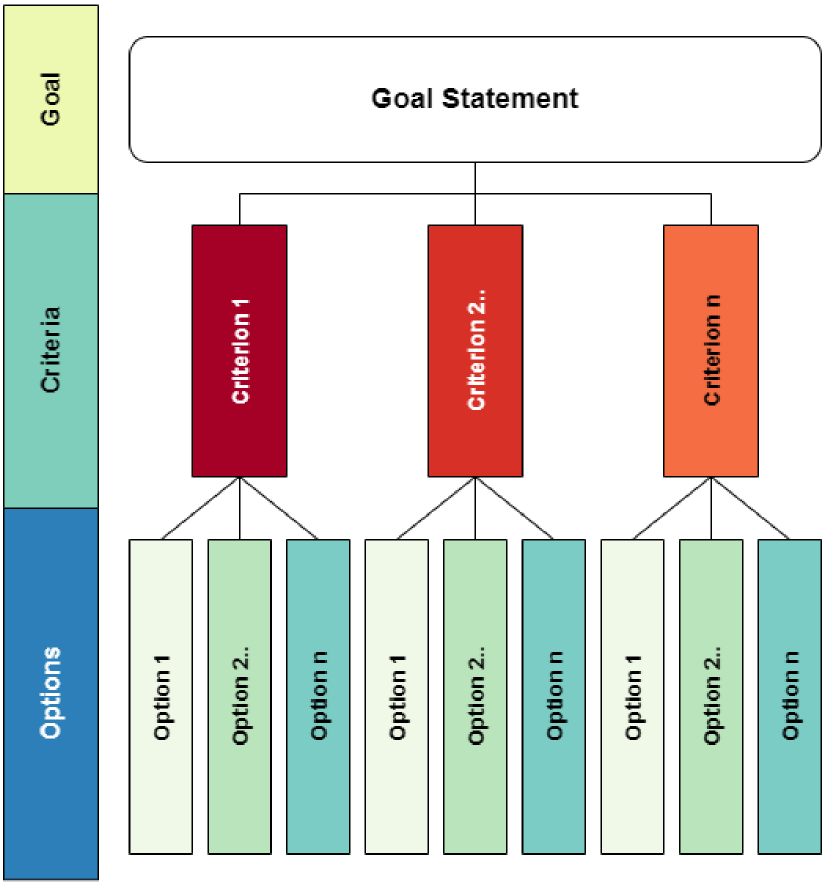

Figure 4-1 Conceptual AHP hierarchy showing goal statement, criteria, and options to achieve the goal

4.1 Define the Goal

The AHP commenced with the formulation of a goal statement. The goal statement is the root of the AHP hierarchy. A goal statement was formulated for each equipment group, which take the form shown below:

"*Determine the relative environmental outcomes of the feasible decommissioning options for the [EQUIPMENT GROUP]*"

Where [EQUIPMENT GROUP] is the equipment group being considered in the AHP. Hierarchy diagrams for each equipment group are provided in Section 6.

The goal statements encompass the requirement of *Section 572 Maintenance and Removal of Property Policy* (NOPSEMA 2020) that any proposed deviation from the decommissioning base case of full removal of equipment is demonstrated to result in equal or better environmental outcomes. By structuring the comparative assessment around this goal, Santos has compared the environmental outcomes for all the feasible decommissioning options that were considered.

4.2 Identify the Feasible Options

The process for identifying the feasible decommissioning options for equipment groups is provided in Section 3. The AHPs for each equipment group considered the feasible options identified for the group.

4.3 Identify the Criteria

Given the comparative impact assessment is intended to demonstrate the relative environmental outcomes of the feasible option, the criteria in the AHP were based on the environmental receptors that could credibly be impacted by the feasible options. Environmental receptors considered in the comparative impact assessments were identified based on the nature and scale of the aspects of each feasible option.

Each environmental receptor identified as a criterion was assessed to determine if the receptor warranted decomposition into sub-criteria. The decision to break down a criterion further into sub-criteria considered:

- whether the sub-criteria differed in their scale, environmental value, and vulnerability to impacts,
- whether the sub-criteria could reasonably be impacted by the decommissioning alternatives in different ways,
- whether the sub-criteria had specific relevant requirements that warranted consideration to meet the needs of OPGGS (E) Regulations.

None of the environmental receptors in the comparative impact assessments for the MEFF equipment warranted decomposition into sub-criteria.

No consideration was made for the environmental receptors that may credibly be at risk of impacts from unplanned events.

The environmental receptors identified as criteria in the AHP hierarchy were compared to determine the relative priority (i.e., weighting) each should receive using the process outlined below in Section 4.4. The relative environmental value of each criterion was determined by considering the:

- value placed on the criterion by legislation (which is intended to protect extrinsic and intrinsic value of the environmental receptor), cultural value, economic value, recreational value.
- value placed on it because it supports other environmental values –the “connectedness” of the receptor.
- uniqueness of the environmental value within the environment.

Sources of information on the environmental value of the criteria included work commissioned specifically to inform the MEFF decommissioning project. Other inputs, such as environmental studies and stakeholder consultation in relation to Santos’ activities in the region were also used.

4.4 Pairwise Comparison of Criteria and Options

Following construction of the AHP hierarchy, all possible pairwise[2] comparisons were made between the child nodes below the goal and the criteria nodes in the hierarchy. These pairwise comparisons were used to determine the local and global priority for each of the nodes below the goal in the hierarchy.

The pairwise comparisons for goal and criteria nodes in the AHP were documented in a square matrix (A) of dimensions n by n, where n are the criteria or options being compared:

$$A = \begin{bmatrix} a_{11} & a_{12} & \dots & a_{1n} \\ a_{21} & a_{22} & \dots & a_{2n} \\ a_{31} & a_{32} & \dots & \dots \\ a_{n1} & a_{n2} & \dots & a_{nn} \end{bmatrix}$$

The comparisons between criteria and options were made based on their relative importance or preference to achieving the goal. The comparison ratings and definitions are listed in Table 4-1.

Deliberations on pairwise comparisons considered the relative merits of the items being compared. The comparisons within each node of the hierarchy were limited to the scope of the node. For example:

- the comparisons within the goal criterion only considered the relative importance of the criteria nodes.
- the comparisons of the decommissioning options within a criterion only considered the potential impacts of each option on that criterion.

Where a comparison of two criteria or alternatives within the judgment matrix was rated, the inverse comparison within the matrix was assigned the reciprocal value (e.g., if a comparison was assigned a value of 5/5, the inverse comparison was assigned the value of 1/5).

The comparisons of the options considered the nature and scale of each of the impacts to the criterion from each option, including spatial extent, temporal extent, and the intensity or magnitude of the impact. A consequence rating derived from the Santos Offshore Division Environmental Hazard Identification and Assessment Guideline (EA-91-IG-0004) detailed environmental consequence descriptors in Table 4-2 was determined for the potential impacts and risks from each decommissioning alternative to the environmental receptors considered.

Once all pairwise comparisons had been made and the judgment matrix for a given element of the hierarchy was completed, the local priorities (i.e., the relative priority of the comparisons within the matrix) were estimated. The estimates were derived from the calculation of the normalised principal eigenvector and eigenvalues of the matrix.

Once calculated, local priorities of comparisons from all judgment matrices were aggregated to obtain the global priorities for each of the options within the hierarchy. This was done by summing the local priorities for each of the nodes within the hierarchy.

[2] Pairwise comparison generally is any process of comparing entities in pairs to judge which of each entity is preferred, or has a greater amount of some quantitative property, or whether or not the two entities are identical.

Table 4-1 Relative qualitative judgment criteria used for pairwise comparisons

Rating	Definition	Description
1	Equal importance/preference	Both elements are of equal importance
3	Moderate importance/preference	Experience and judgment slightly favour one element over the other
5	Strong importance/preference	Experience and judgment strongly favour one element over the other
7	Very strong importance/preference	One element is very strongly favoured over the other
9	Extreme importance/preference	The evidence favouring one element is of the highest possible order of affirmation

Source: Ramanathan (2001)

Table 4-2 Santos Offshore Division detailed environmental 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 Receptor	**Fauna** In particular, EPBC Act listed threatened/migratory fauna or 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; • Widespread (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; habitat within a protected area; habitats that include benthic primary producers and/ or epi-fauna	• 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 ~ 2 year (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 widespread 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.

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.
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.
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.

4.4.1 Comparison Consistency

The logical consistency of pairwise comparisons within a judgment matrix can be assessed by calculating the consistency ratio (CR). Reviewing the CR may indicate if the pairwise comparisons have any unexpected discrepancies that may warrant further assessment. The consistency of the comparisons within each judgment matrix was assessed by calculating the consistency ratio (CR), which was defined by Ramanathan (2001) as:

$$CR = \frac{CI}{RI}$$

where CI and RI are called the consistency index and random index respectively.

CR values of ~10% or less are considered to indicate good agreement between the scores in each judgment matrix. CR values greater than ~10% may indicate internal disagreement within a judgment matrix for the applied ratings and may warrant further consideration.

CI was defined as:

$$CI = \frac{(\lambda_{max} - n)}{(n - 1)}$$

where λ_{max} is the largest value from the non-normalised principal eigenvector of the judgment matrix and n is the number of items being compared (i.e., the dimension of the matrix).

RI is the consistency index of a randomly generated judgment matrix from the scale in Table 4-1. Average RI values were determined by Saaty (2000) for randomly generated matrices using a bootstrapping method for a sample size of 500. RI's for judgment matrices up to n = 10 (i.e., sufficient to encompass all judgment matrices considered in this report) are provided in Table 4-3.

Table 4-3 RI values determined by Saaty (2000)

Number of Items being Compared	RI Value
3	0.58
4	0.9
5	1.12
6	1.24
7	1.32
8	1.41
9	1.45
10	1.49

5 Comparative Assessment of Environmental Receptors

5.1 Identification of Environmental Receptors

The environmental receptors that may credibly be impacted by each of the feasible decommissioning options were identified to determine the relative environmental outcomes of the options. The identification of environmental receptors was informed by the environmental aspects identified for each of the feasible decommissioning options, which are described in Section 3. The identification of environmental receptors considered the nature and scale of the aspects of each decommissioning option, including:

- the spatial extent of each aspect,
- the temporal extent of each aspect, and
- the magnitude or intensity of environmental hazards that may arise from each aspect.

The environmental receptors identified by the process described above comprise:

- water quality,
- sediment quality,
- air quality,
- benthic habitats,
- onshore environmental receptors,
- fauna, and
- other users

These environmental receptors are aligned with the typical structure of the description of the environment in Santos' EPs.

5.2 Description of Environmental Receptors

5.2.1 Water Quality

Water quality in the MEFF field is typical of outer continental shelf waters on the North West Shelf. Physical profiles of the water column at the Goodwyn platform (BMT Oceanica, 2015) and in the Bedout Basin (RPS, 2020a) show a relatively warm, saline, highly oxygenated and well-mixed surface water to approximately 40-60 m depth. Temperature, salinity, and dissolved oxygen concentrations gradually decline below this well-mixed layer to the seabed. Turbidity is generally low in outer continental shelf waters in the region, with monitoring in the Bedout Basin recording turbidity of < 5 nephelometric turbidity units throughout the water column (RPS, 2020a).

Concentrations of potential contaminants, such as metals and hydrocarbons are low, often below the limits of detection for standard analytical laboratory methods. Since the cessation of production of the MEFF field in 2018, the nearest production facility routinely discharging to sea is the Woodside's Angel production platform, over 20 km south of the Exeter manifold.

5.2.2 Sediment Quality

Sediment quality in the MEFF field is generally high, although localised contamination is present, likely to be the result of petroleum activities such as drilling. GHD (2021) recently sampled sediments at the Mutineer, Exeter production manifolds, and Finucane pipeline end manifold (Figure 5-1). Results of this sampling indicated there was a general trend for increased metal concentrations in sediments in proximity to production manifolds. Of the 17 metal concentrations analysed, three were above the default guideline values[3] (DGVs) set by the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (Commonwealth of Australia and New Zealand Government, 2018):

- Antimony,
- Lead, and
- Mercury.

Concentrations of these metals in sediments did not exceed the guideline value – high[4] (GV-high) concentrations set by the Australian and New Zealand guidelines for fresh and marine water quality (Commonwealth of Australia and New Zealand Government, 2018).

Metal concentrations in sediments tended to be highest in proximity to production manifolds (which are also close to wellheads, Christmas trees etc.). Sampling in the Exeter field, and to a lesser extent the Mutineer field, showed relatively high concentrations of metals compared to reference sites, although this pattern was less apparent for the Finucane field (Figure 5-2). However, concentrations of metals in the Exeter and Mutineer fields declined rapidly with distance from the nearest production manifold (Figure 5-3). This suggests that contamination of sediments is concentrated around production manifolds and nearby subsea equipment but is not widespread in the MEFF field.

Given none of the metal concentrations exceeded the GV-high thresholds, toxic effects to marine biota are not expected to occur.

[3] DGVs are the concentrations below which there is a low risk of unacceptable environmental effects occurring.
[4] GV-high values are the concentrations at which toxicity-related effects may be expected to be observed.

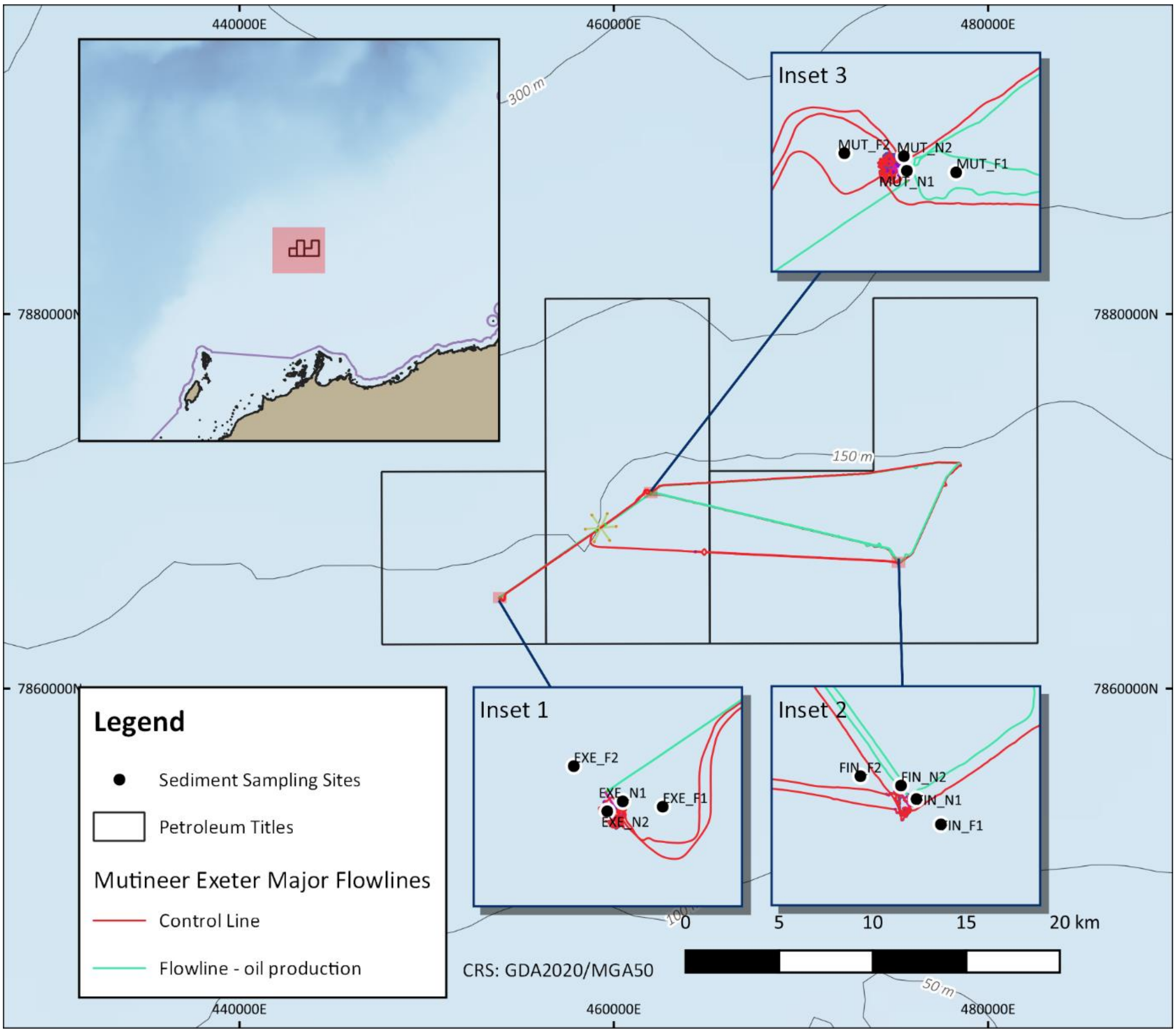

Figure 5-1 Location of sediment samples collected by GHD (2021)

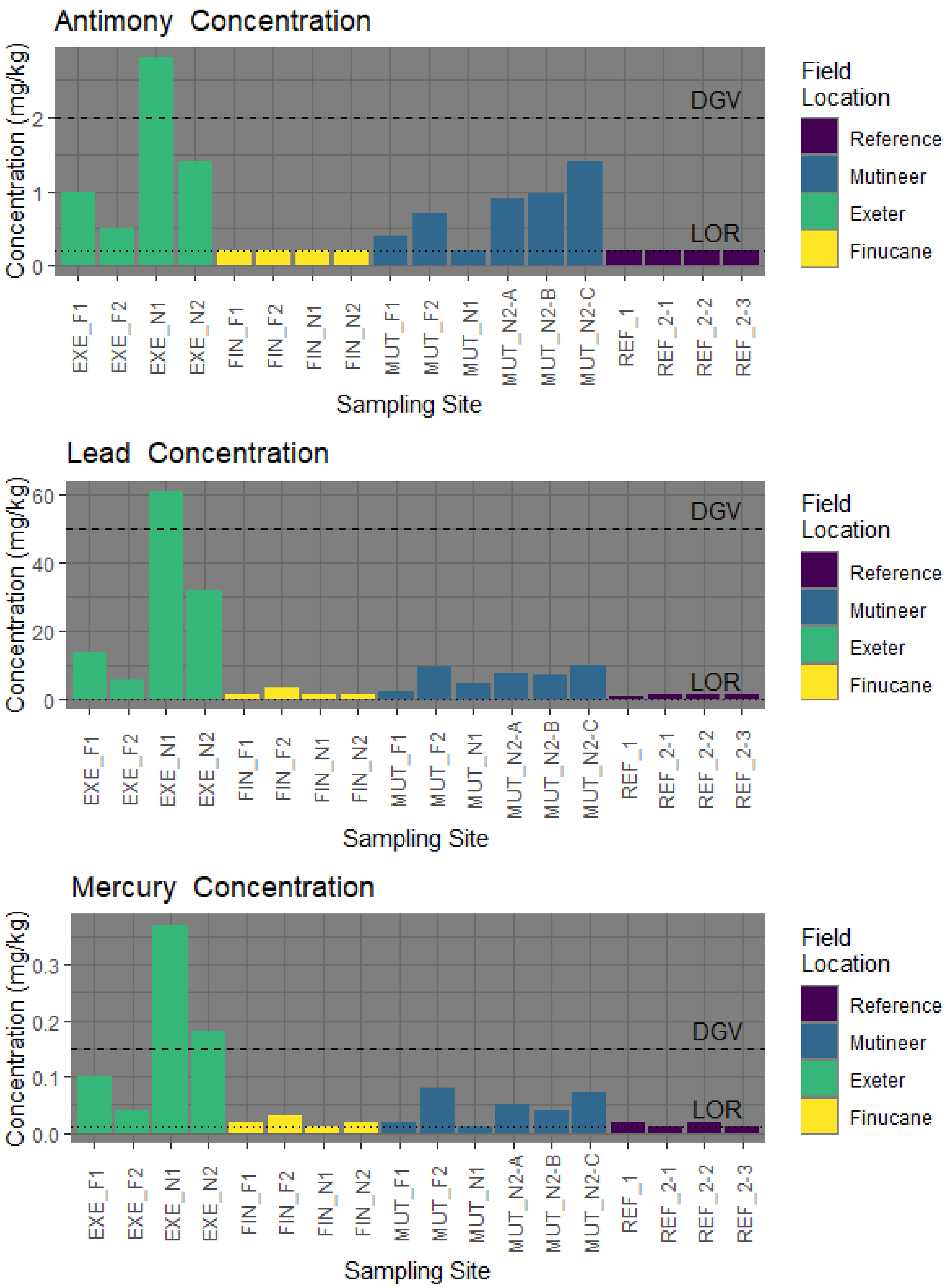

Figure 5-2 Concentrations of metals that exceeded the default guideline values (DGVs) set by the Australian and New Zealand guidelines for fresh and marine water quality (Commonwealth of Australia and New Zealand Government, 2018; data from GHD, 2021) with laboratory limits of reporting (LORs).

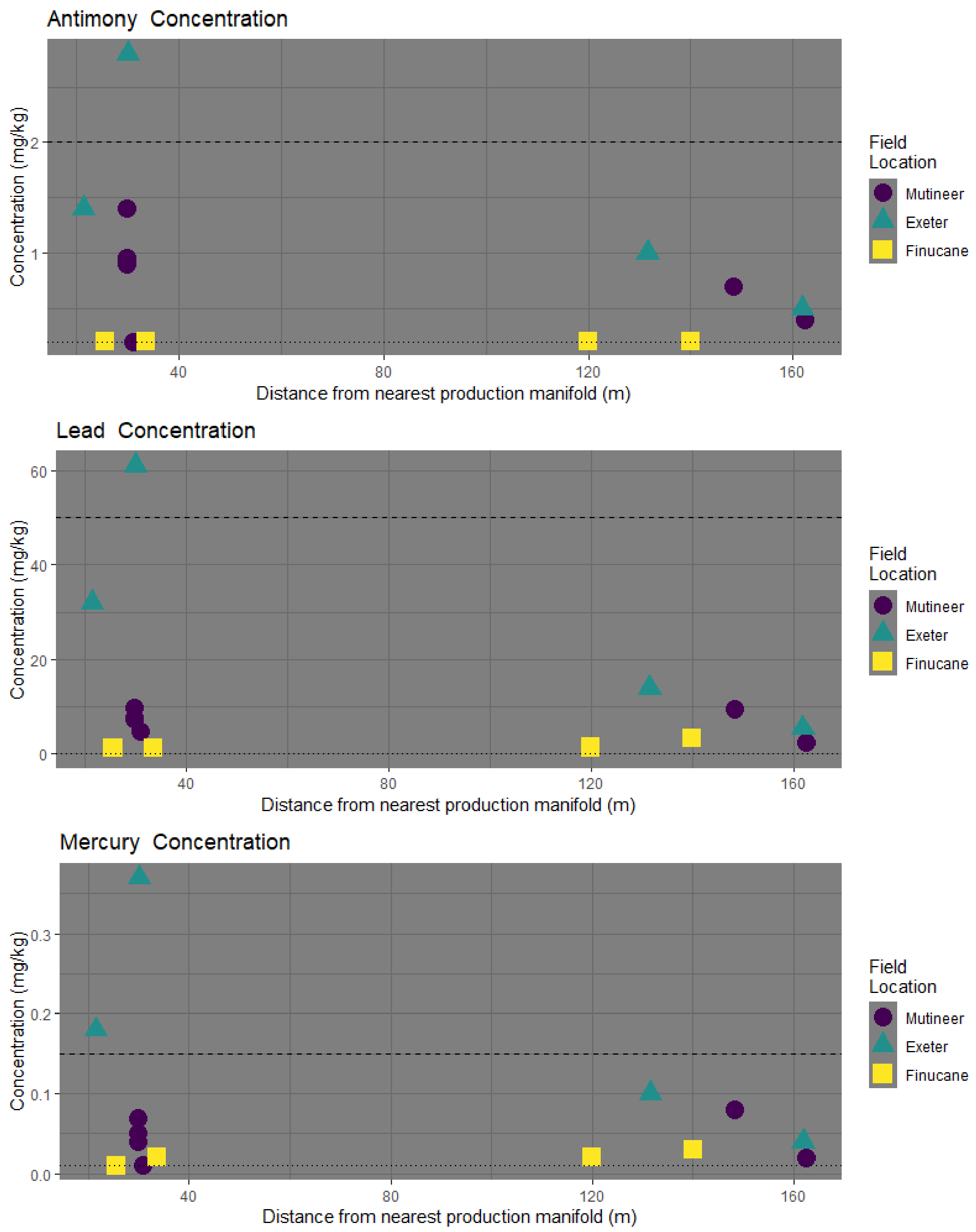

Figure 5-3 Concentrations of metals that exceeded the default guideline values (DGVs) set by the Australian and New Zealand guidelines for fresh and marine water quality (Commonwealth of Australia and New Zealand Government, 2018) and distances from nearest production manifold (data from GHD, 2021).

GHD also analysed sediments for a range of hydrocarbon species:

- Total recoverable hydrocarbons,
- Polycyclic aromatic hydrocarbons,
- Benzene, toluene, ethylbenzene, and xylenes, and
- Phenols.

Concentrations of all hydrocarbon species were below the laboratory limits of reporting (LORs), indicating there is negligible hydrocarbon contamination in sediments.

5.2.3 Benthic Habitats

Benthic habitats in the MEFF field are largely bare sediments with associated sparse assemblages of filter- and deposit-feeders. This habitat type and associated biota are very widely represented in the region and not of conservation significance. The field is in approximately 130-160 m water depth and insufficient light reaches the seabed to support photosynthetic organisms such as zooxanthellate corals, seagrasses and macroalgae.

The subsea equipment in the MEFF field provides relatively complex hard substrate, which is very limited on the outer North West Shelf. A range of sessile benthic biota have become attached to the equipment and a range of mobile fauna, such as fishes and crustaceans, are associated with the habitat provided by the equipment. The biological communities associated with the equipment are distinct from the surrounding bare sediment habitats. GHD (2021) observed taxa associated with the equipment that are absent from the surrounding habitat, including relatively diverse, species-rich fish assemblages.

The MEFF field partially overlaps a Key Ecological Feature (KEF) – the Ancient Coastline at 125 m Depth Contour, referred to as the Ancient Coastline KEF (Figure 5-4). The Ancient Coastline KEF is derived from the shoreline during the last glacial period, and as such is represented on the continental margins in all ocean basins. Studies of the fish assemblages on the Ancient Coastline KEF on the North West Shelf by Currey-Randall et al. (2021) found no evidence of higher fish species diversity within the Ancient Coastline KEF and adjacent habitats. Currey-Randall et al. (2021) noted the Ancient Coastline KEF, and adjacent habitats, ranged in water depth and structural complexity and concluded that these factors were much more important in determining the species richness and diversity of fish assemblages. These findings are consistent with environmental surveys of the Ancient Coastline KEF commissioned by Santos to inform the Dorado Offshore Project Proposal (Keesing et al., 2020; RPS, 2020b) and those of GHD (2021). Based on available information, the part of the Ancient Coastline KEF that overlaps the Finucane pipeline end manifold (which will be removed) does not support environmental values that are consistent with those of a KEF and is not of conservation significance.

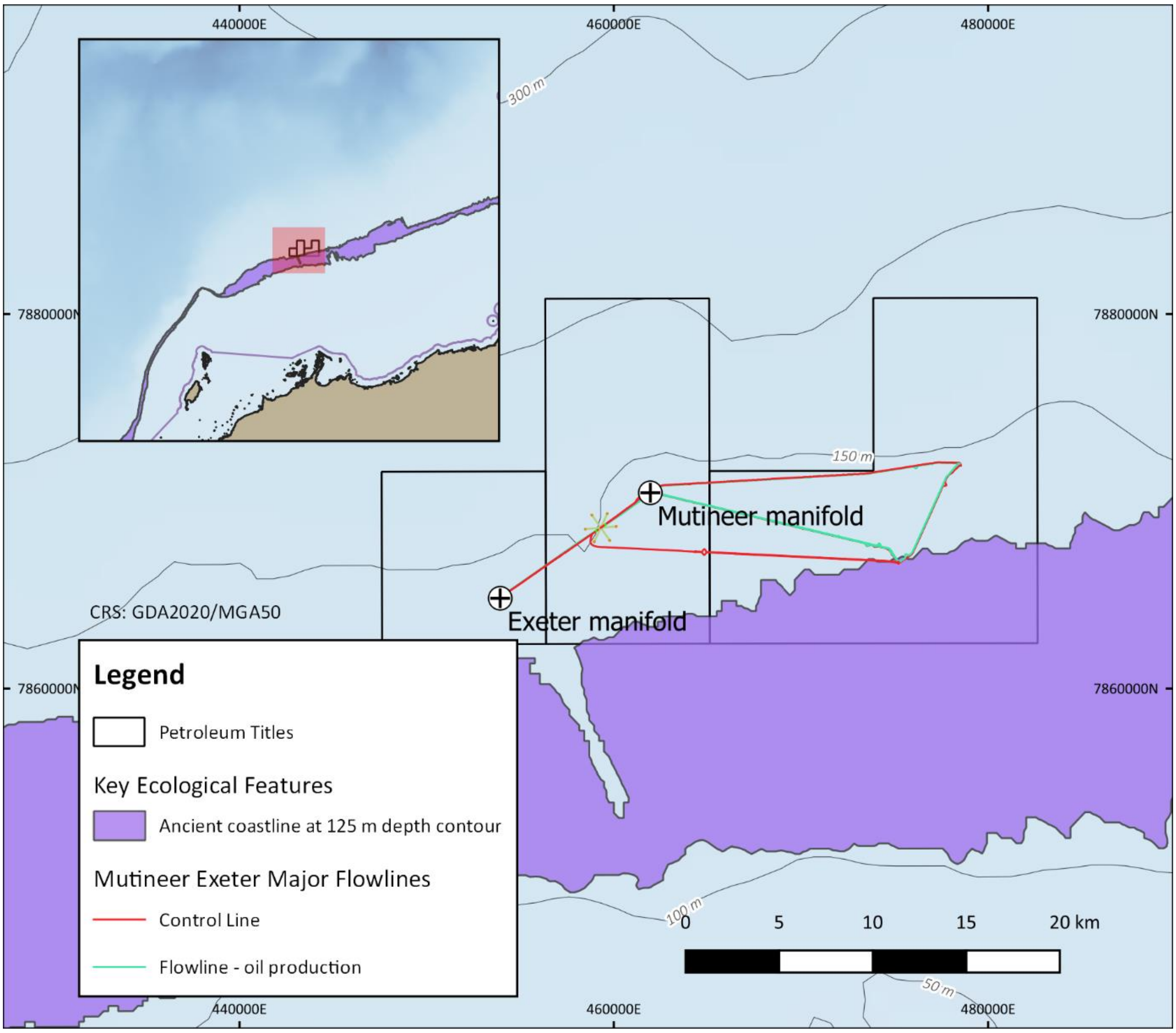

Figure 5-4 Ancient Coastline KEF in relation to the MEFF field

5.2.4 GHG Emissions

Air quality within the MEFF field is consistent with natural conditions, with only localised anthropogenic influences. There are no point source emissions to air within the MEFF field. Transient emissions from vessels within or adjacent to the MEFF field are low, despite the designated shipping fairway in proximity to the eastern part of the field (Figure 5-5). Vessels associated with Woodside's Angel platform and Okha FPSO, approximately 21 km and 33 km from the closest point of the MEFF field respectively, have associated high levels of vessel activity (Figure 5-6).

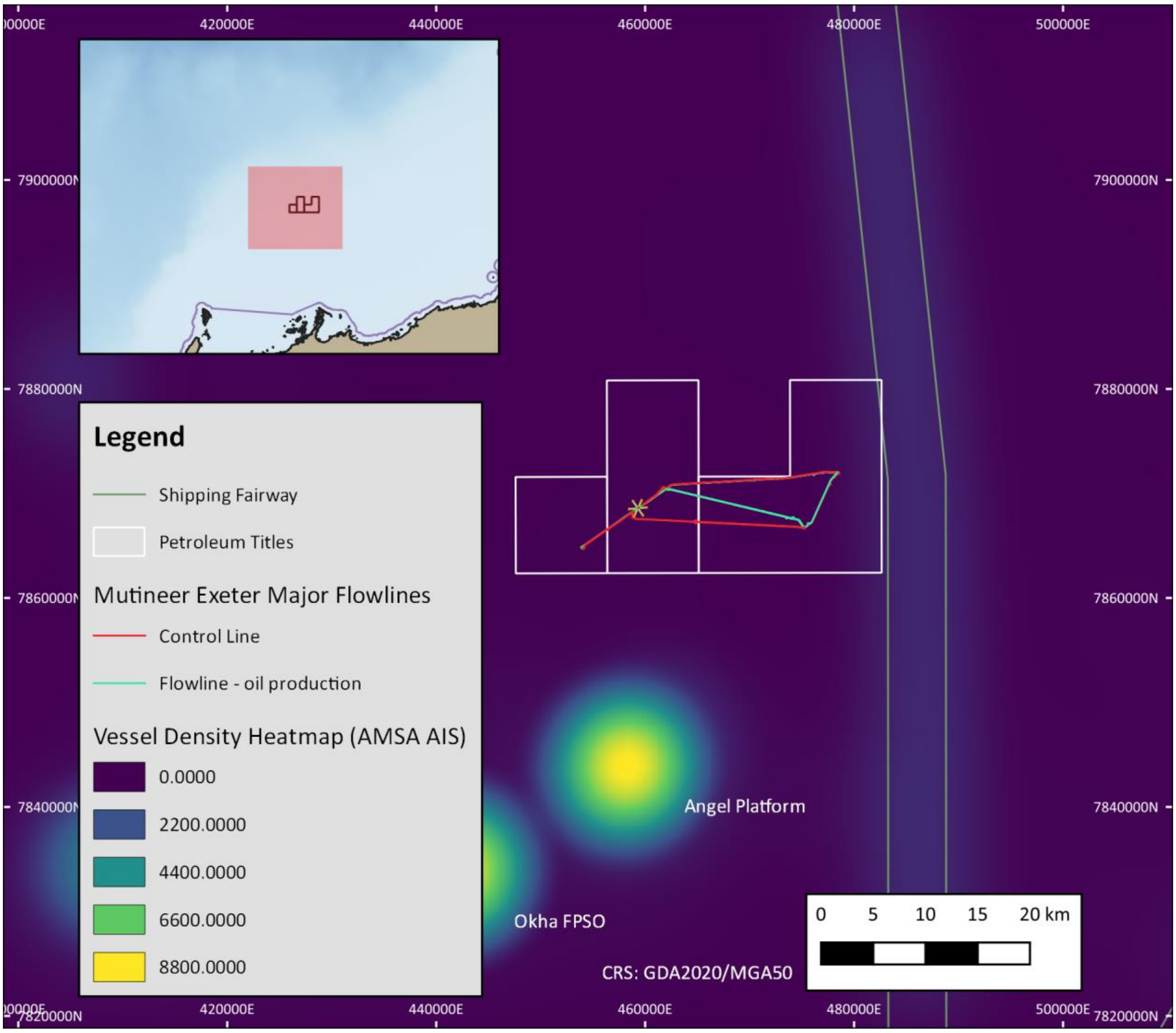

Figure 5-5 Vessel density heatmap derived from automatic identification system data from January to December 2020 (Australian Maritime Safety Authority, n.d.)

The ambient air quality within the MEFF field is a consequence of both local- and global-scale effects. The concentration of greenhouse gases, primarily carbon dioxide (CO_2), have been increasing globally because of anthropogenic activities (Figure 5-6). As a result, the average temperature of the Earth's atmosphere and oceans have been increasing. Global efforts to limit the increase in average global temperatures to 2° C above pre-industrial levels are being made.

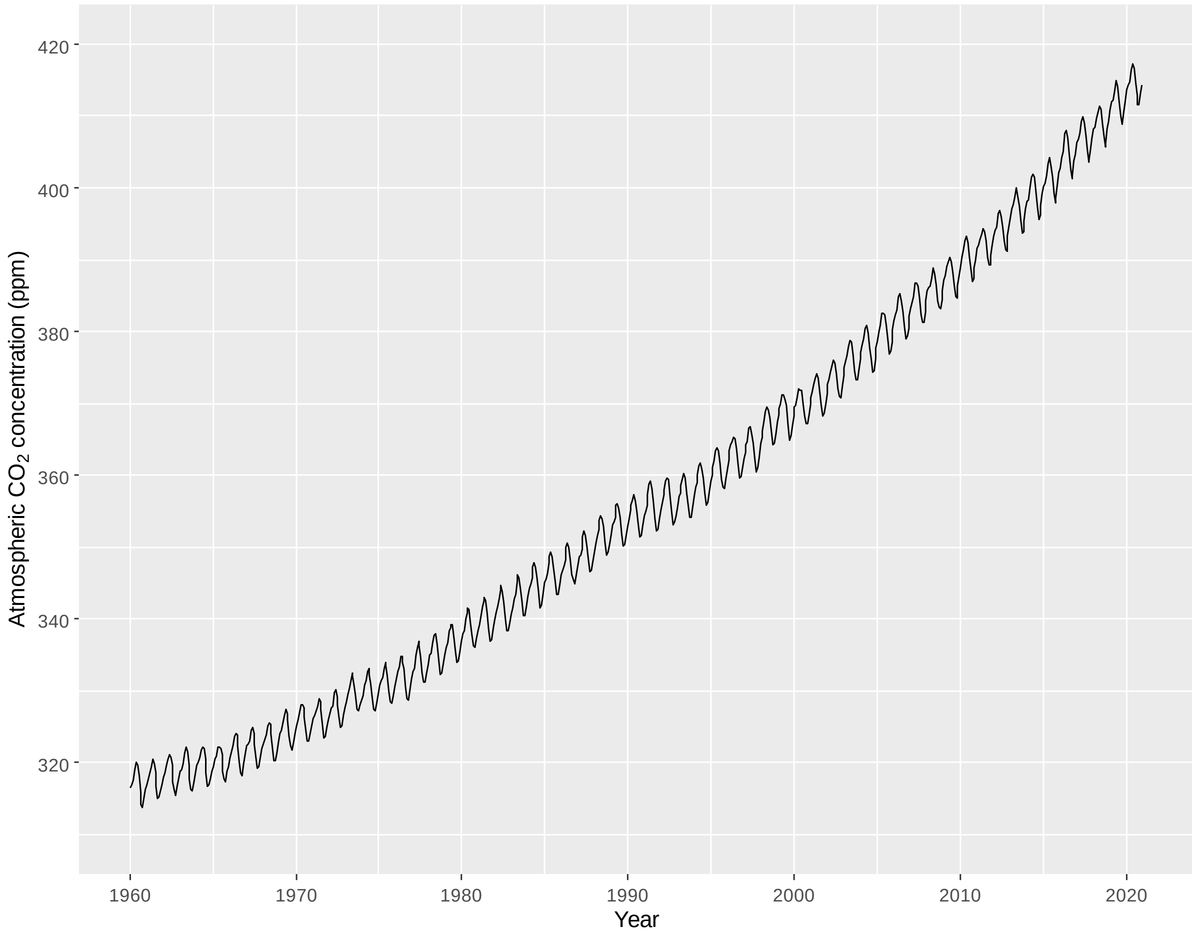

Figure 5-6 Global average atmospheric carbon dioxide concentrations between 1960 and 2020 (data from National Oceanic and Atmospheric Administration and United States Department of Commerce, n.d.)

5.2.5 Onshore Environmental Receptors

Onshore environmental receptors that may be impacted by the feasible options for the MEFF field include:

- Ports, through the activities of vessels undertaking the feasible options,
- Storage and processing areas, required to store and process material recovered from the MEFF field,
- Onshore transportation infrastructure (e.g., roads), to transport material recovered from the MEFF to the final disposal location, and
- Waste management facilities (e.g., landfill and recycling facilities), to handle the material recovered from the MEFF field.

The main port supporting oil and gas activities in the region is Dampier, and this port is assumed to be the site from which vessels undertaking the feasible options will operate. Dampier has a well-developed logistics services which are capable of handling and disposing of any materials recovered from the MEFF field appropriately.

The equipment groups considered in the comparative environmental impact assessment are made of inert materials and were not contaminated during production. No special waste disposal requirements, such as hazardous waste management facilities, will be required for disposal of waste material.

Where practicable, waste materials will be recycled. Only steel recovered from the MEFF field is likely to be economically recycled, and other materials are expected to be disposed of as landfill.

5.2.6 Fauna

Ecosystems in the MEFF fields contain a range of habitat zones and associated fauna, such as:

- Pelagic habitats, with associated drifting (i.e., planktonic), actively swimming (i.e., nektonic) and avian (e.g., seabirds) fauna. Fauna in pelagic ecosystems may complete all their life cycle (e.g., pelagic fishes or planktonic copepods), or part of their life cycle (e.g., larval phase of demersal fish and hard corals), in the ecosystem.
- Demersal habitats, with associated fauna such as fishes, and
- Benthic habitats, with associated benthic fishes, epibenthic fauna (e.g., sponges) and infauna.

Some species may inhabit more than one habitat zones, either through different phases of their life history or through movement between habitat zones.

5.2.6.1 Species Protected under Part 3 of the EPBC Act

Species listed under Part 3 of the EPBC Act (i.e., that are threatened or migratory and are matters of national environmental significance) were identified within the petroleum titles for the MEFF fields by a search of the Protected Matters Search Tool (PMST). These species are listed in Table 5-1, along with their threatened status, migratory status and type of presence predicted by the PMST.

Table 5-1 Threatened and migratory species protected under Part 3 of the EPBC Act within the petroleum titles for the MEFF fields

Species Name	Common Name	Threatened	Migratory	Type of Presence
Birds				
Actitis hypoleucos	Common Sandpiper	-	Migratory	Species or species habitat may occur within area
Anous stolidus	Common Noddy	-	Migratory	Species or species habitat may occur within area
Calidris acuminata	Sharp-tailed Sandpiper	-	Migratory	Species or species habitat may occur within area
Calidris canutus	Red Knot	Endangered	Migratory	Species or species habitat may occur within area
Calidris melanotos	Pectoral Sandpiper	-	Migratory	Species or species habitat may occur within area
Calonectris leucomelas	Streaked Shearwater	-	Migratory	Species or species habitat likely to occur within area

Species Name	Common Name	Threatened	Migratory	Type of Presence
Fregata ariel	Lesser Frigatebird	-	Migratory	Species or species habitat likely to occur within area
Fregata minor	Great Frigatebird	-	Migratory	Species or species habitat may occur within area
Numenius madagascariensis	Eastern Curlew	Critically Endangered	Migratory	Species or species habitat may occur within area
Mammals				
Balaenoptera borealis	Sei Whale	Vulnerable	Migratory	Species or species habitat likely to occur within area
Balaenoptera edeni	Bryde's Whale	-	Migratory	Species or species habitat likely to occur within area
Balaenoptera musculus	Blue Whale	Endangered	Migratory	Species or species habitat likely to occur within area
Balaenoptera physalus	Fin Whale	Vulnerable	Migratory	Species or species habitat likely to occur within area
Megaptera novaeangliae	Humpback Whale	Vulnerable	Migratory	Species or species habitat known to occur within area
Orcinus orca	Killer Whale, Orca	-	Migratory	Species or species habitat may occur within area
Physeter macrocephalus	Sperm Whale	-	Migratory	Species or species habitat may occur within area
Tursiops aduncus (Arafura/Timor Sea populations)	Spotted Bottlenose Dolphin (Arafura / Timor Sea populations)	-	Migratory	Species or species habitat may occur within area
Reptiles				
Caretta caretta	Loggerhead Turtle	Endangered	Migratory	Species or species habitat likely to occur within area
Chelonia mydas	Green Turtle	Vulnerable	Migratory	Species or species habitat likely to occur within area
Dermochelys coriacea	Leatherback Turtle	Endangered	Migratory	Species or species habitat likely to occur within area
Eretmochelys imbricata	Hawksbill Turtle	Vulnerable	Migratory	Species or species habitat likely to occur within area
Natator depressus	Flatback Turtle	Vulnerable	Migratory	Species or species habitat likely to occur within area

Species Name	Common Name	Threatened	Migratory	Type of Presence
Fishes				
Anoxypristis cuspidata	Narrow Sawfish	-	Migratory	Species or species habitat known to occur within area
Carcharhinus longimanus	Oceanic Whitetip Shark	-	Migratory	Species or species habitat likely to occur within area
Carcharodon carcharias	White Shark	Vulnerable	Migratory	Species or species habitat may occur within area
Isurus oxyrinchus	Shortfin Mako	-	Migratory	Species or species habitat likely to occur within area
Isurus paucus	Longfin Mako	-	Migratory	Species or species habitat likely to occur within area
Manta alfredi	Reef Manta Ray	-	Migratory	Species or species habitat likely to occur within area
Manta birostris	Giant Manta Ray	-	Migratory	Species or species habitat likely to occur within area
Pristis zijsron	Green Sawfish	Vulnerable	Migratory	Species or species habitat known to occur within area
Rhincodon typus	Whale Shark	Vulnerable	Migratory	Foraging, feeding or related behaviour known to occur within area

5.2.6.2 Fauna in Pelagic Habitats

The pelagic habitats within the MEFF fields are typical of open water, outer continental North West Shelf region. Pelagic fauna is considered further below and include:

- Plankton
- Nekton, and
- Seabirds.

Planktonic fauna in the MEFF fields will include a wide range of taxa, some of which complete their life history in the plankton and other which are only present for part of their life history. Productivity in planktonic ecosystems within the MEFF fields is influenced by a range of factors, such as the strength of geostrophic flows (e.g., El Nino Southern Oscillation strength), localised wind-driven upwelling and cyclones, with little influence from terrigenous inputs. The planktonic habitat within in the MEFF fields is very widely distributed in the region, and as such this habitat within the fields is not considered to be particularly environmentally sensitive. None of the species protected under Part 3 of the EPBC Act are planktonic.

Nektonic fauna in the MEFF fields comprise a range of taxa, including all the marine mammals and marine reptiles, and most of the marine fishes, protected under Part 3 of the EPBC Act (Table 5-1). The planktonic habitat utilised by nektonic fauna is widely represented and nektonic fauna typically travel long distances. All the pelagic species identified in Table 5-1 are pelagic and are widely distributed.

Some of the species identified in Table 5-1 would only be expected to occur within the MEFF fields seasonally:

- Baleen whales such as pygmy blue whales and humpback whales make seasonal northward and southward migrations in the region and are not present year-round.
- Whale sharks and manta rays (*Manta* spp.) aggregate seasonally off Ningaloo Reef (approximately 350 km south-west of the MEFF fields) and may transit through MEFF fields when moving to or from Ningaloo Reef.

There is are two BIAs identified by the Department of Agriculture, Water and the Environment overlapping the MEFF fields:

- A distribution BIA for pygmy blue whales, and
- A foraging BIA for whale sharks.

The distribution BIA for pygmy blue whales overlapping the MEFF fields is unlikely to constitute important habitat for this species. This BIA covers a very large swath of Australian, international, and high seas waters. Pygmy blue whales are known to migrate seasonally in the region, with tagging studies indicating the northern and southern migration routes occur in continental slope waters (> 200 m water depth) and lie to the north and west of the MEFF fields (Double et al., 2014). Pygmy blue whales are not expected to occur in the MEFF fields; the presence of pygmy blue whales within the MEFF fields is likely to be limited to individual animals undertaking migrations.

The foraging BIA for whale sharks is more likely to represent a migration BIA. Tagging studies of whale sharks aggregating off Ningaloo Reef show that they disperse widely once the aggregations break up, with some animals travelling north-east through North West Shelf waters (Meekan and Radford, 2010). These tagging studies do not suggest notable foraging behaviour occurs within the region.

The presence of other species such as baitfish, tuna, mackerel, and pelagic sharks (e.g., makos and oceanic whitetips) may be less predictable.

Seabirds may occur within the MEFF field, however there are no BIAs overlapping the MEFF fields. The nearest potential seabird nesting and roosting sites are the islands of the Dampier Archipelago, over 100 km to the south of the MEFF fields. The presence of seabirds within the MEFF fields is expected to be limited to low numbers of foraging birds, although they may aggregate temporarily to exploit transient food resources (e.g., schools of baitfish).

5.2.6.3 Fauna in Demersal Habitats

Demersal fauna within the MEFF fields is associated with benthic habitats, which are described in Section 5.2.3. The most conspicuous demersal fauna within the MEFF field are fishes. Environmental surveys in the MEFF field observed relatively diverse fish assemblages associated with the equipment within the MEFF fields, including several species targeted by commercial and recreational fishers (GHD, 2021), although fishing effort in the vicinity of the MEFF fields is relatively low. The bare sand habitats within which the MEFF equipment is located hosts relatively low density, low diversity fish assemblages.

5.2.6.4 *Fauna in Benthic Habitats*

Like demersal fauna, the highest diversity of benthic fauna within the MEFF fields is associated with equipment. Environmental surveys within the fields observed a range of benthic species associated with equipment, such as barnacles, hydroids, and soft corals. These species are present because of the hard substrate provided by the equipment in the MEFF field and would otherwise be absent, or present and much lower densities. The bare sand habitats within the MEFF fields are widely represented in the region and host a range of epibenthic and infauna species, typically at low densities.

5.2.7 Other Users

The MEFF field does not host notable activities by other users. As the titleholder of production licences WA-54-L, WA-26-L and WA-27-L, Santos controls the rights to undertake petroleum activities within the MEFF field. No other petroleum activities by third parties occur within the MEFF fields.

Several Commonwealth- and state-managed commercial fisheries overlap the MEFF field. Each of these fisheries is described in Table 5-2. No activity within any of these fisheries has been recorded in the last 10 years within the MEFF fields, although some trawl fishing activity by participants in the Pilbara Demersal Scalefish Fisheries has been recorded in fisheries management blocks that overlap the MEFF fields.

Bottom trawl fishing gear is at greatest risk of interacting with equipment abandoned *in situ* in the MEFF field. The only fishery that has been active in the vicinity of the MEFF fields between 2010-2020 using trawled gear is the Pilbara Trawl Fishery. Catch data for this fishery is recorded in relatively coarse 60 x 60 NM blocks. Block 19160 overlaps the MEFF fields and is an area of substantial trawl fishery landings (Figure 5-7). However, the MEFF fields lie entirely in an area that is closed to trawling (Figure 5-7) and has been continuously closed since the current fishery management arrangements were implemented in the late 1990’s (except for very limited experimental or research trawling). As such, participants in this fishery are not permitted to trawl in the MEFF field. Interactions with participants in this fishery are very unlikely to occur. However, it is possible that the area becomes open to trawling in the future.

Santos has consulted with some commercial fishers and their industry body, the Western Australian Fishing Industry Council (WAFIC). These consultations indicated there is relatively little interest from commercial fishers consulted in the decommissioning of the MEFF field. This is consistent with historical catch data supplied by the Department of Primary Industries and Resources, which indicate relatively low commercial fishing effort in the vicinity of the MEFF fields. Further details on consultation outcomes are provided in the EPs for the decommissioning of the MEFF fields.

While there is notable commercial shipping in the fairway to the east of the MEFF fields (Figure 5-5), there is negligible commercial shipping activity within the fields.

The MEFF fields are remote and there are no notable reefs or natural attractions. Consequently, there is no tourism activities, such as nature-based tourism, within the MEFF fields. Consultation indicated there is negligible recreational fishing in the MEFF fields.

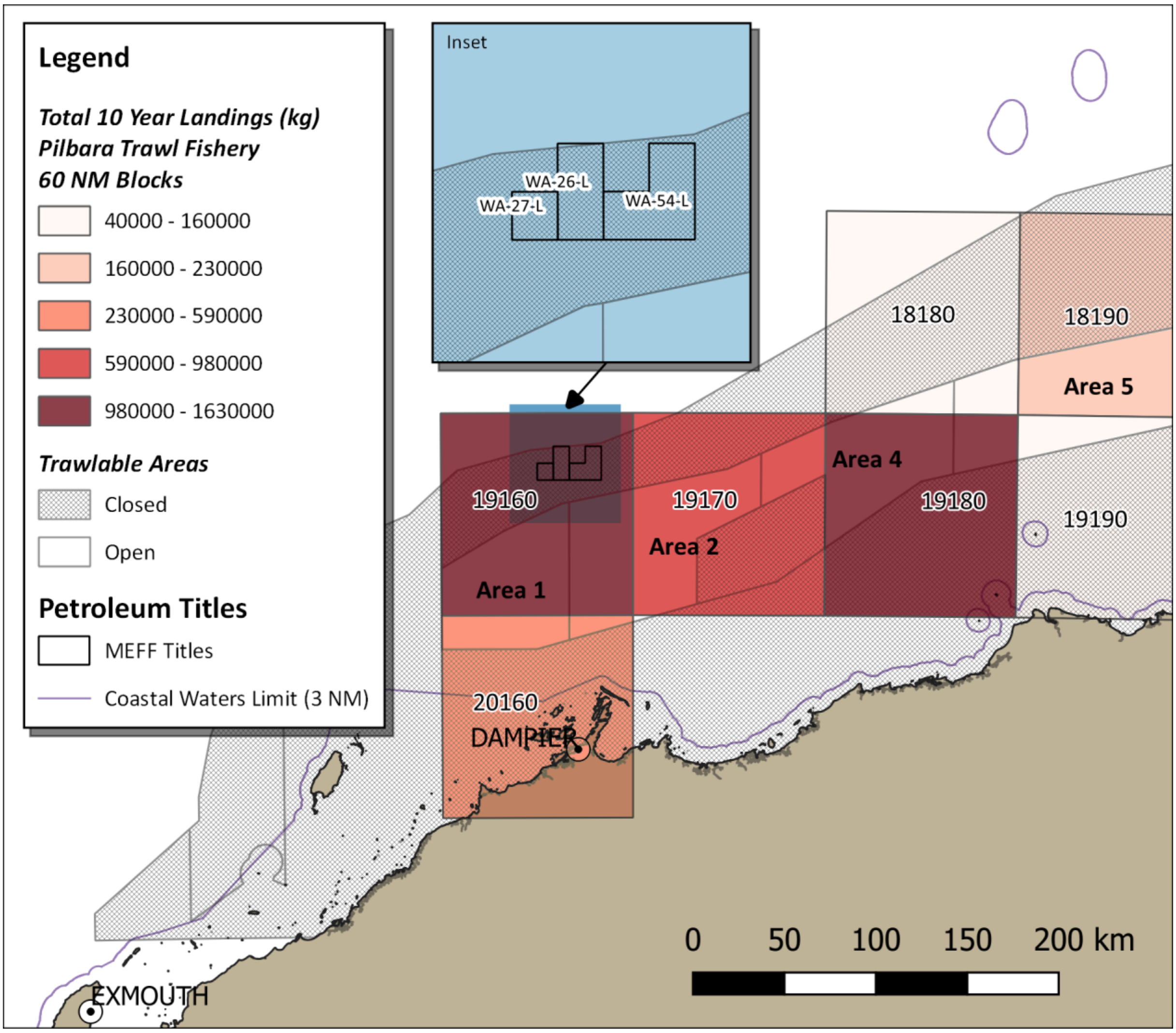

Figure 5-7 Areas where Pilbara Trawl Fishery is permitted to operate and total trawl fishery landings 2010-2020 in 60 x 60 NM blocks

Table 5-2 Descriptions of Commonwealth and State managed fisheries with management boundaries overlapping the MEFF fields. Descriptions derived from Patterson et al. (2020) and Gaughan and Santoro (2020).

Management Authority	Fishery	Description	Relevance in relation to MEFF Fields
Commonwealth Managed Fisheries	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. The main fishing method is pelagic longline, with low levels of minor-line fishing. Fishing largely occurs in outer continental shelf and continental slope waters. Since 2005, there has been fewer than five vessels active in the Western Tuna and Billfish Fishery each year, which has reportedly declined from 50 active vessels in 2000. Fishing activity in the Western Tuna and Billfish Fishery concentrates in waters off southwest Western Australia, and off South Australia. No fishing occurs in the vicinity of the MEFF fields, hence there is no potential for interactions with MEFF equipment.	No commercial fishing in the MEFF fields in the last 10 years. Gear type unlikely to interact with MEFF equipment.
	Southern Bluefin Tuna	Since 1992 juvenile Southern Bluefin Tuna have been targeted in the Great Australian Bight and waters off South Australia. Both purse seine nets and longlines are used to fish for bluefin tuna, with the purse seine catch grown out in aquaculture facilities. No fishing occurs in the vicinity of the MEFF fields, hence there is no potential for interactions with MEFF equipment.	No commercial fishing in the MEFF fields in the last 10 years. Gear type unlikely to interact with MEFF equipment.
	Skipjack Tuna Fishery	The managed fishery boundary covers the entire Australian fishing zone, however activity in this fishery is concentrated off South Australia. There is currently no fishing effort off Western Australia. Most fishing is with purse seine nets, with minor line-based components. No fishing occurs in the vicinity of the MEFF fields, hence there is no potential for interactions with MEFF equipment. No current effort on the North West Shelf.	No commercial fishing in in the MEFF fields in the last 10 years. Gear type unlikely to interact with MEFF equipment.

Management Authority	Fishery	Description	Relevance in relation to MEFF Fields
State Managed Fisheries	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 (typically < 50 m). There has been no record of any fishing effort from this fishery in the MEFF fields, which are too deep to support the target species. Hence, no interactions between fishery participants and the equipment in the MEFF field will occur.	No commercial fishing in the MEFF fields in the last 10 years. MEFF fields too deep to support target species.
	Onslow Prawn Limited Entry 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 114°39.9' on the landward side of the 200 m depth isobath'. Fishing is done using otter trawls, typically in < 50 m water depth. There has been no record of any fishing effort from this fishery in the MEFF fields, which are too deep to support the target species. Hence, no interactions between fishery participants and the equipment in the MEFF field will occur.	No commercial fishing in the MEFF fields in the last 10 years. MEFF fields too deep to support target species.
	Pilbara Demersal Scalefish Fisheries (includes trap and trawl 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. The gear used by participants in the trawl fishery has the greatest likelihood of interacting with equipment abandoned *in situ*, however the MEFF fields lie within an area in which trawling is prohibited. Trap fishing gear is unlikely to interact with equipment abandoned *in situ*.	MEFF fields lie within an area in which trawling is prohibited. Trap gear unlikely to interact with MEFF equipment.
	Pilbara Line Fishery	The Pilbara Line Fishery fishing boat licensees are permitted to operate anywhere within 'Pilbara 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 on the mainland of Western Australia west along the parallel to the intersection of 21° 56' S latitude and the boundary of the Australian Fishing Zone and north to longitude 120° E.	No commercial fishing in in the MEFF fields in the last 10 years. Gear types unlikely to interact with MEFF field equipment.

Management Authority	Fishery	Description	Relevance in relation to MEFF Fields
		The fishery uses lines, which are unlikely to interact with MEFF equipment abandoned *in situ*.	
	Pilbara Crab Managed Fishery	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. Fishing gear consists of baited pots. The target species, blue swimmer crabs, are restricted to coastal waters and will not occur in the MEFF fields.	No commercial fishing in the MEFF fields in the last 10 years. Gear type unlikely to interact with MEFF equipment. MEFF fields too deep to support target species.
	Mackerel Managed Fishery	Trolling or handline. Near-surface trolling gear from vessels in coastal areas around reefs, shoals, and headlands. The target species are all pelagic and occur in the upper part of the water column. Hence, gear is unlikely to interact with MEFF equipment abandoned *in situ*. The bulk of the total catch is taken in the Kimberley area	Very low-level activity was recorded in blocks overlapping the MEFF fields ten years ago. Gear types unlikely to interact with MEFF field equipment.
	Marine Aquarium Fish Fishery	Diver-based fishery collecting specimens by hand. Water depth in the MEFF fields is too deep for this fishery to operate. Hence, no interactions between fishery participants and the equipment in the MEFF field will occur.	Not applicable
	Specimen Shell Managed Fishery	Diver-based fishery collecting specimens by hand. Water depth in the MEFF fields is too deep for this fishery to operate. Hence, no interactions between fishery participants and the equipment in the MEFF field will occur.	Not applicable
	West Coast Deep Sea Crustacean Managed Fishery	Baited pots targeting crabs, occurs between Cape Leeuwin and the Northern Territory border on the seaward side of the 150 m isobath. Target species occurs in deeper waters (> 200 m) than the MEFF fields. Fishing gear consists of baited pots, which are unlikely to interact with equipment in the MEFF fields.	No commercial fishing in the MEFF fields in the last 10 years. Gear type unlikely to interact with MEFF equipment. MEFF fields too shallow to support target species.
	Abalone Managed Fishery	Diver-based fishery collecting specimens by hand. Water depth in the MEFF fields is too deep for this fishery to operate, and the target species to not occur in the Pilbara region. Hence, no interactions between fishery participants and the equipment in the MEFF field will occur.	Not applicable

Management Authority	Fishery	Description	Relevance in relation to MEFF Fields
	South-West Coast Salmon Fishery	Beach seine fishery on the south and south-west coast of Western Australia. Target species does not occur in the Pilbara.	Not applicable

5.3 Pairwise Comparisons of Environmental Receptors

The criteria identified in the AHP hierarchy comprise:

- water quality,
- sediment quality,
- benthic habitats,
- GHG emissions,
- onshore receptors,
- fauna, and
- other users.

These criteria were identified as potentially being impacted by at least one of the feasible decommissioning options. Summary descriptions of each of these criteria are provided in Table 5-3.

The relative weightings of these criteria within the comparative impact assessments of feasible options for each equipment group were determined using the methodology in Section 4.

Table 5-3 Summary descriptions of environmental values of criteria

Criterion	Description
Water quality	Water quality values are ubiquitous in the region. Water quality is highly connected to other environmental receptors, with impacts to water quality potentially impacting other receptors, such as benthic habitats and fauna. Impacts to water quality from the feasible decommissioning options are expected to be of relative short duration and localised in scale, with full recovery to natural levels expected to occur once the activities resulting in a decrease in water quality cease.
Sediment quality	Sediment quality values within the MEFF fields are very widely represented in the region. Sediment quality has a high connected to other environmental values, such as benthic habitats and deposit-feeding fauna. Potential impacts to sediment quality from some feasible decommissioning options have the potential to persist for long periods of time. Sediment contamination from the degradation of equipment abandoned *in situ* may result in persistent debris and low levels of sediment contamination.
Benthic habitats	Benthic habitats provide important ecosystem functions such as habitat for a range of organisms, primary productivity, refuge, and foraging. The benthic habitats in the MEFF fields are primarily bare sediments, with sparsely distributed assemblages of filter feeders and deposit feeders – with the notable exception of the habitats associated with equipment. There are no known natural complex relief benthic habitats (e.g., reefs) within the MEFF fields.
GHG emissions	GHG emissions are increasingly recognised as an environmental risk. Santos recognises the importance of managing GHG emissions and is committed to reducing GHG emissions whilst providing reliable and affordable hydrocarbon-based energy whilst economies transition to more sustainable energy sources. Feedback from a range of Santos' stakeholders has highlighted the importance they place on GHG emissions.

Criterion	Description
Onshore receptors	Onshore environmental receptors are of particular concern as they have the potential to interact with human populations. Onshore receptors of particular concern are those that may be impacted by the management of waste materials. This includes personnel exposed to safety risks from waste materials (e.g., lifting and transporting equipment). Aspects that may impact upon onshore environmental receptors are typically well-regulated by Western Australian and Commonwealth legislation.
Fauna	Fauna species within the MEFF fields are widely represented within the region and are not particularly unique. Several species listed as threatened or migratory under the EPBC Act are expected to occur within the MEFF fields. Commercial fisheries in the region exploit some of the fauna resources, although there has historically been very little fishing effort in the vicinity of the MEFF fields.
Other users	Other users of the marine environment in the vicinity of the MEFF fields include commercial shipping and commercial fishing. The activities of these users occur widely in the region and none of these activities are concentrated within the MEFF fields.

All possible pairwise comparisons of these criteria are provided in Table 5-4, which details:

- the two criteria being compared (labelled A and B),
- which of the criteria is of greater importance,
- the magnitude of the difference in importance (if any), and
- a justification for the selected criterion and magnitude.

The global priorities for the criteria are shown in Figure 5-8.

Table 5-4 Criteria-level pairwise comparative assessment. Cell shading indicates the preferred criterion, with hue intensity reflecting the degree of preference (i.e., the rating column)

Criteria Comparison A	Criteria Comparison B	Preferred Criterion	Rating	Justification
Water Quality	Sediment Quality	B	3 - Moderate importance	Sediment quality is of moderate importance compared to water quality, as the potential impacts to sediment quality from the feasible decommissioning options have the potential to persist for extended periods of time. Impacts to water quality from the feasible decommissioning options are expected to be of shorter duration relative to impacts to sediment quality. Impacts to both sediment quality will be localised to the vicinity of the equipment (10's to 100's of metres).
Water Quality	Benthic Habitats	B	3 - Moderate importance	Depending on the nature of the benthic habitat, recovery from disturbance may occur rapidly (e.g., sediment resuspension in sandy habitats will recover rapidly once the cause of the resuspension ceases) or be irreversible (e.g., changes in benthic habitats from the removal of hard substrate, such as the equipment, will not recover to the pre-removal state). In contrast, impacts to water quality from the feasible decommissioning options are expected to be of relative short duration and localised in spatial scale. Full recovery to natural levels expected to occur once the activities resulting in a decrease in water quality cease. Hence, impacts to benthic habitats from the feasible decommissioning options have a greater potential to result in long-term environmental effects than impacts to water quality. Therefore, benthic habitats are of strong importance relative to water quality.
Water Quality	GHG Emissions	B	5 - Strong importance	GHG emissions are of strong importance compared to water quality, as the potential GHG emissions from the feasible decommissioning options have the potential to persist for extended periods of time, although are small in the overall context of Santos' activities. Impacts to water quality from the feasible decommissioning options are expected to be of shorter duration.
Water Quality	Onshore Environmental Receptors	B	3 - Moderate importance	Onshore receptors are of moderate importance compared to water quality, as impacts to onshore receptors have a greater potential to impact human populations. Aspects that may

Criteria Comparison A	B	Preferred Criterion	Rating	Justification
				impact upon onshore receptors are generally highly regulated, hence the potential for impacts is low but is greater than the potential impacts to water quality in the MEFF fields.
Water Quality	Fauna	B	5 - Strong importance	Fauna species are of strong importance compared to water quality. Several species of fauna that may be impacted, or at risk of impacts, from the feasible decommissioning options are matters of national environmental significance. Recovery from impacts to fauna may take a long time compared to recovery from impacts to water quality. Impacts to fish fauna may have indirect effects on commercial fishers. Impacts to water quality from the feasible decommissioning options are expected to be of shorter duration relative to impacts to fauna.
Water Quality	Other Users	B	5 - Strong importance	Impacts to the functions, interests, and activities of other users from the feasible options may result in impact to these other users. Potential impacts to other users may include damage to equipment (e.g., fishing gear), and displacement of other users. In contract, impacts to water quality from the feasible options are expected to be of relative short duration and localised in scale, with full recovery to natural levels expected to occur once the activities resulting in a decrease in water quality cease. Hence, other users are of strong importance relative to water quality.
Sediment Quality	Benthic Habitats	B	3 - Moderate importance	Potential impacts to sediment quality from the feasible options have the potential to persist for long periods of time. Sediment contamination from the degradation of equipment abandoned *in situ* may result in persistent debris and low levels of sediment contamination within the MEFF fields. Depending on the nature of the benthic habitat, recovery from disturbance may occur rapidly (e.g., sediment resuspension in sandy habitats will recover rapidly once the cause of the resuspension ceases) or be irreversible (e.g., loss of benthic habitats from the removal equipment will not recover to the pre-removal state). While both sediment quality and benthic habitat have a high connectivity with marine ecosystems, benthic habitats are moderately more important than sediment quality.

Criteria Comparison A	Criteria Comparison B	Preferred Criterion	Rating	Justification
Sediment Quality	GHG Emissions	B	3 – Moderate importance	GHG emissions are of moderate importance compared to sediment quality, as the potential GHG emissions from the feasible options have the potential to persist for extended periods of time, although are small in the overall context of Santos' activities. Impacts to sediment quality from the feasible decommissioning options will be much more localised in scale and have to date been of less concern to stakeholders.
Sediment Quality	Onshore Environmental Receptors	A	3 - Moderate importance	Sediment contamination from the degradation of equipment abandoned *in situ* may result in persistent debris and low levels of sediment contamination within the MEFF fields. Impacts to onshore environmental receptors would occur within the land management context, such as local, state and Commonwealth requirements. Complying with the requirements of the land management context is expected to ensure that impacts to onshore environmental receptors are acceptable and do not affect unique or vulnerable environmental values. Considering the preceding points, sediment quality is of moderate importance compared to onshore environmental receptors
Sediment Quality	Fauna	B	5 - Strong importance	While recognising the high environmental connectivity of sediment quality and the potential persistence of sediment contamination over time, the level of protection afforded by the EPBC Act to some fauna species, along with their high ecological connectivity and importance to commercial fishing, results in fauna being rated as of moderate importance compared to sediment quality.
Sediment Quality	Other Users	B	3 - Moderate importance	Sediment contamination from the degradation of equipment abandoned *in situ* may result in persistent debris and low levels of sediment contamination within the MEFF fields. Impacts to other users are likely to receive scrutiny by Santos' stakeholders. Santos is required to consider any claims or objections raised by stakeholders and respect their rights to access the marine environment. While acknowledging the high connectivity of sediment quality to marine ecosystems, other users are of moderate importance compared to sediment quality due to the potential consequences to other users.

Criteria Comparison A	Criteria Comparison B	Preferred Criterion	Rating	Justification
Benthic Habitats	GHG Emissions	-	1 - Equal importance	Benthic habitats have a high connectivity and influence the abundance and diversity of fauna within the MEFF fields. GHG emissions from the feasible options have the potential to persist for extended periods of time, although are small in the overall context of Santos' activities. Santos considers benthic habitats and GHG emissions to be equally important in the context of decommissioning the MEFF field.
Benthic Habitats	Onshore Environmental Receptors	A	3 - Moderate importance	Sediment contamination from the degradation of equipment abandoned *in situ* may result in persistent debris and low levels of sediment contamination within the MEFF fields. Impacts to onshore environmental receptors would occur within the land management context, such as local, state and Commonwealth requirements. Complying with the requirements of the land management context is expected to ensure that impacts to onshore environmental receptors are acceptable and do not affect unique or vulnerable environmental values. Considering the preceding points, sediment quality is of moderate importance compared to onshore environmental receptors.
Benthic Habitats	Fauna	B	3 – Moderate importance	Benthic habitats provide a range of ecosystem functions. Depending on the nature of the benthic habitat, recovery from disturbance may occur rapidly (e.g., sediment resuspension in sandy habitats will recover rapidly once the cause of the resuspension ceases) or be irreversible (e.g., changes in benthic habitats from the removal of equipment will not recover to the pre-removal state). While recognising the high connectivity of benthic habitats with marine ecosystems, threatened and migratory fauna species are protected under the EPBC Act. Fish fauna also provide the basis of commercial and recreational fishing activity. Based on the preceding points, the environmental value of fauna is of moderate importance compared to benthic habitats in the context of the feasible decommissioning options.
Benthic Habitats	Other Users	-	1 – Equal importance	Benthic habitats provide a range of ecosystem functions. Depending on the nature of the benthic habitat, recovery from disturbance may occur rapidly (e.g., sediment resuspension in sandy habitats will recover rapidly once the cause of the resuspension ceases) or be irreversible (e.g., changes in benthic habitats from the removal of equipment will not

Criteria Comparison A	Criteria Comparison B	Preferred Criterion	Rating	Justification
				recover to the pre-removal state). Impacts to other users are likely to receive scrutiny by Santos' stakeholders. Santos is required to consider any claims or objections raised by stakeholders and respect their rights to access the marine environment. Benthic habitats and other users are of equal importance.
GHG Emissions	Onshore Environmental Receptors	A	3 – Moderate importance	GHG emissions from the feasible options have the potential to persist for extended periods of time, although are small in the overall context of Santos' activities. Impacts to onshore environmental receptors would occur within the land management context, such as local, state and Commonwealth requirements. Complying with the requirements of the land management context is expected to ensure that impacts to onshore environmental receptors are acceptable and do not affect unique or vulnerable environmental values. Considering the preceding points, GHG emissions are of moderate importance compared to onshore environmental receptors.
GHG Emissions	Fauna	B	3 - Moderate importance	GHG emissions from the feasible options have the potential to persist for extended periods of time, although are small in the overall context of Santos' activities. Threatened and migratory fauna species are protected under the EPBC Act. Fish fauna also provide the basis of commercial and recreational fishing activity. Based on the preceding points, the environmental value of fauna is of moderate importance compared to GHG emissions.
GHG Emissions	Other Users	-	1 – Equal importance	GHG emissions from the feasible options have the potential to persist for extended periods of time, although are small in the overall context of Santos' activities. Impacts to other users are likely to receive scrutiny by Santos' stakeholders. Santos is required to consider any claims or objections raised by stakeholders and respect their rights to access the marine environment. GHG emissions and other users are of equal importance.
Onshore Environmental Receptors	Fauna	B	3 – Moderate importance	Impacts to onshore environmental receptors would occur within the land management context, such as local, state and Commonwealth requirements. Complying with the requirements of the land management context is expected to ensure that impacts to onshore environmental receptors are acceptable and do not affect unique or vulnerable

Criteria Comparison A	Criteria Comparison B	Preferred Criterion	Rating	Justification
				environmental values. Threatened and migratory fauna species are protected under the EPBC Act. Fish fauna also provide the basis of commercial and recreational fishing activity. Santos considered fauna to be of moderate importance compared to onshore environmental receptors.
Onshore Environmental Receptors	Other Users	B	3 – Moderate importance	Impacts to onshore environmental receptors would occur within the land management context, such as local, state and Commonwealth requirements. Complying with the requirements of the land management context is expected to ensure that impacts to onshore environmental receptors are acceptable and do not affect unique or vulnerable environmental values. Impacts to other users are likely to receive scrutiny by Santos' stakeholders. Santos is required to consider any claims or objections raised by stakeholders and respect their rights to access the marine environment. As such, other users are of moderate importance compared to onshore environmental receptors.
Fauna	Other Users	-	1 – Equal importance	Threatened and migratory fauna species are protected under the EPBC Act. Fish fauna also provide the basis of commercial and recreational fishing activity. Impacts to other users are likely to receive scrutiny by Santos' stakeholders. Santos is required to consider any claims or objections raised by stakeholders and respect their rights to access the marine environment. Fauna and other users are of equal importance.

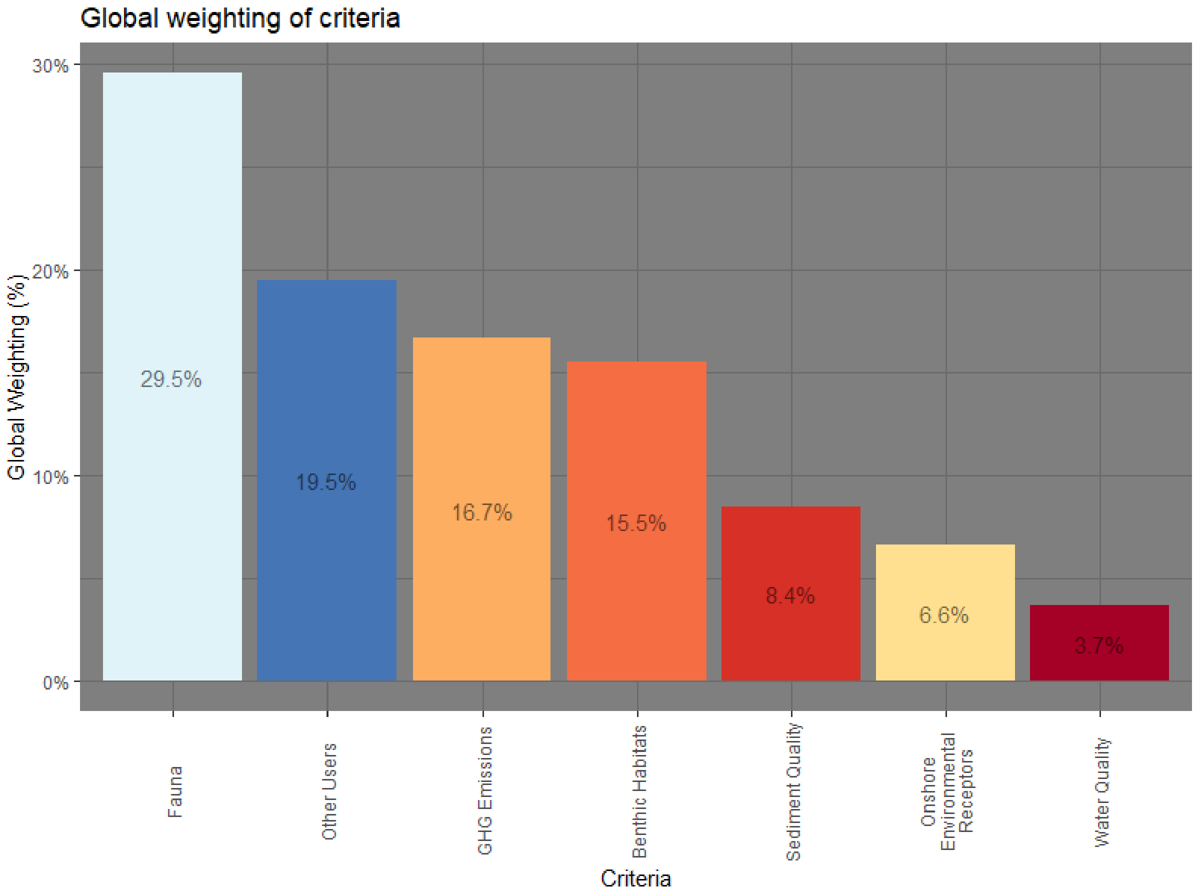

Figure 5-8 Global priorities from criteria-level pairwise comparisons

6 Comparative Environmental Impact Assessment of Decommissioning Options

This section contains a series of comparative environmental impact assessments of the feasible options for each of the equipment groups described in Section 2. Each of these comparative environmental impact assessments considers the suite of environmental receptors and associated weightings determined in Section 5.

6.1 Gravity Bases and Concrete Ballast

This section summarises the comparative environmental impact assessment for the feasible options for the gravity bases and concrete ballast. Refer to Section 2.1 for a description of this equipment group. The AHP hierarchy for this comparative assessment is shown in Figure 6-1. The outcomes of the comparative environmental impact assessment for the gravity bases and concrete ballast are shown in Figure 6-2 and Figure6-3.

The AHP is summarised in this section, with AHP calculations provided in Appendix A.

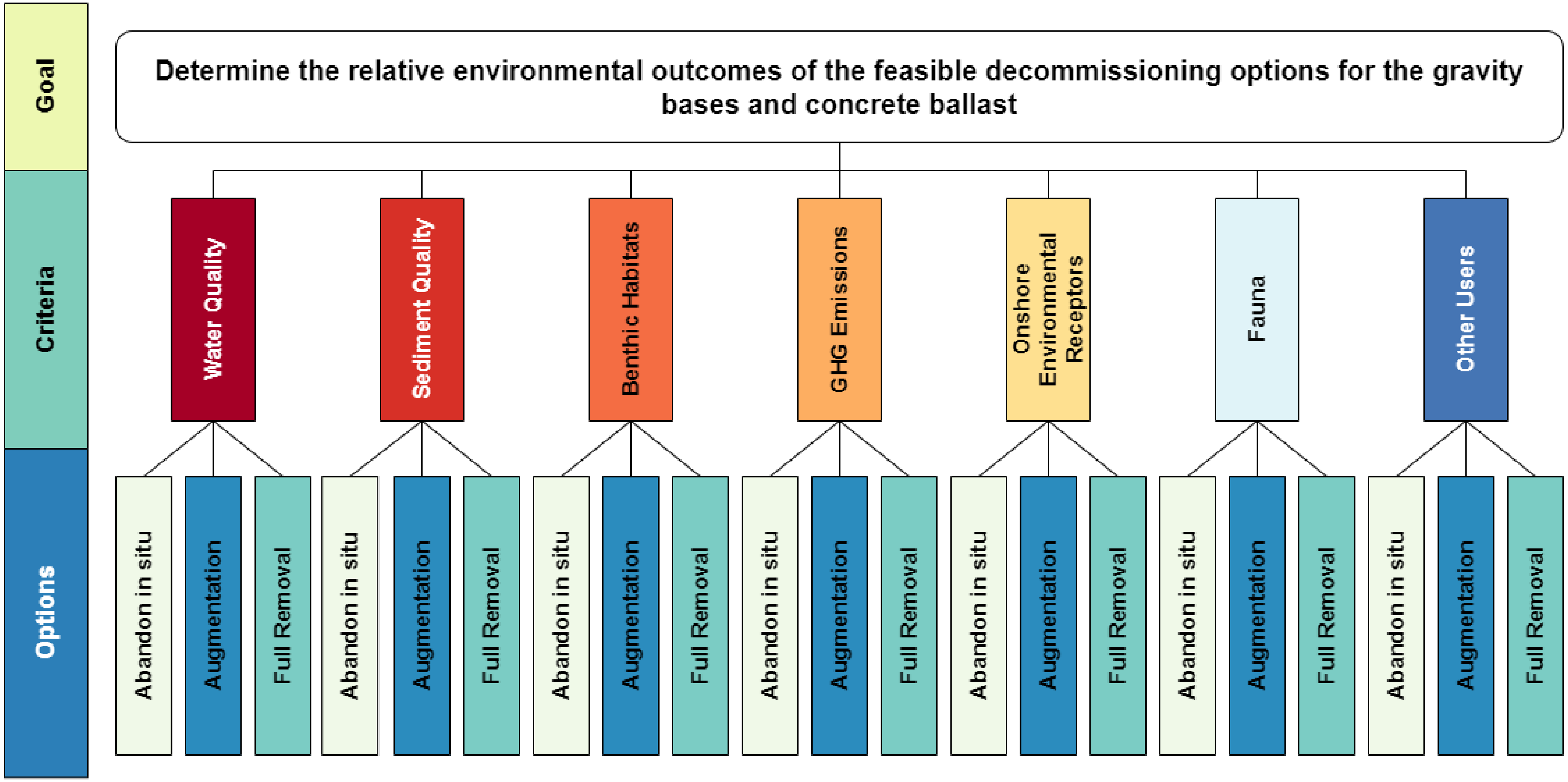

Figure 6-1 AHP hierarchy for the comparative environmental impact assessment of the gravity bases and concrete ballast

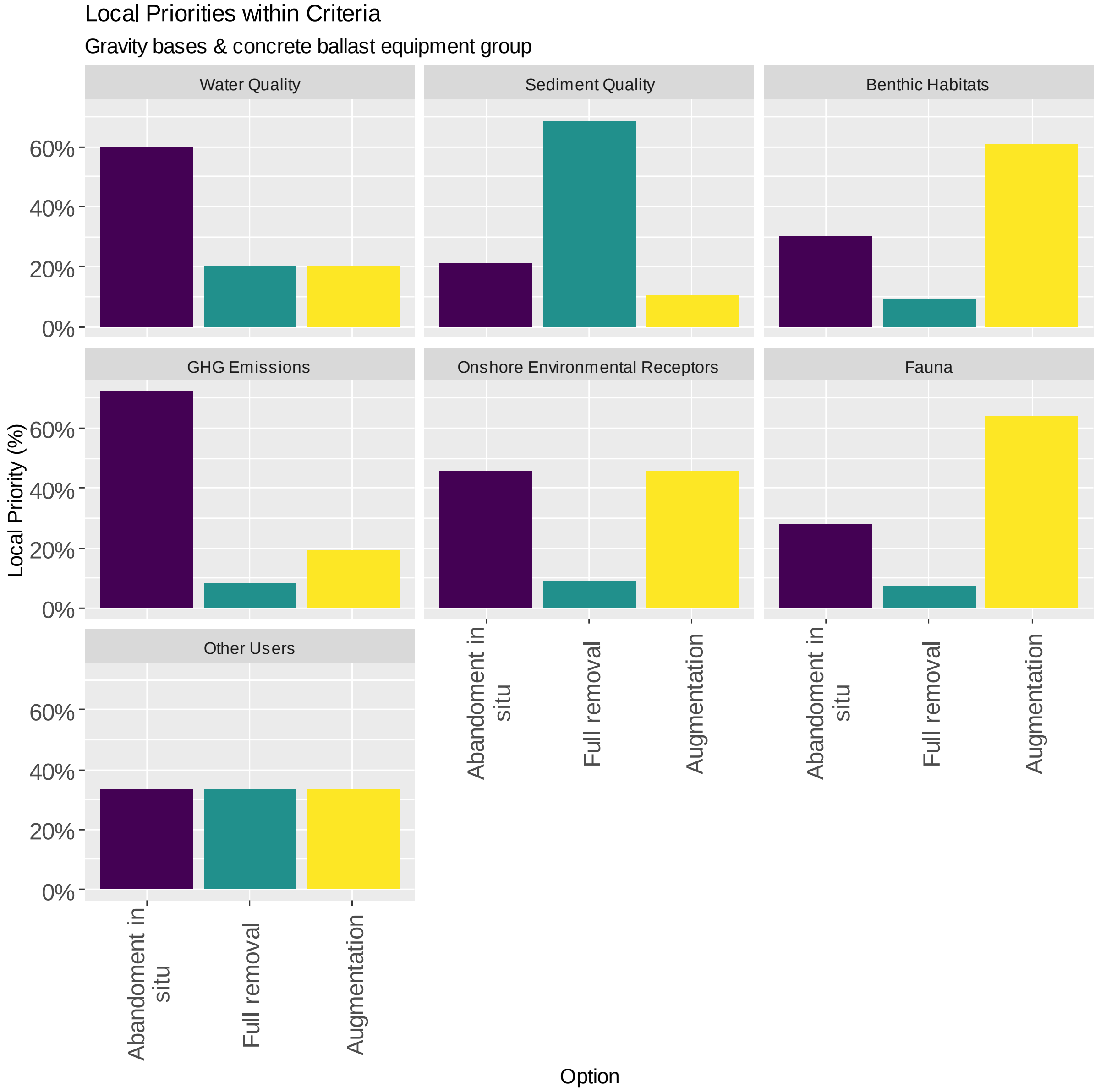

Figure 6-2 Local priorities for the feasible options within environmental receptors for the gravity bases and concrete ballast equipment group

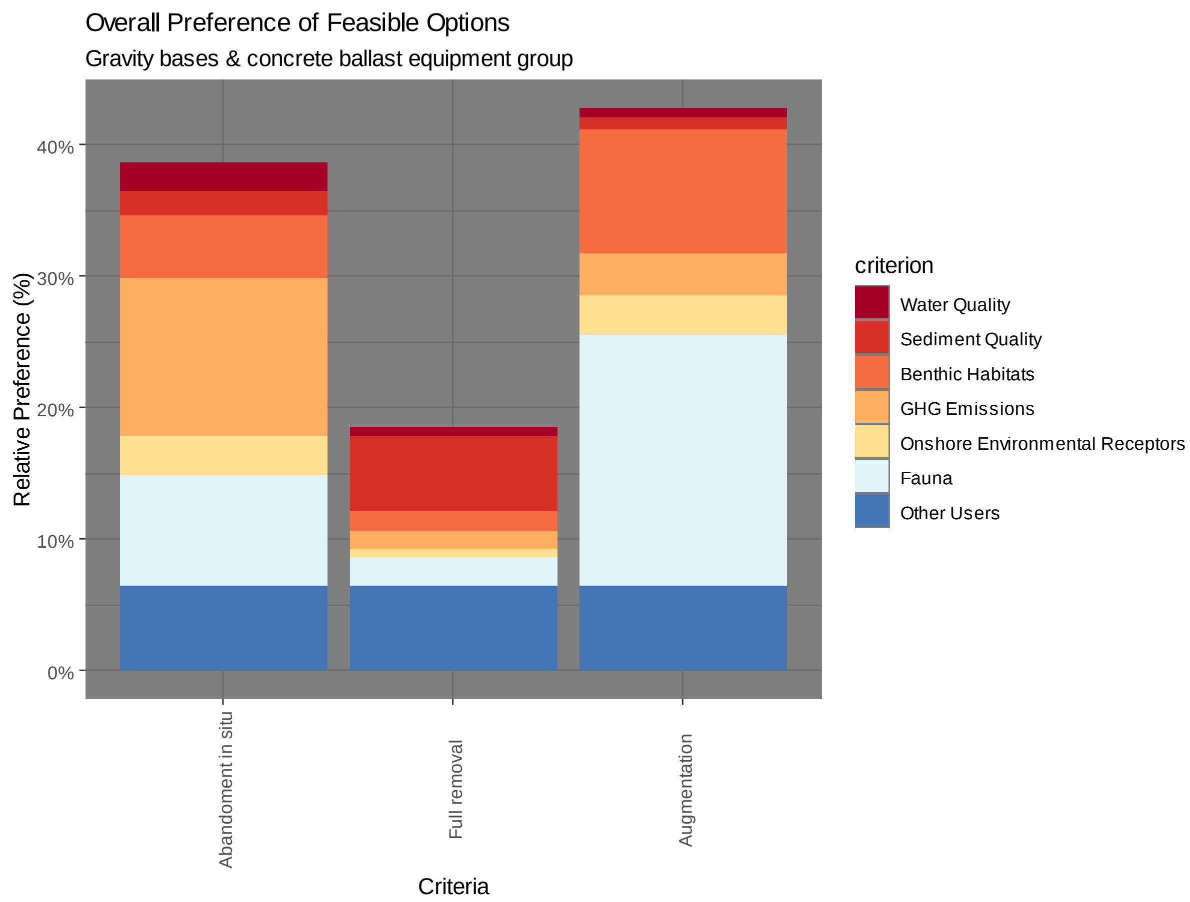

Figure6-3 Stacked bar plot of relative preference of the feasible options within the gravity bases and concrete ballast equipment group.

6.1.1 Water Quality

Environmental aspects of the feasible options for the gravity bases and concrete ballast that may impact water quality are:

- Abandonment *in situ* (Section 3.2.1):
  - Equipment degradation.
- Augmentation (Section 3.3.3):
  - Augmentation installation,
  - Equipment degradation,
  - Utility discharges.
- Full removal (Section 3.1.4):
  - Equipment removal, and
  - Utility discharges.

The pairwise comparisons for the feasible options are summarised in Table 6-1, with impact assessments of each aspect provided in Sections 6.1.1.1 to 6.1.1.4.

Table 6-1 Summary of water quality comparative environmental impact assessment of feasible options for the gravity bases and concrete ballast. Cell shading indicates the preferred criterion, with hue intensity reflecting the degree of preference (i.e., the rating column)

Criteria Comparison		Preferred Criterion	Rating	Justification
A	B			
Abandonment *in situ*	Augmentation	A	3 – Moderate importance	Abandonment *in situ* will not credibly impact upon water quality, as there are no associated vessel-related discharges and degradation products will not impact water quality. The augmentation option will also result in some short-term localised impacts to water quality from vessel utility discharges and installation of the augmentation structures.
Abandonment *in situ*	Full removal	A	3 – Moderate importance	Abandonment *in situ* will not credibly impact upon water quality, as there are no associated vessel-related discharges and degradation products will not impact water quality. The full removal option will also result in some short-term localised impacts to water quality from vessel utility discharges and removal of gravity bases and concrete ballast.
Augmentation	Full removal	-	1 – Equal importance	Both the augmentation and full removal options will have a negligible impact on water quality due to the release of treated seawater. Both options will also result in some short-term localised impacts to water quality from vessel utility discharges and installation / removal of the augmentation structures / gravity bases and concrete ballast.

6.1.1.1 Augmentation

The installation of augmentation structures will result in minor disturbance of the seabed within the installation footprint. This will result in a temporary, localised decrease in water quality through resuspension of sediments. The sediments in the MEFF fields are characterised as sands and silts, which are expected to settle rapidly. Finer sediments will remain suspended for longer, and hence may be advected further from the removal location, however such fine sediments are a relatively small fraction of the sediments. This impact is assessed as negligible when using Santos' offshore division environmental consequence descriptions.

The abandonment *in situ* and full removal options will not install augmentation and hence have no associated impacts.

6.1.1.2 Equipment Degradation

The abandonment *in situ* and augmentation options will result in the gravity bases and concrete ballast being left to degrade on the seabed. Augmentation will introduce additional artificial structures that will also degrade. Much of the material from the progressive degradation of the gravity bases and concrete ballast over time will be insoluble and will remain on the seabed, or in the sediment and hence has little potential to impact water quality.

The full removal option will entirely remove the gravity bases and concrete ballast, hence there are no impacts to water quality from equipment degradation from this option.

6.1.1.3 Equipment Removal

The removal of the gravity bases and concrete ballast by the full removal option will result in some localised sediment resuspension. The sediments in the MEFF fields are characterised as sands and silts, which are expected to settle rapidly. Finer sediments will remain suspended for longer, and hence may be advected further from the removal location, however such fine sediments are a relatively small fraction of the sediments. The footprints of the gravity bases and concrete ballast is relatively small, and hence the amount of sediment that can credibly be resuspended is relatively small compared to the removal of other equipment groups. This impact is assessed as negligible when using Santos' offshore division environmental consequence descriptions.

6.1.1.4 Utility Discharges

Vessel operations for the augmentation and full removal options will result in utility discharges within the MEFF fields. Impacts to water quality from vessel utility discharges may include:

- Increases in nutrients,
- Increased biochemical oxygen demand,
- Increased turbidity,
- Reduced visual amenity, and
- Increases in potential contaminants such as hydrocarbons and chemicals.

The open water environment receiving utility discharges is expected to result in rapid mixing of utility discharges from vessels undertaking the augmentation and full removal options. As a result, the potential impacts to water quality will be highly localised and restricted to the immediate area (i.e., 10's to 100's of metres) around the discharge point.

Potential impacts to water quality from utility discharges from vessels are negligible when assessed using Santos' detailed environmental consequence descriptors.

6.1.2 Sediment Quality

Environmental aspects of the feasible options for the gravity bases and concrete ballast that may impact sediment quality are:

- Abandonment *in situ* (Section 3.2.1):
  - Equipment degradation.
- Augmentation (Section 3.3.3):
  - Augmentation installation, and
  - Equipment degradation.
- Full removal (Section 3.1.4):
  - Equipment removal.

The pairwise comparisons for the feasible options are summarised in Table 6-2, with impact assessments of each aspect provided in Sections 6.1.2.1 to 6.1.2.3.

Table 6-2 Summary of sediment quality comparative environmental impact assessment of feasible options for the gravity bases and concrete ballast. Cell shading indicates the preferred criterion, with hue intensity reflecting the degree of preference (i.e., the rating column)

Criteria Comparison A	Criteria Comparison B	Preferred Criterion	Rating	Justification
Abandonment *in situ*	Augmentation	A	3 – Moderate importance	The abandonment *in situ* option will leave the gravity bases and concrete ballast to degrade, with degradation products having a negligible impact on sediment quality. The augmentation option will leave gravity bases and concrete ballast to degrade as well as the augmentation structures, with degradation products having a negligible impact on sediment quality.
Abandonment *in situ*	Full removal	B	5 – Strong importance	The abandonment *in situ* option will leave gravity bases and concrete ballast to degrade, with degradation products having a negligible impact on sediment quality. The full removal option will remove the gravity bases and concrete ballast, hence eliminating degradation-related impacts to sediment quality.
Augmentation	Full removal	B	5 – Strong importance	The augmentation option will leave the gravity bases and concrete ballast to degrade as well as the augmentation structures, with degradation products having a negligible impact on sediment quality. The full removal option will remove the gravity bases and concrete ballast, hence eliminating degradation-related impacts to sediment quality.

6.1.2.1 Augmentation

Structures installed as augmentation will degrade over a long period of time within the MEFF fields. These structures are assumed to be made primarily of concrete, with a small quantity of steel for lifting points and reinforcement. Both concrete and steel will degrade over the course of hundreds of years and are relatively inert in seawater. Both the steel and concrete will result in negligible impacts to sediment quality within the MEFF fields.

6.1.2.2 Equipment Degradation

The degradation of the gravity bases and concrete ballast on the seabed because of the abandonment *in situ* and augmentation options will impact upon sediments. Degradation will release material among seabed sediments over the course of hundreds to thousands of years (Atteris, 2021).

The gravity bases and concrete ballast consist mainly of steel, with the negligible amount of plastics removed prior to abandonment *in situ*. The gravity bases are partially buried and are expected to continue to become buried over time through natural sediment deposition. Corrosion products will be concentrated in the sediments under and around the gravity bases and concrete ballast and will not disperse widely. Iron, the major component of the gravity bases, is not generally recognised as toxic in sediments and the *Australian and New Zealand guidelines for fresh and marine water quality* (Commonwealth of Australia and New Zealand Government, 2018) do not provide a default guideline value or guideline value-high for this element. Other components of the steel alloys, such as nickel and chromium, do have guideline values published. However, these metals are only present in the steel alloys in trace amounts. Sediment sampling by GHD (2021) found concentrations of these metals in sediments were far below the default guideline values around the gravity bases and concrete ballast. Concrete is comprised of inert aggregate and cement, which are abundant in the natural marine environment. Hence, the increased sediment concentrations of other metals present in the steel alloys or concrete are not expected to cause detectable toxic impacts to organisms.

There is a small amount of plastic in the ball valves on the gravity bases (approximately 0.4 kg total), which will be released to the environment once the valves are sufficiently degraded. The plastic is expected to be negatively buoyant and will become incorporated in the sediment. The plastics are largely inert and will have negligible impact on sediment quality.

The consequence to sediment quality from equipment degradation is assessed as minor when using the Santos offshore division detailed environmental consequence descriptions.

6.1.2.3 Equipment Removal

Some sediment relocation may be required to provide access to lifting points or installation of lifting equipment to remove the gravity bases and concrete ballast from the seabed. This will result in localised sediment resuspension and may result in some temporary modification of the particle size distribution (i.e., a reduction in the portion of fine sediments) and localised depressions in the seabed. Recovery to natural conditions is expected to occur through natural sediment transport processes within weeks, predominantly through redistribution of local sediments by tidal currents as bedload. These changes in sediment characteristics are assessed as negligible when using the Santos offshore division detailed environmental consequence descriptions.

6.1.3 Benthic Habitats

Environmental aspects of the feasible options for the gravity bases and concrete ballast that may impact benthic habitats are:

- Abandonment *in situ* (Section 3.2.1):
  - Equipment degradation.
- Augmentation (Section 3.3.3):
  - Augmentation installation, and
  - Equipment degradation.
- Full removal (Section 3.1.4):
  - Equipment removal.

The pairwise comparisons for the feasible options are summarised in Table 6-3, with impact assessments of each aspect provided in Sections 6.1.3.1 to 6.1.3.3.

Table 6-3 Summary of benthic habitats comparative environmental impact assessment of feasible options for the gravity bases and concrete ballast. Cell shading indicates the preferred criterion, with hue intensity reflecting the degree of preference (i.e., the rating column)

Criteria Comparison A	Criteria Comparison B	Preferred Criterion	Rating	Justification
Abandonment *in situ*	Augmentation	B	3 – Moderate importance	The abandonment *in situ* option will preserve the benthic habitats that have developed on and around the gravity bases and concrete ballast. The augmentation option will preserve the benthic habitats that have developed on and around the gravity bases and concrete ballast, as well as provide additional structures for benthic habitats.
Abandonment *in situ*	Full removal	A	5 – Strong importance	The abandonment *in situ* option will preserve the benthic habitats that have developed on and around the gravity bases and concrete ballast. The full removal option will eliminate benthic habitats associated with the gravity bases and concrete ballast, with the environment expected to return to its natural state.
Augmentation	Full removal	A	5 – Strong importance	The augmentation option will preserve the benthic habitats that have developed on and around the gravity bases and concrete ballast, as well as provide additional structures for benthic habitats. The full removal option will eliminate benthic habitats associated with the gravity bases and concrete ballast, with the environment expected to return to its natural state.

6.1.3.1 Augmentation

Augmentation will provide additional hard substrate for the growth of sessile benthic invertebrates such as hydroids and sponges and relatively complex structures for taxa such as fishes and crustaceans. This will increase the overall abundance and diversity of benthic habitats and associated fauna species within the MEFF fields. This increase will occur until the augmentation structures are completely degraded and buried, which is expected to take hundreds to thousands of years.

6.1.3.2 Equipment Degradation

The abandonment *in situ* and augmentation options will preserve the benthic habitats and associated species that have developed on the gravity bases and concrete ballast. Environmental surveys in the MEFF fields observed that these communities were relatively high in species diversity and abundance compared to the surrounding bare sediment habitat, and hosted some of the most abundant fish assemblages in the MEFF fields (GHD, 2021). Impacts from the retention of benthic habitats associated with the gravity bases and concrete ballast are assessed as negligible when using the Santos offshore division detailed environmental consequence descriptions.

6.1.3.3 Equipment Removal

The gravity bases and concrete ballast support sessile invertebrate communities that are relatively high in diversity compared to the surrounding largely bare sediments (GHD, 2021). This habitat in turn supports increased diversity and abundance of fishes, which is consistent with other studies of pipelines in the region (Bond et al., 2018; McLean et al., 2017). Removal of the gravity bases and concrete ballast will result in the loss of this habitat and associated fish assemblages. There will be a consequent reduction in the diversity of benthic habitats and associated communities in the MEFF fields, with the habitats expected to return to a natural state within months to years. This impact is assessed as negligible when using the Santos offshore division detailed environmental consequence descriptions.

6.1.4 GHG Emissions

Environmental aspects of the feasible options for the gravity bases and concrete ballast that may impact GHG emissions are:

- Abandonment *in situ* (Section 3.2.1):
  - No GHG emissions.
- Augmentation (Section 3.3.3):
  - Atmospheric emissions.
- Full removal (Section 3.1.4):
  - Atmospheric emissions, and
  - Waste management.

The pairwise comparisons for the feasible options are summarised in Table 6-4, with impact assessments of each aspect provided in Sections 6.1.4.1 and 6.1.4.2.

Table 6-4 Summary of GHG emissions comparative environmental impact assessment of feasible options for the gravity bases and concrete ballast. Cell shading indicates the preferred criterion, with hue intensity reflecting the degree of preference (i.e., the rating column)

Criteria Comparison A	Criteria Comparison B	Preferred Criterion	Rating	Justification
Abandonment *in situ*	Augmentation	A	5 – Strong importance	The abandonment *in situ* option will not generate GHG emissions. The augmentation option will generate GHG emissions from the manufacture and installation of the augmentation structures.
Abandonment *in situ*	Full removal	A	7 – Very strong importance	The abandonment *in situ* option will not generate GHG emissions. The full removal option will generate GHG emissions while the vessel is in the field and from processing and disposal of the recovered equipment.
Augmentation	Full removal	A	3 – Moderate importance	The augmentation option will generate GHG emissions from the manufacture and installation of the augmentation structures. Vessel emissions will be lower than the full removal option. The full removal option will generate GHG emissions while the vessel is in the field and from processing and disposal of the recovered equipment.

6.1.4.1 Atmospheric Emissions

Atmospheric emissions from vessels undertaking the augmentation and full removal options will result in a localised decrease in air quality due to exhaust emissions from internal combustion engines. These emissions will mix within the atmosphere and disperse rapidly, with the exhaust stacks on vessel typically mounted high on the vessel to facilitate mixing and avoid exhaust emissions near crewed areas. There are no population centres in the vicinity of the emission locations. Air-breathing fauna, such as marine mammals, birds, and reptiles, are not expected to be present in high numbers in the MEFF fields. Hence, direct impacts to air quality because of atmospheric emissions for these feasible options are negligible.

Fuel combustion onboard vessels will generate carbon dioxide emissions, which is a GHG. GHG emissions will result in indirect environmental impacts from climate change. The augmentation and bury and full removal options will emit carbon dioxide, which is contrasted with no GHG emissions for the abandonment *in situ* option.

The structures installed by the augmentation option will be made of steel and concrete. The manufacturing processes of both these materials requires energy and releases carbon dioxide. The manufacturing process of cement is the single largest GHG emissions source globally, accounting for approximately 8% of global carbon dioxide emissions.

The air quality and GHG environmental consequence of the augmentation and full removal options are assessed as negligible when using the Santos offshore division detailed environmental consequence descriptions. The abandonment *in situ* option does not generate GHG or atmospheric emissions.

6.1.4.2 Waste Management

Waste equipment recovered to shore for full removal option will require processing, transportation, and disposal. These processes will generate atmospheric and GHG emissions from the consumption of electricity from the local network and the combustion of fuel in trucks. These emissions are expected to be considerably smaller than those generated by offshore vessel activities for the full removal option. As such, these emissions are assessed as negligible when using the Santos offshore division detailed environmental consequence descriptions.

Recovery of the steel from the gravity bases and concrete ballast provides a recycling opportunity. Any steel recycled may displace the need for newly manufactured steel, resulting in a consequent reduction in emissions from new steel production. Any reduction of emissions from recycling steel will be offset by emissions to process the equipment and transport it for recycling (likely to be an overseas destination).

6.1.5 Onshore Environmental Receptors

Environmental aspects of the feasible options for the gravity bases and concrete ballast that may impact onshore environmental receptors are:

- Abandonment *in situ* (Section 3.2.1):
  - No aspects impacting onshore environmental receptors.
- Augmentation (Section 3.3.3):
  - No aspects impacting onshore environmental receptors.

- Full removal (Section 3.1.4):
  - Waste management.

The pairwise comparisons for the feasible options are summarised in Table 6-5, with impact assessments of each aspect provided in Section 6.1.5.1.

Table 6-5 Summary of onshore environmental receptors comparative environmental impact assessment of feasible options for the gravity bases and concrete ballast. Cell shading indicates the preferred criterion, with hue intensity reflecting the degree of preference (i.e., the rating column)

Criteria Comparison A	Criteria Comparison B	Preferred Criterion	Rating	Justification
Abandonment *in situ*	Augmentation	A	1 – Equal importance	Neither the abandonment *in situ* or augmentation options will generate waste that requires management onshore, and hence are of equal importance.
Abandonment *in situ*	Full removal	A	5 – Strong importance	The abandonment *in situ* option will not generate any waste that requires management onshore. The full removal option will bring the gravity bases and concrete ballast onshore for processing and disposal. Whilst generating wastes that will be landfilled, this option also creates opportunities for recycling.
Augmentation	Full removal	A	5 – Strong importance	The augmentation option will not generate any waste that requires management onshore. The full removal option will bring the gravity bases and concrete ballast onshore for processing and disposal. Whilst generating wastes that will be landfilled, this option also creates opportunities for recycling.

6.1.5.1 *Waste Management*

Waste management of the gravity bases and concrete ballast recovered by the full removal option may impact upon onshore environmental receptors by:

- Using onshore storage and processing facilities, and
- Contributing to landfill.

The onshore processing of waste management facilities is assumed to take place locally at a port such as Dampier, Onslow, or Exmouth. Each of these ports have cleared land suitable for the storage and processing of required equipment. No clearing or construction of new facilities will be required.

Waste materials that cannot practicably be recycled will be disposed of in a landfill facility in the Pilbara region. Such facilities are regulated under Western Australian law to reduce their environmental impacts and risks. Concentrations of potential contaminants such as mercury and naturally occurring radioactive material in equipment will be negligible and are expected to be suitable for disposal in a general-purpose waste management facility. Consequently, impacts to onshore environmental receptors are assessed as negligible when using the Santos offshore division environmental consequence definitions.

6.1.6 Fauna

Environmental aspects of the feasible options for the gravity bases and concrete ballast that may impact upon fauna are:

- Abandonment *in situ* (Section 3.2.1):
  - Equipment degradation, and
  - Physical presence.
- Augmentation (Section 3.3.3):
  - Equipment degradation,
  - Physical presence,
  - Underwater noise.
- Full removal (Section 3.1.4):
  - Physical presence, and
  - Underwater noise.

The pairwise comparisons for the feasible options are summarised in Table 6-6, with impact assessments of each aspect provided in Sections 6.1.6.1 to 6.1.6.4.

Table 6-6 Summary of fauna comparative environmental impact assessment of feasible options for the gravity bases and concrete ballast. Cell shading indicates the preferred criterion, with hue intensity reflecting the degree of preference (i.e., the rating column)

Criteria Comparison A	Criteria Comparison B	Preferred Criterion	Rating	Justification
Abandonment *in situ*	Augmentation	B	3 – Moderate importance	The abandonment *in situ* option will preserve the relatively diverse fauna that utilises the habitats associated with the gravity bases and concrete ballast. The augmentation option will preserve and enhance the relatively diverse fauna that utilises the habitats associated with the gravity bases and concrete ballast.
Abandonment *in situ*	Full removal	A	5 – Strong importance	The abandonment *in situ* option will preserve the relatively diverse fauna that utilises the habitats associated with the gravity bases and concrete ballast. The full removal option will result in the loss of fauna associated with the habitats provided by the gravity bases and concrete ballast.
Augmentation	Full removal	B	7 – Very strong importance	The augmentation option will preserve and enhance the relatively diverse fauna that utilises the habitats associated with the gravity bases and concrete ballast. The full removal option will result in the loss of fauna associated with the habitats provided by the gravity bases and concrete ballast.

6.1.6.1 Augmentation

The installation of structures by the augmentation option will provide relatively complex habitat for fauna. Augmentation will increase the abundance of fauna species within the MEFF field. Augmentation may result in an overall increase in fauna species diversity as the spatial extent of complex habitat will be greater than the gravity bases and concrete ballast alone. As outlined in 6.1.2.2, degradation of augmentation will have negligible impacts on sediment quality, and hence is not expected to impact upon fauna.

6.1.6.2 Equipment Degradation

The abandonment *in situ* and augmentation options will leave the gravity bases and concrete ballast in the environment, which will degrade over time. Given the gravity bases and concrete ballast consist almost entirely of steel and concrete, impacts of degradation on fauna will be negligible. The presence of the gravity bases and concrete ballast provides habitat for a range of fauna species. The timeframe for degradation of the gravity bases and concrete ballast is in the order of hundreds to thousands of years, hence the fauna communities associated with this equipment will persist over the same timeframe.

There is a small amount of plastic within the ball valves on the gravity bases (approximately 0.4 kg in total). This plastic is encased within the valves and will not be released until the steel valve casing sufficiently corrodes. The plastic is likely to be negatively buoyant, and hence is expected to become deposited in the sediment along with other degradation products from the gravity bases. Given the small quantity of plastics released, along with the deposition in the sediments, plastics released from the degradation of the gravity bases and concrete ballast will not impact upon threatened or migratory fauna. Deposit-feeding fauna, such as sea cucumbers, may ingest plastic particles. These are expected to pass through the deposit feeder and be re-deposited within the sediment.

6.1.6.3 Physical Presence

Unlike fishes, marine mammals and reptiles must surface to breathe and are more closely associated with the sea surface. Behavioural disturbance from the physical presence of vessels undertaking the augmentation and full removal options may affect marine mammals and reptiles within the MEFF fields. Such disturbance is expected to only affect a small number of animals, as there are no known concentrations of marine mammals or reptiles within the MEFF fields and suitable habitat is widespread in the region.

6.1.6.4 Underwater noise

Underwater noise emissions from the augmentation and full removal options are unlikely to cause hearing impairment in marine mammals, reptiles or fishes, such as permanent and temporary threshold shifts (Popper et al., 2014; Southall et al., 2019, 2007). However, there is the potential for behavioural disturbance and masking to occur. Behavioural impacts will depend on the audible frequency range of each potential receptor in relation to the frequency of the noise, as well as the intensity of the noise.

DP thruster noise has a low frequency component which propagates well through water, meaning marine fauna may be exposed to relatively high levels of this noise at greater distances from the source compared to a high frequency noise. Surveys which reported maximum source levels for DP vessels holding station (182 dB re 1 µPa at 1 m), found reduced levels of 137 dB re 1 µPa at 405 m away from the source (measured in strong currents) (McCauley, 1998). Given marine fauna will only be affected behaviourally, impacts from DP thruster noise are not expected to cause more than small temporary changes in behaviour such as avoidance of vessels. The MEFF fields do not represent important habitat for marine fauna, and any behavioural disturbance will not preclude biologically important activities such as migration or breeding.

6.1.7 Other Users

Environmental aspects of the feasible options for the gravity bases and concrete ballast are:

- Abandonment *in situ* (Section 3.2.1):
  - Equipment degradation.
- Augmentation (Section 3.3.3):
  - Equipment degradation, and
  - Physical presence,
- Full removal (Section 3.1.4):
  - Physical presence.

The pairwise comparisons for the feasible options are summarised in Table 6-7, with impact assessments of each aspect provided in Sections 6.1.7.1 and 6.1.7.2.

Table 6-7 Summary of other users comparative environmental impact assessment of feasible options for the gravity bases and concrete ballast. Cell shading indicates the preferred criterion, with hue intensity reflecting the degree of preference (i.e., the rating column)

Criteria Comparison A	Criteria Comparison B	Preferred Criterion	Rating	Justification
Abandonment *in situ*	Augmentation	-	1 – Equal importance	The abandonment *in situ* option will preserve the fish assemblages associated with the gravity bases and concrete ballast but will also leave equipment that may pose a risk to future trawl fishing activities should such fishing commence. The augmentation option will enhance the fish assemblages associated with the gravity bases and concrete ballast but will also leave equipment that may pose a risk to future trawl fishing activities should such fishing commence. Vessels installing augmentation may displace other users temporarily from a relatively small area within the MEFF fields. Consultation with commercial fishing industry stakeholders indicated they saw little benefit or risk to their activities from any of the feasible decommissioning options.
Abandonment *in situ*	Full removal	-	1 – Equal importance	The abandonment *in situ* option will preserve the fish assemblages associated with the gravity bases and concrete ballast but will also leave equipment that may pose a risk to future trawl fishing activities should such fishing commence. Full removal will result in the loss of the fish assemblages associated with the gravity bases and concrete ballast but will also remove equipment that may pose a risk to future trawl fishing activities should such fishing commence. This is of little benefit based on the current negligible levels of trawl fishing effort in similar depths in the region. Vessels undertaking full removal may displace other users temporarily from a relatively small area within the MEFF fields. Consultation with commercial fishing industry stakeholders indicated they saw little benefit or risk to their activities from any of the feasible decommissioning options.
Augmentation	Full removal	-	1 – Equal importance	The augmentation option will enhance the fish assemblages associated with the gravity bases and concrete ballast but will also leave equipment that may pose a risk to future trawl fishing activities should such fishing commence.

Criteria Comparison A	Criteria Comparison B	Preferred Criterion	Rating	Justification
				Full removal will result in the loss of the fish assemblages associated with the gravity bases and concrete ballast but will also remove equipment that may pose a risk to future trawl fishing activities should such fishing commence. This is of little benefit based on the current negligible levels of trawl fishing effort in similar depths in the region. Vessels undertaking either option may displace other users temporarily from a relatively small area within the MEFF fields. Consultation with commercial fishing industry stakeholders indicated they saw little benefit or risk to their activities from any of the feasible decommissioning options.

6.1.7.1 Equipment Degradation

The abandonment *in situ* and augmentation options will retain and enhance the habitat that has developed on the gravity bases and concrete ballast, which supports a distinct fish assemblage with relatively high abundance of commercially valuable fish compared to the surrounding bare habitat (GHD, 2021). This is consistent with studies elsewhere in Australia and overseas (e.g., Bond et al., 2018; McLean et al., 2021, 2017; Schramm et al., 2021), demonstrating the potential value of the equipment abandoned *in situ* to commercial fisheries. This habitat is expected to progressively be reduced over time as the structures degrade, which will take hundreds to thousands of years.

Given the negligible commercial fishing effort in the MEFF fields, the habitat and associated fish assemblage associated with the gravity bases and concrete ballast is unlikely to yield any direct benefits to commercial fishers. Indirect benefits may be provided through increased recruitment of commercially valuable species through movement of fish or supply of larvae. However, consultation with commercial fishers and their industry body indicated fishers saw little benefit from the abandonment of MEFF equipment *in situ* as the fish resources associated with the equipment were deemed to be of little value and difficult to access.

The equipment and structures left on the seabed by the abandonment *in situ* and augmentation options may pose a snagging risk to trawled fishing equipment. As outlined in Section 5.2.7, the most active trawl fishery in the region is the Pilbara Fish Trawl managed fishery. This fishery is prohibited from operating in the vicinity of the MEFF fields (Figure 5-7). Trawling activity in the vicinity of the MEFF fields in similar depths is negligible and hence the likelihood of trawl fishing activity around the gravity bases and concrete ballast is negligible. These structures, along with any augmentation structures, occur in relatively small areas which would be easily avoidable by trawl fishers should such fishing activity in the MEFF fields commence in the future. Consultation with commercial fishers and their industry body indicated fishers did not fishers consider the abandonment of MEFF equipment *in situ* to pose a risk to their activities. Fishing effort in the vicinity of the MEFF fields has been negligible between 2010 and 2020.

The full removal option will remove habitats associated with the gravity bases and concrete ballast, which will eliminate any benefits and risks to commercial fishers because of the equipment degrading *in situ*.

6.1.7.2 Physical Presence

The physical presence of vessels undertaking the augmentation and full removal options may displace other users, such as commercial fishers and shipping, from the vicinity of the decommissioning activity. However, these impacts are negligible given the low levels of commercial fishing and shipping within the MEFF fields.

6.2 Mooring Anchors and Chains

This section summarises the comparative environmental impact assessment for the feasible options for the mooring anchors and chains. Refer to Section 2.1 for a description of this equipment group. The AHP hierarchy for this comparative assessment is shown in Figure 6-4. The outcomes of the comparative environmental impact assessment for the mooring anchors and chains are shown in Figure 6-5 and Figure 6-6.

The AHP is summarised in this section, with AHP calculations provided in Appendix B.

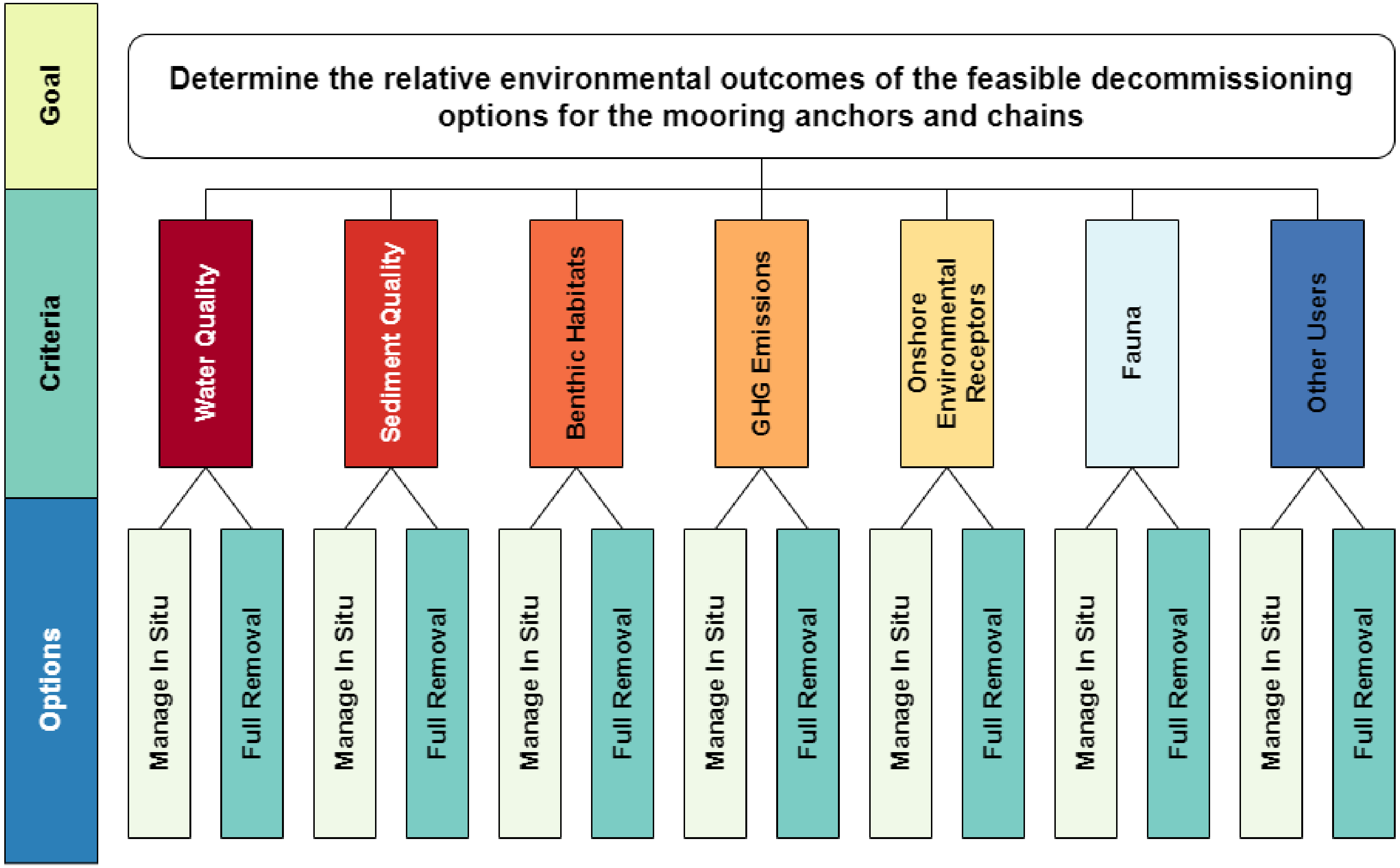

Figure 6-4 AHP hierarchy for the comparative environmental impact assessment of the mooring anchors and chains

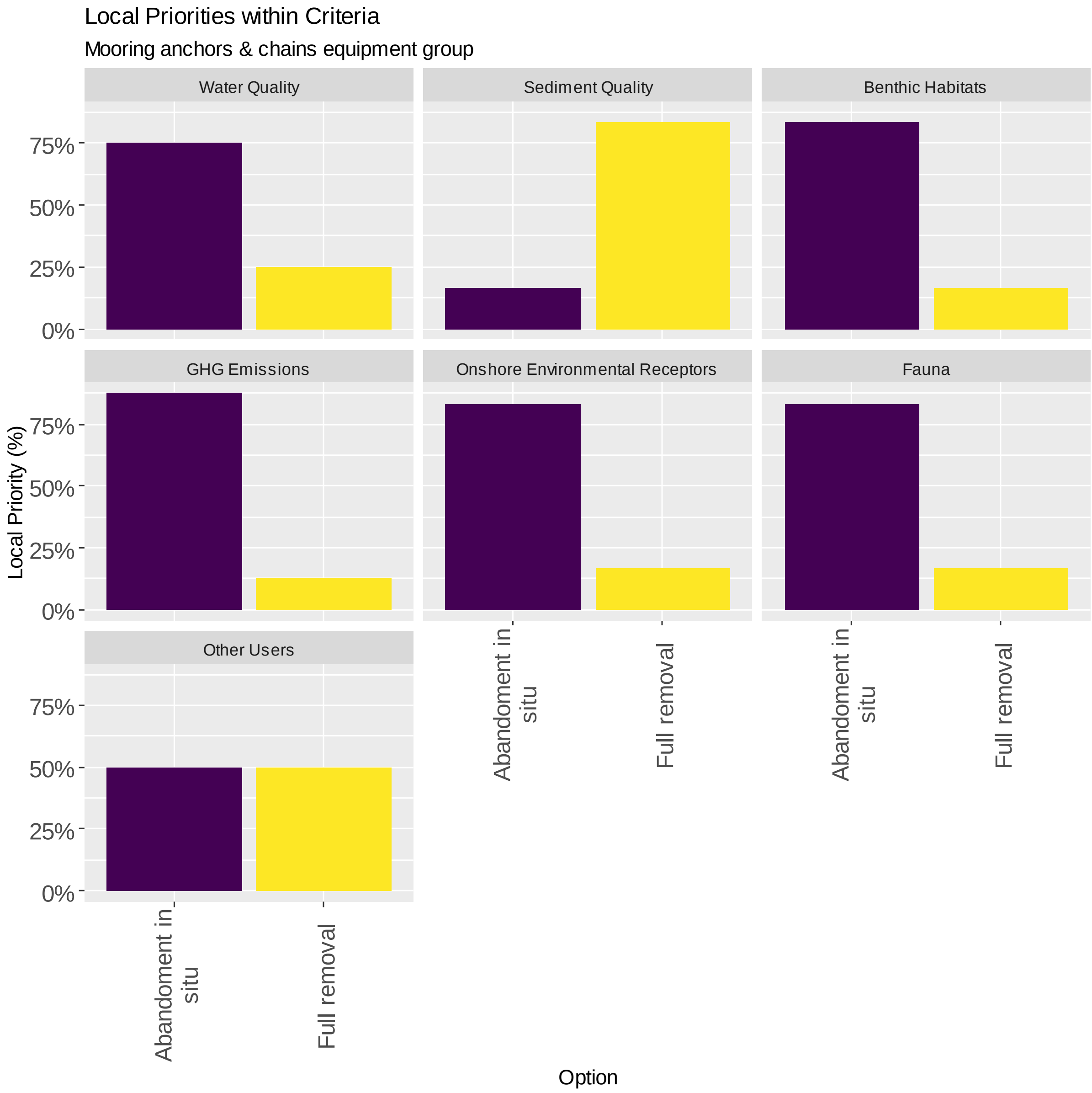

Figure 6-5 Local priorities for the feasible options within environmental receptors for the mooring anchors and chains equipment group

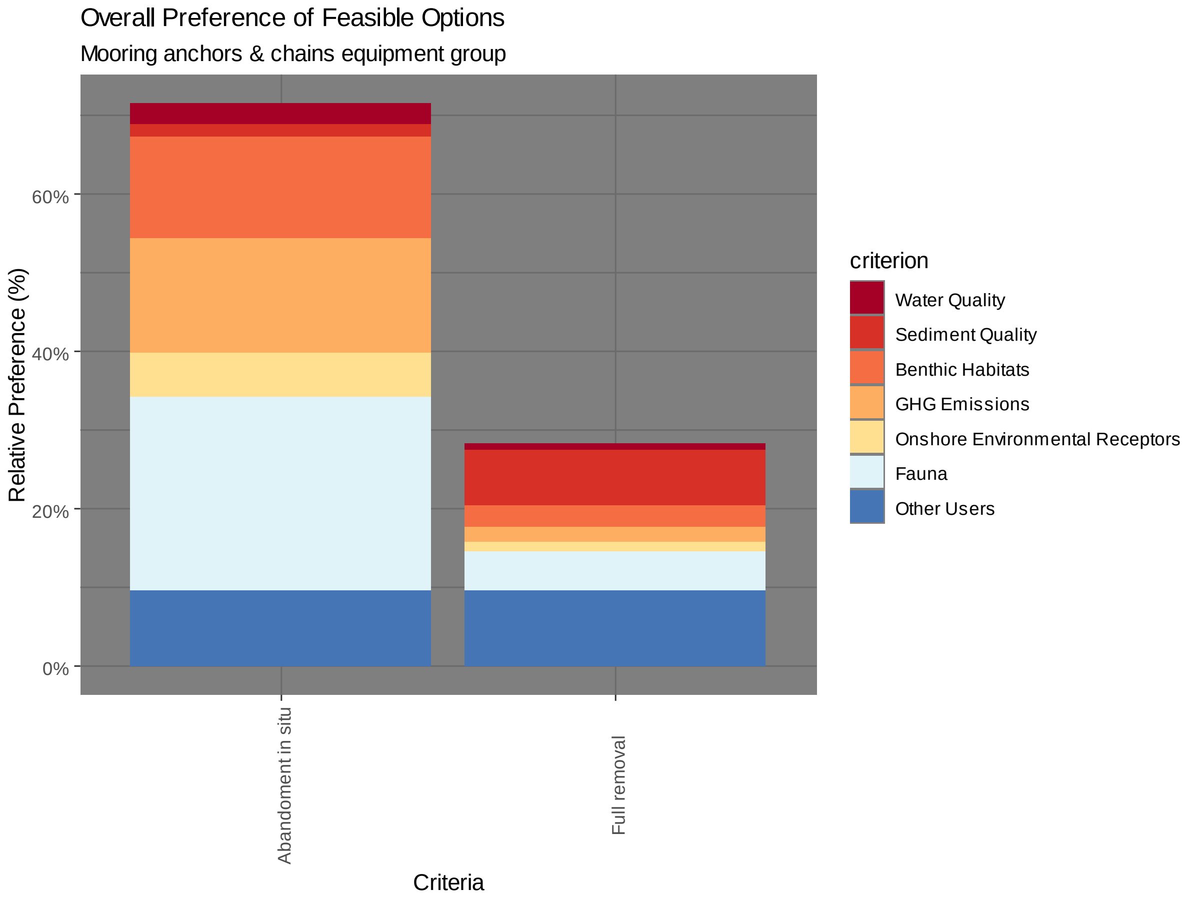

Figure 6-6 Stacked bar plot of relative preference of the feasible options within the mooring anchors and chains equipment group.

6.2.1 Water Quality

Environmental aspects of the feasible options for the mooring anchors and chains that may impact water quality are:

- Abandonment *in situ* (Section 3.2.1):
  - Equipment degradation, and
- Full removal (Section 3.1.4):
  - Equipment removal,
  - Utility discharges.

The pairwise comparisons for the feasible options are summarised in Table 6-8, with impact assessments of each aspect provided in Sections 6.2.1.1 to 6.2.1.3.

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Table 6-8 Summary of water quality comparative environmental impact assessment of feasible options for the mooring anchors and chains. Cell shading indicates the preferred criterion, with hue intensity reflecting the degree of preference (i.e., the rating column)

Criteria Comparison		Preferred Criterion	Rating	Justification
A	**B**			
Abandonment *in situ*	Full removal	A	3 – Moderate importance	Abandonment *in situ* will not credibly impact upon water quality, as there are no associated vessel-related discharges and degradation products will not impact water quality. The full removal option will also result in some short-term localised impacts to water quality from vessel utility discharges and removal of mooring anchors and chains.

6.2.1.1 *Equipment Degradation*

The abandonment *in situ* and augmentation options will result in the mooring anchors and chains being left to degrade on the seabed. Augmentation will introduce additional artificial structures that will also degrade. Much of the material from the progressive degradation of the mooring anchors and chains over time will be insoluble and will remain on the seabed, or in the sediment and hence has little potential to impact water quality.

The full removal option will entirely remove the mooring anchors and chains, hence there are no impacts to water quality from equipment degradation from this option.

6.2.1.2 *Equipment Removal*

The removal of the mooring anchors and chains by the full removal option will result in some localised sediment resuspension. The sediments in the MEFF fields are characterised as sands and silts, which are expected to settle rapidly. Finer sediments will remain suspended for longer, and hence may be advected further from the removal location, however such fine sediments are a relatively small fraction of the sediments. The footprints of the mooring anchors and chains is relatively small, and hence the amount of sediment that can credibly be resuspended is relatively small compared to the removal of other equipment groups. This impact is assessed as negligible when using Santos' offshore division environmental consequence descriptions.

6.2.1.3 *Utility Discharges*

Vessel operations for the augmentation and full removal options will result in utility discharges within the MEFF fields. Impacts to water quality from vessel utility discharges may include:

- Increases in nutrients,
- Increased biochemical oxygen demand,
- Increased turbidity,
- Reduced visual amenity, and
- Increases in potential contaminants such as hydrocarbons and chemicals.

The open water environment receiving utility discharges is expected to result in rapid mixing of utility discharges from vessels undertaking the full-length trench and bury and full removal options. As a result, the potential impacts to water quality will be highly localised and restricted to the immediate area (i.e., 10's to 100's of metres) around the discharge point.

Potential impacts to water quality from utility discharges from vessels are negligible when assessed using Santos' detailed environmental consequence descriptors.

6.2.2 Sediment Quality

Environmental aspects of the feasible options for the gravity bases and concrete ballast that may impact sediment quality are:

- Abandonment *in situ* (Section 3.2.1):
  - Equipment degradation.
- Full removal (Section 3.1.4):

- Equipment removal.

The pairwise comparisons for the feasible options are summarised in Table 6-9,with impact assessments of each aspect provided in Sections 6.2.2.1 to 6.2.2.2.

Table 6-9 Summary of sediment quality comparative environmental impact assessment of feasible options for the mooring anchors and chains. Cell shading indicates the preferred criterion, with hue intensity reflecting the degree of preference (i.e., the rating column)

Criteria Comparison A	Criteria Comparison B	Preferred Criterion	Rating	Justification
Abandonment *in situ*	Full removal	B	5 – Strong importance	The abandonment *in situ* option will leave the mooring anchors and chains to degrade, with degradation products having a negligible impact on sediment quality. The full removal option will remove the mooring anchors and chains, hence eliminating degradation-related impacts to sediment quality.

6.2.2.1 *Equipment Degradation*

The degradation of the mooring anchors and chains on the seabed because of the abandonment *in situ* and augmentation options will impact upon sediments. Degradation will release material among seabed sediments over the course of hundreds to thousands of years (Atteris, 2021).

The mooring anchors and chains consist mainly of steel. The mooring anchors and chains are partially buried and are expected to continue to become buried over time through natural sediment deposition. Corrosion products will be concentrated in the sediments under and around the mooring anchors and chains and will not disperse widely. Iron, the major component of the mooring anchors and chains, is not generally recognised as toxic in sediments and the *Australian and New Zealand guidelines for fresh and marine water quality* (Commonwealth of Australia and New Zealand Government, 2018) do not provide a default guideline value or guideline value-high for this element. Other components of the steel alloys, such as nickel and chromium, do have guideline values published. However, these metals are only present in the steel alloys in trace amounts. Sediment sampling by GHD (2021) found concentrations of these metals in sediments were far below the default guideline values around the mooring anchors and chains. Hence, the increased sediment concentrations of other metals present in the steel alloys are not expected to cause detectable toxic impacts to organisms.

The consequence to sediment quality from equipment degradation is assessed as minor when using the Santos offshore division detailed environmental consequence descriptions.

6.2.2.2 *Equipment Removal*

Some sediment relocation may be required to provide access to lifting points or installation of lifting equipment to remove the mooring anchors and chains from the seabed. This will result in localised sediment resuspension and may result in some temporary modification of the particle size distribution (i.e., a reduction in the portion of fine sediments) and localised depressions in the seabed. Recovery to natural conditions is expected to occur through natural sediment transport processes within weeks, predominantly through redistribution of local sediments by tidal currents as bedload. These changes in sediment characteristics are assessed as negligible when using the Santos offshore division detailed environmental consequence descriptions.

6.2.3 Benthic Habitats

Environmental aspects of the feasible options for the mooring anchors and chains that may impact benthic habitats are:

- Abandonment *in situ* (Section 3.2.1):
  - Equipment degradation.
- Full removal (Section 3.1.4):
  - Equipment removal.

The pairwise comparisons for the feasible options are summarised in Table 6-10, with impact assessments of each aspect provided in Sections 6.2.3.1 to 6.2.3.2.

Table 6-10 *Summary of benthic habitats comparative environmental impact assessment of feasible options for the mooring anchors and chains. Cell shading indicates the preferred criterion, with hue intensity reflecting the degree of preference (i.e., the rating column)*

Criteria Comparison A	Criteria Comparison B	Preferred Criterion	Rating	Justification
Abandonment *in situ*	Full removal	A	5 – Strong importance	The abandonment *in situ* option will preserve the benthic habitats that have developed on and around the mooring anchors and chains. The full removal option will eliminate benthic habitats associated with the mooring anchors and chains, with the environment expected to return to its natural state.

6.2.3.1 Equipment Degradation

The abandonment *in situ* and augmentation options will preserve the benthic habitats and associated species that have developed in the bare sand burying the mooring anchors and chains and on the exposed sections of the chains. Environmental surveys in the MEFF fields observed that these communities were relatively high in species diversity and abundance compared to the surrounding bare sediment habitat, and hosted some of the most abundant fish assemblages in the MEFF fields (GHD, 2021). Impacts from the retention of benthic habitats associated with the mooring anchors and chains are assessed as negligible when using the Santos offshore division detailed environmental consequence descriptions.

6.2.3.2 Equipment Removal

The mooring anchors and chains support sessile invertebrate communities that are relatively high in diversity compared to the surrounding largely bare sediments (GHD, 2021), particularly the sections of chain that were relatively high in the water column. Marine growth on the mooring anchors and chains in turn supports increased diversity and abundance of fishes, which is consistent with other studies of infrastructure in the region (Bond et al., 2018; McLean et al., 2017). Removal of the mooring anchors and chains during full removal or lowering them to the seabed during abandonment *in situ* will result in the loss of this habitat and associated fish assemblages.

The section of chain on the seabed are largely buried and the anchors are completely buried. The unconsolidated sediments above these buried components hosts filter- and deposit-feeding epifauna and infauna communities. Full removal of the anchors and chains will substantially disturb the existing communities above and around the mooring chains and anchors. These communities are widely represented in the region. Epifauna and infauna communities above the anchors and buried sections of chain during full removal, resulting in the loss of the biological communities associated with the bare sediment habitat. Disturbed habitats are expected to return to a natural state within months to years. This impact is assessed as negligible when using the Santos offshore division detailed environmental consequence descriptions.

6.2.4 GHG Emissions

Environmental aspects of the feasible options for the mooring anchors and chains that may impact GHG emissions are:

- Abandonment *in situ* (Section 3.2.1):
  - No GHG emissions.
- Full removal (Section 3.1.4):
  - Atmospheric emissions, and
  - Waste management.

The pairwise comparisons for the feasible options are summarised in Table 6-11, with impact assessments of each aspect provided in Sections 6.2.4.1 and 6.2.4.2.

Table 6-11 Summary of GHG emissions comparative environmental impact assessment of feasible options for the mooring anchors and chains. Cell shading indicates the preferred criterion, with hue intensity reflecting the degree of preference (i.e., the rating column)

Criteria Comparison A	Criteria Comparison B	Preferred Criterion	Rating	Justification
Abandonment *in situ*	Full removal	A	7 – Very strong importance	The abandonment *in situ* option will not generate GHG emissions. The full removal option will generate GHG emissions while the vessel is in the field and from processing, transport, and disposal of the recovered equipment.

6.2.4.1 Atmospheric Emissions

Atmospheric emissions from vessels undertaking the augmentation and full removal options will result in a localised decrease in air quality due to exhaust emissions from internal combustion engines. These emissions will mix within the atmosphere and disperse rapidly, with the exhaust stacks on vessel typically mounted high on the vessel to facilitate mixing and avoid exhaust emissions near crewed areas. There are no population centres in the vicinity of the emission locations. Air-breathing fauna, such as marine mammals, birds, and reptiles, are not expected to be present in high numbers in the MEFF fields. Hence, direct impacts to air quality because of atmospheric emissions for these feasible options are negligible.

Fuel combustion onboard vessels will generate carbon dioxide emissions, which is a GHG. GHG emissions will result in indirect environmental impacts from climate change. The augmentation and bury and full removal options will emit carbon dioxide, which is contrasted with no GHG emissions for the abandonment *in situ* option.

The structures installed by the augmentation option will be made of steel and concrete. The manufacturing processes of both these materials requires energy and releases carbon dioxide. The manufacturing process of cement is the single largest GHG emissions source globally, accounting for approximately 8% of global carbon dioxide emissions.

The air quality and GHG environmental consequence of the augmentation and full removal options are assessed as negligible when using the Santos offshore division detailed environmental consequence descriptions. The abandonment *in situ* option does not generate GHG or atmospheric emissions.

6.2.4.2 Waste Management

Waste equipment recovered to shore for full removal option will require processing, transportation, and disposal. These processes will generate atmospheric and GHG emissions from the consumption of electricity from the local network and the combustion of fuel in trucks. These emissions are expected to be considerably smaller than those generated by offshore vessel activities for the full removal option. As such, these emissions are assessed as negligible when using the Santos offshore division detailed environmental consequence descriptions.

Recovery of the steel from the mooring anchors and chains provides a recycling opportunity. Any steel recycled may displace the need for newly manufactured steel, resulting in a consequent reduction in emissions from new steel production. Any reduction of emissions from recycling steel will be offset by emissions created to process the equipment and transport it for recycling (likely to be an overseas destination).

6.2.5 Onshore Environmental Receptors

Environmental aspects of the feasible options for the mooring anchors and chains that may impact onshore environmental receptors are:

- Abandonment *in situ* (Section 3.2.1):
  - No aspects impacting onshore environmental receptors.
- Full removal (Section 3.1.4):
  - Waste management.

The pairwise comparisons for the feasible options are summarised in Table 6-12, with impact assessments of each aspect provided in Section 6.2.5.1.

Table 6-12 Summary of onshore environmental receptors comparative environmental impact assessment of feasible options for the mooring anchors and chains. Cell shading indicates the preferred criterion, with hue intensity reflecting the degree of preference (i.e., the rating column)

Criteria Comparison		Preferred Criterion	Rating	Justification
A	B			
Abandonment *in situ*	Full removal	A	5 – Strong importance	The abandonment *in situ* option will not generate any waste that requires management onshore. The full removal option will bring the mooring anchors and chains onshore for processing and disposal. Whilst generating wastes that will be landfilled, this option also creates opportunities for recycling.

6.2.5.1 *Waste Management*

Waste management of the mooring anchors and chains recovered by the full removal option may impact upon onshore environmental receptors by:

- Using onshore storage and processing facilities, and
- Contributing to landfill.

The onshore processing of waste management facilities is assumed to take place locally at a port such as Dampier, Onslow, or Exmouth. Each of these ports have cleared land suitable for the storage and processing of required equipment. No clearing or construction of new facilities will be required.

Waste materials that cannot practicably be recycled will be disposed of in a landfill facility in the Pilbara region. Such facilities are regulated under Western Australian law to reduce their environmental impacts and risks. Consequently, impacts to onshore environmental receptors are assessed as negligible when using the Santos offshore division environmental consequence definitions.

6.2.6 Fauna

Environmental aspects of the feasible options for the mooring anchors and chains that may impact upon fauna are:

- Abandonment *in situ* (Section 3.2.1):
  - Equipment degradation, and
  - Physical presence.
- Full removal (Section 3.1.4):
  - Physical presence, and
  - Underwater noise.

The pairwise comparisons for the feasible options are summarised in Table 6-13, with impact assessments of each aspect provided in Sections 6.2.6.1 to 6.2.6.3.

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Table 6-13 Summary of fauna comparative environmental impact assessment of feasible options for the mooring anchors and chains. Cell shading indicates the preferred criterion, with hue intensity reflecting the degree of preference (i.e., the rating column)

Criteria Comparison		Preferred Criterion	Rating	Justification
A	B			
Abandonment *in situ*	Full removal	A	5 – Strong importance	The abandonment *in situ* option will preserve the relatively diverse fauna that utilises the habitats associated with the mooring anchors and chains. The full removal option will result in the loss of fauna associated with the habitats provided by the mooring anchors and chains.

6.2.6.1 Equipment Degradation

The abandonment *in situ* and augmentation options will leave the mooring anchors and chains in the environment, which will degrade over time. Given the mooring anchors and chains consist almost entirely of steel, impacts of degradation on fauna will be negligible. The riser wires are the only component with a notable amount of plastic – these wires and associated plastic sheath will be removed. The presence of the mooring anchors and chains provides habitat for a range of fauna species. The timeframe for degradation of the mooring anchors and chains is in the order of tens to hundreds of years, hence the fauna communities associated with this equipment will persist over the same timeframe. This timeframe is shorter than some other equipment groups as the mooring anchors and chains don't have sacrificial anodes.

Note that the riser wire, which has a plastic sheath, and the top chain components will be removed.

6.2.6.2 Physical Presence

Unlike fishes, marine mammals and reptiles must surface to breathe and are more closely associated with the sea surface. Behavioural disturbance from the physical presence of vessels undertaking the augmentation and full removal options may affect marine mammals and reptiles within the MEFF fields. Such disturbance is expected to only affect a small number of animals, as there are no known concentrations of marine mammals or reptiles within the MEFF fields and suitable habitat is widespread in the region.

6.2.6.3 Underwater noise

Underwater noise emissions from the augmentation and full removal options are unlikely to cause hearing impairment in marine mammals, reptiles or fishes, such as permanent and temporary threshold shifts (Popper et al., 2014; Southall et al., 2019, 2007). However, there is the potential for behavioural disturbance and masking to occur. Refer Section 6.1.6.4 for a discussion of noise-related impacts on fauna.

6.2.7 Other Users

Environmental aspects of the feasible options for the mooring anchors and chains are:

- Abandonment *in situ* (Section 3.2.1):
  - Equipment degradation.
- Full removal (Section 3.1.4):
  - Physical presence.

The pairwise comparisons for the feasible options are summarised in Table 6-14, with impact assessments of each aspect provided in Sections 6.2.7.1 to 6.2.7.2.

Table 6-14 Summary of other users comparative environmental impact assessment of feasible options for the mooring anchors and chains. Cell shading indicates the preferred criterion, with hue intensity reflecting the degree of preference (i.e., the rating column)

Criteria Comparison A	Criteria Comparison B	Preferred Criterion	Rating	Justification
Abandonment *in situ*	Full removal	-	1 – Equal importance	The abandonment *in situ* option will preserve the biological assemblages associated with the mooring anchors and chains but will also leave equipment that may pose a risk to future trawl fishing activities should such fishing commence. Given the anchors are deeply embedded and the chains are largely buried, the risk of interactions with trawled fishing gear is negligible. Full removal will result in the loss of the fish assemblages associated with the mooring anchors and chains but will also remove equipment that may pose a risk to future trawl fishing activities should such fishing commence. This is of little benefit based on the current negligible levels of trawl fishing effort in similar depths in the region and the burial status of the mooring anchors and chains. Vessels undertaking full removal may displace other users temporarily from a relatively small area within the MEFF fields. Consultation with commercial fishing industry stakeholders indicated they saw little benefit or risk to their activities from any of the feasible decommissioning options.

6.2.7.1 Equipment Degradation

The abandonment *in situ* and augmentation options will retain and enhance the habitat that has developed on the mooring anchors and chains, which supports a distinct fish assemblage with relatively high abundance of commercially valuable fish compared to the surrounding bare habitat (GHD, 2021). This is consistent with studies elsewhere in Australia and overseas (e.g., Bond et al., 2018; McLean et al., 2021, 2017; Schramm et al., 2021), demonstrating the potential value of the equipment abandoned *in situ* to commercial fisheries. This habitat is expected to progressively be reduced over time as the structures degrade, which will take hundreds to thousands of years. Consultation with commercial fishers and their industry body indicated fishers saw little benefit from the abandonment of MEFF equipment *in situ*.

Given the negligible commercial fishing effort in the MEFF fields, the habitat and associated fish assemblage associated with the mooring anchors and chains is unlikely to yield any direct benefits to commercial fishers. Indirect benefits may be provided through increased recruitment of commercially valuable species through movement of fish or supply of larvae. However, consultation with commercial fishers and their industry body indicated fishers saw little benefit from the abandonment of MEFF equipment *in situ* as the fish resources associated with the equipment were deemed to be of little value and difficult to access.

The equipment and structures left on the seabed by the abandonment *in situ* and augmentation options may pose a snagging risk to trawled fishing equipment. As outlined in Section 5.2.7, the most active trawl fishery in the region is the Pilbara Fish Trawl managed fishery. This fishery is prohibited from operating in the vicinity of the MEFF fields (Figure 5-7). Trawling activity in the vicinity of the MEFF fields in similar depths is negligible and hence the likelihood of trawl fishing activity around the mooring anchors and chains is negligible. These structures, along with any augmentation structures, occur in relatively small areas which would be easily avoidable by trawl fishers should such fishing activity in the MEFF fields commence in the future. Consultation with commercial fishers and their industry body indicated fishers did not fishers consider the abandonment of MEFF equipment *in situ* to pose a risk to their activities. Fishing effort in the vicinity of the MEFF fields has been negligible between 2010 and 2020.

The full removal option will remove habitats associated with the mooring anchors and chains, which will eliminate any benefits and risks to commercial fishers because of the equipment degrading *in situ.*

6.2.7.2 Physical Presence

The physical presence of vessels undertaking the augmentation and full removal options may displace other users, such as commercial fishers and shipping, from the vicinity of the decommissioning activity. However, these impacts are temporary and negligible given the low levels of commercial fishing and shipping within the MEFF fields.

7 Conclusions

Based on the outcomes of the comparative assessments, the relative preferences of the decommissioning options for each equipment group are in order of preference:

- Gravity bases and concrete ballast:
  - Augmentation: 1st preference (42.77%),
  - Abandonment *in situ*: 2nd preference (38.64%),
  - Full removal: 3rd preference (18.59%).
- Mooring anchors and chains:
  - Abandonment *in situ*: 1st preference (71.60%),
  - Full removal: 2nd preference (28.40%).

These results are shown in Figure 7-1.

The full removal option was not the preferred option for either of the equipment groups, demonstrating that abandonment *in situ* yielded equal or better environmental outcomes for both. Note that the comparative assessment only considered environmental impacts of the feasible options. No consideration of non-environmental decision-making criteria, such as safety and cost, has been made.

The comparative assessments considered the available information. There is uncertainty in the predictions made about the environmental impacts of the feasible options and hence an element uncertainty in the conclusions made by the comparative assessment. Reducing uncertainty associated with environmental criteria that have a high weighting, such as fauna, may improve confidence in the outcomes of the comparative assessment. The following considerations may warrant attention:

- The degradation timeframes and material composition of the equipment proposed to be abandoned *in situ*
- The potential for recycling of recovered equipment.
- GHG life cycle estimates for each of the feasible options under consideration.

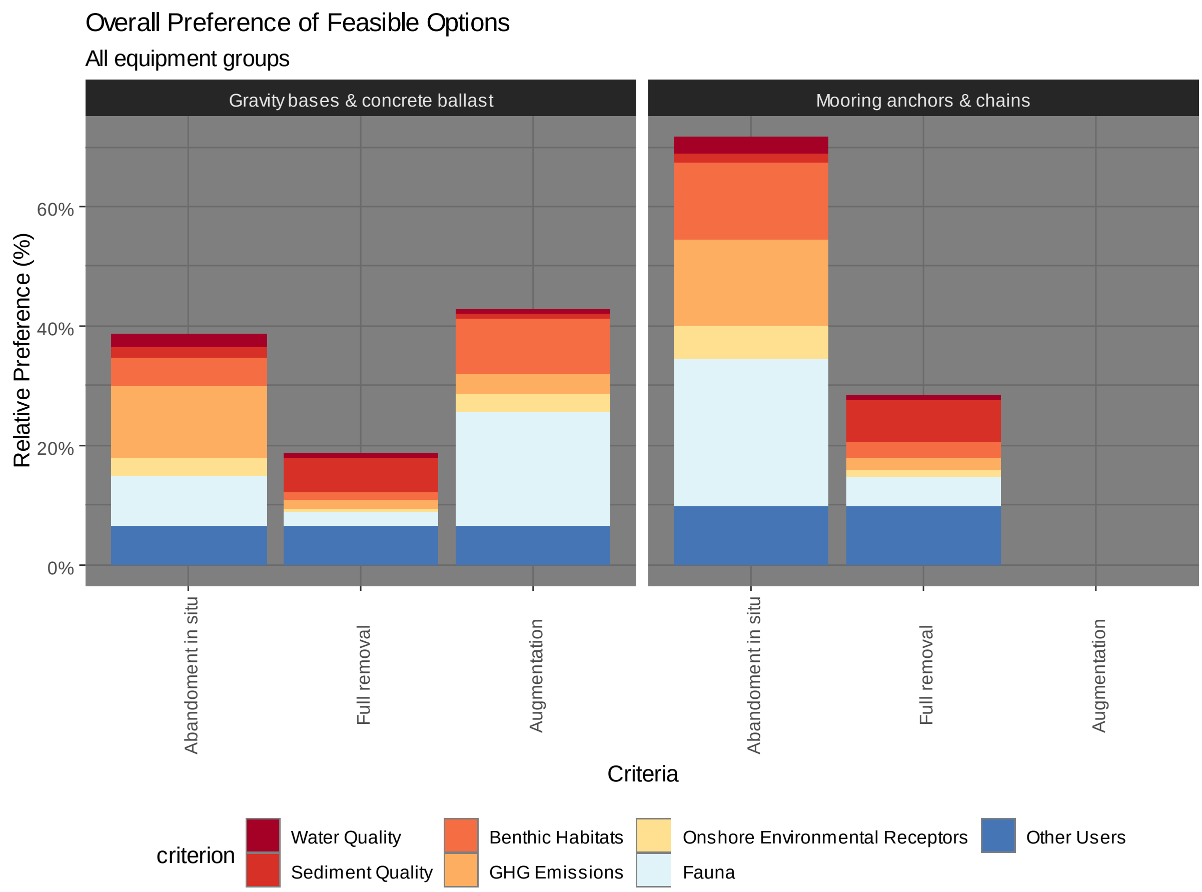

Figure 7-1 Stacked bar plot of relative preference of the feasible options faceted by equipment group

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Appendix A
AHP Comparisons for Gravity Bases and Concrete Ballast

Reciprocal Array

	Water Quality	Sediment Quality	Benthic Habitats	GHG Emissions	Onshore Environmental Receptors	Fauna	Other Users
Water Quality	1	0.33	0.33	0.2	0.33	0.2	0.2
Sediment Quality	3	1	0.33	0.33	3	0.2	0.33
Benthic Habitats	3	3	1	1	3	0.33	1
GHG Emissions	5	3	1	1	3	0.33	1
Onshore Environmental Receptors	3	0.33	0.33	0.33	1	0.33	0.33
Fauna	5	5	3	3	3	1	1
Other Users	5	3	1	1	3	1	1
Sum	25	15.7	7	6.87	16.3	3.4	4.87

Normalised Array

	Water Quality	Sediment Quality	Benthic Habitats	GHG Emissions	Onshore Environmental Receptors	Fauna	Other Users	Eigen Vector	Rank
Water Quality	0.04	0.02	0.05	0.03	0.02	0.06	0.04	0.04	7
Sediment Quality	0.12	0.06	0.05	0.05	0.18	0.06	0.07	0.08	5
Benthic Habitats	0.12	0.19	0.14	0.15	0.18	0.1	0.21	0.16	4
GHG Emissions	0.2	0.19	0.14	0.15	0.18	0.1	0.21	0.17	3
Onshore Environmental Receptors	0.12	0.02	0.05	0.05	0.06	0.1	0.07	0.07	6
Fauna	0.2	0.32	0.43	0.44	0.18	0.29	0.21	0.30	1
Other Users	0.2	0.19	0.14	0.15	0.18	0.29	0.21	0.19	2

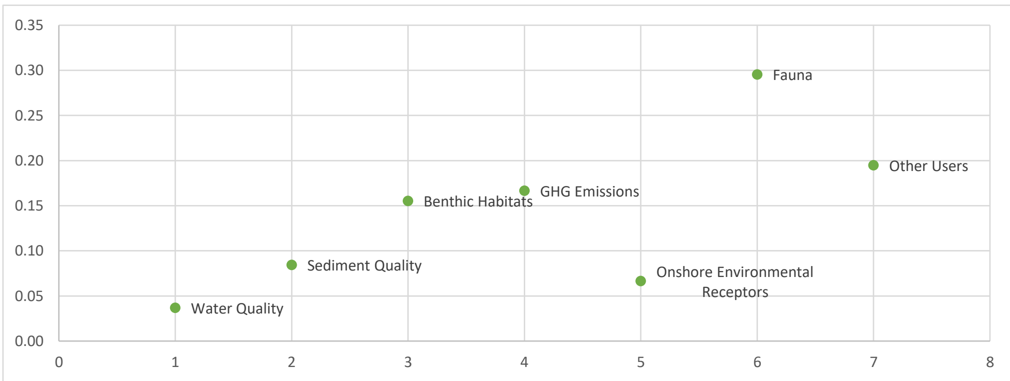
Consistency Index

Principal Eigen Value	7.52
N	7
Consistency Index	0.09
Random Index (n=7)	1.32
Consistency Ratio	7%

Summary Tab

3.69%
8.44%
15.53%
16.67%
6.65%
29.54%
19.47%

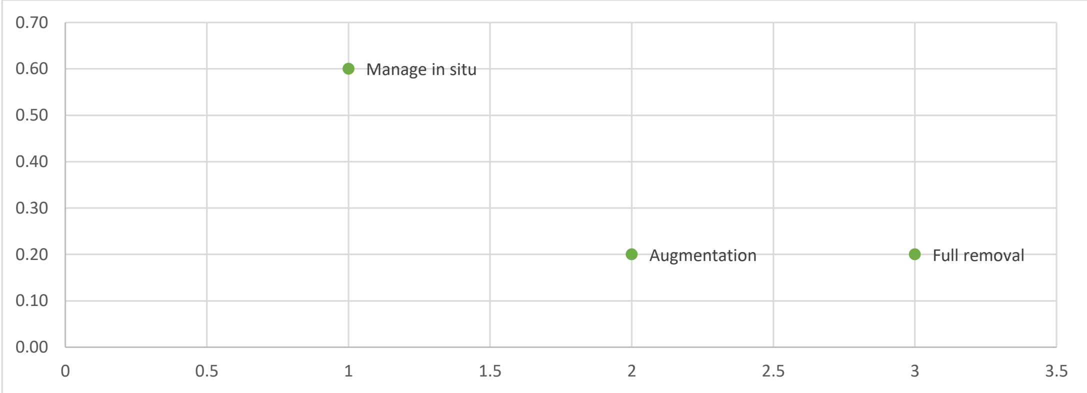
Statement	Ranking	Switch	Rank	Commentary
Sediment Quality is of moderate importance comapred to Water Quality	moderate importance	Yes	0.3333	
Benthic Habitats is of moderate importance comapred to Water Quality	moderate importance	Yes	0.3333	
GHG Emissions is of strong importance comapred to Water Quality	strong importance	Yes	0.2	
Onshore Environmental Receptors is of moderate importance comapred to Water Quality	moderate importance	Yes	0.3333	
Fauna is of strong importance comapred to Water Quality	strong importance	Yes	0.2	
Other Users is of strong importance comapred to Water Quality	strong importance	Yes	0.2	
Benthic Habitats is of moderate importance comapred to Sediment Quality	moderate importance	Yes	0.3333	
GHG Emissions is of moderate importance comapred to Sediment Quality	moderate importance	Yes	0.3333	
Sediment Quality is of moderate importance comapred to Onshore Environmental Receptors	moderate importance	No	3	
Fauna is of strong importance comapred to Sediment Quality	strong importance	Yes	0.2	
Other Users is of moderate importance comapred to Sediment Quality	moderate importance	Yes	0.3333	
Benthic Habitats is of equal importance compared to GHG Emissions	equal importance	No	1	
Benthic Habitats is of moderate importance comapred to Onshore Environmental Receptors	moderate importance	No	3	
Fauna is of moderate importance comapred to Benthic Habitats	moderate importance	Yes	0.3333	
Benthic Habitats is of equal importance compared to Other Users	equal importance	No	1	
GHG Emissions is of moderate importance comapred to Onshore Environmental Receptors	moderate importance	No	3	
Fauna is of moderate importance comapred to GHG Emissions	moderate importance	Yes	0.3333	
Other Users is of equal importance comapred to GHG Emissions	equal importance	Yes	1	
Fauna is of moderate importance comapred to Onshore Environmental Receptors	moderate importance	Yes	0.3333	
Other Users is of moderate importance comapred to Onshore Environmental Receptors	moderate importance	Yes	0.3333	
Fauna is of equal importance comapred to Other Users	equal importance	No	1	



Reciprocal Array

	Manage in situ	Augmentation	Full removal
Manage in situ	1	3	3
Augmentation	0.33	1	1
Full removal	0.33	1	1
Sum	1.67	5	5

Statement	Ranking	Switch	Rank	Commentary
Manage in situ is of moderate importance comapred to Augmentation	moderate importance	No	3	
Manage in situ is of moderate importance comapred to Full removal	moderate importance	No	3	
Augmentation is of equal importance comapred to Full removal	equal importance	No	1	



Normalised Array

	Manage in situ	Augmentation	Full removal	Eigen Vector	Rank
Manage in situ	0.6	0.6	0.6	0.60	1
Augmentation	0.2	0.2	0.2	0.20	2
Full removal	0.2	0.2	0.2	0.20	2

Consistency Index

Principal Eigen Value	3
N	3
Consistency Index	0
Random Index (n=3)	0.58
Consistency Ratio	0%

Summary Tab

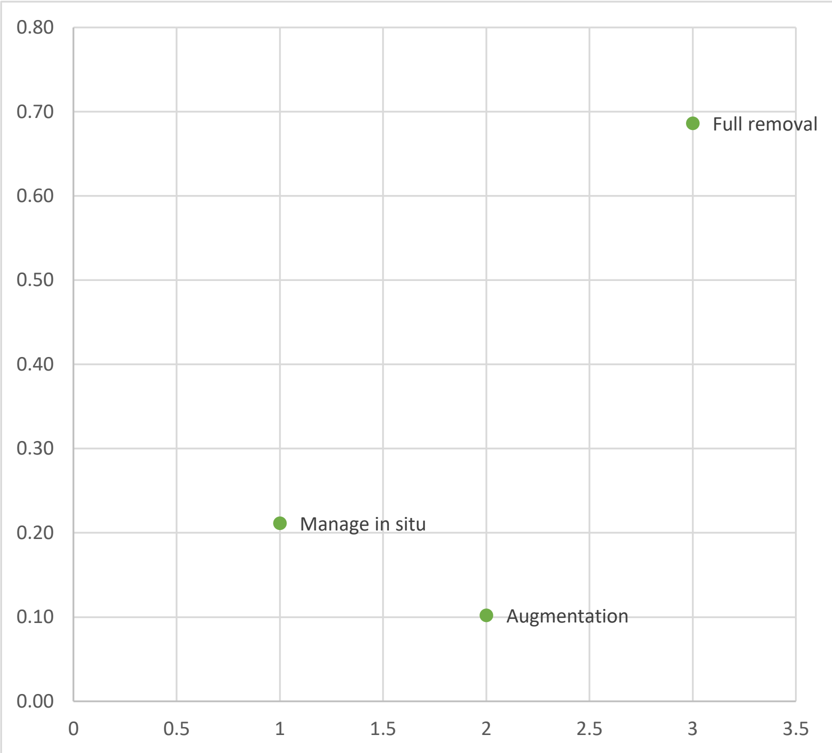
Reciprocal Array

	Manage in situ	Augmentation	Full removal
Manage in situ	1	3	0.2
Augmentation	0.33	1	0.2
Full removal	5	5	1
Sum	6.33	9	1.4

Statement	Ranking	Switch	Rank	Commentary
Manage in situ is of moderate importance comapred to Augmentatio	moderate importance	No	3	
Full removal is of strong importance comapred to Manage in situ	strong importance	Yes	0.2	
Full removal is of strong importance comapred to Augmentation	strong importance	Yes	0.2	

Normalised Array

	Manage in situ	Augmentation	Full removal	Eigen Vector	Rank
Manage in situ	0.16	0.33	0.14	0.21	2
Augmentation	0.05	0.11	0.14	0.10	3
Full removal	0.79	0.56	0.71	0.69	1



Consistency Index

Principal Eigen Value	3.22
N	3
Consistency Index	0.11
Random Index (n=3)	0.58
Consistency Ratio	19%

Summary Tab

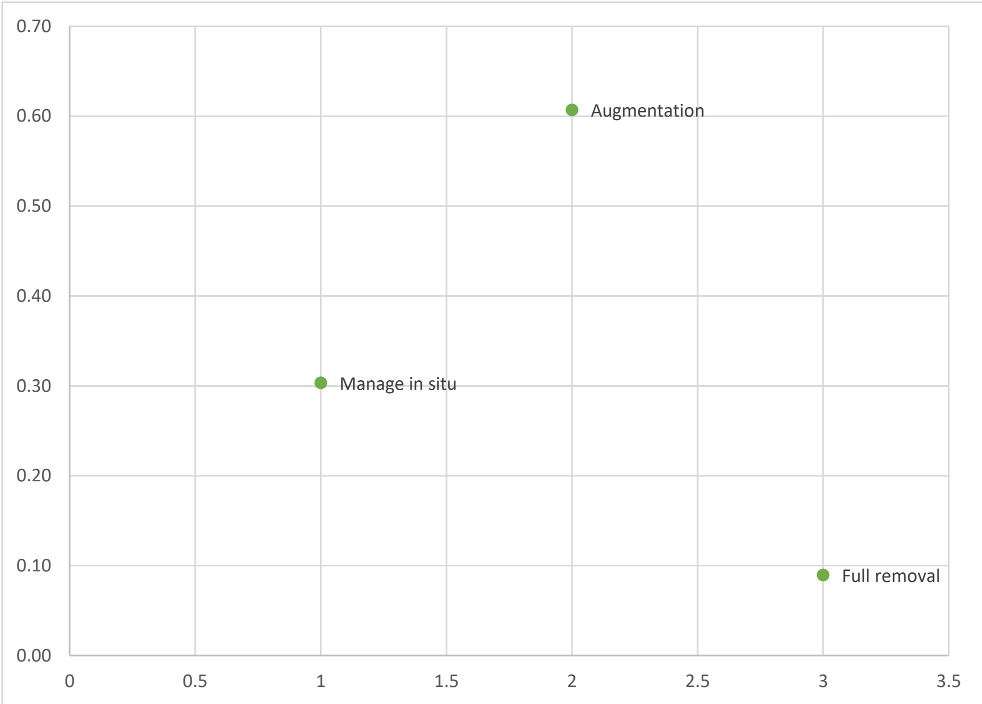
Reciprocal Array

	Manage in situ	Augmentation	Full removal
Manage in situ	1	0.33	5
Augmentation	3	1	5
Full removal	0.2	0.2	1
Sum	4.2	1.53	11

Statement	Ranking	Switch	Rank	Commentary
Augmentation is of moderate importance comapred to Manage in situ	moderate importance	Yes	0.33333	
Manage in situ is of strong importance comapred to Full removal	strong importance	No	5	
Augmentation is of strong importance comapred to Full removal	strong importance	No	5	

Normalised Array

	Manage in situ	Augmentation	Full removal	Eigen Vector	Rank
Manage in situ	0.24	0.22	0.45	0.30	2
Augmentation	0.71	0.65	0.45	0.61	1
Full removal	0.05	0.13	0.09	0.09	3



Consistency Index

Principal Eigen Value	3.19
N	3
Consistency Index	0.1
Random Index (n=3)	0.58
Consistency Ratio	16%

Summary Tab

Reciprocal Array

	Manage in situ	Augmentation	Full removal
Manage in situ	1	5	1
Augmentation	0.2	1	0.33
Full removal	1	3	1
Sum	2.2	9	2.33

Statement	Ranking	Switch	Rank	Commentary
Manage in situ is of strong importance comapred to Augmentation	strong importance	No	5	
Manage in situ is of equal importance comapred to Full removal	equal importance	No	1	
Full removal is of moderate importance comapred to Augmentation	moderate importance	Yes	0.33333	

Normalised Array

	Manage in situ	Augmentation	Full removal	Eigen Vector	Rank
Manage in situ	0.45	0.56	0.43	0.48	1
Augmentation	0.09	0.11	0.14	0.11	3
Full removal	0.45	0.33	0.43	0.41	2

Consistency Index

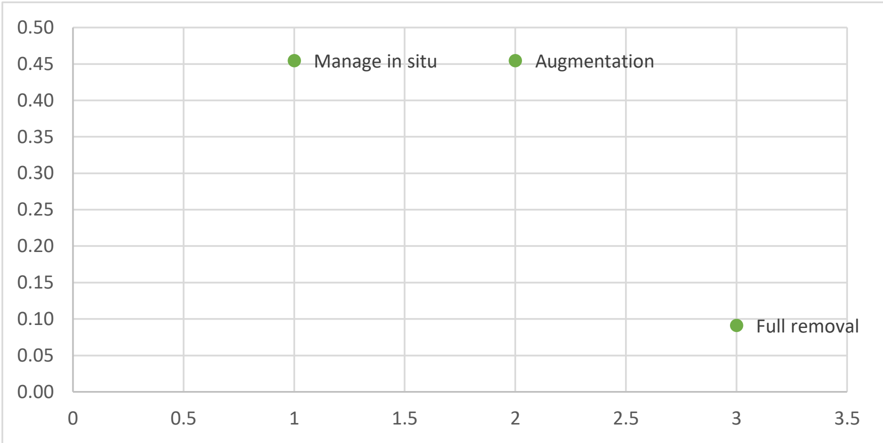
Principal Eigen Value	3.04
N	3
Consistency Index	0.02
Random Index (n=3)	0.58
Consistency Ratio	3%

Summary Tab

Reciprocal Array

	Manage in situ	Augmentation	Full removal
Manage in situ	1	1	5
Augmentation	1	1	5
Full removal	0.2	0.2	1
Sum	2.2	2.2	11

Statement	Ranking	Switch	Rank	Commentary
Manage in situ is of equal importance comapred to Augmentation	equal importance	No	1	
Manage in situ is of strong importance comapred to Full removal	strong importance	No	5	
Augmentation is of strong importance comapred to Full removal	strong importance	No	5	



Normalised Array

	Manage in situ	Augmentation	Full removal	Eigen Vector	Rank
Manage in situ	0.45	0.45	0.45	0.45	1
Augmentation	0.45	0.45	0.45	0.45	1
Full removal	0.09	0.09	0.09	0.09	3

Consistency Index

Principal Eigen Value	3
N	3
Consistency Index	0
Random Index (n=3)	0.58
Consistency Ratio	0%

Summary Tab

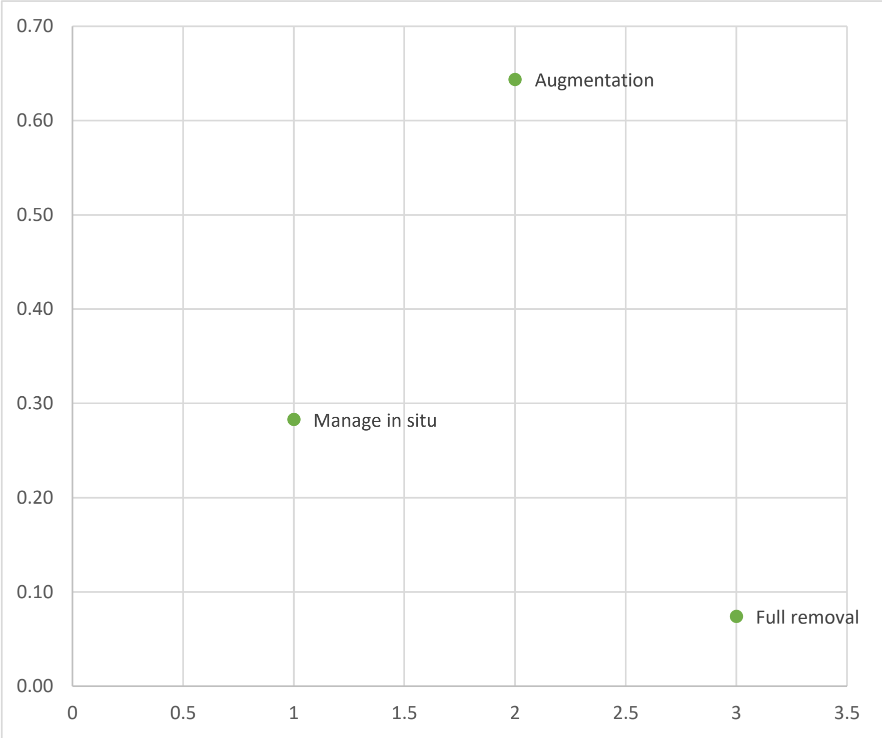
Reciprocal Array

	Manage in situ	Augmentation	Full removal
Manage in situ	1	0.33	5
Augmentation	3	1	7
Full removal	0.2	0.14	1
Sum	4.2	1.48	13

Statement	Ranking	Switch	Rank	Commentary
Augmentation is of moderate importance comapred to Manage in situ	moderate importance	Yes	0.33333	
Manage in situ is of strong importance comapred to Full removal	strong importance	No	5	
Augmentation is of very strong importance comapred to Full removal	very strong importance	No	7	

Normalised Array

	Manage in situ	Augmentation	Full removal	Eigen Vector	Rank
Manage in situ	0.24	0.23	0.38	0.28	2
Augmentation	0.71	0.68	0.54	0.64	1
Full removal	0.05	0.1	0.08	0.07	3



Consistency Index

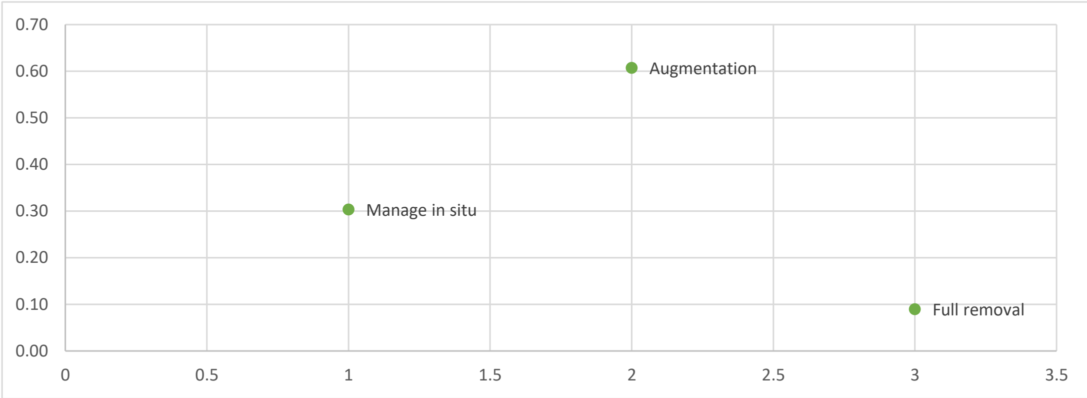
Principal Eigen Value	3.1
N	3
Consistency Index	0.05
Random Index (n=3)	0.58
Consistency Ratio	8%

Summary Tab

Reciprocal Array

	Manage in situ	Augmentation	Full removal
Manage in situ	1	0.33	5
Augmentation	3	1	5
Full removal	0.2	0.2	1
Sum	4.2	1.53	11

Statement	Ranking	Switch	Rank	Commentary
Augmentation is of moderate importance comapred to Manage in situ	moderate importance	Yes	0.33333	
Manage in situ is of strong importance comapred to Full removal	strong importance	No	5	
Augmentation is of strong importance comapred to Full removal	strong importance	No	5	



Normalised Array

	Manage in situ	Augmentation	Full removal	Eigen Vector	Rank
Manage in situ	0.24	0.22	0.45	0.30	2
Augmentation	0.71	0.65	0.45	0.61	1
Full removal	0.05	0.13	0.09	0.09	3

Consistency Index

Principal Eigen Value	3.19
N	3
Consistency Index	0.1
Random Index (n=3)	0.58
Consistency Ratio	16%

Summary Tab

Appendix B
AHP Comparisons for Mooring Anchors and Chains

Reciprocal Array

	Water Quality	Sediment Quality	Benthic Habitats	GHG Emissions	Onshore Environmental Receptors	Fauna	Other Users
Water Quality	1	0.33	0.33	0.2	0.33	0.2	0.2
Sediment Quality	3	1	0.33	0.33	3	0.2	0.33
Benthic Habitats	3	3	1	1	3	0.33	1
GHG Emissions	5	3	1	1	3	0.33	1
Onshore Environmental Receptors	3	0.33	0.33	0.33	1	0.33	0.33
Fauna	5	5	3	3	3	1	1
Other Users	5	3	1	1	3	1	1
Sum	25	15.7	7	6.87	16.3	3.4	4.87

Normalised Array

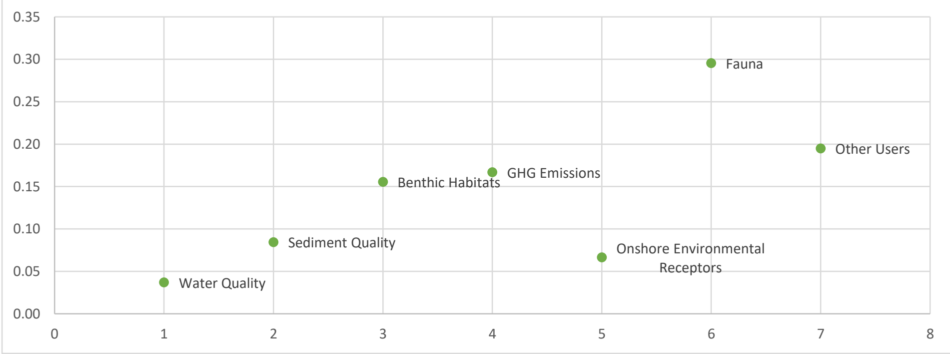
	Water Quality	Sediment Quality	Benthic Habitats	GHG Emissions	Onshore Environmental Receptors	Fauna	Other Users	Eigen Vector	Rank
Water Quality	0.04	0.02	0.05	0.03	0.02	0.06	0.04	0.04	7
Sediment Quality	0.12	0.06	0.05	0.05	0.18	0.06	0.07	0.08	5
Benthic Habitats	0.12	0.19	0.14	0.15	0.18	0.1	0.21	0.16	4
GHG Emissions	0.2	0.19	0.14	0.15	0.18	0.1	0.21	0.17	3
Onshore Environmental Receptors	0.12	0.02	0.05	0.05	0.06	0.1	0.07	0.07	6
Fauna	0.2	0.32	0.43	0.44	0.18	0.29	0.21	0.30	1
Other Users	0.2	0.19	0.14	0.15	0.18	0.29	0.21	0.19	2

Consistency Index

Principal Eigen Value	7.52
N	7
Consistency Index	0.09
Random Index (n=7)	1.32
Consistency Ratio	7%

Summary Tab

Statement	Ranking	Switch	Rank	Commentary
Sediment Quality is of moderate importance comapred to Water Quality	moderate importance	Yes	0.3333	
Benthic Habitats is of moderate importance comapred to Water Quality	moderate importance	Yes	0.3333	
GHG Emissions is of strong importance comapred to Water Quality	strong importance	Yes	0.2	
Onshore Environmental Receptors is of moderate importance comapred to Water Quality	moderate importance	Yes	0.3333	
Fauna is of strong importance comapred to Water Quality	strong importance	Yes	0.2	
Other Users is of strong importance comapred to Water Quality	strong importance	Yes	0.2	
Benthic Habitats is of moderate importance comapred to Sediment Quality	moderate importance	Yes	0.3333	
GHG Emissions is of moderate importance comapred to Sediment Quality	moderate importance	Yes	0.3333	
Sediment Quality is of moderate importance comapred to Onshore Environmental Receptors	moderate importance	No	3	
Fauna is of strong importance comapred to Sediment Quality	strong importance	Yes	0.2	
Other Users is of moderate importance comapred to Sediment Quality	moderate importance	Yes	0.3333	
Benthic Habitats is of equal importance comapred to GHG Emissions	equal importance	No	1	
Benthic Habitats is of moderate importance comapred to Onshore Environmental Receptors	moderate importance	No	3	
Fauna is of moderate importance comapred to Benthic Habitats	moderate importance	Yes	0.3333	
Benthic Habitats is of equal importance comapred to Other Users	equal importance	No	1	
GHG Emissions is of moderate importance comapred to Onshore Environmental Receptors	moderate importance	No	3	
Fauna is of moderate importance comapred to GHG Emissions	moderate importance	Yes	0.3333	
Other Users is of equal importance comapred to GHG Emissions	equal importance	Yes	1	
Fauna is of moderate importance comapred to Onshore Environmental Receptors	moderate importance	Yes	0.3333	
Other Users is of moderate importance comapred to Onshore Environmental Receptors	moderate importance	Yes	0.3333	
Fauna is of equal importance comapred to Other Users	equal importance	No	1	



Reciprocal Array

	Manage in situ	Full removal
Manage in situ	1	3
Full removal	0.33	1
Sum	1.33	4

Normalised Array

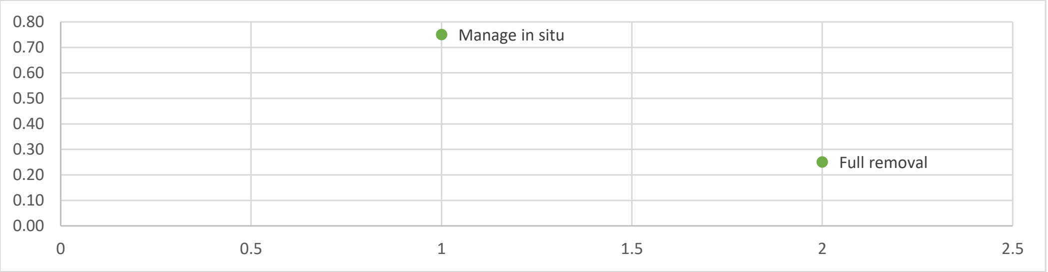
	Manage in situ	Full removal	Eigen Vector	Rank
Manage in situ	0.75	0.75	0.75	1
Full removal	0.25	0.25	0.25	2

Consistency Index

Principal Eigen Value	2
N	2
Consistency Index	0
Random Index (n=2)	0
Consistency Ratio	####

Summary Tab

Statement	Ranking	Switch	Rank	Commentary
Manage in situ is of moderate importance comapred to Full removal	moderate importance	No	3	



Reciprocal Array

	Manage in situ	Full removal
Manage in situ	1	0.2
Full removal	5	1
Sum	6	1.2

Normalised Array

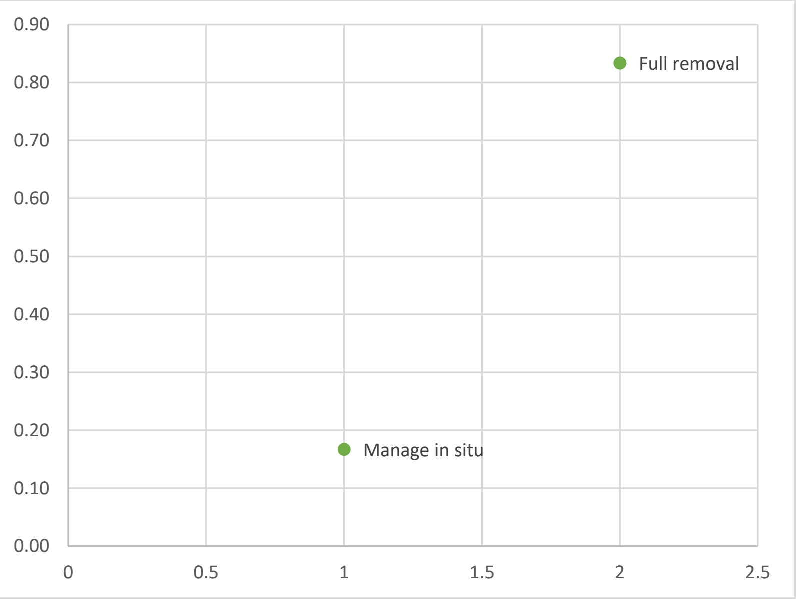
	Manage in situ	Full removal	Eigen Vector	Rank
Manage in situ	0.17	0.17	0.17	2
Full removal	0.83	0.83	0.83	1

Consistency Index

Principal Eigen Value	2
N	2
Consistency Index	0
Random Index (n=2)	0
Consistency Ratio	####

Summary Tab

Statement	Ranking	Switch	Rank	Commentary
Full removal is of strong importance comapred to Manage in situ	strong importance	Yes	0.2	



Reciprocal Array

	Manage in situ	Full removal
Manage in situ	1	5
Full removal	0.2	1
Sum	1.2	6

Normalised Array

	Manage in situ	Full removal	Eigen Vector	Rank
Manage in situ	0.83	0.83	0.83	1
Full removal	0.17	0.17	0.17	2

Consistency Index

Principal Eigen Value	2
N	2
Consistency Index	0
Random Index (n=2)	0
Consistency Ratio	####

Summary Tab

Statement	Ranking	Switch	Rank	Commentary
Manage in situ is of strong importance comapred to Full removal	strong importance	No	5	

Reciprocal Array

	Manage in situ	Full removal
Manage in situ	1	7
Full removal	0.14	1
Sum	1.14	8

Normalised Array

	Manage in situ	Full removal	Eigen Vector	Rank
Manage in situ	0.88	0.88	0.88	1
Full removal	0.13	0.13	0.13	2

Consistency Index

Principal Eigen Value	2
N	2
Consistency Index	0
Random Index (n=2)	0
Consistency Ratio	####

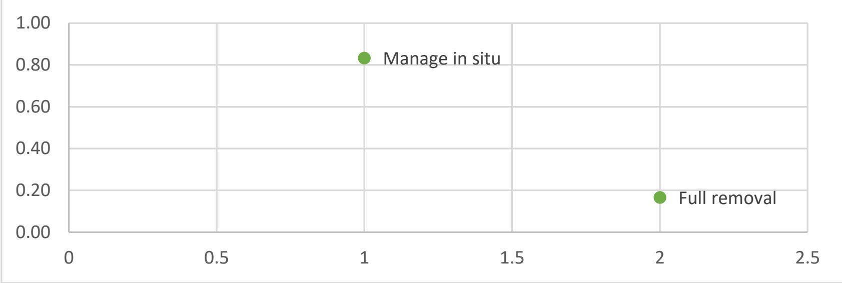
Summary Tab

Statement	Ranking	Switch	Rank	Commentary
Manage in situ is of very strong importance comapred to Full removal	very strong importance	No	7	

Reciprocal Array

	Manage in situ	Full removal
Manage in situ	1	5
Full removal	0.2	1
Sum	1.2	6

Statement	Ranking	Switch	Rank	Commentary
Manage in situ is of strong importance comapred to Full removal	strong importance	No	5	



Normalised Array

	Manage in situ	Full removal	Eigen Vector	Rank
Manage in situ	0.83	0.83	0.83	1
Full removal	0.17	0.17	0.17	2

Consistency Index

Principal Eigen Value	2
N	2
Consistency Index	0
Random Index (n=2)	0
Consistency Ratio	####

Summary Tab

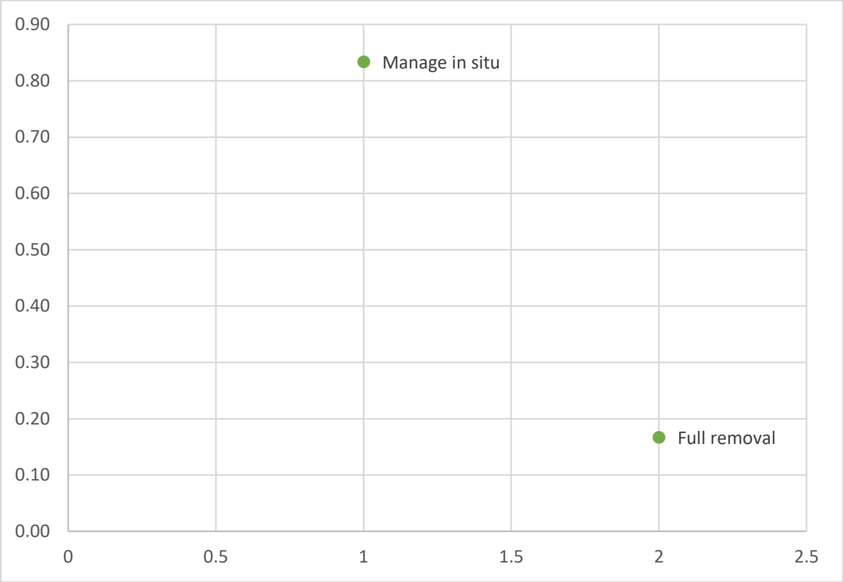
Reciprocal Array

	Manage in situ	Full removal
Manage in situ	1	5
Full removal	0.2	1
Sum	1.2	6

Statement	Ranking	Switch	Rank	Commentary
Manage in situ is of strong importance comapred to Full removal	strong importance	No	5	

Normalised Array

	Manage in situ	Full removal	Eigen Vector	Rank
Manage in situ	0.83	0.83	0.83	1
Full removal	0.17	0.17	0.17	2



Consistency Index

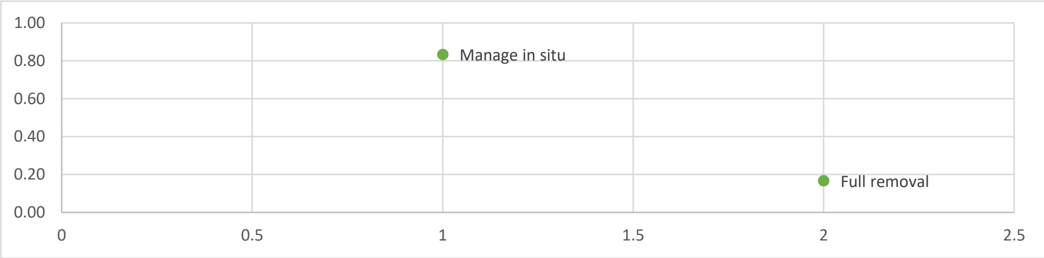
Principal Eigen Value	2
N	2
Consistency Index	0
Random Index (n=2)	0
Consistency Ratio	####

Summary Tab

Reciprocal Array

	Manage in situ	Full removal
Manage in situ	1	5
Full removal	0.2	1
Sum	1.2	6

Statement	Ranking	Switch	Rank	Commentary
Manage in situ is of strong importance comapred to Full removal	strong importance	No	5	



Normalised Array

	Manage in situ	Full removal	Eigen Vector	Rank
Manage in situ	0.83	0.83	0.83	1
Full removal	0.17	0.17	0.17	2

Consistency Index

Principal Eigen Value	2
N	2
Consistency Index	0
Random Index (n=2)	0
Consistency Ratio	####

Summary Tab

Appendix D: Values and Sensitivities of the Marine and Coastal Environment

Santos

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
	Senior Environmental Approvals Adviser	Senior Environmental Approvals Adviser	Team Leader- Regulatory Approvals
9	Joanna Edwards	Annette McGovern	Daniel Thompson
	JMEdwards	AMG	

Any hard copy of this document, other than those identified above, are uncontrolled. Please refer to the Santos Offshore Business Document Management System for the latest revision.

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
7A	25/02/2021	Advisian	Issued for Technical review
8	31/03/2021	Advisian	Issued for use
8A	02/07/2021	Advisian	Issued for technical review
9	09/07/21	Advisian	Issued for use

Contents

Figures

Tables

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. With the exception of Bayu Undan, this document describes the combined 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 combined EMBA represents the largest possible spatial extent that could be contacted by combining the worst-case spill event modelled for Santos activities to date.

The combined EMBA encompasses the full range of environmental receptors that might be contacted by surface and subsurface hydrocarbons in the highly unlikely event of any 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 combined EMBA.

The combined EMBA does not represent the worst case loss of well control event of any one activity .

This document is informed by searches of the protected matters search tool (PMST) provided by the WA Department of Agriculture, Water and the Environment (DAWE) (previously the Department of the Environment and Energy (DoEE) (in December 2020 and June 2021 and provided in **Appendix A**), as well as published scientific literature and studies, and other State and Territory protected species databases 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.

The PMST searches are completed using the exact coordinates that are utilised to produce the figures throughout Section 3 of the EP, ensuring that the combined 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.

The co-ordinates are also provided within the PMST report to allow for duplication of the searches 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.

Figures provided throughout this document are zoomed to the relevant data represented to allow detail to be shown at a readable scale.

1.1 Geographical Extent

The combined EMBA, includes the coastal waters and shoreline habitats of Western Australia (WA) and part of the Northern Territory (NT), encompassing the south of WA to the most northern coastlines of the NT 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 18 bioregions that occur within the combined 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 combined 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;
- Southwest Shelf Province;
- Southern Province; and
- Great Australian Bight Shelf Transition.

North Marine Region

- Northwest Shelf Transition (as above);
- Timor Transition; and
- Northern Shelf Province.

Other IMCRA 4.0 bioregions of interest include: Christmas Island Province and Cocos (Keeling) Island Province.

The international waters of south west Indonesia and Timor-Leste (in part) are also included in the combined EMBA and described where relevant throughout this document.

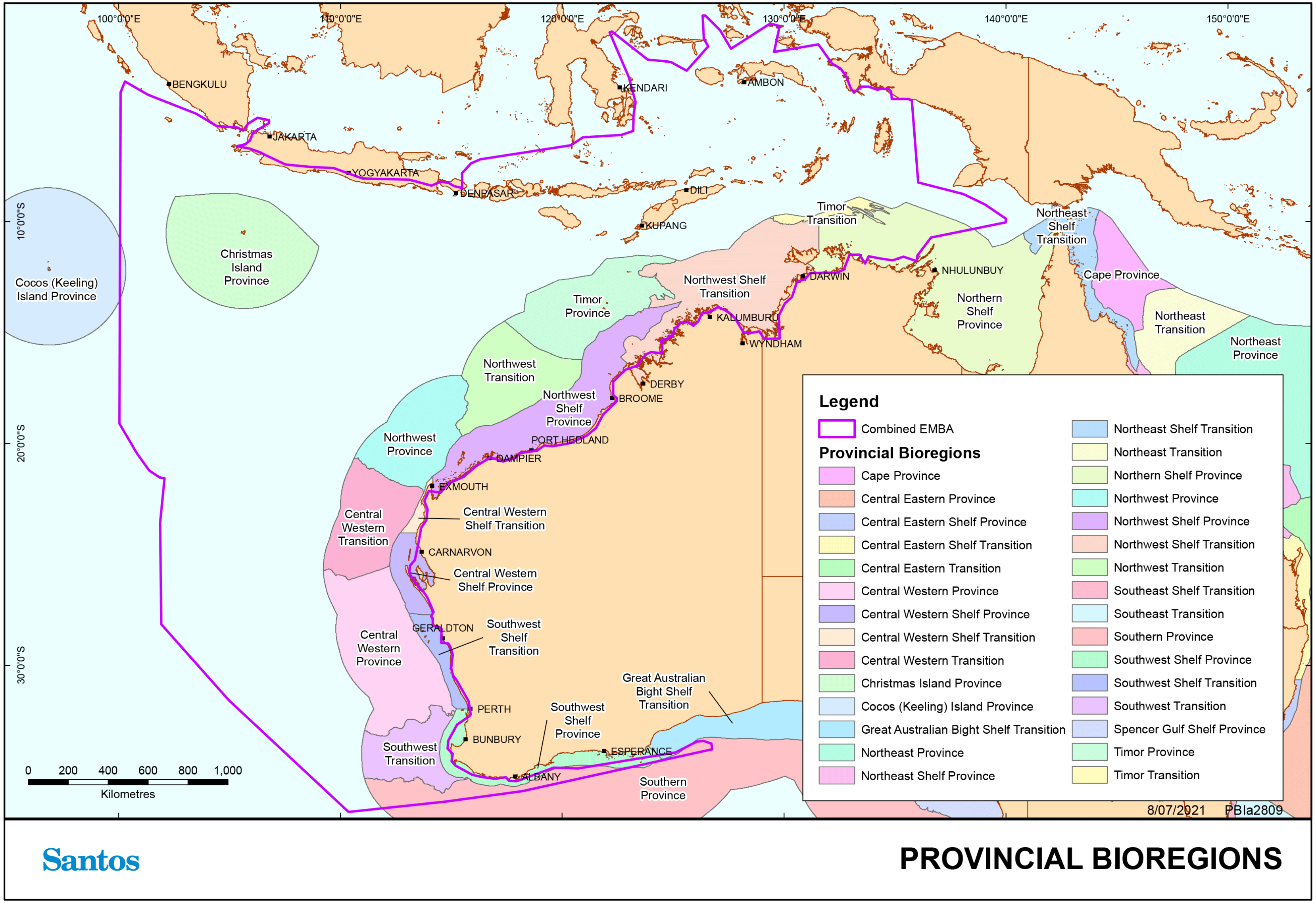


Figure 1-1: EMBA within IMCRA 4.0 Provincial Bioregion

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 combined 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 combined 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.

Several geomorphic formations within the combined EMBA have been associated with Key Ecological Features (DEWHA 2008a) and these are discussed in **Section 10**.

2.1.3 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.

2.1.4 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 combined 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.

2.1.5 Southwest Shelf Transition

This bioregion consists of a narrow continental shelf, ranging from approximately 40-80 km wide that is noted for its physical complexity. It includes a series of 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 (DEWHA, 2008b).

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 combined EMBA and include the Albany Canyons Group, the Ceduna and Eyre Terraces (covering approximately 147,150 km^2) and the Diamantina Fracture Zone.

2.1.6.1 Great Australian Bight

The Great Australian Bight Shelf Transition is characterised by the largest seafloor feature of the Region – an extensive flat continental shelf covering 177 130 km^2. The centre of the shelf reaches widths of 260 km narrowing to 80 km at its margins. Geomorphology, sedimentology and hydrodynamics interact to create ideal conditions for carbonate organisms such as molluscs and bryozoans to flourish without being smothered or buried. As a result carbonate sediments derived from invertebrate skeletons and shells make up over 80 per cent of shelf sediments, making the Bight part of the world's largest modern cool-water carbonate bioregion that extends along Australia's southern margin. Within the wave abrasion zone (0-120 m) sediments are typically rippled and coarse grained, forming a 'shaved shelf' where carbonate accumulation is less than the amount of active erosion and therefore there is a net loss of sediment from the shelf (DEWHA, 2008b).

2.1.7 Central Western Province

This bioregion is characterised by a narrow continental slope that is heavily incised by many submarine canyons as far north as Kalbarri. The Perth Canyon, located at the southern margin of the bioregion, is an order of magnitude larger than any other canyon in the Region (Figure 2.11). The Perth Canyon, formed by erosive processes associated with the ancient Swan River, cuts into the continental shelf at approximately the 150 m depth contour, north-east of Rottnest Island. Other relatively large canyons, such as the Murchison Canyon, occur in the bioregion but little is known about them as they have not yet been studied (DEWHA, 2008b).

The bioregion contains the most extensive area (52 185 km2) of continental rise on the Australian margin. The continental rise is located on the edge of the Perth Abyssal Plain (103 911 km2). There is a large terrace known as the Carnarvon Terrace on the continental slope, extending north from the Houtman Abrolhos Islands at an average of 780 m water depth (DEWHA 2008b).

2.1.8 Central Western Shelf Province

This bioregion is located on the Dirk Hartog Shelf and is generally very flat. It varies in width from less than 20 km in the north to around 125 km in the vicinity of Shark Bay. A small area of reef and tidal sandwaves or sandbanks occur at the entrance to Shark Bay and within its vicinity. Other topographic features of the bioregion include a deep hole and associated area of banks and shoals offshore of Kalbarri. The banks and shoals in this bioregion are of note because they occur at latitudes significantly south of banks and shoals elsewhere in the North-west Marine Region (DEWHA, 2008a).

2.1.9 Central Western Transition

The Central Western Transition is characterised by large areas of continental slope, with sediments dominated by muds and sands that decrease in grain size with increasing depth. The slope is incised by numerous topographic features such as terraces (i.e. the Carnarvon Terrace), canyons (i.e. Cloates Canyon and Carnarvon Canyon) and rises. A large part of the bioregion consists of the Cuvier Abyssal Plain. The Wallaby Saddle is another important feature of this bioregion and it is the most extensive area of this type of topographic feature in the North-west Marine Region (DEWHA, 2008a).

2.1.10 Central Western Shelf Transition

The Central Western Shelf Transition is located entirely on the continental shelf and is comprised mainly of sandy sediments. The close proximity of the coast to the shelf break is a significant feature of this bioregion and is an important factor in determining its biodiversity (DEWHA, 2008a).

Ningaloo Reef is the most significant geomorphic feature in the bioregion. It extends south of North West Cape along the Cape Range Peninsula, and stretches for over 260 km. It is the only example in the world of an extensive fringing coral reef on the west coast of a continent (DEWHA, 2008a).

2.1.11 Northwest Province

The bioregion occurs entirely on the continental slope and is comprised of muddy sediments. It is distinguished by a number of topographic features, such as the Exmouth Plateau, terraces and canyons (including the Swan and Cape Range canyons), as well as deep holes and valleys on the inner slope. The Montebello Trough occurs on the eastern side of the Exmouth Plateau and represents more than 90 per cent of the area of troughs in the North-west Marine Region. Significantly, this bioregion contains the steepest shelf break of the North-west Marine Region, along the Cape Range Peninsula near Ningaloo Reef (DEWHA, 2008a).

2.1.12 Northwest Transition

The majority (52 per cent) of the Northwest Transition bioregion occurs on the continental slope, with smaller areas in the north-west of the bioregion located on the Argo Abyssal Plain and continental rise. The sediments of the slope are dominated by sands, whereas the sediments of the abyssal plain/deep ocean floor are dominated by muds. More than 60 per cent of the Argo Abyssal Plain occurs within this bioregion and much of the Northwest transition occurs in water over 4000 m deep (DEWHA, 2008a).

Other topographic features within the bioregion include areas of rise, ridges, canyons and apron/fans. The bioregion also has reefs such as Mermaid, Clerke and Imperieuse reefs, which are collectively known as the Rowley Shoals (DEWHA, 2008a).

2.1.12.1 Northwest Shelf Province

The Northwest Shelf Province is located almost entirely on the continental shelf, except for a small area to the north of Cape Leveque that extends onto the continental slope. This bioregion includes more than 60% of the continental shelf in the North-west Marine Region (DEWHA, 2008a). The shelf gradually slopes from the coast to the shelf break, but displays a number of seafloor features such as banks/shoals and holes/valleys. These are thought to be morphologically distinct from other features of these types found elsewhere in the North-west Marine Region, and have a different sedimentology (DEWHA, 2008a). For example, the Glomar Shoals occur approximately 30–40 km offshore of Dampier in water depths of between 26–70 m and are distinguished by highly fractured molluscan debris, coralline rubble and coarse carbonate sand. The province also includes the

Leveque Rise, a large plateau, and one of only two shelf plateaux within the North-west Marine Region (DEWHA, 2008a).

2.1.12.2 Northwest Shelf Transition

The Northwest Shelf Transition is predominantly located on the continental shelf with a small portion extending onto the continental slope causing waters in the area to be relatively shallow, only up to 330 m. It also consists of geomorphic features that are unique to the Northwest Shelf Transition and not found elsewhere in the North-west Marine Region (DEWHA, 2008a). An example of this is that 90% of the Region's carbonate banks are located within the Northwest Shelf Transition (DEWHA, 2008a).

The Bonaparte Depression lies within the Northwest Shelf Transition, which is a 45 000 km^2 geomorphic basin that is the only occurrence of its type in the North-west Marine Region (DEWHA, 2008a). The Bonaparte Depression is a relatively flat feature with a higher content of mud and gravel than what is found elsewhere in the Northwest Shelf Transition and it has a number of pinnacles of which form the key ecological feature 'pinnacles of the Bonaparte Basin' (see **Section 9.8**).

2.1.12.3 Timor Province

The Timor Province is located on the continental slope. The notable topographical features include the Scott Plateau, the Ashmore Terrace and part of the Rowley Terrace and Argo Abyssal Plain (DEWHA, 2008a). Of these, the Scott Plateau is particularly significant with water depths of up to 3000 m and being fringed by spurs and valleys (DEWHA, 2008a). The Scott Plateau is also separated from Rowley Terrace by canyons that are up to 50 million years old (DEWHA, 2008a).

The Timor Province encompasses almost half of the reefs in the North-west Marine Region, including Scott Reef, Seringapatam Reef and Ashmore Reef which are all within the combined EMBA (DEWHA 2008a).

2.1.12.4 Timor Transition

The Timor Transition is predominantly shelf terrace and slope, which extend into waters that are 200-300 m deep. The deepest point (300 m) is the Arafura Depression. The Timor Transition is also dominated by a series of canyons that represent a drowned river system from the Pleistocene era (DEWHA, 2008c). The canyons are approximately 80-100 m deep and up to 20 km wide (DEWHA, 2008c).

2.1.12.5 Northern Shelf Province

The Northern Shelf Province consists of large areas of relatively featureless sandy and muddy sediments (DWEHA, 2008c). A significant feature of the Northern Shelf Province is the Gulf of Carpentaria, which is outside the combined EMBA, the majority of the reefs in the Northern Shelf Province are also outside the combined EMBA and form a broken margin around the Gulf of Carpentaria. However, within the combined EMBA is the Arafura Shelf which is characterised by continental shelf, canyons, terraces, the Arafura Sill and the Arafura Depression (DEWHA, 2008c).

2.1.12.6 Christmas Island Province

This bioregion contains the 4th largest abyssal plain/deep ocean floor area and smallest area of slope of all the National Benthic Marine Bioregionalisation (NBMB) bioregions (DEH, 2005a). Due to the similar geomorphology and location adjacent to Indonesia in the tropical Indian Ocean, the fauna contained in this bioregion is probably similar or related to the fauna associated with the Cocos (Keeling) Island bioregion.

2.1.12.7 Cocos (Keeling) Island Province

This bioregion contains the largest abyssal plain/deep ocean floor area of all the NBMB bioregions and is the deepest NBMB bioregion on average due to the relatively large areas of abyssal plain/deep ocean floor (DEH, 2005b). Due to the similar geomorphology and location adjacent to Indonesia in the tropical Indian Ocean, the fauna contained in this bioregion is probably similar or related to the fauna associated with the Christmas Island bioregion. The Cocos basin comprises dominantly flat abyssal plain occurring at water depths around 5,500 km.

2.1.13 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**.

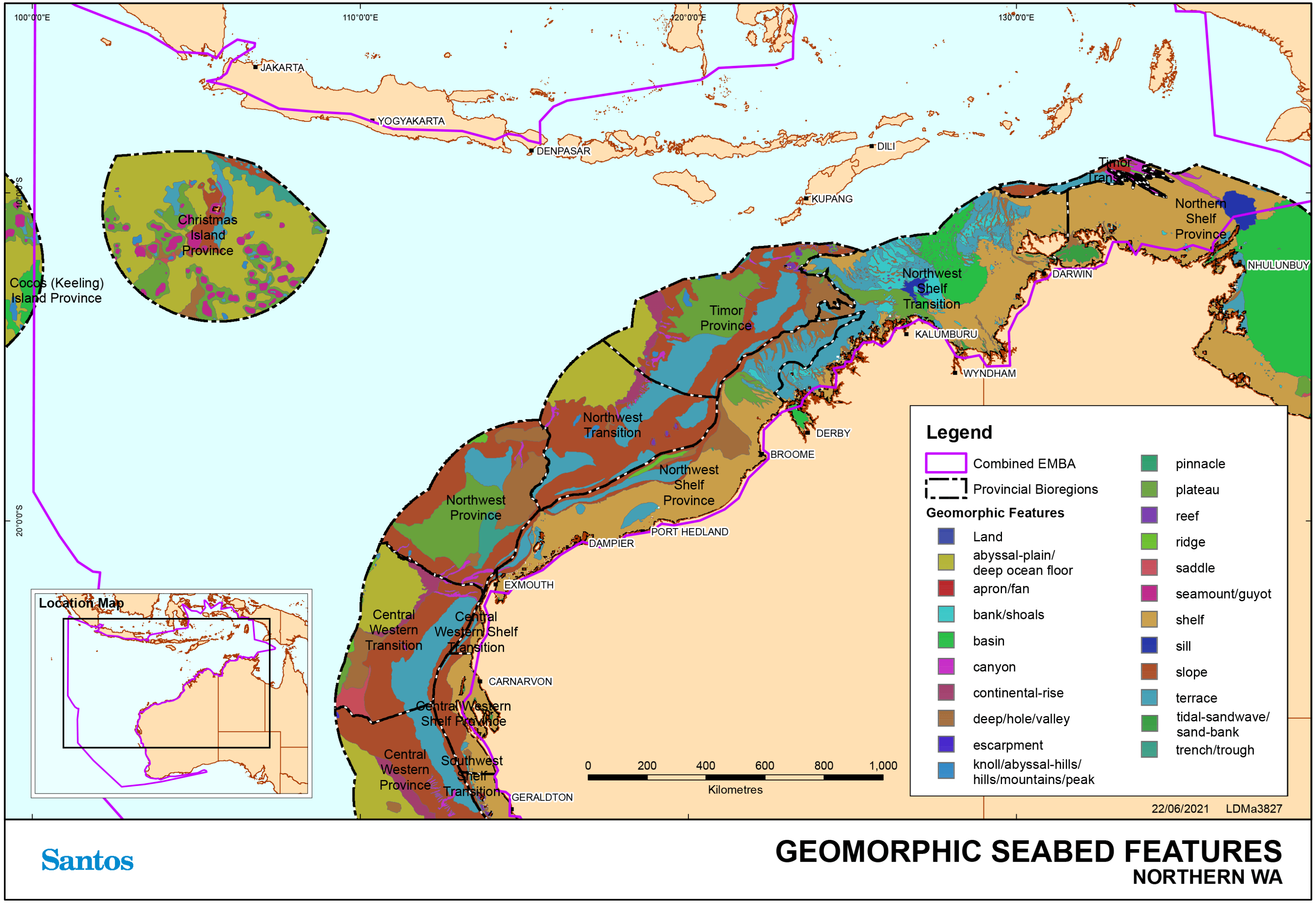


Figure 2-1: Geomorphic/seafloor features of Northern WA

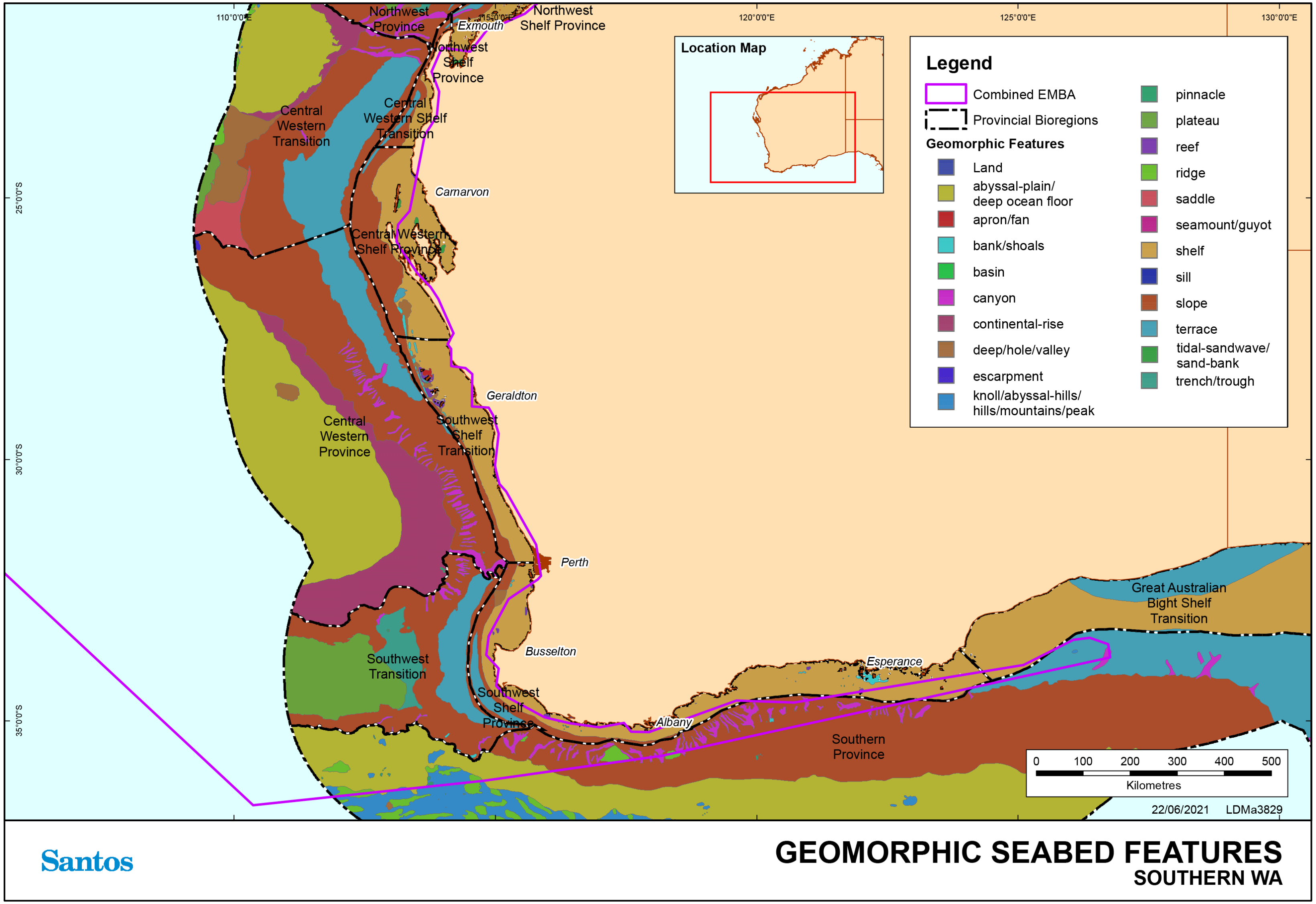


Figure 2-2: Geomorphic/seafloor features of Southern WA

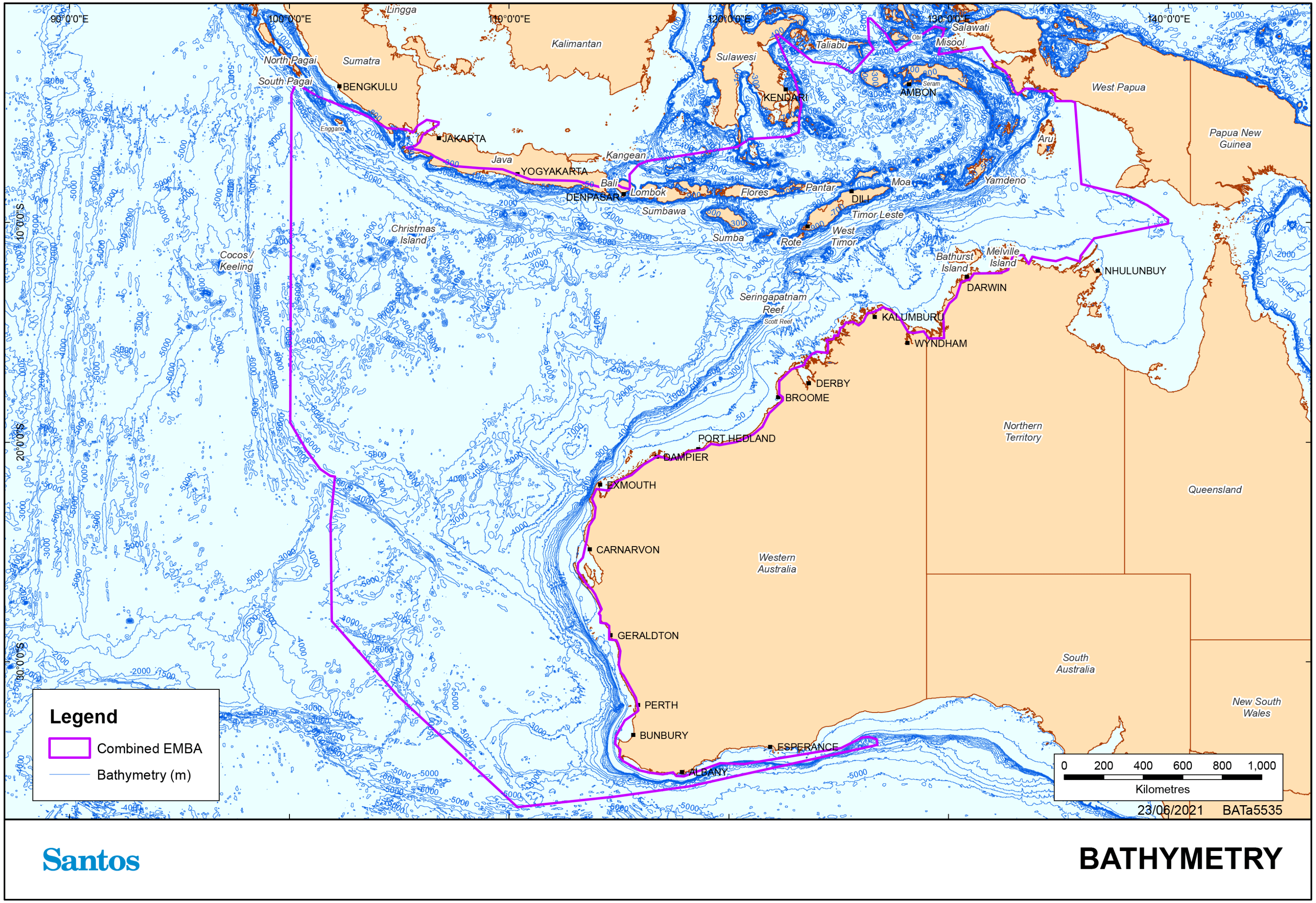


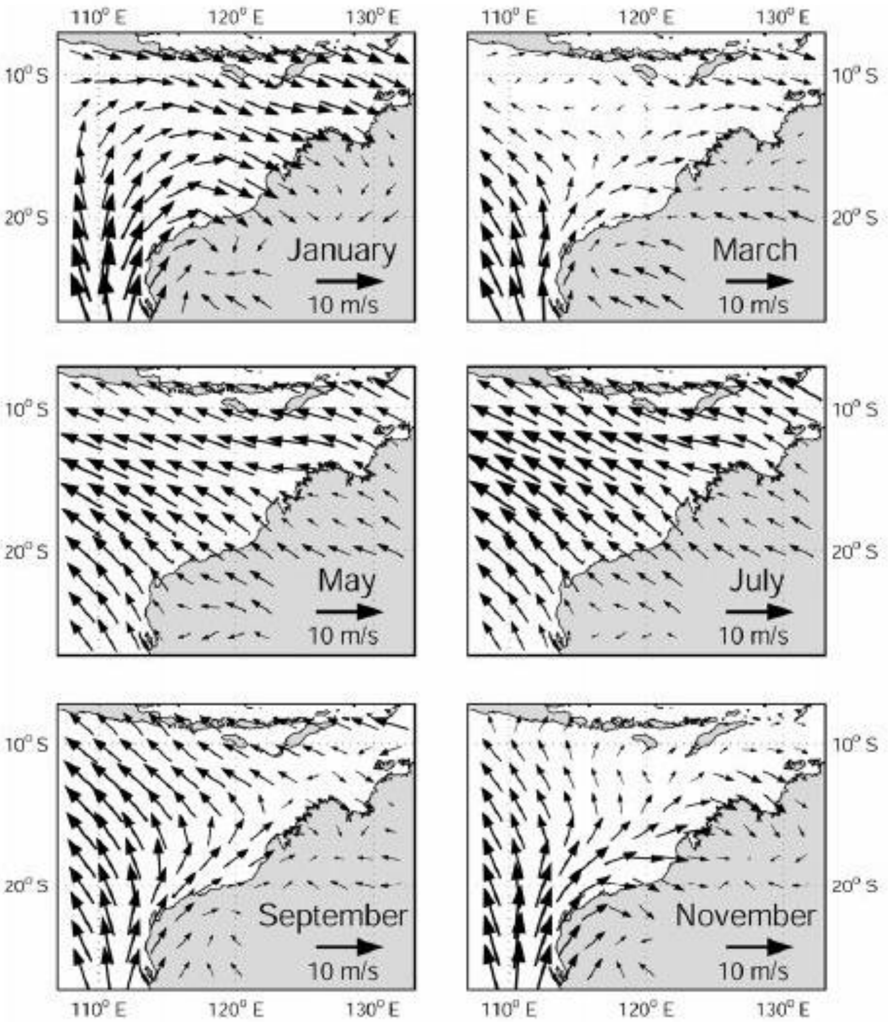
Figure 2-3: Bathymetry of the combined EMBA

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.

The Bonaparte Basin and Timor Sea region in the north has a tropical climate. These areas experience a distinct 'wet' season with summer monsoonal conditions from October to March and a distinct 'dry' season with cooler and drier conditions from April to September. The wet season usually comprises south-westerly winds capable of generating thunderstorm activity, high rainfall and cyclones. The dry season usually comprises dry and warm conditions with little rainfall (Fugro, 2015).

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). It is a relatively narrow boundary current that flows along the north-west shelf at between 100 m and 200 m depth, flowing towards the north-east in summer and the south-west in winter (Fugro, 2015).

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). Large-scale currents of the Timor and Arafura seas in the north are dominated by the Indonesian Throughflow. Christmas and Cocos (Keeling) Islands territories are located in the eastern Indian Ocean, in the path of the South Equatorial Current that carries the Indonesian Throughflow waters into the Indian Ocean.

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). Cyclones and tropical storms can greatly increase wave heights by up to 8 m in the outer Timor Sea during the cyclone season (Przeslawski et al. 2011).

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).

Santos

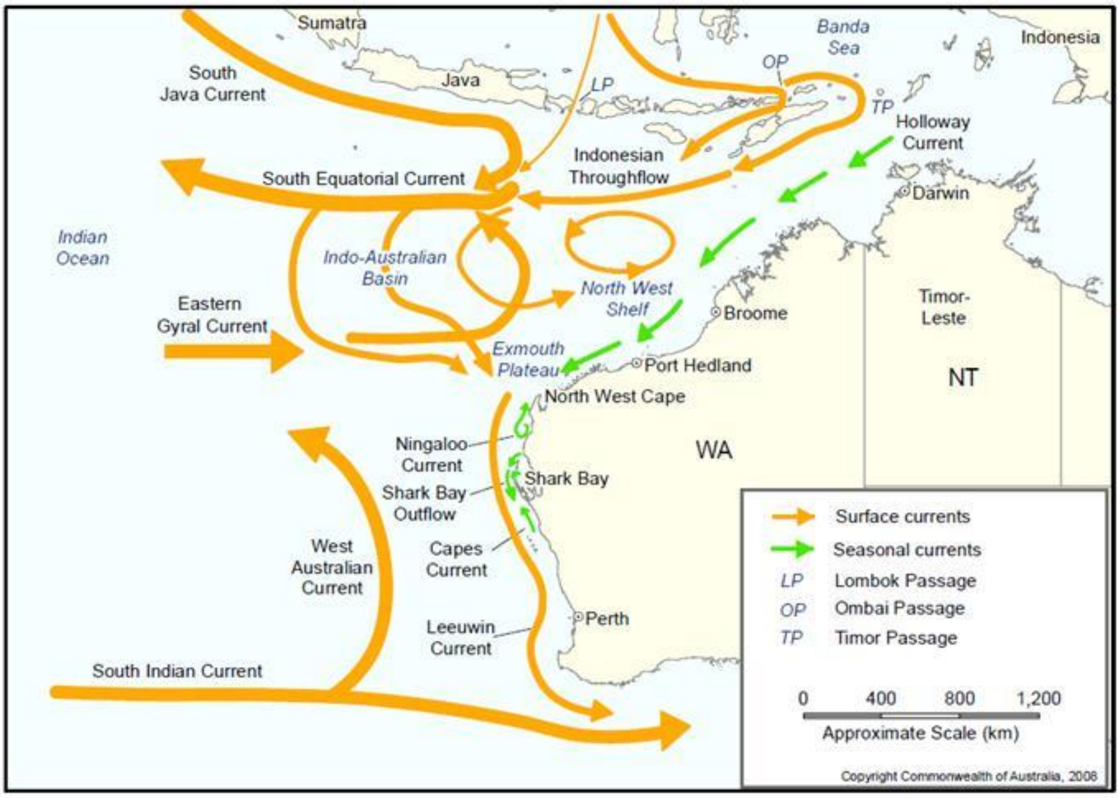


Figure 2-5: Surface currents in the Northern Territory and Western Australia

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 combined EMBA lie at depths ranging from LAT down to more than 6,000 m at Argo and Cuvier abyssal plains (DEWHA 2008a, 2008b, 2008c).

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 photic zone in the offshore north extends to 100 m (DEWHA 2008c).

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 18 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 combined 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.

Three bioregions (Northwest Province, Central Western Province and Central Western Transition) lie in deep waters below the photic zone. Two bioregions (Southwest Transition and Southern 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. The EMBA overlaps the deeper waters of the Cocos (Keeling) Island Province, (not those close to shore) which are greater than 4000m deep and therefore photosynthetic corals are not present.

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 Southwest Shelf Province

The Southwest Shelf Province is a nearshore bioregion that extends from Rottnest Island to Point Dempster, approximately 185 km east of Esperance. Adjacent to Commonwealth waters, the extensive area of granite reef (35 203 km2 of reef habitat) and seagrass habitat of the Recherche Archipelago is noted for its high diversity of warm temperate species including 263 known species of fish, 347 known species of molluscs, 300 known species of sponges, and 242 known species of macro-algae (DEWHA, 2008a).

3.1.3 Great Australian Bight Shelf Transition

Few species of scleractinian and soft coral (Orders Stolinifera, Telestacea and Alcyonacea) occur in southern Australia. Three reef-building species occur in shallow waters and >50 species of non-reef-building (ahermatypic) species occur in waters up to 900 m deep. The distribution patterns of corals in the GAB are largely unknown (McLeay et.al, 2003).

3.1.4 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).

3.1.5 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).

3.1.6 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.

3.1.7 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.

3.1.8 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).

3.1.9 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).

3.1.10 Timor Transition

Due to the deep, offshore nature of the Timor Transition (up to 300 m with no coastal areas), there are no corals expected within this area (DEWHA 2008c). However, there is evidence of relic reef next to drainage channels of the outer slope of the Timor Transition. This is thought to be associated with local upwellings of cooler nutrient rich water from the Timor Sea (DEWHA 2008c).

3.1.11 Northern Shelf Province

The Northern Shelf Province contains submerged patch or barrier reefs in areas with approximately 30-50 m depth of water, these mainly occur around the margin of the Gulf of Carpentaria (which lies outside the combined EMBA) (DEWHA 2008c). The majority of the province is relatively featureless with sandy and muddy sediments and this is expected to be the case for the portion of the combined EMBA that overlaps the Northern Shelf Province.

3.1.12 Christmas Island Province

The subsurface marine habitat immediately surrounding Christmas Island consists of a relatively narrow and shallow coral reef shelf about 20 to 100 metres wide in approximately six to 20 metres of water depth. There are caves in some of the island's rocky sea cliffs that adjoin the coral reef shelves. Coral reef shelves also contain areas of sand and rubble.

The shallow coral reef shelves drop off steeply to the island's mid and deep-water marine habitats which include outer reef seaward slopes, vertical walls and oceanic waters. The marine boundary of the Christmas Island National Park extends 50 metres seaward from the low water mark, which means that the park has no true deep-water habitats but some outer reef slopes and vertical walls fall within the park's waters (DNP, 2012).

3.1.13 International Waters

Important areas outside of the IMCRA bioregions include:

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).

The world heritage sites of Siberut and Ujung Kulon are also recognised for their extensive coral ecosystems, as well as marine national parks in the waters and islands surrounding Indonesia, such as Laut Sawu, Teluk Cenderawasih, Bunaken, Kapulauan Wakatobi, Togian Islands, Karimunjawa, the islands of Kepulauan Seribu, the table reefs of Taka Bonerate and the Savu Sea National Marine Conservation Area (refer to **Section 9.8**).

Majority of these sites form parts of the marine area known as the Coral Triangle, named for its staggering number of corals and associated marine life, situated in the waters of Indonesia, Malaysia, the Philippines, Papua New Guinea, Timor Leste and Solomon Islands (ADB, 2014).

Timor-Leste

See **Section 3.1.8** 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, and over 30 species of seagrasses have been recorded as occurring within Australian waters (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). Other seagrass meadows of note include those around Tiwi Islands which provide significant habitat to a number of species. Seagrass habitats also occur within shallower waters near islands and have potential to occur closer to the Indonesian and Timor-Leste coastlines.

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).

Four bioregions (Northwest Province, Central Western Province, Central Western Transition and Timor Transition) lie entirely in deep waters below the photic zone. Two bioregions (Southwest Transition and Southern Province) occur in waters that are too cold to support seagrasses. The EMBA overlaps the deeper waters of the Cocos (Keeling) Island Province, (not those close to shore) which are greater than 4000m deep and therefore seagrasses are not present.

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 Great Australian Bight Shelf Transition

The Australian coastline has the highest number of seagrass species of any continent. There are approximately 30 species of seagrasses in Australia belonging to 11 genera. Approximately one third (18 species) of all species known worldwide are endemic in Australia. Of these, 16 species are restricted to temperate waters.

Southern temperate waters have two endemic genera, *Heterozostera* and *Amphibolis*. Many endemic species belong to the genera *Posidonia*. The distribution and abundance of seagrasses is a function of topography and environment. A distinction exists between subtropical and warm temperate types. In southern Australia, species with warm water affinities (*Posidonia, Amphibolis*) decline in number from west to east as water temperatures decrease.

In South Australia, seagrasses cover approximately 9620 km2 and represent one of the largest seagrass ecosystems in the world. Seagrass distribution in the GAB is patchy and limited by exposure to swell. Most seagrass is found in sheltered bays or in the lee of reefs and islands in the eastern GAB. These areas contain nearly 10% of the seagrass meadows found in South Australia. Posidonia species dominate, especially *P. angustifolia, P. coriacea* at the base of cliffs and *P. australis* and *P. angustifolia* in the sheltered lee of fringing reefs. *Amphibolis antarctica* and *Heterozostera tasmanica* are present but less common in sheltered bays of the region (McLeay et al., 2003).

3.2.4 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).

3.2.5 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).

3.2.6 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).

3.2.7 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).

3.2.8 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 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.

3.2.10 Northern Shelf Province

Coastlines adjacent to the Northern Shelf Province contain seagrasses providing habitat to a number of marine species, particularly juvenile tiger prawns, which make up approximately 50% of the total prawn catch in the province. However, majority of these seagrass habitats exist within the Gulf of Carpentaria, which lies outside the combined EMBA.

3.2.11 Christmas Island Province

The subsurface marine habitat immediately surrounding Christmas Island consists of a relatively narrow and shallow coral reef shelf about 20 to 100 metres wide in approximately six to 20 metres of water depth. The sandy areas and some lagoons are also known to support seagrass habitat (DNP 2012).

3.2.12 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 combined 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, Laut Sawu Marine National Park, Bunaken National Park, Karimunjawa Marine National Park and Savu Sea National Marine Conservation Area are also known for their 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).

Three bioregions (Northwest Province, Central Western Province and Central Western Transition) lie entirely in deep waters below the photic zone. Two bioregions (Southwest Transition and Southern Province) occur in colder waters. The EMBA overlaps the deeper waters of the Cocos (Keeling) Island Province, (not those close to shore) which are greater than 4000m deep and therefore macroalgae are not present.

Macroalgae are not present hence these bioregions are not discussed.

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 Great Australian Bight Shelf Transition

Seaweed diversity and endemism in temperate waters of Australia is among the highest in the world, perhaps due to the length of the southerly-facing rocky coastline and the long period of geological isolation. The number of species found in southern Australia is 50-80% greater than other temperate regions of the world. A small number of tropical species and isolated species from tropical genera also occur in the GAB.

Oceanic waters of South Australia support one of the world's most diverse seaweed assemblages, with >1200 species recorded. Many species of macroalgae found in South Australian waters extend into the cool temperate waters of Victoria and Tasmania and warmer waters of Western Australia. However, South Australia has the highest concentration of species. The waters of the GAB are clear and allow chlorophyllus plants to live at depths of up to 70 m.

Among the green algae (Chlorophyta), few microscopic forms have been studied; however, a few southern Australian species are recognised in the genera *Ulva* (2) and *Bryopsis* (6). Coenocytic green algae are well represented, including *Codium* (15 species) and *Caulerpa* (19 species). Brown algae (*Phaeophyta*) and red algae (*Rhodophyta*) are particularly diverse. Approximately 43% of the genera (658) and 20% of the species

(~4000) of red algae that occur worldwide are found in southern Australia. Over 75% of red algae, 57% of brown algae, and 30% of green algae are endemic to southern Australia (Womersley 1990). Womersley (1984, 1987, 1994, 1996, 1998 and 2003) documents the macroalgae of southern Australia. (McLeay et al., 2003).

3.3.4 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).

3.3.5 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).

3.3.6 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).

3.3.7 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).

3.3.8 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).

It is also considered that in offshore parts of the Northwest Shelf Transition, there are high levels of primary production, including macroalgae. This is due to light penetration through relatively clear, shallow waters (DEWHA, 2008a). In particular, carbonate banks and reefs in the Northwest Shelf Transition are considered to support macroalgae, therefore macroalgae would be expected to be present within the Carbonate Bank and Terrace System of the Van Diemen Rise key ecological feature, located within the Northwest Shelf Transition.

3.3.9 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).

3.3.10 Timor Transition

There is a lack of published information regarding macroalage within the Timor Transition. However, the presence of the Shelf Break and Slope of the Arafura Shelf key ecological feature indicates that macroalgae may be present in association with this seabed feature. Upwelling associated with the topography of the shelf break lifts nutrient rich deep ocean water onto the edge of the shelf and into the euphotic zone, leading to enhanced biological productivity (DSEWPAC, 2012).

3.3.11 Northern Shelf Province

Macroalgae is sparse in the Northern Shelf Province (DEWHA, 2008c). However, around reef areas, there have been observations of phytoplankton blooms, thought to occur at localised micro-upwellings of nutrients potentially driven by wind and tidal eddies (DEWHA, 2008c).

3.3.12 Christmas Island Province

Coral reefs are 'turfed' with fine hair-like algae which are grazed by many animals. Some red algae form hard pink crusts which cement sand and dead coral together (DNP, 2012).

3.3.13 International Waters

No information on macroalgae in international waters has been identified other than for Timor-Leste waters.

See **Section 3.1.8** 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 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 Southwest Shelf Province

East of Albany, the dominant lobster species changes from the western rock lobster to the southern rock lobster. In this bioregion there is a notable increase in the ratio of benthic fish to crustaceans. Crustaceans appear to be less important in structuring shallow benthic communities here than in bioregions to the north and to the south-east of the Murray River mouth, around the Bonney Upwelling and Tasmania (DEWHA 2008b).

3.4.3 Southwest Shelf Transition

The inner shelf of the bioregion, extending between 0-50 m deep, includes distinct ridges of limestone reef with extensive beds of macro-algae (principally *Ecklonia* spp.). These inshore lagoons are inhabited by a diverse range of coralline algae, sponges, molluscs and crustaceans. On the outer shelf and shelf break filter feeding sponges and bryozoans dominate the hard bottom. The reefs around the Houtman Abrolhos islands support 492 known species of molluscs, 110 known species of sponges, 172 known species of echinoderms and 234 known species of benthic algae (DEWHA 2008b). Western rock lobster, the dominant large benthic invertebrate in this bioregion, is considered to be an important part of the food web of the inner shelf.

3.4.4 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).

3.4.5 Great Australian Bight Shelf Transition

The invertebrate fauna of the GAB also displays a high degree of endemism (85-95%, Shepherd 1991). South Australia's benthic invertebrate assemblages also include tropical species. Fossils of benthic foraminiferans, nektonic nautiloids and planktonic protists suggest that tropical species have been transported into South Australia by the Leeuwin Current since the Eocene.

Early research in the GAB included an expedition on Australia's first fisheries research vessel, the Southern Endeavour that reported the presence of hydroids, molluscs and sponges. Many of South Australia's invertebrate species are included in the South Australian Handbook Series Marine Invertebrates of Southern Australia. Part I, includes the Porifera, Cnidaria, Platyhelminths, Annelida, Sipuncula, Echiura, Bryozoa and Echinodermata (Shepherd and Thomas 1982); Part II deals solely with the Mollusca (Shepherd and Thomas 1989); and Part III includes the Nemertea, Entoprocta, Phoronida, Brachiopoda, Hemichordata, Pycnogonids and Tunicates (Shepherd and Davies 1997). The most notable group not covered by these books is the Crustacea. Edgar (2000) describes 1200 species of invertebrates, fish, algae and sea grasses that occur in the intertidal zone to 30 m depth between Sydney and Perth (McLeay et al., 2003).

3.4.6 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.

3.4.7 Central 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).

3.4.8 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).

3.4.9 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).

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3.4.10 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.

3.4.11 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).

3.4.12 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).

3.4.13 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).

3.4.14 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).

3.4.15 Timor Transition

Carbonate banks and reefs of the Timor Transition have been found to support non-coral communities and benthic invertebrate communities associated with hard substrates (DEWHA, 2008c). Of particular note is the Shelf Break and Slope of the Arafura Shelf key ecological feature which is located within the Timor Transition. This key ecological feature has been recognised for the invertebrates that is hosts, which are thought to be the basis for the offshore food webs in the area (DEWHA, 2008c). Furthermore, the Tributary Canyons of the Arafura Depression key ecological feature is also in the Timor Transition and surveys of this key ecological feature identified around 245 macroscopic species of invertebrates (Wilson, 2005).

3.4.16 Northern Shelf Province

Studies of taxa within the Northern Shelf Province found 684 taxa of infaunal benthic invertebrates in waters deeper than 20 m. However, the Gulf of Carpentaria Basin contains the most significant non-coral benthic habitats within the Northern Shelf Province, which is outside the boundary of the combined EMBA (DEWHA, 2008c).

3.4.17 Christmas Island Province

Three major molluscs grow on Christmas Island's reefs: bivalves, gastropods and cephalopods. Echinoderms include sea stars, brittle stars, feather stars, sea urchins and sea cucumbers (DNP, 2012). The deeper waters connecting Christmas Island to the Cocos (Keeling) Island Province are described below (**Section 3.4.18**).

3.4.18 Cocos (Keeling) Island Province

The hard substrates that occur on seamounts within the province are likely to provide surfaces and topographical structure for recruitment and growth of passive,sessile, epi-benthic suspension feeders (Genin et al., 1986) such as deep sea corals, sponges,crinoids, ascidians and bryozoans. Most of the seamounts within the subregion are relatively deep (>2000 m) and the deeper seamounts (>3000 m) are a unique feature of this subregion. Little is known about the communities that live on the tops and slopes of these seamounts. However, it seems likely that their unique position in the water column, and geographically, will support unique benthic and demersal communities (Brewer *et al*., 2009).

3.4.19 International Waters

No information on non-coral benthic invertebrates in international waters has been identified other than for Timor-Leste waters.

See **Section 3.1.8** 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 combined 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 combined 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.

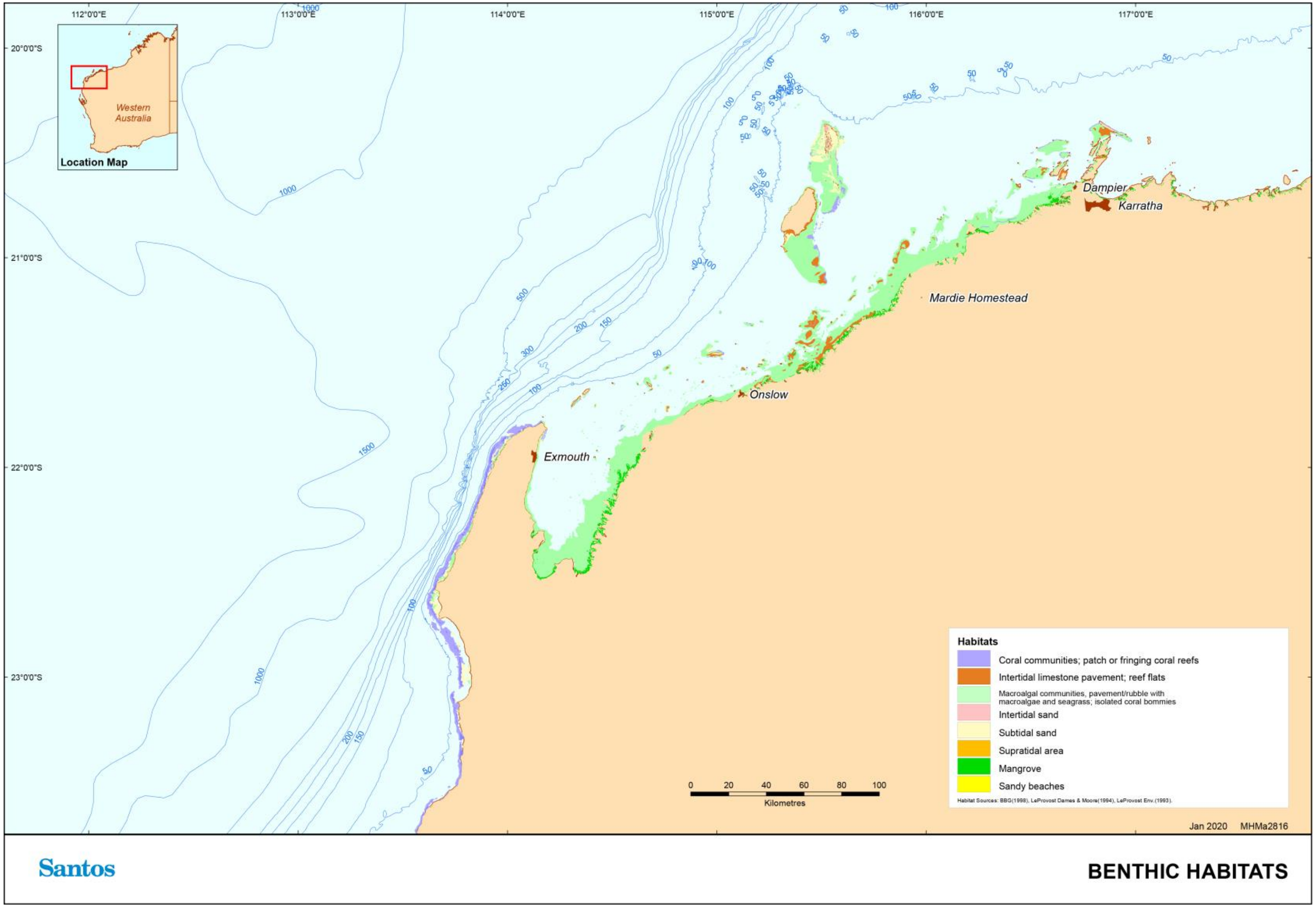

Figure 3-1: Benthic habitats from Coral Bay to Dampier

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 18 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. Noting that shoreline habitats of the Cocos (Keeling) Islands are not described as the combined EMBA is restricted to the outermost deep waters of the bioregion.

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 Great Australian Bight Shelf Transition

Mangrove forests occur at sheltered sites on the South Australian coast and cover an area of approximately 230 km2. Mangroves are poorly represented in the Great Australian Bight as they show preference for low energy, muddy shorelines, particularly in the tropics. Of the 69 species in the world only one occurs in the eastern part of the GAB, the grey mangrove, Av*icennia marina*. It forms coastal woodlands up to 5m tall with the most significant stands in the GAB occurring near Ceduna in the east (McLeay, 2003).

4.1.2 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.

4.1.3 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).

4.1.4 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).

4.1.5 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).

Further north, mangroves also occur at the Tiwi Islands. Mangrove communities in the Tiwi Islands are predominantly within tidal creeks and are not expected along the shoreline. The Northern Territory mainland coastline, however, has a number of estuaries and rivers that drain into the surrounding hinterland during the wet season, this includes Darwin Harbour that contains approximately 260 km^2 of mangroves (INPEX, 2010).

4.1.6 Timor Province

Details on habitats in the Timor Province is provided in **Section 12.3.12**.

4.1.7 Northern Shelf Province

Coastlines within the Northern Shelf Province are described as being dominated by mangroves, which provide significant habitat for commercial and non-commercial fish species. In particular, banana prawns tend to favour mangrove areas with the highest catch of banana prawns being recorded in areas with the highest concentration of mangroves (DEWHA, 2008).

4.1.8 Christmas Island Province

There are no coastal mangroves, but a stand of normally estuarine *Bruguiera gymnorhiza* and *B. sexangula* occurs at Hosnie's Spring (registered as a Ramsar Wetlands site of international importance) about 50 metres above sea level. Two other mangrove species occur on the east coast. *Heritiera littoralis* occurs on the inland terrace above Greta Beach (outside the park) and further south towards Dolly Beach, as well as a discrete stand on the terrace above Dean's Point. *Cynometra ramiflora* occurs in two small stands south of Ross Hill (DNP, 2012).

4.1.9 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 Laut Sawu Marine National Park, Karimunjawa National Park, Kepulauan Seribu National Park, Teluk Cenderawasih National Park, Kapulauan Wakatobi National Park, Meru Betiri National Park, Togian Islands National Park, Bali Barat National Park, Savu Sea National Marine Conservation Area and the World Heritage sites of Komodo National Park, Siberut and Ujung Kulon 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.

Further north, the Tiwi islands have also been identified as containing tidal flats, whilst the extent of these are not well documented they are thought to be closely related to the mangrove habitats at the Tiwi Islands (ConocoPhillips, 2020).

4.2.4 Timor Province

Details on habitats in the Timor Province is provided in **Section 12.3.12**.

4.2.5 Northern Shelf Province

The subtidal and intertidal communities in Darwin Harbour and around the NT coastline, within the Northern Shelf Province are characterised as including a variety of shoreline habitats, including intertidal mud flats (URS 2010). The Tiwi Islands are also partially located within the Northern Shelf Province and are identified as supporting a number of shoreline habitats including sand and mud flats.

4.2.6 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 combined 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 Great Australian Bight Transition

The coastline is subject to moderate to high wave energy and high swells (2-4 m). This region features limestone cliffs interspersed by rocky headlands, narrow intertidal rock platforms, reefs and beaches backed by dune barriers.

The Eyre Region is subject to moderate to high wave energy and features a rocky coast with numerous headlands, sheltered bays, cliffs, shore platforms, beaches backed by dune barriers, offshore islands, seamounts and lagoon deposits in sheltered areas (McLeay, 2003).

4.3.3 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.

4.3.4 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.

4.3.5 Christmas Island Province

Rocky shore platforms occur at many locations around the island, more extensively on the western coastline between North West Point and Egeria Point. There are also tidal rock pools which are maintained by wave splash and tidal surge (DNP, 2012).

4.3.6 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 combined 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 combined 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**).

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 Central Western Shelf Province

Sandy beaches are found along the coastline at Shark bay within the marine park which is further described in **Section 12.3.2**.

4.4.4 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).

4.4.5 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).

Significant sandy beaches occur on the Tiwi Islands, specifically the west coast of Bathurst Island and the north coast of Melville Island. These beaches are important areas for marine turtles with nesting dominated by flatback and olive ridley turtles (peak nesting in March to May) (Chatto and Baker, 2008).

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.

4.4.6 Timor Province

Details on habitats in the Timor Province is provided in **Section 12.3.12**.

4.4.7 Christmas Island Province

These are formed of sand and of coral and shell rubble, often with limestone outcrops. Dolly and West White Beaches are the two largest beaches in the island, while Dolly and Greta Beaches hold sufficient sand to provide habitat for hermit and ghost crabs and to enable green turtles to dig nests (DNP, 2012).

4.4.8 International Waters

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**).

The World Heritage site of Ujung Kulon is also a known site of sandy beaches, as well as the marine national parks of Kepulauan Seribu and Taka Bonerate which are also known as important turtle nesting sites (See **Section 9.8**).

4.5 Rocky Shorelines

Rocky shorelines are found across the combined 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.

The World Heritage site of Ujung Kulon is also known for its coastline of rocky outcrops, among other ecosystems (see **Section 9.8**).

4.6 International Shorelines

The EMBA extends to the Indonesian, West-Timor and Timor-Leste coastline. The coastlines of these countries support a range of habitats and communities, including sand and gravel beaches, rocky shores and cliffs, intertidal mudflats, mangroves, seagrass and coral reefs (Tomascik et al. 1997; Asian Development Bank 2014). The coastal waters provide habitat for a number of protected species, including humphead wrasses, marine turtles, giant clams, some mollusc species, crustaceans, cetaceans (dolphins and whales) and dugongs, and commercially important species of fish, shrimps, and shellfish (Asian Development Bank, 2014). Nearshore waters also support significant capture fisheries (commercial and subsistence) that contribute to the nation’s economy and employment (Asian Development Bank 2014).

5. Fish and Sharks

Fish distributions in the combined 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 combined EMBA, according to the Protected Matters search (**Appendix A**), are shown in **Table 5-1** along with their WA and NT conservation listings (as applicable) and discussed in **Section 5.2** below.

The following WA conservation codes apply to WA conservation significant fauna:

- Threatened species (listed under the *Biodiversity Conservation Act 2016* (WA) (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.

The following NT conservation codes apply to NT conservation significant fauna:

- Threatened wildlife (listed under the Territory Parks and Wildlife Conservation Act 1976 (TPWC Act))
  - Extinct in the wild
  - Critically endangered
  - Endangered
  - Vulnerable
- Protected wildlife (listed under the Territory Parks and Wildlife Conservation Act 1976)
  - Wildlife in a Territory park, reserve, sanctuary, wilderness zone or area of essential habitat
  - Any vertebrate that is indigenous to Australia

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* 2018/2019 (Gaughan *et al.*, 2020).

Table 5-1: EPBC listed fish and shark species in the combined EMBA

Species	Conservation Status				Likelihood of occurrence in EMBA	BIA in EMBA
	EPBC Act 1999	BC Act 2016[1]	Other WA Conservation Code	*TPWC Act 1976*		
Blind gudgeon (*Milyeringa veritas)*	Vulnerable	Vulnerable	-	-	Species or species habitat known to occur within area.	None - No BIA defined
Balstons pygmy perch (*Nannatherina balstoni*)	Vulnerable	Vulnerable	-	-	Species or species habitat likely to occur within area.	None - No BIA defined
Blind cave eel (*Ophisternon candidum)*	Vulnerable	Vulnerable	-	-	Species or species habitat known to occur within area.	None - No BIA defined
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	-	Listed nationally	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)	-	Listed nationally	Foraging, feeding or related behaviour known to occur within area.	Yes – Refer to **Table 5-3**
Northern river shark (*Glyphis garricki)*	Endangered	-	Priority 1	Endangered	Breeding likely to occur within the area.	None - BIA not found in EMBA
Speartooth shark *(Glyphis glyphis)*	Critically Endangered	-	-	Vulnerable	Species or species habitat known to occur within area.	None - BIA not found in EMBA
Dwarf sawfish (*Pristis clavata)*	Vulnerable & Migratory	-	Priority 1	Vulnerable	Breeding known to occur within area.	Yes – Refer to **Table 5-3**

[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	*TPWC Act 1976*		
Freshwater sawfish (*Pristis pristis*)	Vulnerable & Migratory	-	Priority 3	Vulnerable	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	-	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
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 combined EMBA:

- Orange roughy (Hoplostethus atlanticus);
- Southern blue fin tuna (*Thunnus maccoyii*);
- Southern dogfish (Centrophorus zeehaani);
- School shark (*Galeorhinus galeus*); and
- Scalloped hammerhead (*Sphyrna lewini*).

[2] Conservation dependent species are listed species under the EPBC Act and are considered as part of the Commonwealth marine area.

5.1 Regional Surveys

Within the combined 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 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 Southern Province

The demersal fish assemblages inhabiting the shelf break and slope resemble those found on the Southeast Marine Region's continental slope more than those of the Central Western Province. The canyons south of Kangaroo Island and adjacent shelf break appear to be important areas for biological productivity and for spawning and aggregation for a range of marine species, particularly during winter. The Albany Group of submarine canyons south of Albany and Esperance are also considered important for biological productivity that attracts feeding aggregations (DEWHA 2008b).

Scientists have described 463 species of fish on the slope of this bioregion, of which 26 are endemic. Only one extensive study of slope fish communities, undertaken during the late 1980s, has been conducted in this bioregion. There is a lower proportion of bottom-feeding demersal fish in this bioregion compared with the west coast, which appears to relate to greater availability of food such as meso-pelagic fish like myctophids (lantern fish) in the water column. Commercial fish landings taken from the shelf break and down the upper and mid-slope include orange roughy, blue grenadier, Bight redfish, school shark, gummy shark, angel shark, gemfish, deep water flatheads, leatherjackets, latchets, stingrays and stingarees (DEWHA 2008b).

Fisheries scientists and some fishers speculate that species such as blue grenadier and western gemfish may have spawning aggregations amongst the submarine canyons and other prominent geological features rising from the seafloor on the slope adjacent to Esperance and Hopetoun. The Diamantina Fracture Zone represents a unique but virtually unknown region of deep-sea habitat and experts speculate it is highly likely that marine communities in this area comprise unique species with high biodiversity. The physical complexity of numerous troughs and ridges and complex water circulation that occurs in this area support these assertions. A number of KEFs are defined which support enhanced productivity and aggregations of marine life (Section 10) (DEWHA 2008b).

5.1.4 Great Australian Bight Shelf Transition

Of the 600 species of fish occurring in southern Australia, 370 are recorded from South Australian waters (Scott et al. 1980). Species restricted to South Australia that occur in the GAB include the coastal stingaree (*Urolophus orarius*) and the crested threefin (*Norfolkia cristata*.

In South Australia, 77 species of fish are utilised commercially. The main fishes targeted by commercial fishers in the GAB are southern bluefin tuna (*Thunnus maccoyii)*, sardine (*Sardinops sagax*), school shark (*Galeorhinus galeus*), gummy shark (*Mustelus antarcticus*), bronzewhaler shark (*Carcharhinus brachyurus*), snapper *(Pagrus auratus*), King George whiting (*Sillaginodes punctata*) and deepwater species such as deepwater flathead (*Neoplatycephalus conatus*), bight redfish (*Centroberyx gerrardi*), deep sea trevalla (*Hyperoglyphe antarctica*) and orange roughy (*Hoplostethus atlanticus*). Surveys conducted by the CSIRO in the GAB between 1965 and 1989 collected information on species composition, sizes, and distribution patterns of fishes. Surveys were conducted by trolling (1979, 1981) and demersal (1978-81), pelagic (1979) and mid-water trawling (1978, 1980-81). CSIRO also have data from Russian surveys conducted in the GAB in 1965-1974.

Recreational fishers in the GAB target Australian salmon (*Arripis truttacea*), mulloway (*Argyrosomus japonicus*), snapper (*Pagrus auratus*), King George whiting (*Sillaginodes punctata*), Australian herring (*Arripis georgiana*) and yellowtail kingfish (*Seriola lalandi*) (Mcleay et al., 2003; DEWHA, 2008b).

5.1.5 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).

5.1.6 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 9.1.3**).

5.1.7 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).

5.1.8 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.

5.1.9 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 10.1.19**.

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 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).

5.1.11 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.

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											

5.1.12 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).

5.1.13 Timor Transition

Records show that the Timor Transition hosts at least 284 demersal fish species (DEWHA, 2008c). The Timor Transition is also known to have a number of pelagic species that are prominent in the open water environment, including some which also have pelagic larval stages in the area (DEWHA, 2008c). The North Marine Bioregional Plan Profile specifically describes pelagic species found within the trough of the Timor Transition including snaggle-teeth fish, hatchet fish and lantern fish (DEWHA, 2008c). The soft-edge/slope of the Timor Transition is also known to support whale sharks and threadfin fish species, with the canyons and channels having distance genetic stocks of red snapper (DEWHA, 2008c).

5.1.14 Northern Shelf Province

Records of the fish species in the Northern Shelf Province show that the majority of available information shows an abundance of fish species in the Gulf of Carpentaria, which is outside the combined EMBA. However, other fish species, including sharks and sawfish are known to occur within the estuarine waters and coastal waters of the Northern Shelf Province (DEWHA, 2008c).

Within the combined EMBA, the Arafura Shelf supports a number of submerged reefs that are used for breeding and aggregation of a number of fish species including mackerel, mangrove jack and snapper (DEWHA, 2008c). Sea snakes and shark species have also been observed in the reef areas (DEWHA, 2008c). Furthermore, the Canyons of the Arafura Depression key ecological feature, which is also within the combined EMBA, is specifically identified as attracting aggregations of predatory fish, whale sharks and sawfish (DEWHA, 2008c).

5.1.15 Christmas Island Province

The Christmas Island Province is in deep, offshore waters (2,200 m – 6,000 m depth range). The island's predominantly intact fringing reefs and adjacent waters support a number of marine and coastal ecosystems and species, including over 600 fish species, with most being typical of the Indian Ocean region. 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)*. The island has more than 50 reef fish species that are not found anywhere else in Australia (although some species may also occur at the neighbouring Cocos Islands) (DNP, 2014).

5.1.16 Cocos (Keeling) Islands Province

The bulk of fish species are widespread or Indo-west Pacific in origin, which points to the significance of the Indonesian Throughflow current in delivering larval recruits to the island. About two thirds of fish species are shared with Christmas Island. A range of pipefish (syngnathidae) have been sighted in with eight identified at the Cocos (Keeling) Islands. This list is biased towards the shallow habitats where data has been collected by divers. There are likely to be more species occurring in these territories than recorded (e.g. in deeper water, on seamounts, slopes etc) (Brewer et al 2009).The province has an intermediate level of primary productivity due to the distance from upwelling events such as those associated with the Java coast. However, the shallower seamounts would be likely to have some significant upwelling or associated with them, which in turn will produce increased productivity and populations of pelagic fish such as bigeye (*Thunnus obesus*) and yellowfin tuna (*T. albacares*).

5.2 Fish Species

Four species of fish listed as Threatened under the EPBC Act (**Table 5-1**) were identified in the Protected Matters search (**Appendix A**):

- Balston's pygmy perch (*Nannatherina balstoni*);
- 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 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 five species of shark and three species of sawfishes listed as threatened within the search area between south west WA and northern NT (**Table 5-1**), including:

- Grey nurse shark (*Carcharias taurus*);
- Great white shark (*Carcharodon carcharias*);
- Northern river shark (*Glyphis garricki*);
- Whale shark (*Rhincodon typus*);
- Speartooth shark (Glyphis glyphis);
- 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 5-1).**

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 combined 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 combined 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 combined EMBA are detailed in **Table 5-3** and is shown on **Figure 5-1** (DoEE 2019b).

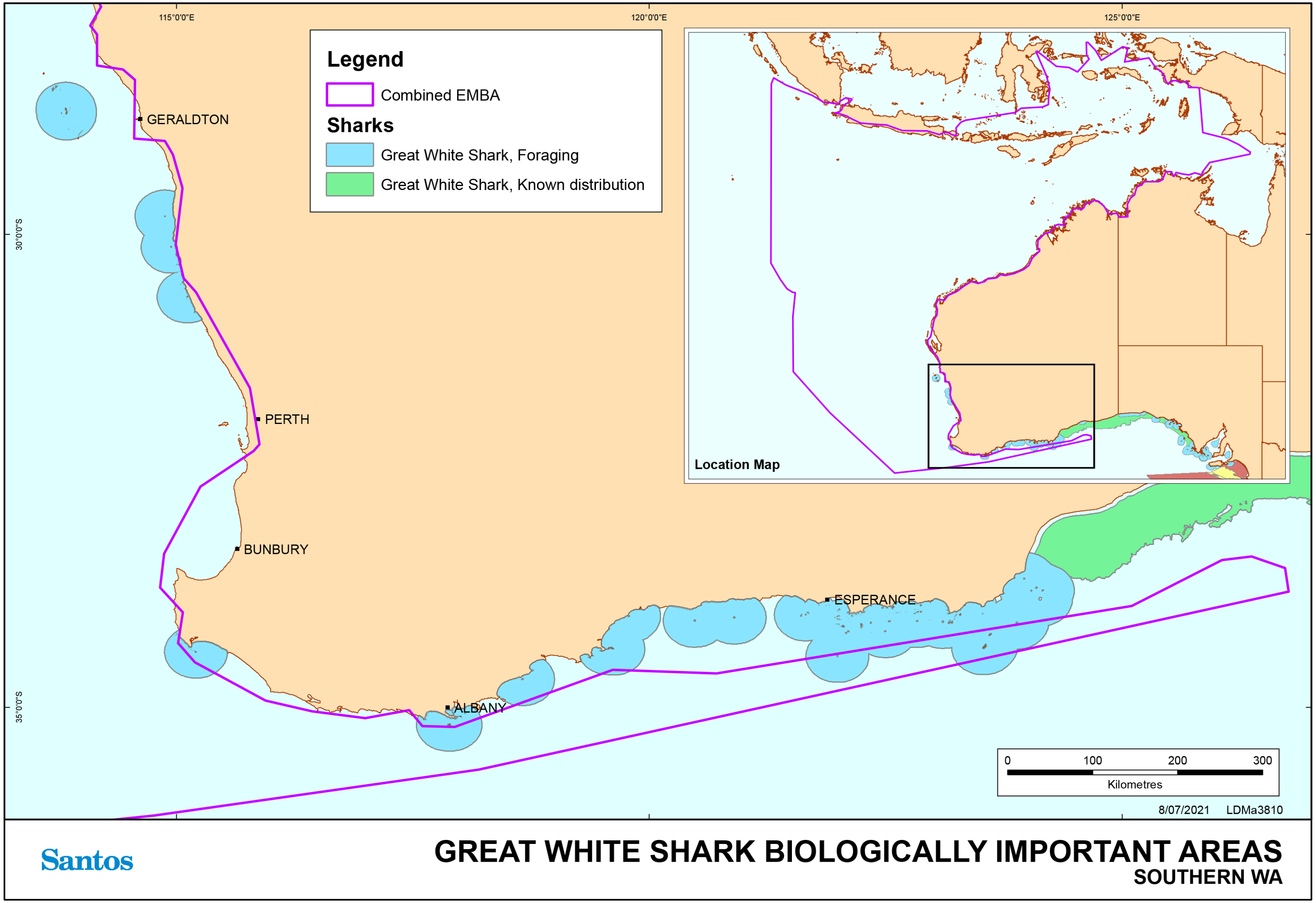

Figure 5-1: Biologically important area – great white shark

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 and as Endangered under the NT *Territory Parks and Wildlife Conservation Act 1976*.

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, NT Territory Parks and Wildlife Conservation Act 1976* 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). Whale sharks are well known to occur in the Christmas Island territory. There is evidence that the Christmas Island territory is on the migration route for many individuals, but they are rarely sighted within the Cocos (Keeling) Islands territory.

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 combined 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).*

5.3.5 Speartooth Shark

The speartooth shark (*Glyphis glyphis)* is a medium sized shark found in tidal rivers and estuaries within the Northern Territory and Queensland (DAWE, n.d). It is listed as critically endangered under the EPBC Act and Vulnerable under the NT *Territory Parks and Wildlife Conservation Act 1976.*

There are three distinct geographical locations where the speartooth shark is known to occur with only one of these areas within the combined EMBA, the Van Diemen Gulf.

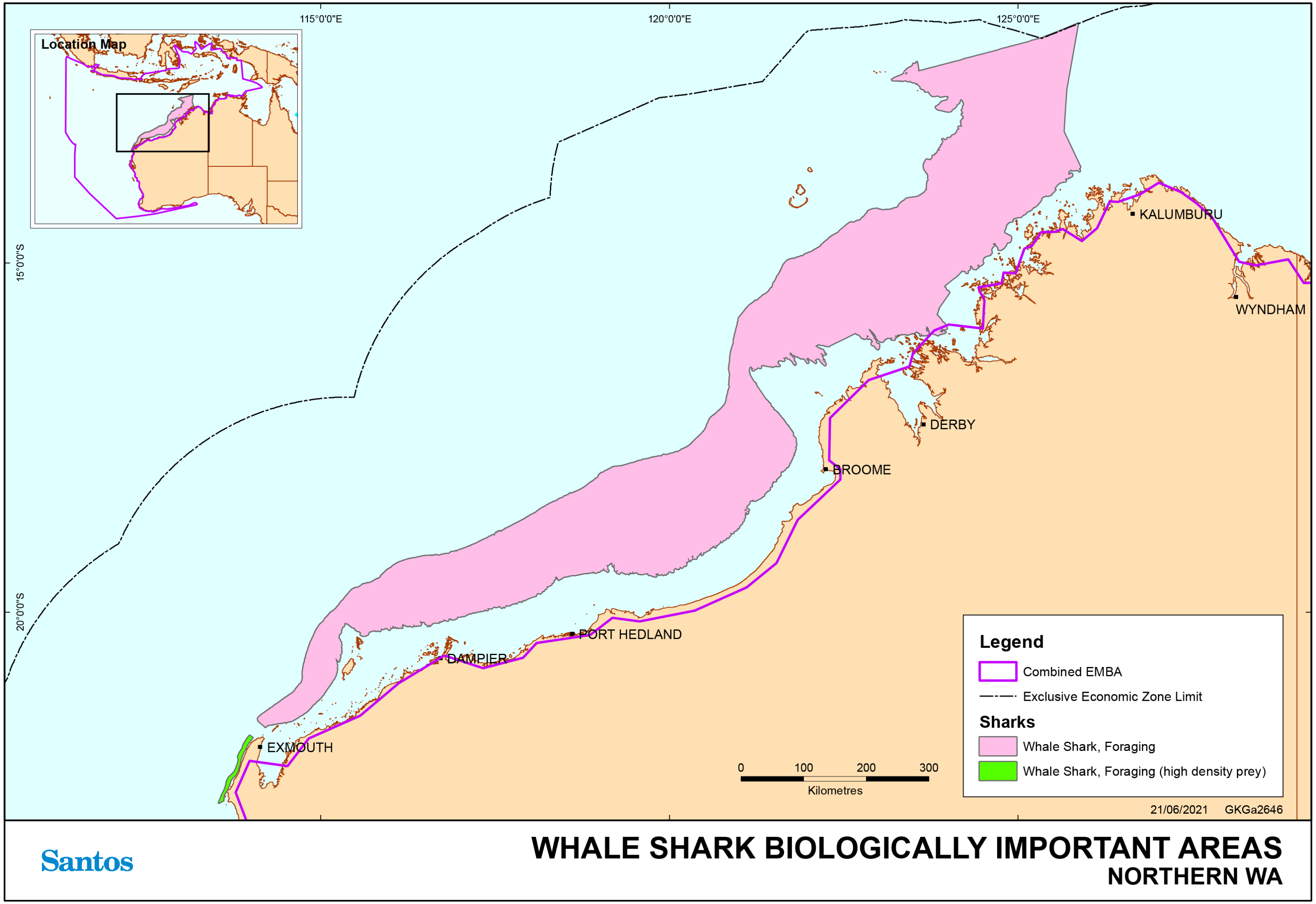

Figure 5-2: Biologically important area – whale shark

5.3.6 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 and as Vulnerable in the NT. 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 and the NT 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 combined EMBA are detailed in **Table 5-3** and are shown on **Figure 5-3**.

5.3.7 Freshwater and Green Sawfish

The freshwater sawfish (*Pristis pristis) (*also previously listed as the Largetooth sawfish*)* and green sawfish (*Pristis zijsron)* are 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 and both species are listed as Vulnerable in the NT under the *Territory Parks and Wildlife Conservation Act 1976.*

The freshwater 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 combined EMBA are detailed in **Table 5-3** and are shown on **Figure 5-3**.

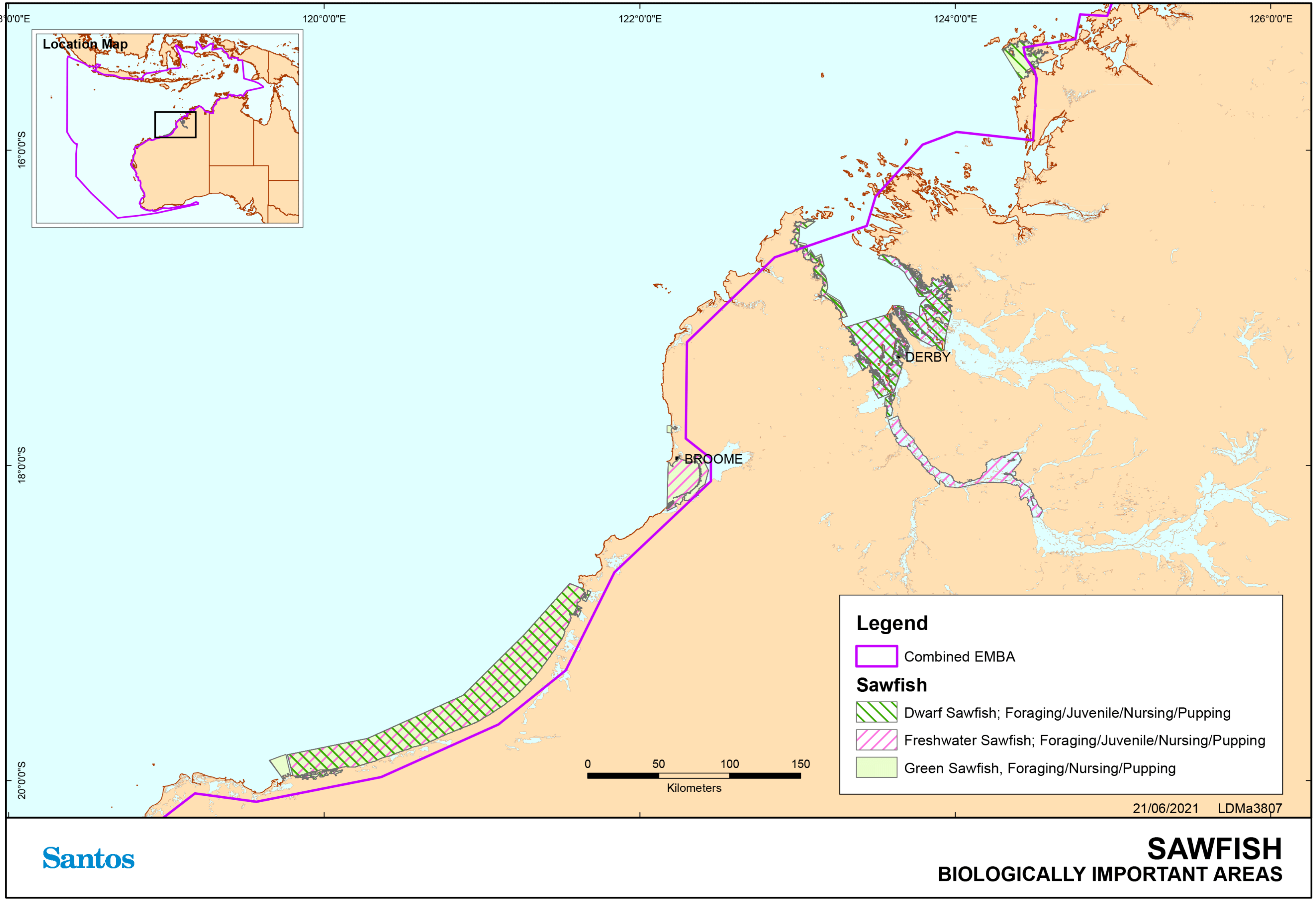

Figure 5-3: Biologically important areas – sawfish

5.3.8 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).

5.3.9 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.

5.3.10 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).

5.3.11 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.

5.3.12 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 combined 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. No provision is made under the Territory Parks and Wildlife Conservation Act 1976 for listing critical habitat.

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

6. Marine Reptiles

Thirty-four species of listed marine reptiles under the Commonwealth EPBC Act are known to occur in Australian waters in the combined 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 combined 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 and NT conservation listings (as applicable)[3]. BIAs within the combined EMBA area discussed in **Table 6-3**.

Table 6-1: EPBC listed marine reptile species in the combined EMBA

Species	Conservation Status				Likelihood of occurrence in EMBA	BIA in EMBA
	EPBC Act 1999	BC Act 2016	Other WA Conservation Code	*TPWC Act 1976*		
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	-	Vulnerable	Breeding known to occur within area	Yes – refer to **Table 6-3**
Loggerhead turtle (*Caretta caretta*)	Endangered Migratory	Endangered	-	Vulnerable	Breeding known to occur within area	Yes – refer to **Table 6-3**
Olive ridley turtle (*Lepidochelys olivacea*)	Endangered Migratory	Endangered	-	-	Breeding known to occur within area	Yes – refer to **Table 6-3**
Leatherback turtle (*Dermochelys coriacea*)	Endangered Migratory	Vulnerable	-	Critically Endangered	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	*TPWC Act 1976*		
					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
Salt-water crocodile *(Crocodylus porosus)*	Migratory	Specially protected species (other specially protected fauna)	-	-	Species or species habitat likely 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 and around the combined EMBA. 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 and the hawksbill turtle, loggerhead turtle and leatherback turtle are also protected under the NT *Territory Parks and Wildlife Conservation Act 1976.*

A summary of the different habitat types used during the various life stages of marine turtle species identified in the combined 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 combined 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). Loggerhead turtles have also been sighted in the Christmas and Cocos (Keeling) Islands. 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).

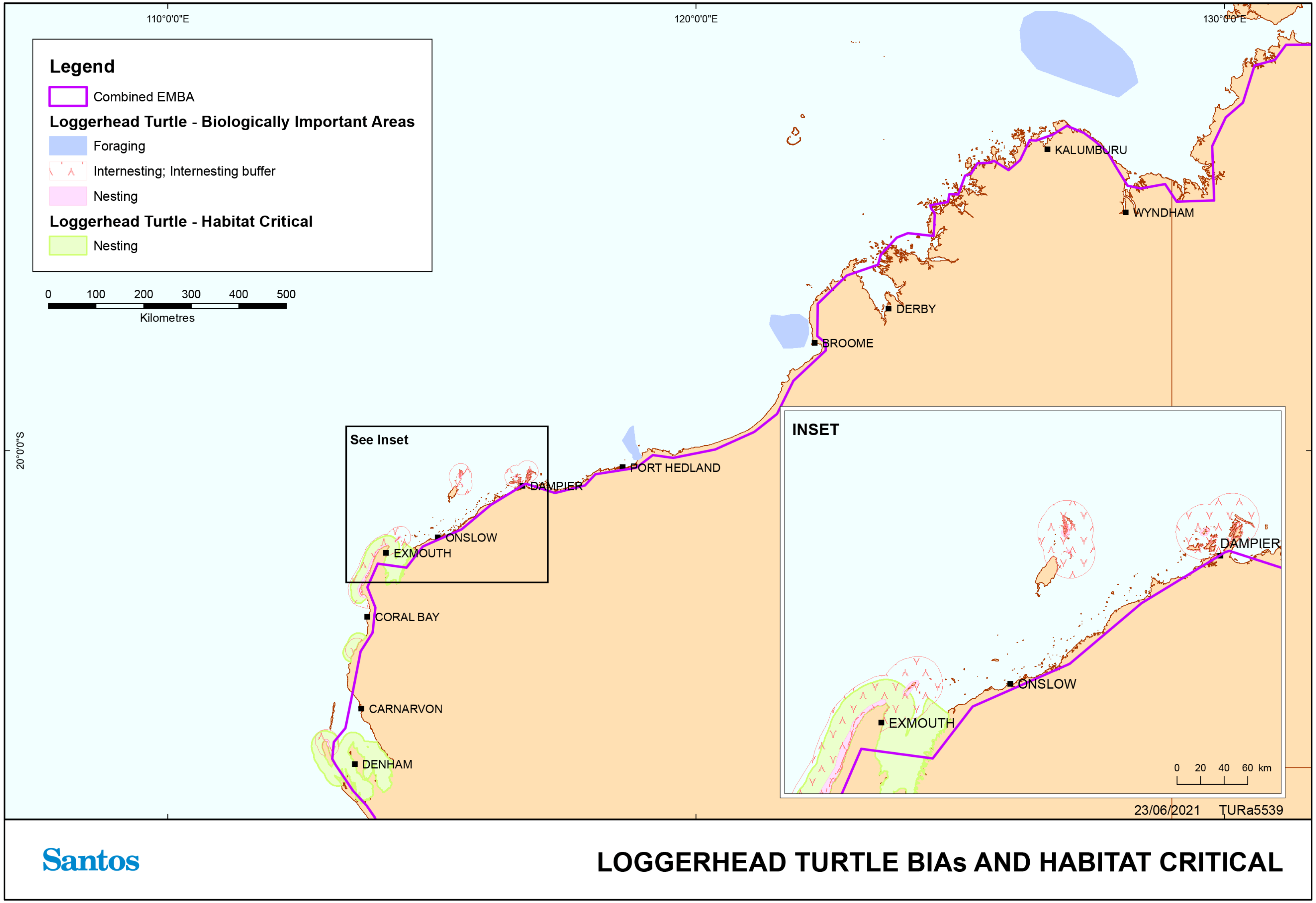

Figure 6-1: Biologically Important Areas and Habitat Critical – Loggerhead Turtle

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 and NT 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 turtles have also been recorded nesting in the Bonaparte or Van Diemen Gulf bioregions and some nesting has been recorded on the west coast of Bathurst Island in the Tiwi Islands and Melville Island. BIAs for Green turtles occur on the north coast of the Tiwi Islands and an internesting buffer has been defined 20 km from the Tiwi Islands with internesting expected between October and April (DoEE, 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).

In northern and eastern Australia, fluctuations in green nesting numbers have been linked the Southern Oscillation Index (Limpus & Nicholls, 1994, Limpus & Nicholls, 1988) and sea surface temperatures (Solow et al., 2002). In the NT nesting sites occur mostly from the western end of Melville Island to near the border with Queensland (Northern Territory Government, n.d). There are also four nationally significant nesting sites in the NT being the Cobourg Peninsula, the mainland from Gove to the northern edge of Blue Mud Bay, the southeast of Groote Eylandt and the northern beaches of islands in the Sir Edward Pellew group (Northern Territory Government, n.d). The Cobourg Peninsula genetic stock of Green turtles is the closest to those found within the combined EMBA on the Tiwi Islands. The nesting period for these are between October and April with the peak nesting period occurring between December and January.

Green turtles nest on both Christmas and Cocos (Keeling) Islands, though in low densities on Christmas Island. Up to 100 green turtles nest per year on Cocos (Keeling) Islands, mainly on the north atoll. Green turtles nesting on both Christmas and Cocos (Keeling) Islands are likely to be unique genetic stocks. They also use shallow reef habitats on both islands to forage (Brewer et al, 2009).

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).

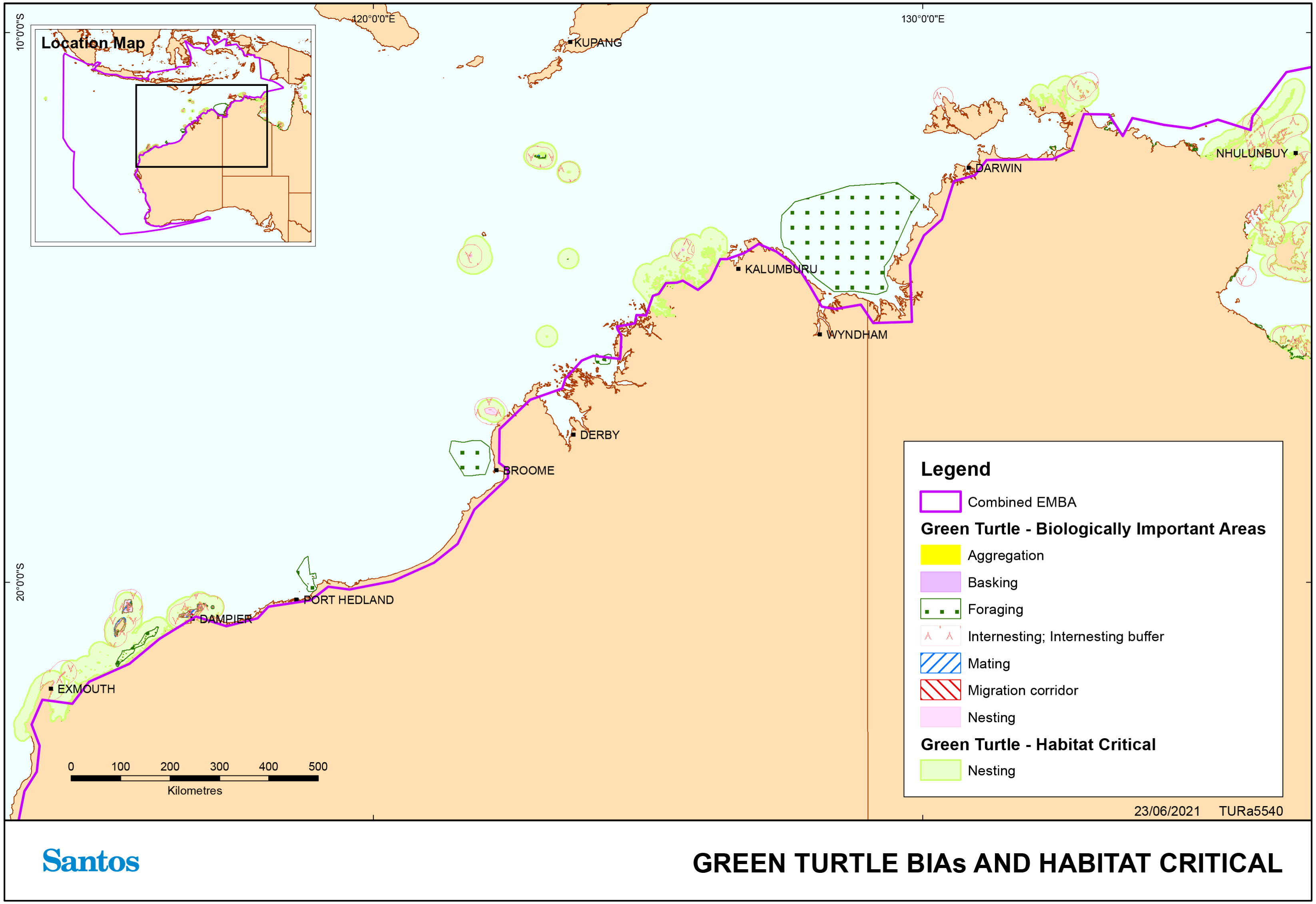

Figure 6-2: Biologically Important Areas and Habitat Critical – Green Turtle

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). There is a second major population of Hawksbill turtles in Australia, which is genetically isolated from the North West Shelf population located along the Northern Territory coast and north-eastern Queensland (Northern Territory Government, n.d).

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. Recent baseline data was collected at the Montebello and Dampier AMPs by Keesing, 2019 showing that only one hawksbill turtle was identified during the survey at the Dampier AMP only. No marine turtle species were identified during the survey at Montebello AMP.

In the NT, nesting occurs on islands rather than on mainland beaches. In particular, NT nesting sites are concentrated around north-eastern Arnhem land and Groote Eylandt (Northern Territory Government, n.d). Within the combined EMBA, nesting is known to occur at Ashmore Reef. Although Scott Reef has been described as a nesting beach for hawksbill turtles, this is based on the tagging and recapture of a single hawksbill at this location (Guinea, 2009). Small numbers of Hawksbill turtles also nest on Cocos (Keeling) Islands (mainly the north island). However, thousands of individuals forage in the shallow reef environments feeding on encrusting algae and sessile invertebrates (Brewer et al , 2009).

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). In the NT nesting is reported to occur from July – December (Chatto, 1997, 1998).

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).

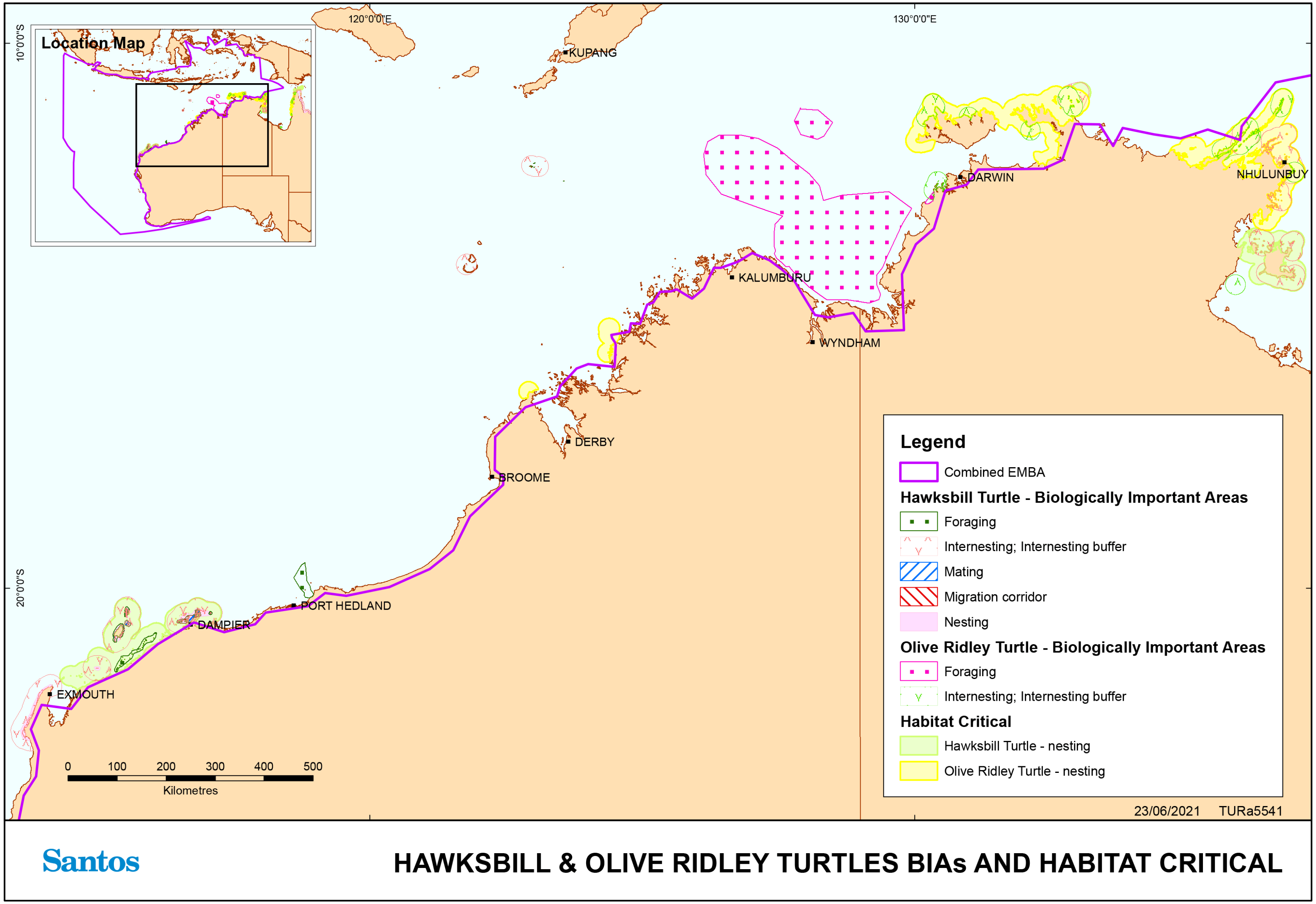

Figure 6-3: Biologically Important Areas and Habitat Critical – Hawksbill and Olive Ridley Turtle

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. Populations in western NT are thought to nest all year round with nesting density reaching its peak in July. Populations in northern Australia also nest all year round, with nesting density reaching its peak between June and August (Limpus, 2007).

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). NT populations are typically found in the Gulf of Carpentaria, western Torres Strait, Wellesley Islands Group and Sand Islet.

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).

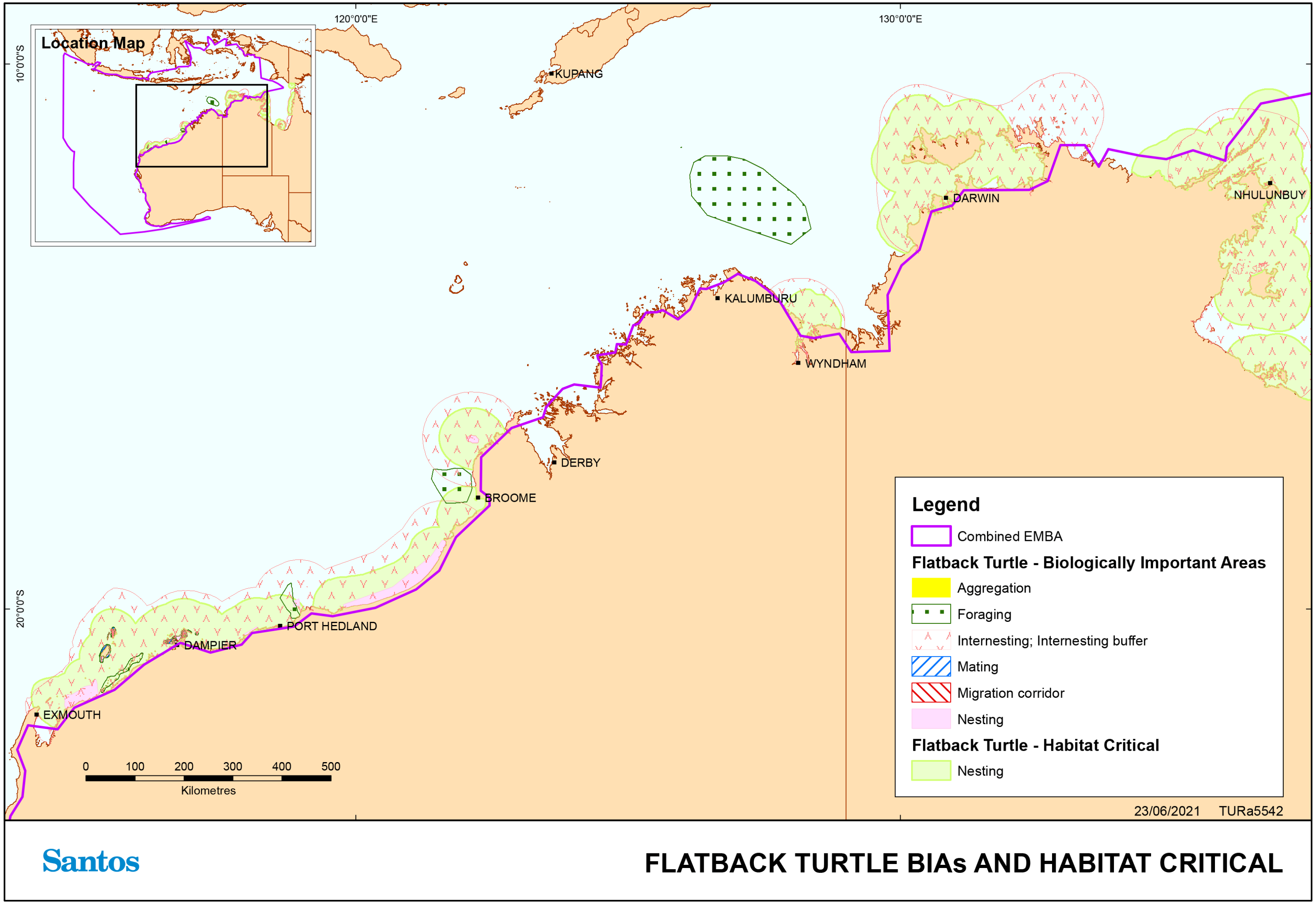

Figure 6-4: Biologically Important Areas and Habitat Critical – Flatback Turtle

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 and NT, 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 combined 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). They are also known to nest on Tiwi Islands, specifically on the west coast of Bathurst Island and the north coast of Melville Island. The turtles found nesting on the Tiwi Islands is the NT genetic stock whereby the long-term trends of this genetic stock are currently unknown (Commonwealth of Australia 2017). However, the number of females nesting on the Tiwi Islands are considered significant at the genetic stock, national and international level. Nesting of the NT genetic stock can occur year-round with a peak between April and June, and hatchling emergence peaking between June and August (Commonwealth of Australia, 2017).

Internesting habitat, critical to the survival of the olive ridley turtle, encompasses nearshore waters along the north, west and east coasts of the Tiwi Islands. Satellite tracking on a small sample of internesting olive ridley turtles in the region recorded that the individuals remained close to shore (waters depths typically less than 55 m deep) and within 37 km of the nesting beach during the internesting interval (Whiting et al. 2007, Whiting et al. 2005).

This species forages within the shallow benthic habitats of northern WA and the NT 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 and have also been sighted in the Christmas and Cocos (Keeling) Islands in the north of the combined EMBA.

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 combined 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 of WA and NT waters (**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). The limited evidence available suggests that there are no sea snakes in at least the coastal waters of Cocos (Keeling) Islands, and few sea snake sightings in the waters of the Christmas Island territory (Brewer *et al,* 2009).

Two species of seasnakes listed as threatened under the EPBC Act were identified in the Protected Matters search within the combined 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).

In the NT salt-water crocodile has been found in the Mary, Adelaide, Daly, Moyle, Victoria, Finniss, Wildman, West Alligator, East Alligator, South Alligator, Liverpool, Blyth, Glyde, Habgood, Baralminar, Goromuru, Cator and Peter John Rivers with a total 79 individuals per km identified in these river systems (Fukuda, 2007).

6.4 Biologically Important Areas/Habitat Critical – Marine Reptiles

Table 6-3 provides an overview of BIAs in the combined 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].

[4] Further background information on BIA and identification of critical habitat in recovery plans is provided in **Section 5.4**.

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. No provision is made under the Territory Parks and Wildlife Conservation Act 1976 for listing critical habitat.

Santos

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 North-west of Melville Island	
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 Island 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) New Year Island 20 km internesting buffer

Species	Scientific name	Aggregation area and use	BIAs within EMBA	Habitat Critical within EMBA
Flatback turtle	*Natator depressus*	Nesting, migration, mating, aggregation, foraging, internesting – Islands of the North West Shelf and the Pilbara/Kimberley coastlines Mating, nesting – Barrow Island	Eighty Mile beach Barrow Island Cape Domett Cape Thouin/ Mundabullangana/ Cowrie Beach Coral reef habitat west of the Montebello group. Extends the entire length of Montebellos Dampier Archipelago (islands to the west of the Burrup Peninsula) De Grey River area to Bedout 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	Cape Domett and Lacrosse Island Lacepede Islands Eighty Mile beach Cemetary beach Eco Beach Mundabullangana Beach Dampier Archipelago Barrow Island, Montebello Island, coastal islands from Cape Preston to Locker Island Soldier Point to Pirlangimpi including Seafull Island 60 km internesting buffer Brace point to One Tree Point, including all offshore islands 60 km internesting buffer Waigait Beach to south of Point Blaze, including all offshore islands 60 km internesting buffer.

Species	Scientific name	Aggregation area and use	BIAs within EMBA	Habitat Critical within EMBA
			Western Joseph Bonaparte Depression Melville Island, Cobourg Peninsula	
Leatherback turtle	*Dermochelys coriacea*	None within EMBA	None within EMBA	All sandy beaches from Coburg Peninsula to Cape Arnhem including Danger Point and Elcho Island 20 km internesting buffer
Olive ridley turtle	*Lepidochelys olivacea*	Foraging, migration – Joseph Bonaparte Gulf – Kimberley region	Western Joseph Bonaparte Depression Northern Joseph Bonaparte Gulf	Cape Leveque Prior Point and Llanggi Darcy Island Vulcan Island Soldier Point to Pirlangimpi including Seafull Island 20 km internesting buffer Brace Point to One Tree Point, including all offshore islands 20 km internesting buffer Croker Island, Coburg Peninsula, west of Murganella to the West Alligator River 20 km internesting buffer

7. Marine Mammals

Forty-four species of listed marine mammals are known to occur in Australian waters in the combined 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 combined 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 and *Territory Parks and Wildlife Conservation Act 1976* (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**.

In addition, the New Zealand fur-seal *(Arctocephalus forsteri)*, has been identified as a species of relevance to the combined 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.

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	TPWC Act 1976		
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 Migration route 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

Species	Conservation Status				Likelihood of occurrence in EMBA	BIA in EMBA
	EPBC Act 1999 (Cwth)	BC Act 2016 (WA)	Other WA Conservation Code	TPWC Act 1976		
Killer whale *(Orcinus orca)*	Migratory	-	-	-	Species or species habitat may occur within area	None - No BIA defined
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 known 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**

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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 combined 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 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). A noise monitoring study conducted in 2014-15 recorded pygmy blue whales moving in a northward direction in August 2014 and between late-May to early July 2015 (JASCO Applied Sciences, 2016; McPherson, Craig et al., 2015). 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). No detections of the species were made during the period of their southward migration during the noise monitoring study.

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 combined 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.

The BIAs for blue whale and pygmy blue whale are detailed in **Table 7-3** and depicted in **Figure 7-2** and **Figure 7-1.**

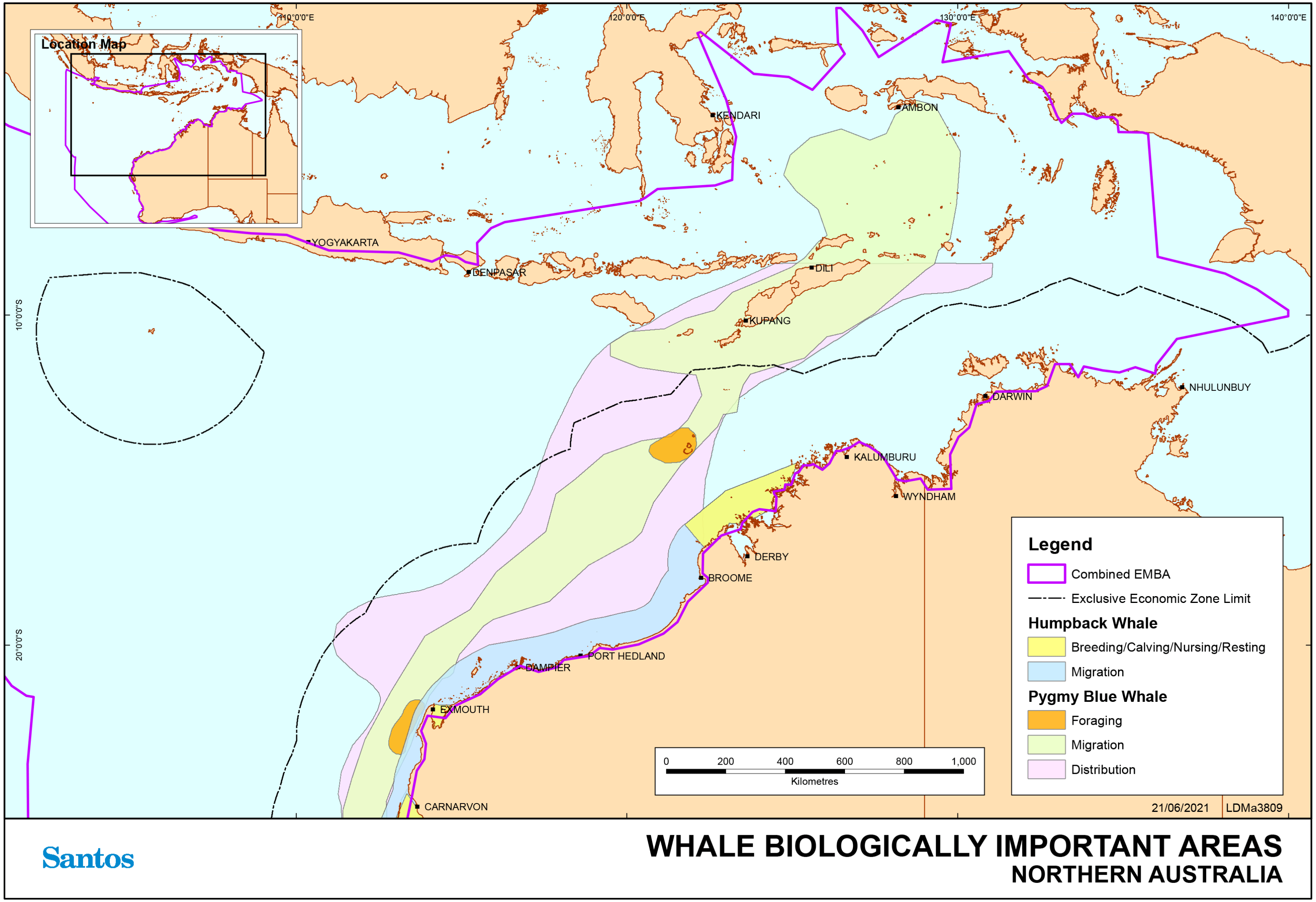

Figure 7-1: Biologically important areas – whales – Northern WA

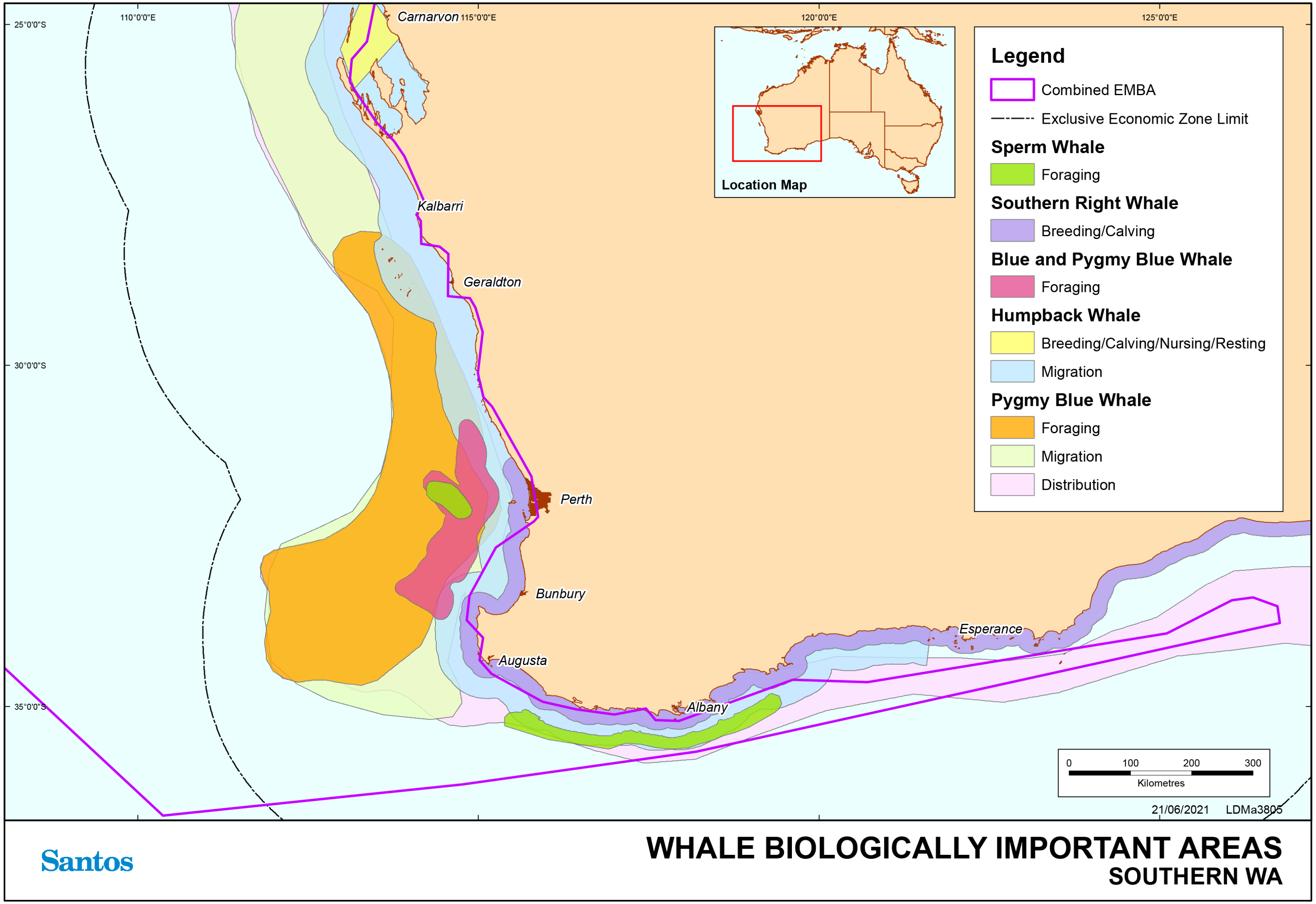

Figure 7-2: Biologically important areas – whales – Southern WA

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 7-2** and **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).

Humpback whale populations have increased since being placed on the threatened species list for exploitation from whaling, resulting in a higher abundance of species off our Western Australian coastline. Humpback whales have been able to thrive and increase in numbers despite the heavy oil and gas exploration. A study presented by Bejder et al (2016) has prompted a review of the species being down listed under Commonwealth legislation and regulations, as they are not eligible for listing as a threatened species under all statutory criteria.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; Irvine et al., 2018). 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). Woodside have conducted aerial surveys that have confirmed that the reported distribution of migrating humpback whales off the North West Cape is consistent with baseline surveys first conducted in 2000 to 2001 (RPS, 2010 in Woodside 2020).

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 7-2** and **Figure 7-1**.

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 7-2** and **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 combined 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 shallower coastal areas. Killer whales are known to make seasonal movements and are most likely to follow the migratory routes of their prey, however, little is known about these movements (DoEE, 2019). They are more likely to be observed around seal colonies, with a significant seal colony within the combined EMBA being located in WA at the Abrolhos Islands.

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 combined 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 combined 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 combined 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.

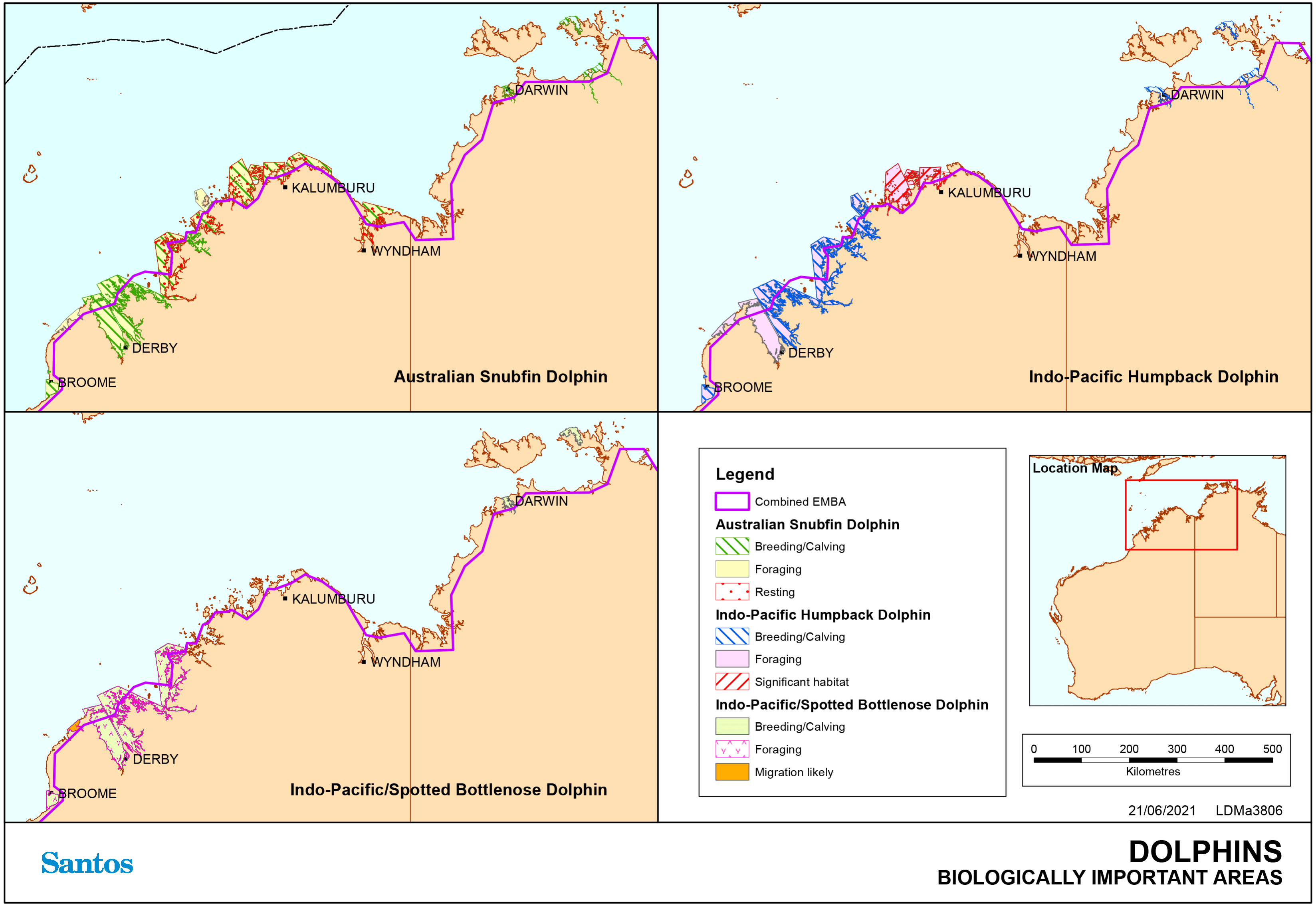

Figure 7-3: Biologically important areas – dolphins

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 (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 combined EMBA is outlined in **Table 7-3** and is depicted in **Figure 7-4.**

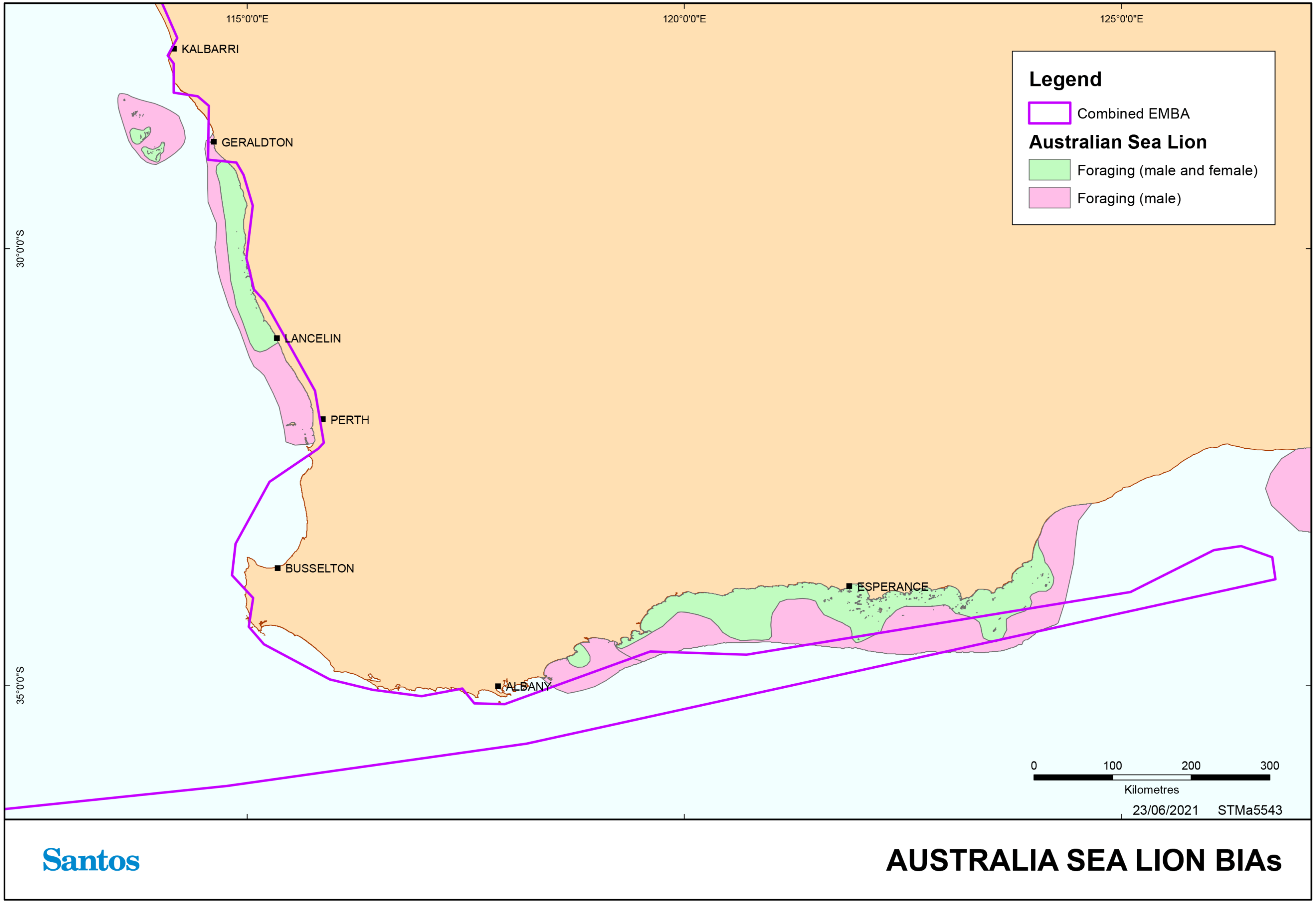

Figure 7-4: Biologically important areas – Australian sea lion

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, and the north coast of the Tiwi Islands is recognised as a key site for the conservation of dugongs. A well-known major dugong aggregation of approximately 4, 400 individuals occurs in waters seaward (within approximately 50 km) of the Tiwi Islands and ranks in the top eight of dugong populations in the world.

Dugong distribution and movement is based on the abundance, size and species of seagrass meadow. Dugongs can migrate hundreds of kilometres between seagrass habitats. Dugongs have been tracked moving long distances of up to 300 km between the Australia mainland and the Tiwi Islands (Whiting et al., 2009). Satellite-tracking data from dugongs tagged as part of the INPEX Ichthys Project baseline surveys observed that dugongs around the Vernon Islands, south of Melville Island, spent time in Darwin Harbour and around the Tiwi Islands (INPEX, 2010). Routine sightings occur in various locations along the NT coastline, including within Darwin Harbour, to the south of Melville Island.

Dugongs in the NT coastal waters have been observed foraging in intertidal rocky reef flats supporting sponges and algae as seagrass habitat is thought to be rare in the north marine region bioregion (INPEX, 2010; Whiting et al., 2009). However, seagrass communities are known to exist along the north coast of the Tiwi Islands.

The dugong BIAs in the combined 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]

[5] Identified as a relevant species through review of *Biodiversity Conservation Act 2016* listed species for marine species without an EBPC Act listing.

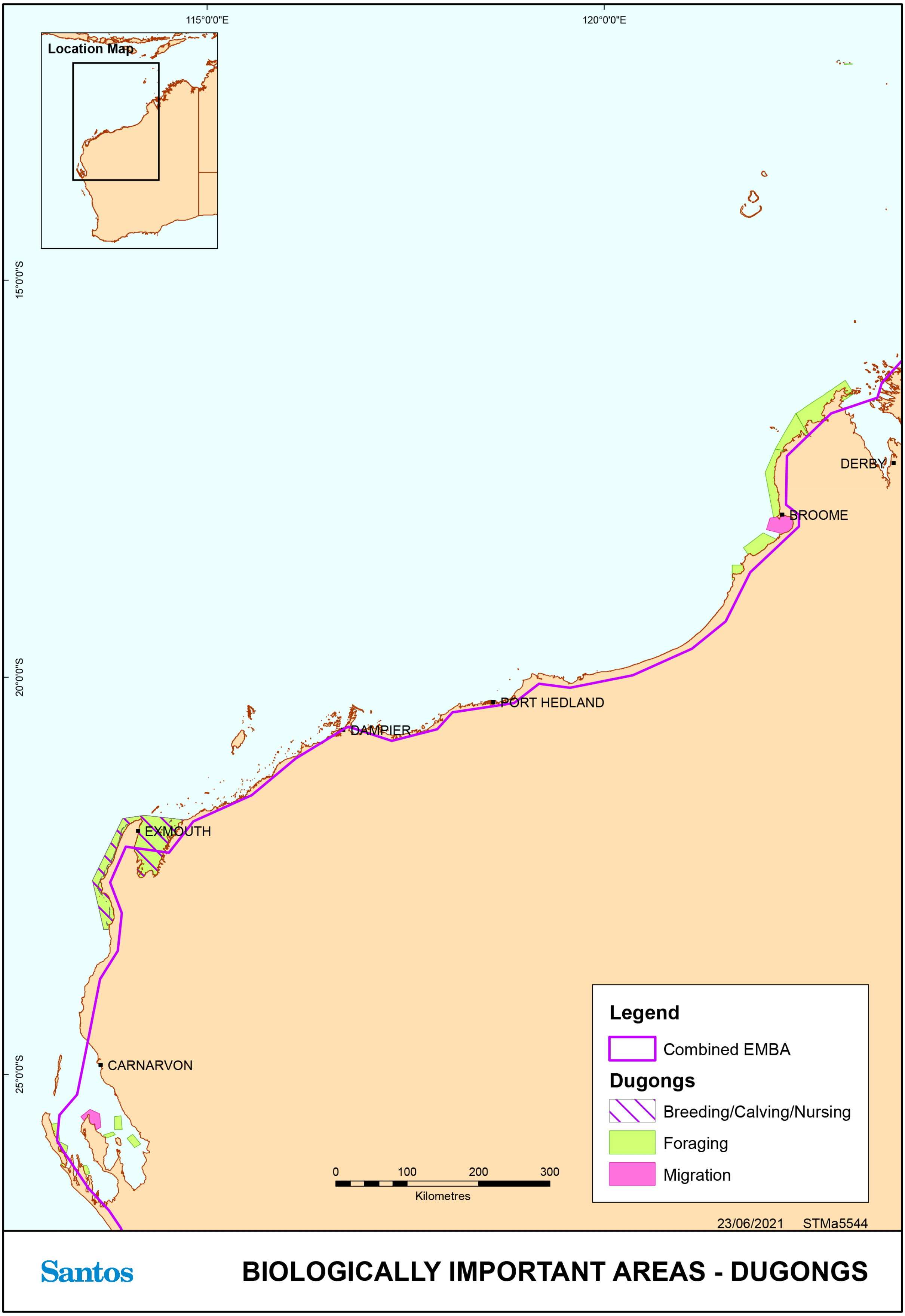

Figure 7-5: Biologically important areas – dugongs

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 combined 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. No provision is made under the Territory Parks and Wildlife Conservation Act 1976 for listing critical habitat.

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 Distribution – along the WA coastline towards and beyond Indonesia.	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

[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
			Scott Reef
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

Species	Scientific name	Aggregation area and use	BIAs within EMBA
			Willie Creek
Indo-Pacific/spotted bottlenose dolphin	*Tursiops aduncus*	Breeding, calving, foraging – Kimberley coastal waters and islands Migration – Pender Bay	Camden Sound Area - Walcott Inlet, Doubtful Bay, Deception Bay, Augustus Island (Kuri Bay) King Sound North and Yampi Sound and Talbot Bay Fjord area near Horizontal Falls King Sound Southern Sector Pender bay Roebuck Bay
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	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

Species	Scientific name	Aggregation area and use	BIAs within EMBA
		Breeding/calving/nursing – Exmouth and the Ningaloo coastline	Exmouth Gulf Kimberley coast, Dampier Peninsula Middle Island, Kimberley coast North East Peron Peninsula, Shark Bay North of Faure Island, Shark Bay Pilbara and Kimberley coast near Dampier Peninsula Pilbara and Kimberley coast near James Price Point Roebuck Bay, Broome South Passage, Shark Bay Useless Loop, Shark Bay

8. Birds

Marine waters and coastal habitats in the combined 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 9.1.3**.

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 breeding 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 combined EMBA identified 33 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 combined 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 and NT conservation status (as applicable), and discussed below. There are an additional 51 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**.

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	*TPWC Act 1976*		
Shorebirds						
Red knot (Calidris canutus)	Endangered, Migratory	Endangered	-	Vulnerable	Species or species habitat known to occur within area	None - No BIA defined
Christmas Island Goshawk (*Accipiter fasciatus natalis*)	Endangered	Endangered	-	-	Species or species habitat known to occur within area	None - No BIA defined
Curlew sandpiper (*Calidris ferruginea*)	Critically endangered, Migratory	Critically endangered	-	Vulnerable	Species or species habitat known to occur within area	None - No BIA defined
Great knot (*Calidris tenuirostris)*	Critically endangered, Migratory	Critically endangered	-	Vulnerable	Roosting known to occur within area	None - No BIA defined
Greater sand plover (*Charadrius leschenaultii)*	Vulnerable, Migratory	Vulnerable	-	Vulnerable	Roosting known to occur within area	None - No BIA defined
Lesser sand plover (*Charadrius mongolus)*	Endangered, Migratory	Endangered	-	Vulnerable	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]	-	Vulnerable	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]	-	Vulnerable	Species or species habitat known to occur within area	None - No BIA defined
Eastern curlew (*Numenius madagascariensis)*	Critically endangered, Migratory	Critically endangered	-	Vulnerable	Species or species habitat known to 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	*TPWC Act 1976*		
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	-	Vulnerable	Species or species habitat may occur within area	None - No BIA defined
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

Species	Conservation Status				Likelihood of occurrence in EMBA	BIAs in EMBA
	EPBC Act 1999	BC Act 2016	Other WA Conservation Code	*TPWC Act 1976*		
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**
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**

Species	Conservation Status				Likelihood of occurrence in EMBA	BIAs in EMBA
	EPBC Act 1999	BC Act 2016	Other WA Conservation Code	*TPWC Act 1976*		
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
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 combined 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 combined 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).

Christmas Island Goshawk

The Christmas Island Goshawk is considered to be the rarest endemic bird on Christmas Island, where it occurs in all habitats from primary and marginal rainforests to suitable areas of secondary regrowth vegetation. The total population size is thought to be very small, perhaps as few as 100 adults, and is probably limited by the availability of suitable rainforest habitat.

Crazy Ants pose an unknown but potentially critical threat to the survival of this bird. The National recovery plan for the Christmas Island Goshawk (*Accipiter fasciatus natalis*) aims to downgrade the Christmas Island Goshawk from Endangered to Conservation Dependent, primarily through successful implementation of the Invasive Ants on Christmas Island Action Plan and protection of habitat critical to the survival of the species from clearance. An assessment of goshawk population dynamics is the most essential requirement of this recovery plan, and community awareness and participation in the conservation of this endemic raptor are also important actions.

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 combined 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.

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 combined 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 combined EMBA.

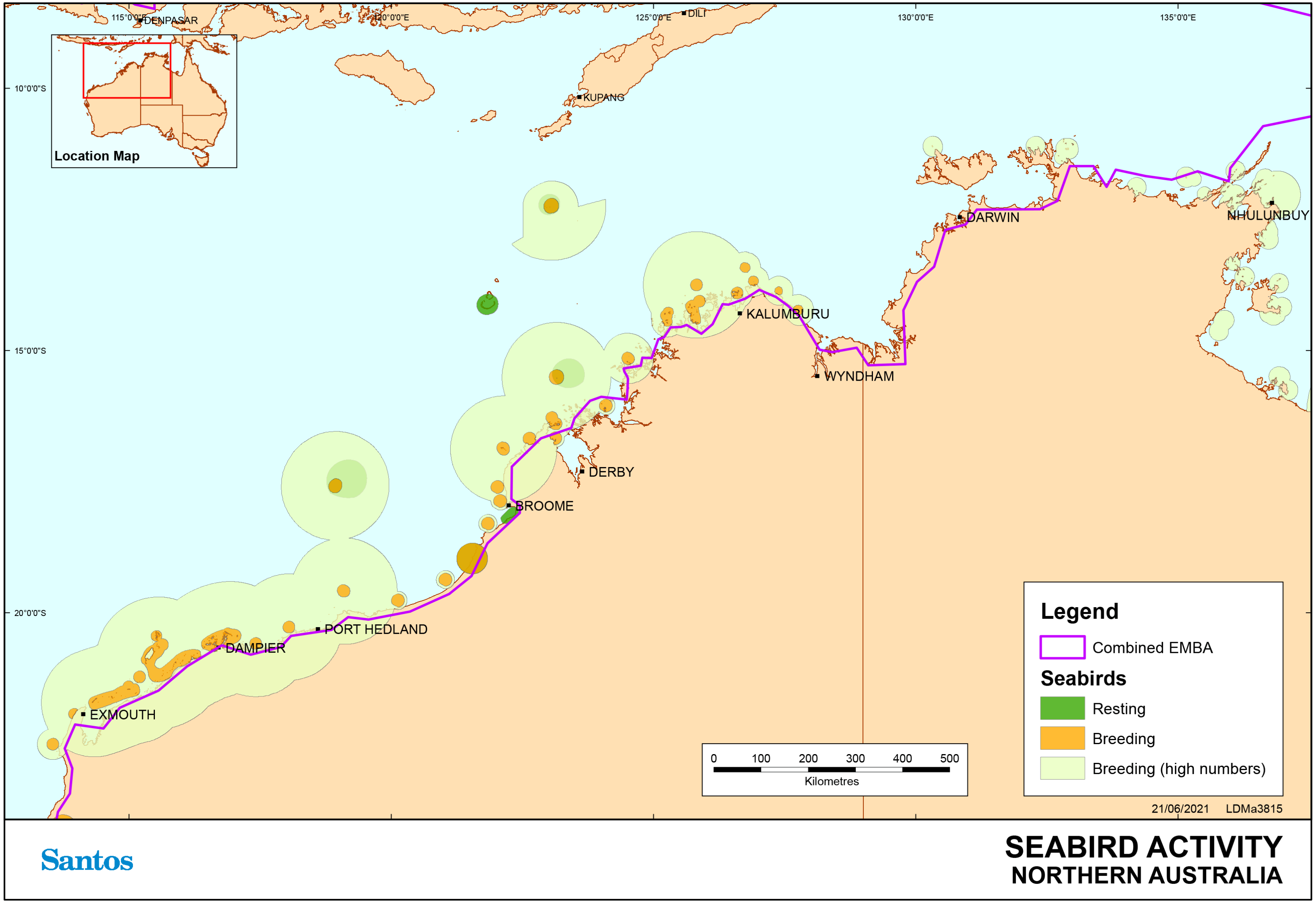

Figure 8-1: Biologically important areas – birds – Northern WA

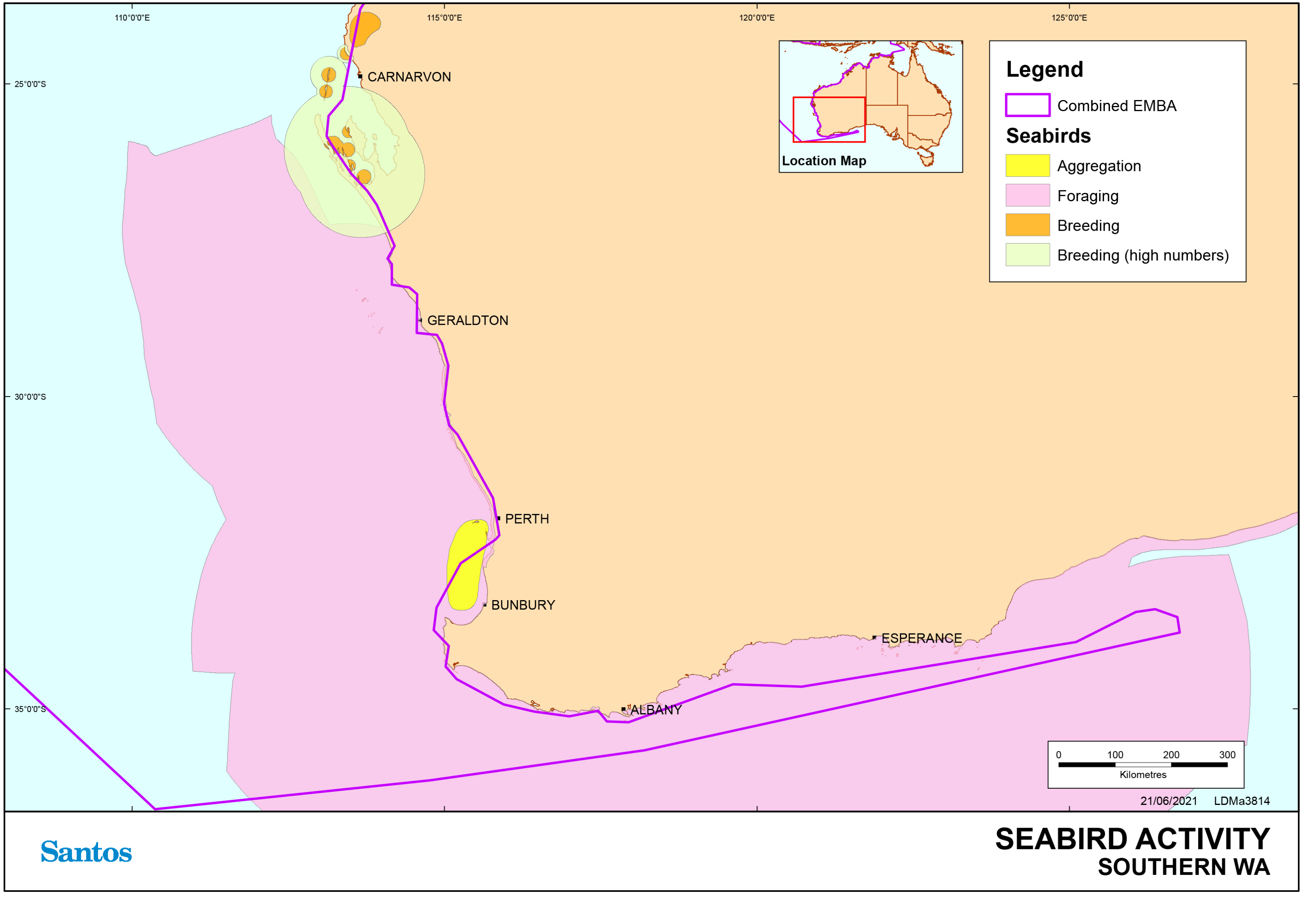

Figure 8-2: Biologically important areas – birds – Southern WA

Table 8-2: Summary of information for birds listed as threatened under the EPBC Act that may be in the combined 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 51 species listed as migratory under the EPBC Act that may occur within the combined 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 combined 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
Thalasseus bergii	Greater crested tern	Breeding known 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
Numenius minutus	Little curlew	Roosting 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
Tringa stagnatilis	Marsh sandpiper	Roosting 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
Gallinago stenura	Pin-tailed snipe	Roosting 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
Erythrotriorchis radiatus	Short-tailed shearwater	Species or species habitat may occur within area
Ardenna grisea	Sooty shearwater	Species or species habitat may occur within area

Species	Common Name	Likelihood of occurrence in EMBA
Calonectris leucomelas	Streaked shearwater	Species or species habitat known to occur within area
Gallinago magala	Swinhoe's snipe	Roosting known to occur within area
Xenus cinereus	Terek sandpiper	Roosting known to occur within area
Tringa glareola	Wandering Tattler	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
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.

Eleven internationally recognised areas that can support shorebird migrations are protected as wetlands of international importance. These wetlands are discussed further in **Section 9.1.3**.

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

Feeding habitat	Feeding guild	Species
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
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. In the NT populations have been recorded from Darwin and Melville Island. Sites of international importance from WA and the NT include; + Eighty Mile Beach, WA (110,290 individuals); + Roebuck Bay, WA (65,000 individuals); + Milingimbi coast, NT (7,000 individuals); and + Elcho Island, NT (5,000 individuals).
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 inhabits 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

Migratory species	DoEE SPRAT information on distribution within the area of interest
	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). The NT does not have any sites of international importance.
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. NT distribution includes: + Kakadu National Park; and + Darwin area.
Double-banded plover	The double-banded plover can be found in both coastal and inland areas. There are no nationally significant sites within WA.
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). In the NT scattered records exist around some offshore islands, mostly south to Victoria River Downs.
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

Migratory species	DoEE SPRAT information on distribution within the area of interest
	+ 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: + 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, WA (approximately 60,000 birds); and + Roebuck Bay, WA (Approximately 8,500 birds).
Oriental pratincole	Internationally important site: + Eighty Mile Beach, WA (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, and throughout the entire coastline of the NT.
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.

Migratory species	DoEE SPRAT information on distribution within the area of interest
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); + 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.
Swinhoe's snipe	No conclusive records exist for this species in Australia so the number of individuals that appear in Western Australia are unknown. In WA the species has been recorded in parts of the Pilbara, the Kimberley, Mount Goldsworthy, Mount Blaize. It has also been found in the north west-regions around the Mitchell Plateau
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:

Migratory species	DoEE SPRAT information on distribution within the area of interest
	+ 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 combined 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’. No provision is made under the Territory Parks and Wildlife Conservation Act 1976 for listing critical habitat.

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

[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
			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 tenuirostris 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.
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 crested tern	*Thalasseus bergii*	Breeding (high numbers)	Melville 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

Species	Scientific name	Aggregation area and use	Specific geographic locations for species
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 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-	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

Species	Scientific name	Aggregation area and use	Specific geographic locations for species
		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 combined 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 9-2**, **Figure 9-3**, **Figure 9-4** and **Figure 9-4** 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 combined 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. 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 combined EMBA

Area type	Title
World Heritage Area	Shark Bay
	The Ningaloo Coast
	Kakadu National Park
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
	Cobourg Peninsula
	Kakadu National Park
	Ord River Floodplain
	The Dales
Wetlands of National Importance	Ashmore Reef
	Mermaid Reef
	Vasse-Wonnerup Wetland System
	"The Dales", Christmas Island
	Adelaide River Floodplain System
	Eighty Mile Beach System
	Exmouth Gulf East
	Hosnies Spring, Christmas Island
	Kakadu National Park
	Mary Floodplain System

Santos

Area type	Title
	Hutt Lagoon System
	Lake Macleod
	Lake Thetis
	Learmonth Air Weapons Range – Saline Coastal Flats
	Leslie (Port Hedland) Saltfields System
	Prince Regent River System
	Roebuck Bay
	Rottnest Island Lakes
	Shark Bay East
	Cape Leeuwin System
	Doggerup Creek System
	Cape Range Subterranean Waterways
	Cobourg Peninsula System
	Daly-Reynolds Floodplain-Estuary System
	Finniss Floodplain and Fog Bay Systems
	Moyle Floodplain and Hyland Bay System
	Murgenella-Cooper Floodplain System
	Ord Estuary System
	Port Darwin
	Shoal Bay - Micket Creek
	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)
	Kakadu National Park (Natural)
	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

Area type	Title
	Christmas Island Natural Areas
	Yampi Defence Area
	Learnmonth Air Weapons Range Facility
	Bradshaw Defence Area
	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). One WHA is within the combined EMBA adjacent to NT, although most of the area is terrestrial: Kakadu National Park.

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.

9.1.3 Kakadu National Park

Kakadu National Park was included on the World Heritage List in 1981 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 significant on-going ecological and biological processes in the evolution and development of terrestrial, fresh water, coastal and marine ecosystems and communities of plants and animals; 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 Kakadu National Park WHA covers an area of around 1,916,000ha and is the largest national park in Australia. The WHA is managed by the Director of National Parks who performs functions and exercises powers under the *Environment Protection and Biodiversity Conservation Act 1999* (the Act) in accordance with the park's management plan and relevant decisions of the Kakadu National Park Board of Management. Approximately 50% of Kakadu National Park is Aboriginal land under the Aboriginal Land rights (Northern Territory) Act 1976.

9.2 Wetlands of International Importance (Ramsar)

There are eleven wetlands of international importance (Ramsar wetlands) in waters from the South Australian border to the NT; all were listed in 1990 with the exception of the Cobourg Peninsula which was listed in 1974, Kakadu National Park which was listed in 1980 and further expanded in 1995, 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). The Ramsar wetland is managed under the Eighty Mile Beach Marine Park Management Plan 2014-2024 (DPAW, 2014).

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. The Ramsar wetland is currently managed under the Preliminary Draft Roebuck Bay Ramsar Site Management Plan (RBWG, 2010).

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. The Ramsar site is managed under the Ashmore Reef National Nature Reserve and Cartier Island Marine Reserve Management Plan (Commonwealth of Australia, 2002).

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). The Ramsar wetland is managed under the Rockingham Lakes Regional Park Management Plan (DEC, 2010c).

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. The Rasmar site is managed under the Swan Coastal Plain South Management Plan (DPAW, 2016c).

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). This Rasmar site is also managed under the Swan Coastal Plain South Management Plan (DPAW, 2016c).

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). The Ramsar site is managed under the Christmas Island National Park Management Plan (DNP, 2002).

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). This Ramsar site is also managed under the Christmas Island National Park Management Plan (DNP, 2002).

9.2.9 Cobourg Peninsula

Under the Ramsar convention, the Cobourg peninsula site is listed as a Wetland of International Importance. The site is located 163km north-east of Darwin within the Timor Sea Drainage Division. Within 220’700 hectares, the site covers the entire peninsula and several nearby islands including the Sir George Hope Islands, Sandy Island No. I and II, Allaru Island, High Black Rock and Buford Island. Under the Cobourg Peninsula Aboriginal Land, Sanctuary and Marine act 1996, Cobourg peninsula and surrounding waters was declared a Nation Park (Garig Gunak Barlu National Park) BMT WBM (2011).

The Cobourg site is composed of a diverse coastal and inland wetland types. Wetland types present include intertidal forested wetlands and salt flats, seasonal freshwater marshes and permanent freshwater pools. Ramsar topology identifies ten coastal and ten inland types within the site. The site contains unique biodiversity and wildlife including terrestrial, riverine, freshwater, brackish and coastal/marine ecosystems. Identifiable wetland types include intertidal forested wetland and salt flats, seasonal freshwater marshes, and permanent freshwater pools.

Cobourg Peninsula is listed as a Wetland of International importance due to the diversity of coastal and inland wetland types that support population of threatened species, including a number of endangered turtles. The Cobourg site meets five of the current nine nomination criteria of the Ramsar Convention and is therefore recognised as a representative wetland habitat that is at bioregional level, support of populations of threatened species, support for key life-cycle functions such as marine turtle and waterbird breeding, refugia values, and its importance for supporting fish and nursery spawning habitats BMT WBM (2011). The Ramsar site is managed under the Cobourg Marine Park Plan of Management (DNREAS, 2011).

9.2.10 Kakadu National Park

Kakadu National Park Ramsar site is composed of a diversity of coastal and inland wetland types that range form intertidal forested wetlands and mudflats to seasonal freshwater marshes and permanent freshwater pools. Ramsar topology identifies 13 coastal types and 15 inland types throughout Kakadu National Park. Hydrology, fire regimes and notable biological processes, with supporting processes including climate, tidal hydraulics, groundwater, water quality, geology and geomorphology are ecosystem processes present in Kakadu National Park habitats (BMT WBM, 2010).

The site also meets all nine Nomination Criteria of the Convention, recognising the representative wetland habitats of the site at a bioregional level, support of populations of vulnerable wetland species, its characteristics as a centre of endemism and high biodiversity including its diversity of habitats, support for key life-cycle functions such as waterbird breeding and refugia values, its importance for supporting substantial populations of waterbirds and fish diversity and fish nursery and spawning habitats and its support of at least one percent of the national population of several non-avian wetland species (BMT WBM, 2010). The Ramsar site is managed under the Kakadu National Park Management Plan 2016-2026 (DNP, 2016).

9.2.11 Ord River Flood Plains

Site lies within the Victoria-Bonaparte bioregion and contains a wide range of wetland types and includes all inland and marine components. This Ramsar site comprises of Parry Lagoons, Ord Estuary and the False Mouths of the Ord. Parry Lagoons includes both the permanent waterholes, such as Marglu Billabong, as well as the broader area of the flood plain within the Parry Lagoons Nature Reserve that are subject to periodic inundation. The area from the boundary near Adolphis Island to the Rocks is known as the Ord Estuary. The False Mouths of the Ord is an area of extensive intertidal creeks and flats in the north of the Ramsar site.

The Ord River Floodplain Ramsar site meets seven of the nine Nomination Criteria. The site represents the best example of wetlands associated with the floodplain, and estuary of a tropical river system in the Kimberly Region of Western Australia. Ord River contains extensive and diverse mangrove community containing 14 of the 18 species of mangrove known to occurs in Western Australia (Hale, 2008).

A number of threatened species including Freshwater Sawfish (*Pristis microdon*), the Green Sawfish (*Pristis zijsron*) and the Australian Painted Snipe (*Rostratula australis*), which are listed as vulnerable under the EPBC Act are supported in this area. The site also provides one of the two known habitats for the nationally endangered Northern River Shark (*Glypis* sp. C). The Ord River Floodplain Ramsar site provides an important nursery, breeding and feeding ground for at least 50 species of fish and a migratory route for 15 diadromous species.

There is sufficient evidence to suggest the sire regularly supports 20,000 birds in the site alone, although it should be acknowledged that there are difficulties associated with surveying the Ord River Floodplain. According to the 4th edition of Waterbird Population Estimates, the site regularly supports 1% of the population of Plumed Whistling Duck and Little Curlew (Hale, 2008). The Ramsar site is managed under the Ord River and Parry Lagoons Nature Reserves Management Plan (DEC, 2012c).

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**).

9.3.21 Adelaide River Floodplain System

Several swamps, lakes, lagoons and dams are included in the 134,800-hectare site. Four principal plant structural formations are present consisting of mangal low closed-forest (mangroves) mainly in the far north-west but extending along the river to south of the site, scattered chenopod low shrubland (samphire) in the far north, patches of melaleuca open-forest near the floodplain edges and missed closed grassland/sedgeland (seasonal floodplain) over most of the site (Jaensch, 1993).

The site is of particular significance as it contains one of the largest blocks of mangroves associated with the Top End floodplain as well as near-permanent marsh (Fogg Dam and Melacca Swamp), a rare wetland type in the Northern Territory. A rare species of the wetland plant Goodenia quadrigida also occurs within the floodplain. Surface inflow from the Adelaide-Margaret River System as well as numerous creeks (e.g. Hollands, Sunday and Buffalo Creeks) and Manton River provides a water supply for the area. The total volume of inflow is moderately high. The area provides a good example of the major floodplain-tidal wetland system typical of the Top End Region with substantial area of each component wetland type (Jaensch, 1993).

Adelaide River Floodplain system is a major breeding area for multiple species such as the Magpie Goose (*Anseranas semipalmata*), Saltwater Crocodile (*Crocodylus porosus*) and herons and allies. It is also a major dry season refuge area for waterbirds and a significant migration stop-over area for shorebirds (Jaensch, 1993).

9.3.22 Kakadu National Park

See Kakadu National Park Ramsar site (**Section 9.2.10**).

9.3.23 Mary Floodplain System

Included in the 127,600hectare site is the entire floodplain of the Mary River, from near Bark Hit Inn downstream to Van Diemen Gulf (including intertidal mudflats) and including Swim Creek Plain. Three principal plant formations occur within the site. These include melaleuca open-forest (paperbark swamp), scattered chenopod low shrubland (samphire) in the north and centre-north; and the remainder, mixed closed-grassland/sedgeland (seasonal floodplain). Mangroves occur in the far north fringing the coast and at estuary mouths. The site includes some of the largest areas of wooded swamp in the Northern Territory. 21 of the 36 described floodplain flora communities occur in the Mary Floodplain system (Jaensch, 1993).

Water supply mainly occurs from the surface inflow form the Mary-McKinlay River system as well as many creeks. Mudflats, estuaries, and saline coastal flats are tidal. Tidal areas of mudflats and estuaries are inundated twice daily compared to the large parts of coastal flats that may be only periodically inundated. The floodplain water supply is seasonal, with near-permanent water in deeper channels and billabongs, as well as Eleocharis swamp. The site is a good example of a major floodplain-tidal wetland system typical of the Top End Region and features a complex network of channels and billabongs (Jaensch, 1993).

Mary Floodplain System provides a major breeding area for the Magpie Goose (*Anseranas semipalmata*) as well as refuge during dry season for waterbirds (geese, ducks and herons) and Saltwater Crocodiles (*Crocodylus porosus*). At least 75 species recorded within the area, of those 33 species were listed under treaties and 11 species were found breeding. The mudflat and coastal flats support at least several thousand migrant shorebirds at a time (Jaensch, 1993).

9.3.24 Cobourg Peninsula System

See Cobourg Peninsula Ramsar site (**Section 9.2.9**).

9.3.25 Daly-Reynolds Floodplain-Estuary System

The Daly-Reynold Floodplain-Estuary System includes the entire floodplain of the Daly River, entire floodplain of the Reynolds River and the tidal mudflats of north-east Anson Bay and is in the Darwin Coastal and Daly Basin biographical regions. Six principal plant formations exist within the 159,300-hectare site. This includes mixed closed-grassland/sedgeland (seasonal floodplain) over most of the site; Melaleuca open-forest (paperbark swamp) in patches throughout, Coolibah/Gutta-percha low woodland over grassland in the far south-east; closed-forest (monsoon vine-thicket) around the Daly River in the far south-east; mangal low closed-forest (mangroves), discontinuously along the Daly River estuary (to 1 km wide); and scattered chenopod low shrubland (samphire) at/near the coast and river mouth. The site provides a good example of a major floodplain-tidal wetlands system as it contains substantial areas of all the principal features of such a system in the Top End Region. It is also one of the largest floodplains in the Northern Territory (Jaensch, 1993).

31 of the 36 described floodplain flora communities occur on the Daly-Reynolds Floodplain. The Daly-Reynolds Floodplain-Estuary System plays an important ecological role by providing a top three breeding ground for Magpie goose (*Anseranas semipalmata*), as well as herons, allies and Saltwater Crocodiles. Additionally the site is a major dry season refuge area for waterbirds and a significant migration stop-over area for shorebirds. The site also contains more than 80 fauna species, 30 of which are listed under treaties. Up to 2100 shorebirds are known to frequent this site as a migratory stop over (Jaensch, 1993).

9.3.26 Finniss Floodplain and Fog Bay Systems

The floodplain and bay systems provide a good example of a beach-fringed, curved bay with intertidal mudflats and intact floodplain with extensive paperback swamps. Plant structural formations within the area include mixed closed grassland/sedgeland and melaleuca open forests. Small areas of mangal and samphire occur near the estuaries and the south-west part of the bay. Surface inflow from the Finniss River, and several creeks supply the site with water (Jaensch, 1993).

At least 70 species of fauna are recorded in the area, 20 of which are listed under treaties. Finnis Floodplain and Fog Bay Systems are major breeding areas for Magpie goose and Saltwater Crocodile, a significant dry season refuge area for water birds and a major migration stop-over for over 25’000 shorebirds. 24 of the described floodplain flora communities along with the best floating mats in the Northern territory occur within this site (Jaensch, 1993).

9.3.27 Moyle Floodplain and Hyland Bay System

Plant structural formations of the area consist of closed grassland/sledgeland latiform arrangements, some fringing and scattered patches of melaleuca open-forests, and mangal low closed forest (mangroves) along the lower river. Surface inflow to floodplain areas from multiple creeks and Moyle River is the main source of water supply.

The Moyle Floodplain and Hyland Bay System is one of the least distributed examples of a Top End floodplain system associated with a small river a mudflat-fringed bay. The site is a major breeding area for magpie goose, a refuge for waterbirds (whistling duck) in the dry season, migration stop over area for shorebirds and a major breeding area for Saltwater Crocodiles. 27 of the described floodplain flora communities occur at this site. 47 fauna species are known to occur on the floodplain and adjacent coast, 26 of which are listed under treaties (Jaensch, 1993).

9.3.28 Murgenella-Cooper Floodplain System

Murgenella-Cooper Floodplain System includes the entire contiguous floodplains and saline coastal flats, estuaries, and tidal mudflats of Murgenella, Cooper and Salt-Water Creeks within 81,500 hectares. Surface flow from Cooper Creek and several unnamed creeks provide water supply for the area. Plant structural formations that are present include mixed closed grassland/sedgeland over most of the site, scattered chenopod low shrubland and narrow areas of mangal closed-forest (mangroves) along tidal channels and at the coast. The site provides a good example of floodplain-tidal wetland system of the Top End Region, with relatively low volume of freshwater inflow (Jaensch, 1993).

13 of the 36 described floodplain flora communities occur within the site. The site is a major breeding ground for Magpie Goose, cormorants, herons and allies, a major dry season refuge area for waterbirds and a major migration stop-over area for more than 10’000 shorebirds. At least 71 species of fauna are recorded in the area, 26 of which are on treaties (Jaensch, 1993).

9.3.29 Ord Estuary System

See Ord River Flood Plains Ramsar site (**Section 9.2.11**).

9.3.30 Port Darwin

The entire Port Darwin site covers 48,800 hectares. The whole site is tidal with mangal low closed-forest (mangroves) plant structural formations present. The site provides a good example of a shallow branching embayment of the Top End Region, supporting one of the largest discrete areas of mangrove swamp in the Northern Territory (Jaensch, 1993).

36 flora species, 23 of them trees and tall shrubs are present within the mangrove communities. Including Northern territory endemic *Avicennia integra*. The mangrove communities of this site are the most extensive and species rich of any Northern Territory embayment. The site is a major nursery for estuarine and offshore fish and crustaceans in the Beagle Gulf area. 48 fauna species, with 25 listed under treaties existing within this site. Rare species such as Red-necked Phalarope have also been recorded within the site. Furthermore, Woods Inlet is frequented by the uncommon dolphin *Orcaella brevirostris*. At least 72 fish species occur within the site as well as there being an unusual richness in sponges (220 species), soft and hard coral as well as invertebrates (Jaensch, 1993).

9.3.31 Shoal Bay - Micket Creek

Shoal bay is approximately 10km immediately north-east of the City of Darwin and the site includes King Creek and Noogoo swamp within 1,600 hectares. The site contains wetland marshes, mangrove woodlands, beaches, mudflats, creeks and estuaries and is a good example of a spring fed coastal wetland system. Micket Creek is a tidal estuary flowing into Shoal Bay while King Creek and water from Noogoo Swamp all flow into Shoal Bay. All areas contain remnants of monsoon forest interspersed with open woodland bounded by grassed backsoil plain (Hodgson, 1995).

Within the site there are some notable species. It has a bird habitat of over 200 species and provides a dry season refuge for waterfowl and birds of prey. Migratory birds regularly use the areas of mudflats with more than 15,000 wader species and 25 of them listed on international agreements with Japan and China. The Nationally endangered Littler Tern and two other uncommon species, the Eastern Grass Owl and Peregrin Falcon have been recorded within Shoal Bay – Micker Creek (Hodgson, 1995).

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, with ten of these occurring within the combined EMBA. Kakadu National Park, 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).

9.4.10 Kakadu National Park

See Kakadu National Park World Heritage Area (**Section 9.1.3**).

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. Ten Commonwealth Heritage Places are found in or adjacent to the combined 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.

9.5.10 Bradshaw Defence Area

The Bradshaw Defence Area is located in the Northern Territory and is bounded by the Fitzmaurice and Victoria Rivers on the shores of the Joseph Bonaparte Gulf and the Bradshaw Defence field training area.

The complex topography of the Bradshaw area results in a broad range of highly distinct environments and habitats that include lowland woodlands, heaths, grasslands, sandstone escarpments, monsoon rainforest patches and wetlands. Compared to surrounding areas, the vegetation within the Bradshaw area is more diverse and incorporates more than one fifth of the vegetation types that occur in the Top End of the Northern Territory and includes grassland, woodland flora that are restricted on a national level (DAWE, 2002).

The topological complexity that results in a broad range of environments also contributes to the unusually rich vertebrate fauna. The species richness of frogs, reptiles and mammals is considered significant at a national level. Furthermore, it is also worth noting that the Bradshaw area supports many species that have declined elsewhere in Australia (DAWE, 2002).

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. Most conservation areas in the NT are managed under the *Territory Parks and Wildlife Conservation Act*.

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.

In NT there are a number of types of terrestrial conservation reserves with legislative protection, those present within the combined EMBA include coastal reserves, national parks and conservation parks.

There are numerous terrestrial conservation reserves located adjacent to the coast in the combined 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 combined 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 WA 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 9-6)				
Lawley River	Northern Kimberley	-	No [10]	Kimberley Marine Park
Mitchell River		-		
Prince Regent		-		
Reserves of North-West WA (see Figure 9-7)				
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 9-8)				
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)	

[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)
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]	-
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]	
Reserves of the Northern Territory (NT) – (see Figure 9-5)				
Djukbinj National Park	Darwin Coastal and Pine Creek	-	Yes[11]	-

National Park	IBRA bioregion[9]	Management plan	Includes inter-tidal zone	Adjacent Marine Management Park (see Section 11)
Garig Gunak Barlu National Park	Tiwi Cobourg	Cobourg Marine Park Plan of Management (PAWCNT, 2011)	Yes[11]	Cobourg Marine Park
Mary River National Park	Darwin Coastal	Mary River National Park Joint Management Plan March 2015 (PAWCNT, 2015)	Yes[11]	-
Keep River National Park	Victoria Bonaparte	-	Yes[11]	-
Charles Darwin National Park	Darwin Coastal	Charles Darwin National Park Plan of Management (NT government, nd)	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 combined EMBA are listed in **Table 9-3** and shown in **Figure 9-6**, **Figure 9-7** and **Figure 9-8** for the north, north-west and south of WA respectively. Protected lands in the NT are shown in Figure 9-5 as gazetted under the (NT) Crown Lands Act 1992. 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	IUCN	Management Plan	Includes inter-tidal zone	Adjacent Marine Park (see Section 11)
Reserves of Northern WA (see Figure 9-6)					
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]	-

[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	IUCN	Management Plan	Includes inter-tidal zone	Adjacent Marine Park (see Section 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 9-7)					
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]	-
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]	-

[12] Reserve R42197 includes the inter-tidal zone and reserve R42196 does not.

Reserve name and type	Reserve class	IUCN	Management Plan	Includes inter-tidal zone	Adjacent Marine Park (see Section 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 9-8)					
Koks Island NR	A	1a	Shark Bay Terrestrial Reserves and Proposed Reserve Additions Management Plan (DPAW 2012)	Yes [11]	-
Bernier and Dorre Islands NR	A	4			
Shell Beach CP	-	3		No	Shark Bay Marine Park
Freycinet, Double Islands etc NR	A	1a			Shark Bay Marine Park
Zuytdorp NR	-	1a		Yes [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			

Reserve name and type	Reserve class	IUCN	Management Plan	Includes inter-tidal zone	Adjacent Marine Park (see Section 11)
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	
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		Yes[11]	-

Reserve name and type	Reserve class	IUCN	Management Plan	Includes inter-tidal zone	Adjacent Marine Park (see Section 11)
Breaksea Island NR	A	1a	Albany coast draft management plan 2016 (DPAW 2016b)	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	-
Figure 9-5					
Channel Point Coastal Reserve	-	5	-	Yes[11]	-
Casuarina Coastal Reserve	1 and 3	5	Casuarina Coastal Reserve Management Plan (PAWCNT, 2016)	Yes[11]	-
Shoal Bay Coastal Reserve	-	6	-	Yes[11]	-
Tree Point Conservation Area	-	5	-	Yes[11]	-

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 combined 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.

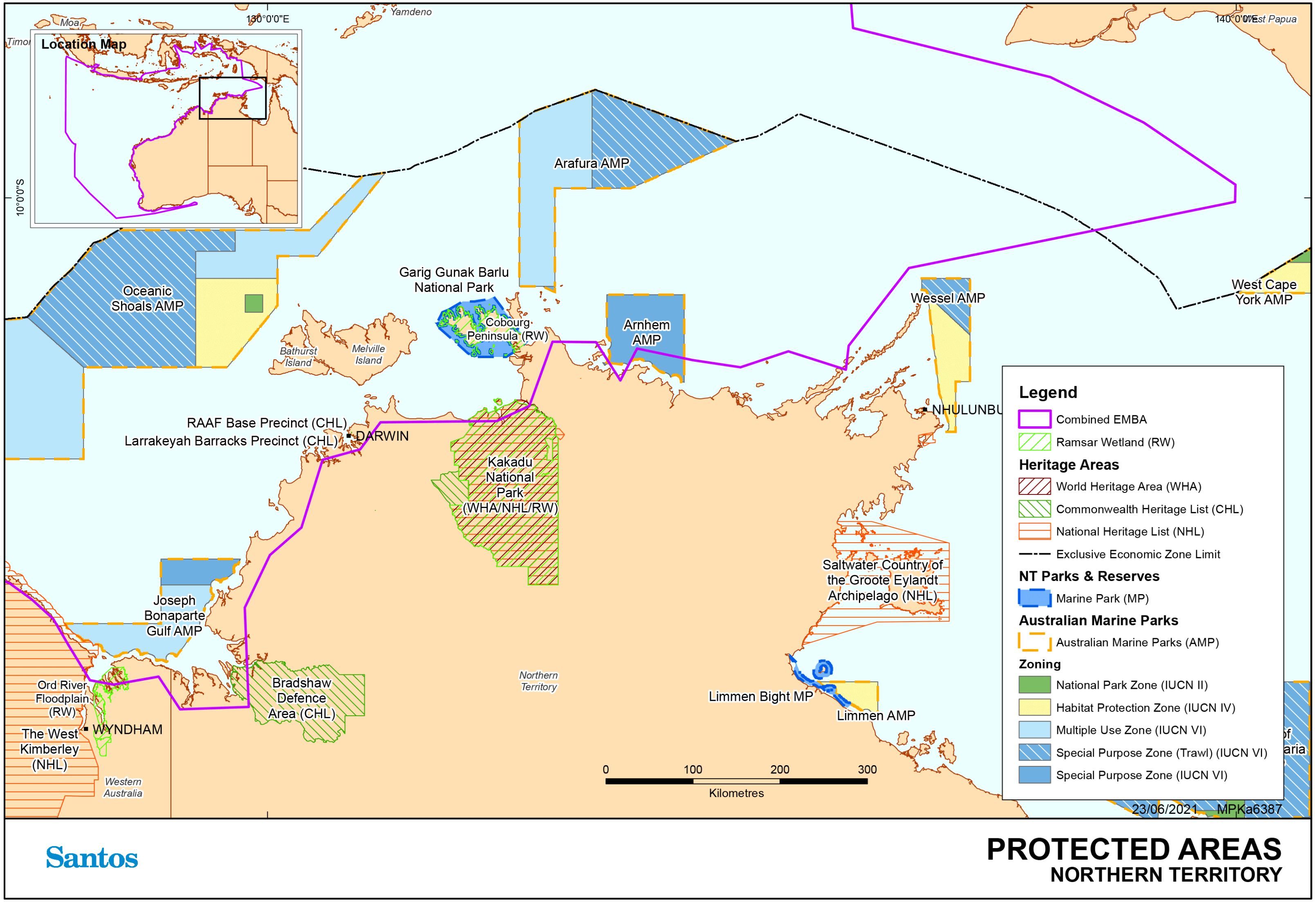

Figure 9-1: Protected areas in NT

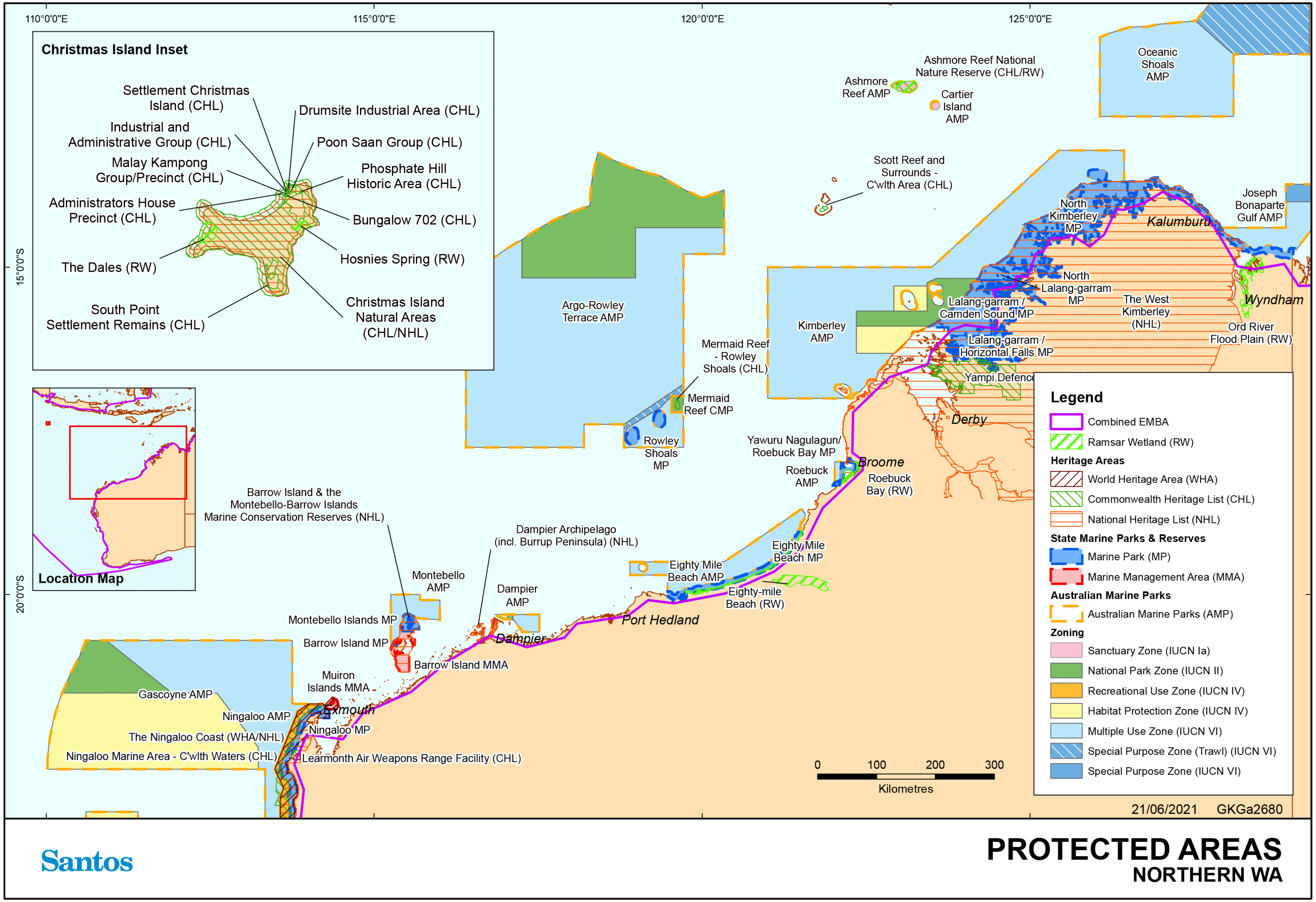

Figure 9-2: Protected areas in Northern WA

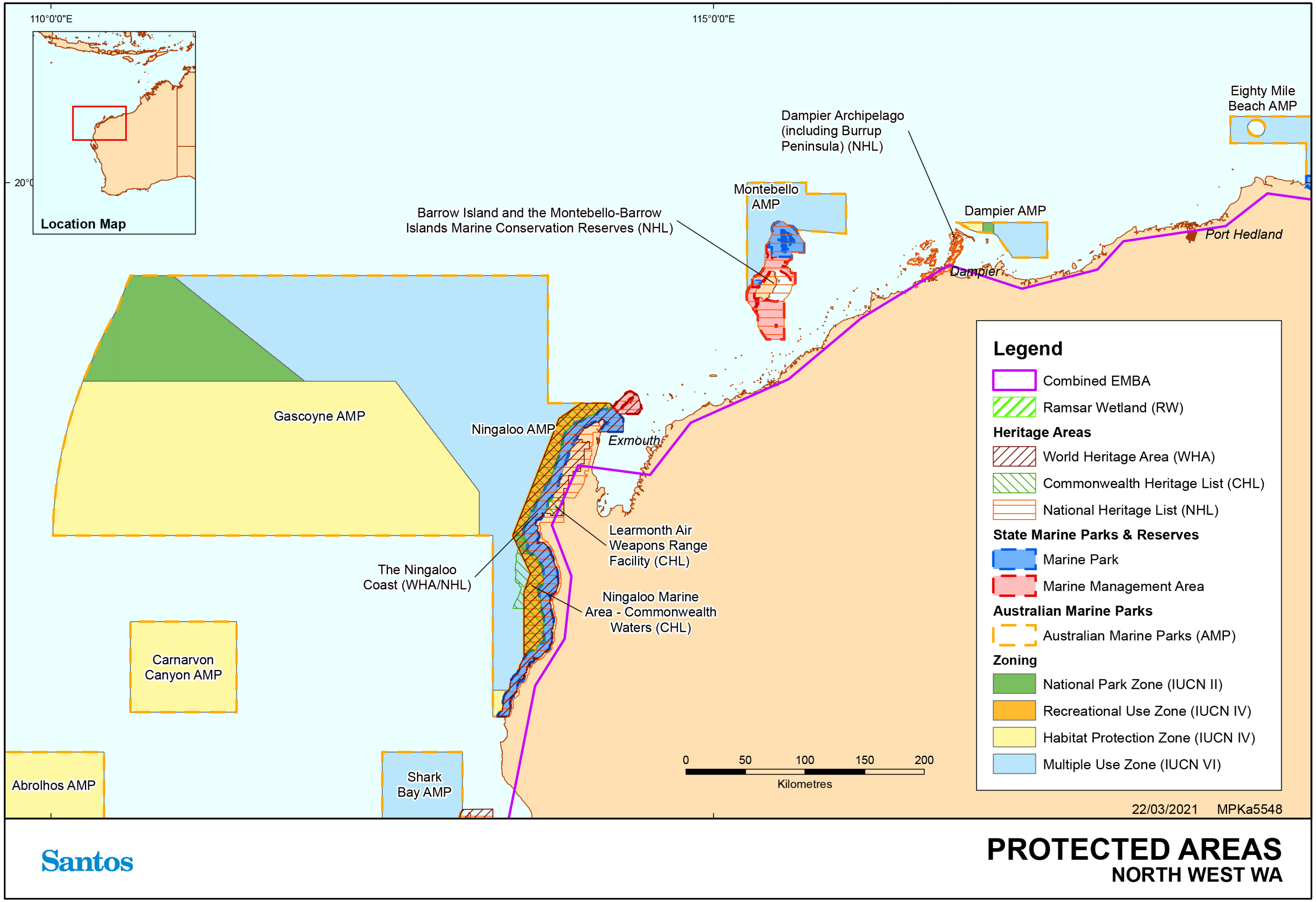

Figure 9-3: Protected areas in North West WA

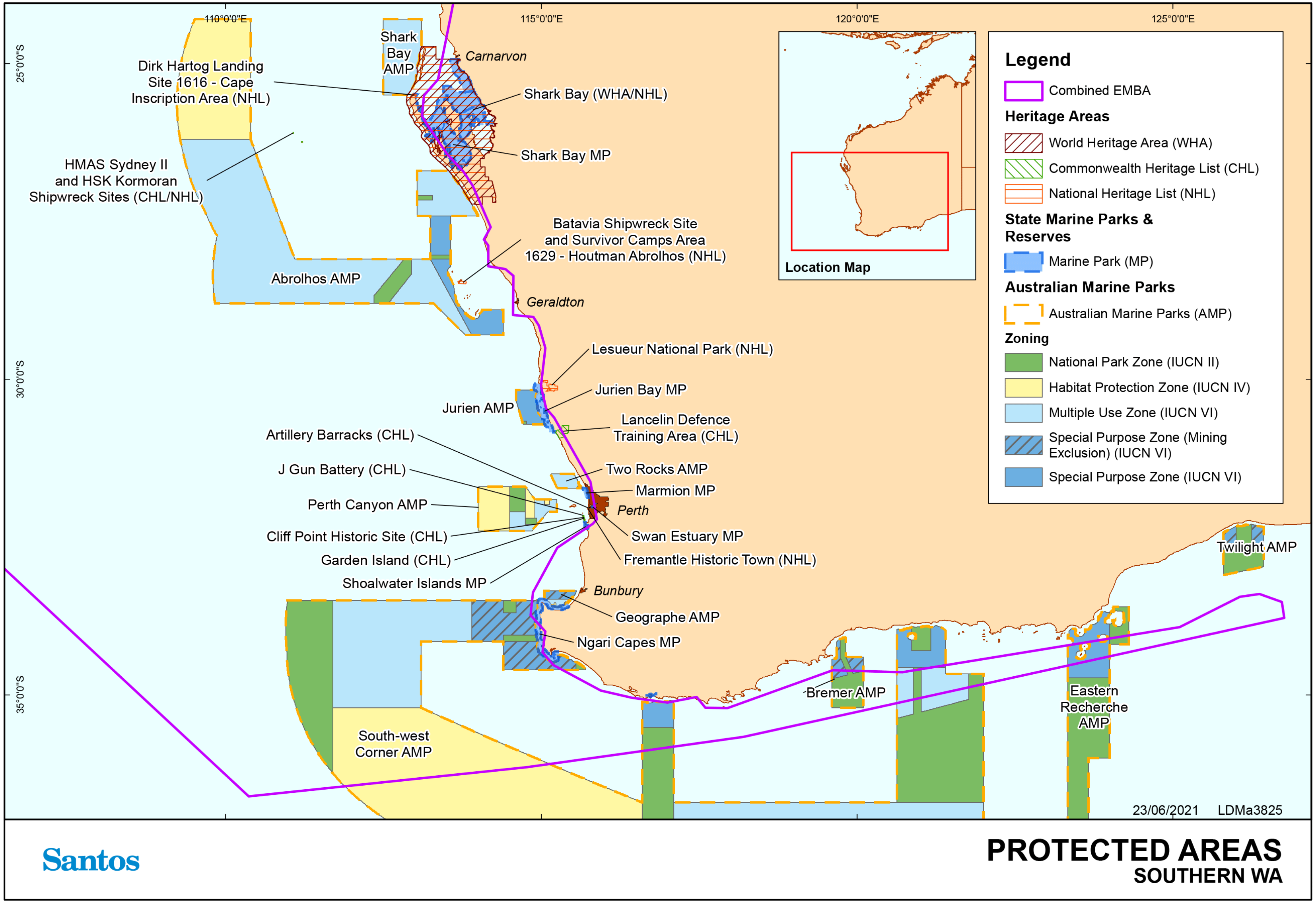

Figure 9-4: Protected areas in Southern WA

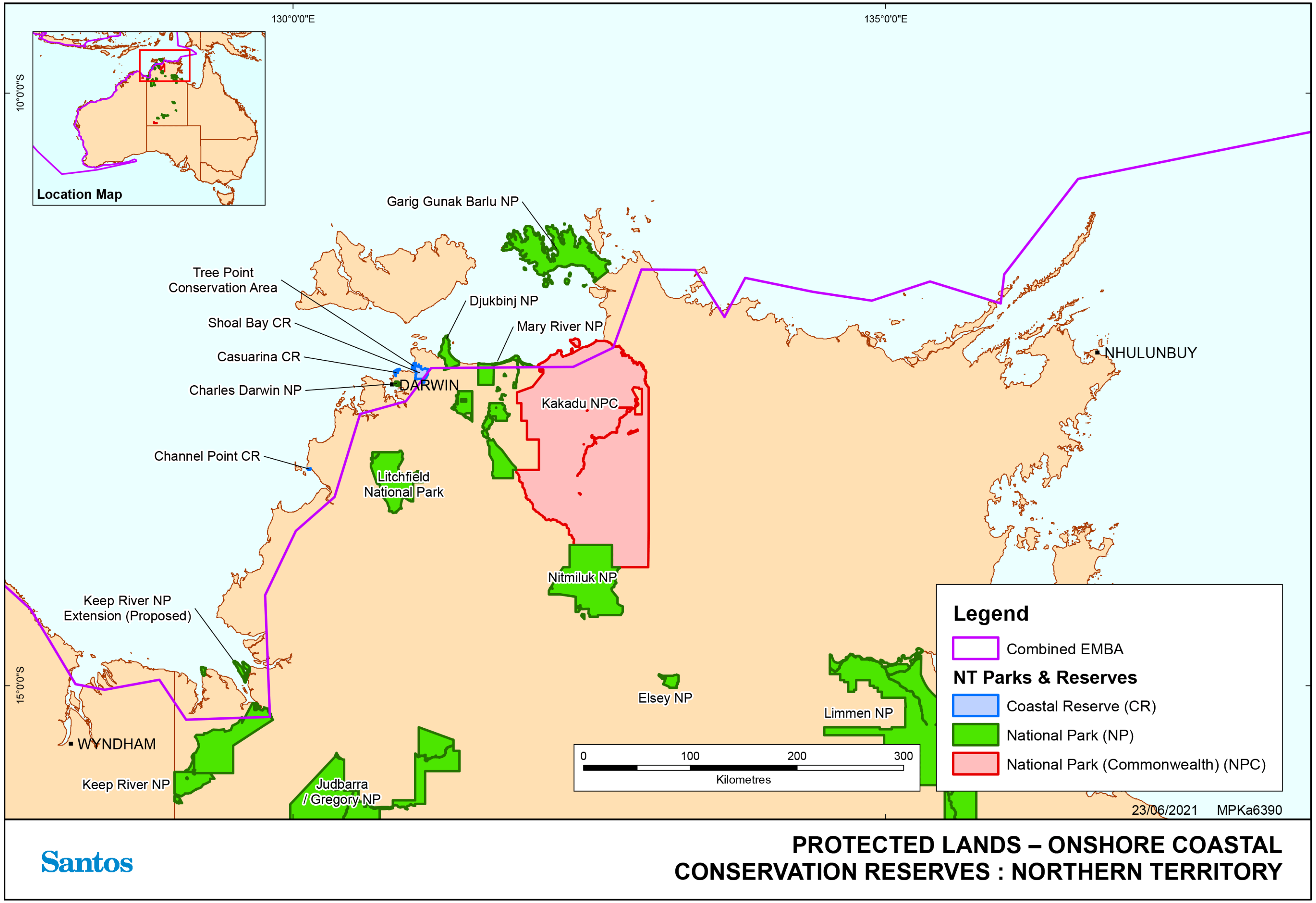

Figure 9-5: Protected Lands (CALM Act 1984) – terrestrial coastal reserves bounding marine waters in NT

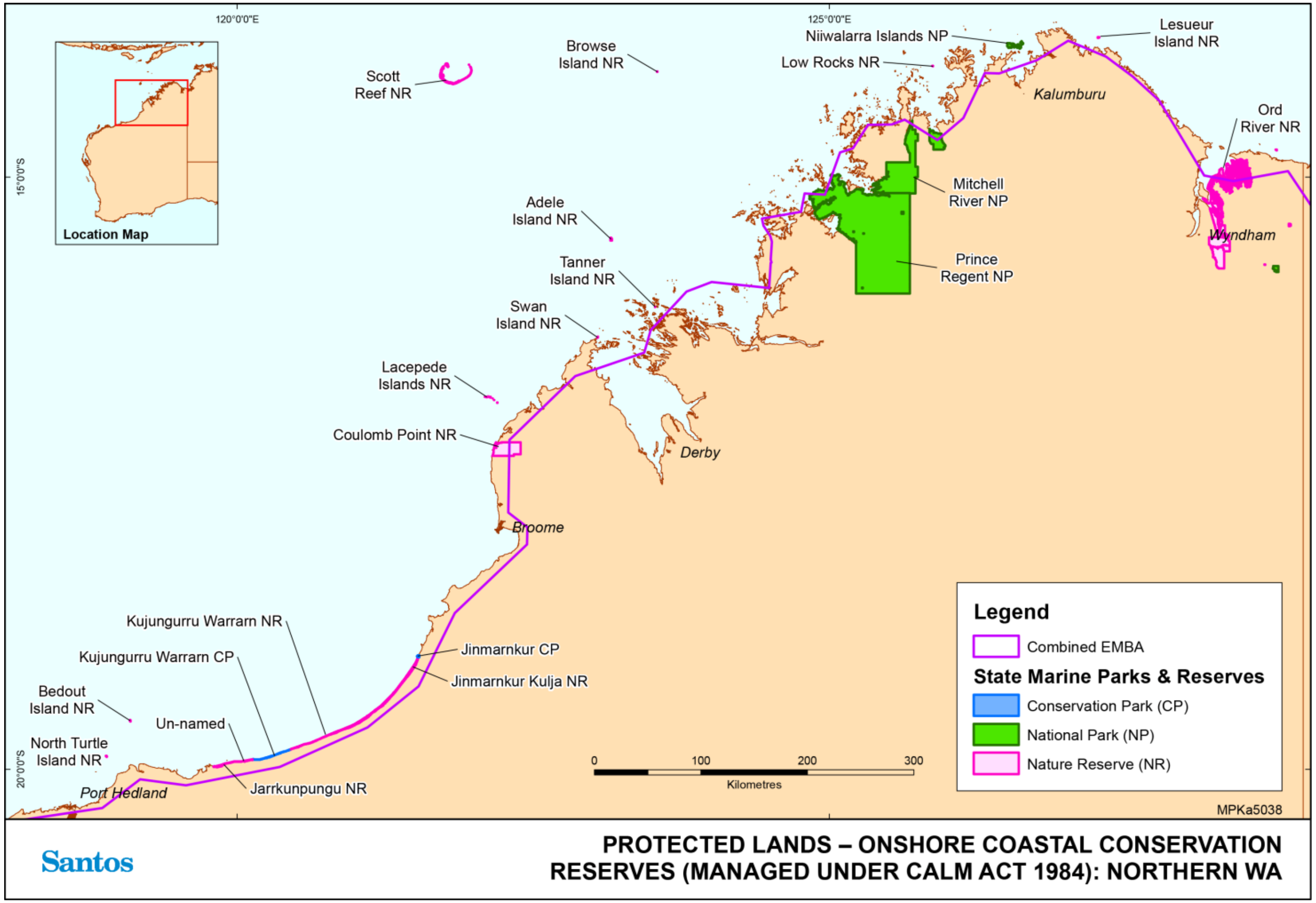

Figure 9-6: Protected Lands (CALM Act 1984) – terrestrial conservation reserves bounding marine waters in northern WA[13]

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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**).

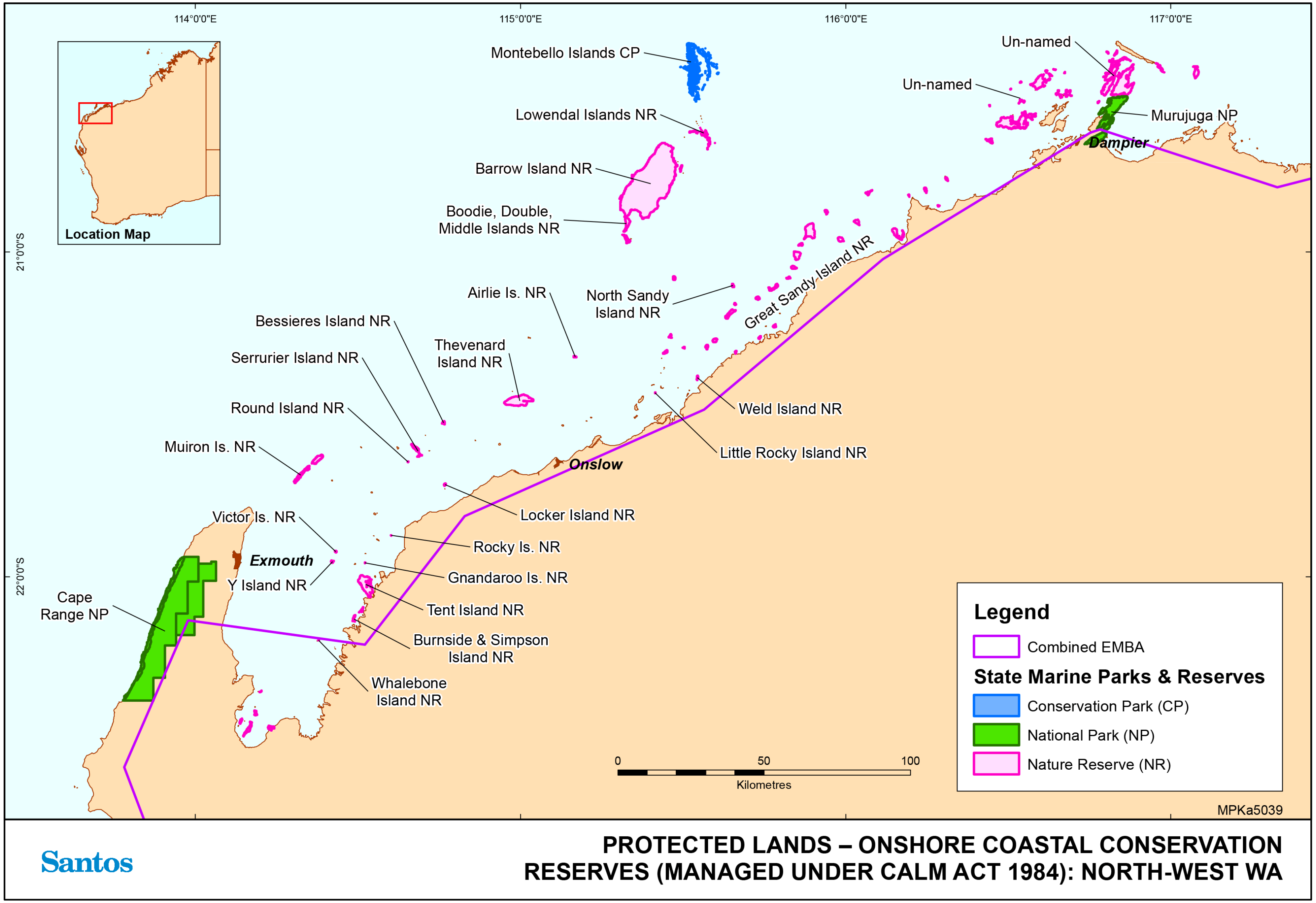
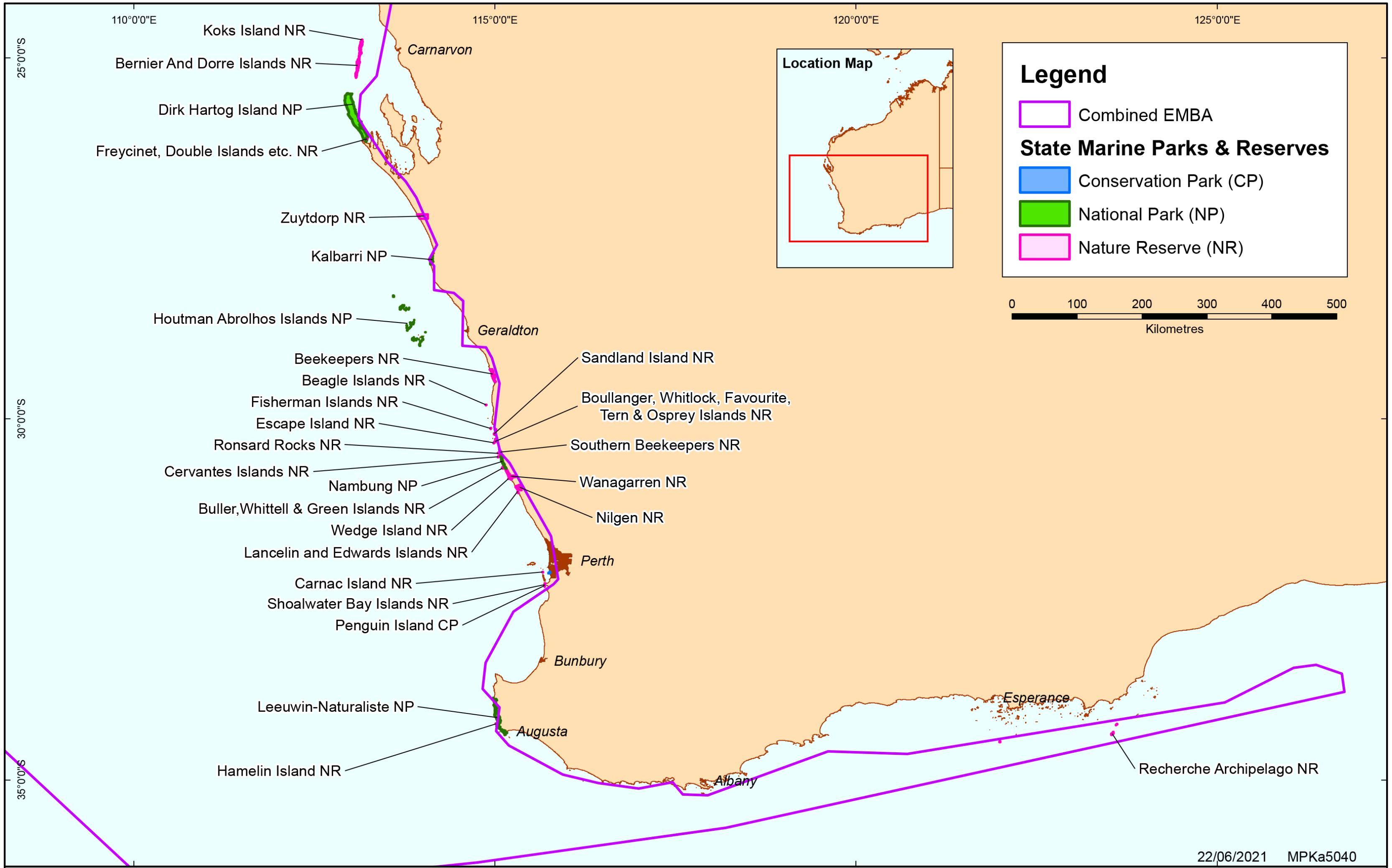


Figure 9-7: Protected Lands (CALM Act 1984) – terrestrial conservation reserves bounding marine waters in North-West WA



Santos

PROTECTED LANDS – ONSHORE COASTAL CONSERVATION RESERVES (MANAGED UNDER CALM ACT 1984): SOUTHERN WA

Figure 9-8: Protected Lands (CALM Act 1984) – terrestrial conservation reserves bounding marine waters in Southern WA[14]

9.8 International Protected Areas

There are 54 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). the combined EMBAA number of marine national parks, nature reserves and protected areas are overlapped by the combined EMBA. A summary of these is provided below. The waters and islands of these protected areas are frequented by tourists undertaking diving, snorkelling, sailing and other marine nature based tourism with many attractions such as shipwrecks and whale sharks as well as the extensive terrestrial ecosystems. Traditional fishing also occurs throughout the parks where allowed.

9.8.1 World Heritage and Protected Sites

9.8.1.1 Komodo

Komodo National park is located within the lesser Sunda Island between the provinces of East Nusa Tenggara and West Nusa Tenggara. Within the 1733km^2 site, three larger island (Komodo, Padar and Rincach) and 26 smaller ones are included. The marine fauna and flora are generally the same as that found throughout the Indo Pacific area, though species richness is very high, notable marine mammals include blue whale (*Balaenoptera musculus*) and sperm whale (*Physeter catodon*) as well as 10 species of dolphin, dugong (*Dugong dugon*) and five species of sea turtles (WHC, 2021). Fringing and patch coral reefs are extensive and most developed on the north-east side of Komodo (Indahnesia, 2011). The property is identified as a global conservation priority area, comprising unparalleled terrestrial and marine ecosystems (WHC, 2021).

The islands have an irregular coastline characterized by bays, beaches and inlets separated by headlands, often with sheer cliffs falling vertically into the surrounding seas.

9.8.1.2 Siberut

Siberut is located about 155km off the coast of West Sumatra across the Mentawaian strait and covers an area of 4050km^2. Sand beaches, lagoons, mangroves, and coral sea gardens create ecosystems within the site (Indahnesia, 2011).

9.8.1.3 Ujung Kulon

Ujung Kulon covers 1230km^2 of area. The coastline features various ecosystems such as sandy beaches, lagoons, rocky outcrops, as well as mangrove swamps. The water is an unusually warm 29 to 30 degrees Celsius and is home to multiple species of coral and fish (Indahnesia, 2011). The property includes the Ujung Kulon peninsula and several offshore islands that demonstrate on-going evolutionary processes (WHC, 2021).

9.8.2 Marine National Parks

9.8.2.1 Laut Sawu

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).

9.8.2.2 Kepulauan Seribu

Kepulauan Seribu, also known as Thousand Islands National Park, consists of a string of 105 islands within a reported area of 1074.89km^2. It is designated with an IUCN category II status. The closest island lies in Jakarta Bay, only a few kilometres from off mainland Jakarta with islands stretching as far as 45km north into the Java Sea (Indahnesia, 2011). Some islands are uninhabited, others have resorts or are privately owned. The coastlines are dominated by sandy beaches with some of the islands declared as protected historical sites to protect the artifacts and ruins on the islands dating back to the 19th century. Extensive coral reefs surround the islands. A Hawksbill turtle preservation program is in places in the park to protect the species that are found in the waters and nest on sandy beaches there (UNDP Indonesia, 2017). Mangroves are also found in the park, including plantations to increase the mangrove coverage.

9.8.2.3 Teluk Cenderawasih

Teluk Cenderawasih National Park is the largest marine park in Indonesia, with the reported area being 14535 km^2. It is designated with an IUCN category II status. The National Park is in Cenderawasih Bay, south-east of Bird's Head Peninsula, and includes the Islands of Misowaar, Nusrowi, Roon, Rumberpon and Yoop. The Park protects a rich marine ecosystem where over 150 coral species have been recorded. It is therefore considered to be a potential World Heritage Site (Indahnesia, 2011).

3.8% of the site consists of island tropical forest ecosystems, where some 46 species of plant have been recorded on the islands. 0.9% of the site is specifically mangrove ecosystems. Although only 5.5% of the site consists of coral reef ecosystems, 150 species of coral have been recorded. This coral reef ecosystem forms part of the Coral Triangle region. Within the remaining area of the site, over 200 fish species, various species of molluscs, whale sharks, four species of turtle as well as mammals such as the dugong, blue whale and dolphins inhabit the 89.8% of marine water ecosystems.

9.8.2.4 Taka Bonerate

Taka Bonerate National Park includes the Takabonerate Atoll Islands within a 5307 km^2 area within the Flores Sea. Taka Bone Rate consists of separate table reefs, enclosing a lagoon filled with massive reefs and is a site of major ecological importance (Indahnesia, 2011). According to the Indonesian Department of Forestry, the site has 261 species of coral, 295 species of coral fish, 244 species of molluscs as well as many other species such as turtles including green turtles that are known to nest on sandy beaches within the park (UNDP Indonesia, 2017).

9.8.2.5 Bunaken

Bunaken National Park is located in the north of the Sulawesi Islands, located near the centre of the Coral Triangle, it is designated with an IUCN category II status. This site typifies Indonesian tropical water ecosystems, consisting of seagrass plains, coral reefs and coastal ecosystems. 97% of the site is classified as marine habitat with the remaining being terrestrial, including 5 islands (Indahnesia, 2011). 390 species of coral, 90 fish species as well as mollusc, reptile, marine and mammal species have all been recorded.

9.8.2.6 Kapulauan Wakatobi

Kapulauan Wakatobi is located south of Sulawesi Island of Indonesia within a 13900km^2 area. It is designated with an IUCN category II status. Types of vegetation found in the National Park include mangrove forests, coastal forests, lowland swamp forests, riverbank vegetation, lowland rainforests, mountain rainforests and coral reefs (Indahnesia, 2011). There are 25 groups of coral reefs, including fringing reefs, barrier reefs and atolls. 396 species of coral belonging to 68 genera and 15 families populate the coral reef. Turtles are found nesting on the beaches and in the waters of the marine park.

9.8.2.7 Meru Betiri

Meru Betiri National Park lies within the province of East Java and extends over 580km^2. Of that area, 8.45 km^2 is marine (Indahnesia, 2011). The beaches of the park provide nesting grounds for endangered turtle species such as leatherback turtles, hawksbill turtles, green turtles, and olive ridley turtles (ADB 2014). The coastal vegetation is mostly found around Sukamade Bay and Meru Bay. Mangrove vegetation is largely found at the eastern side of the Rajegwesi Bay. The dominant genera are *Rhizophora, Avicennia* and *Bruguiera*. At the outlet of the Sukamade River, there is *Nypa fruticans*.

9.8.2.8 Togian Islands

The Togian Islands National Park, otherwise known as Kepulauan Togean, is a largely marine national park and provides habitat and breeding areas for hawksbill and green turtles and dugongs (Indahnesia, 2011). Mangroves forests are found within the marine park and extensive coral reefs.

9.8.3 Marine Nature Reserves and Conservation Areas

9.8.3.1 Karimunjawa

Karimunjawa is a national marine park in the Karimumjawa archipelago, 80km north of Jepara in the Java sea. The national park was formally declared a marine protected area in 2001 and has an IUCN category Ia status.

Karimunja has five types of ecosystems; coral reef, seagrass and seaweed, mangrove forest, coastal forest and low land tropical rainforest. The coral reefs of Karimunja are composed of fringing and barrier reefs along with several patch reefs. More than 90 species of coral biota is known to make up these ecosystems that creates a habitat for over 242 species of ornamental fish. Protected coral biota such as black coral, hornet helmet, titron trumpet, green shell and organ pipe coral, can be found here.

The 300 hectares of mangrove forests contain 32 species of mangroves and habitat many endemic species such as the dewadaru tree (*Fragraea elliptica*), setgi (*Pemphis acidula*) and kalimsada (*Cordia Subcordata*). Around 40 species of bird habitat this area as well as other terrestrial animals. Several species of turtles are known to use this national park as a breeding ground. Marine species within the area are particularly diverse, and in more abundance than the terrestrial populations.

9.8.3.2 Savu Sea National Marine Conservation Area

Savu Sea National Marine Conservation Area is located between the islands Sumba and Timor encompassing Pulau Roti and Sawu. The park includes coral reefs, mangroves, seagrass and deepwater habitats such as seamounts and deepwater canyons. Savu Sea NMCA is located within the Lesser Sunda seascape which is regarded as a high priority seascape for marine biodiversity conservation (Huffard et al. 2012). The Lesser Sundas is the main corridor between the Indian and Pacific Oceans including for migrating whales and commercially-important pelagic fishes (Huffard et al. 2012). Savu Sea NMCA covers ranges of species diversities and habitats within its region which includes:

- 532 corals species, 11 endemic and sub endemic species;
- 350 reef fish species;
- 15 mangrove species are recorded that represented nine families of mangrove;
- 10 sea grass species in two families;

- Deep-water habitats such as seamounts, deep-water canyons, straits (migratory corridors) and large persistent pelagic habitats were covered within Savu Sea NMP boundaries;
- Main migratory corridors and habitats for 14 whales species, seven dolphins species and one dugong species;
- Habitats for five sea turtles species (green, leatherback, olive ridley, loggerhead, and flat back), as well as for large marine fauna such as sharks, napoleon, parrotfish and groupers (Savu Sea Management Plan 2014).

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 eight key ecological features of the Commonwealth waters in the combined EMBA (covering the NMR, the NWMR and the SWMR) have been identified in the protected matters search (**Figure 10-2,Figure 10-3** and **Figure 10-1**) and are discussed in this section.

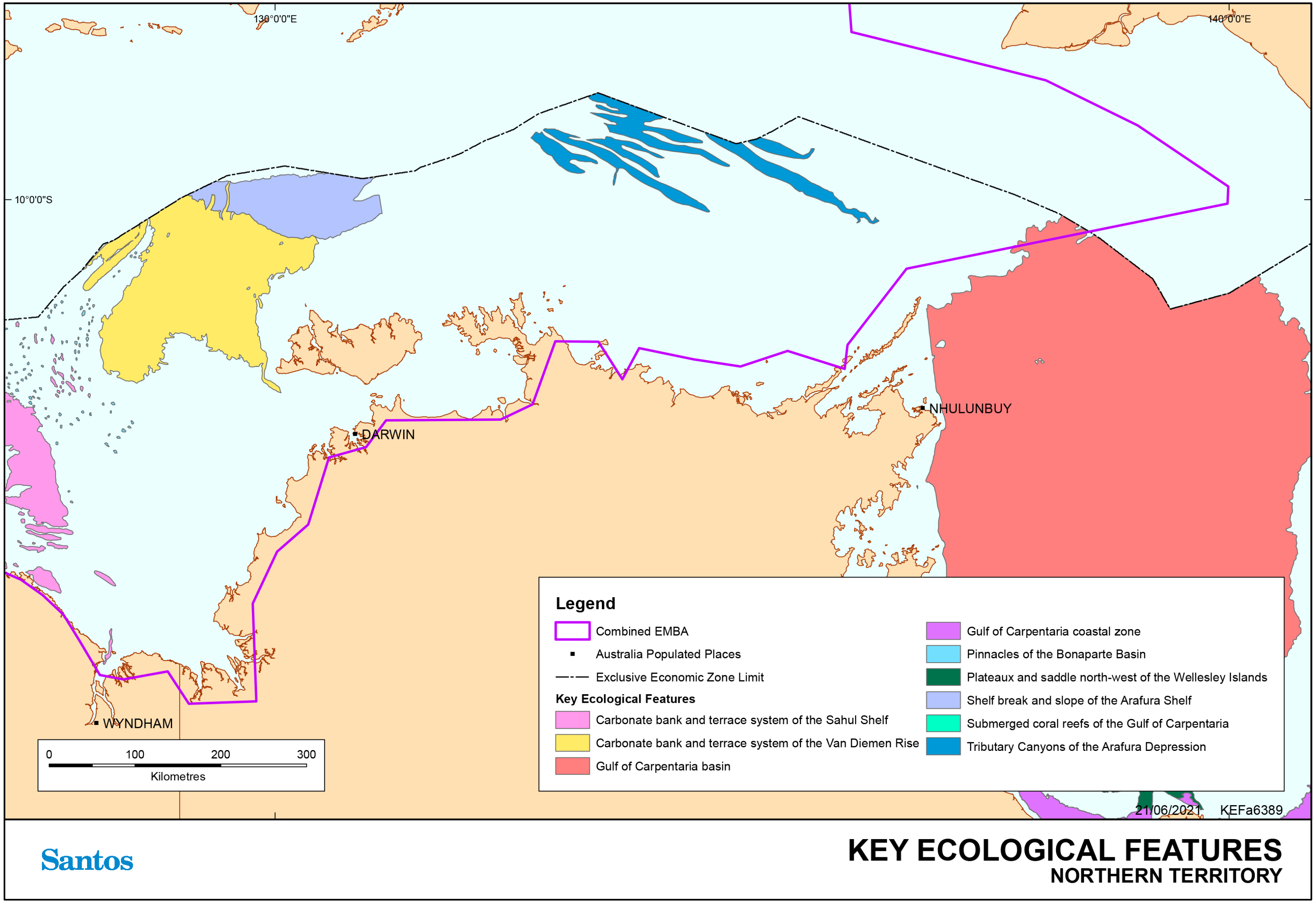


Figure 10-1: Key ecological features of NT

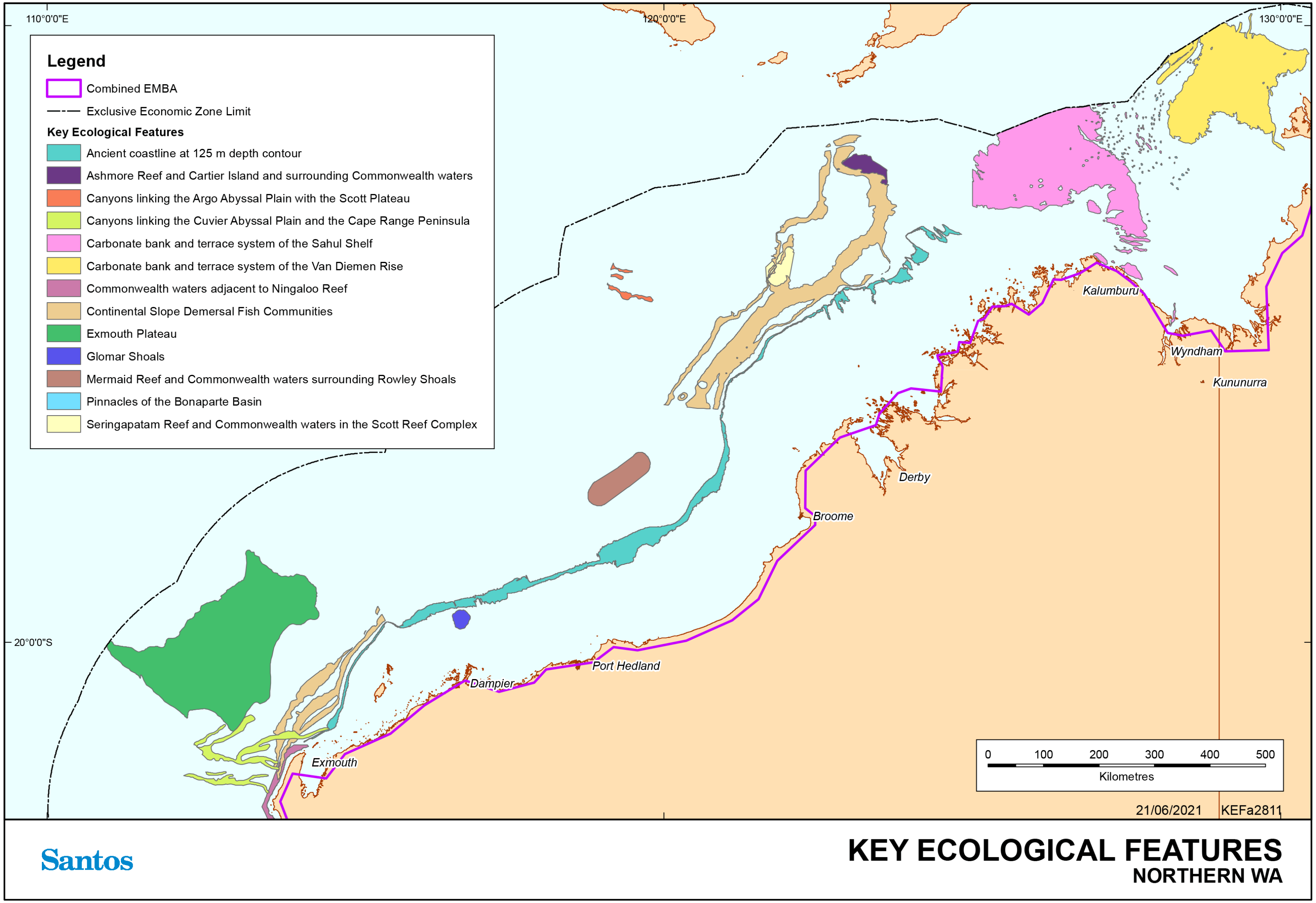


Figure 10-2: Key ecological features of Northern WA

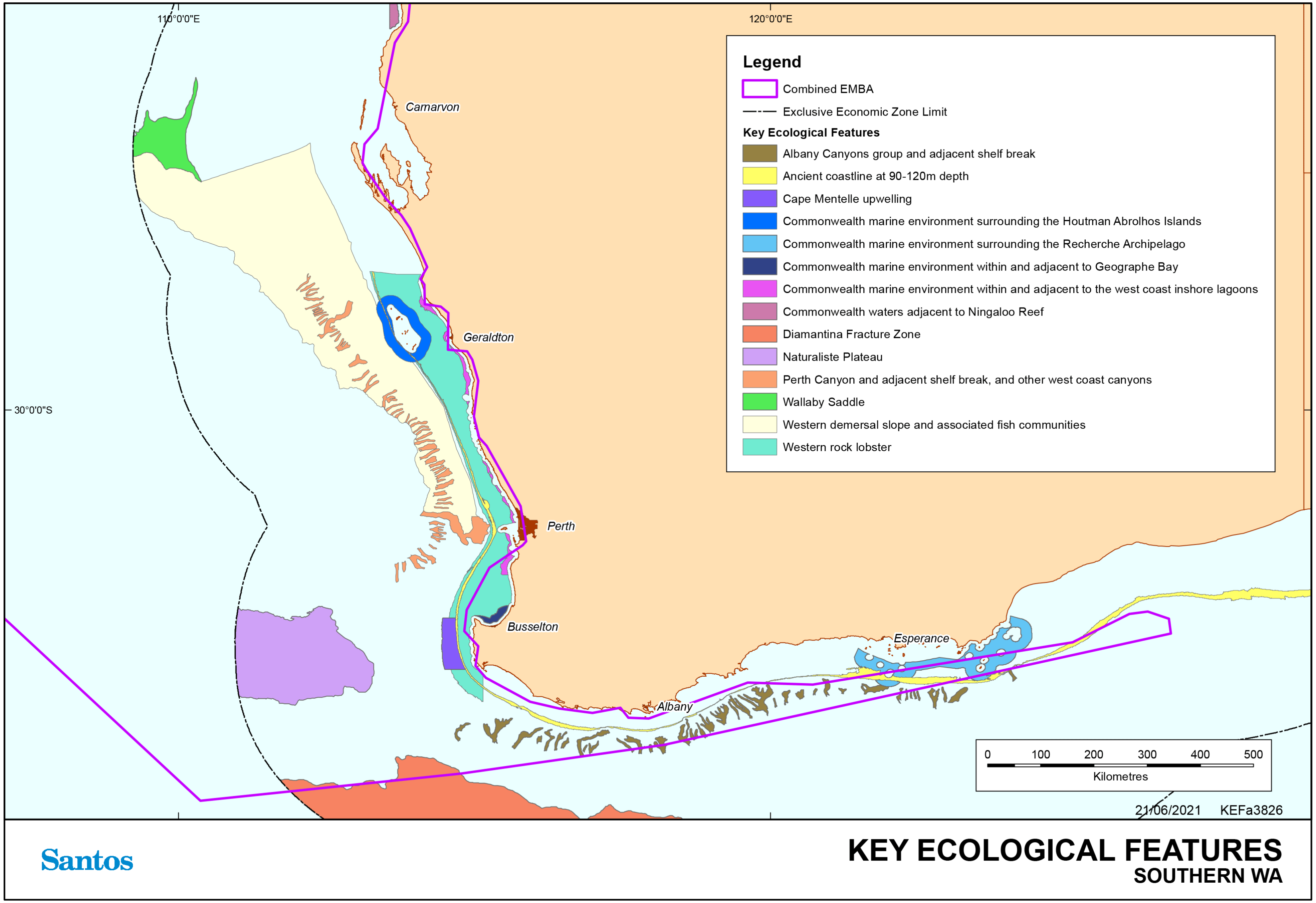


Figure 10-3: Key ecological features of Southern WA

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 Commonwealth Marine environment surrounding the Recherche Archipelago

The Recherche Archipelago is a chain of approximately 105 islands and 1 500 islets extending over 470 km of coastline near Esperance, Western Australia. This area is defined as a KEF as it is a region of high biodiversity, The Recherche Archipelago is the most extensive area of reef in the South-west Marine Region. Its reef and seagrass habitat support a high species diversity of warm temperate species, including 263 known species of fish, 347 known species of molluscs, 300 known species of sponges, and 242 known species of macroalgae. The islands also provide haul-out (resting areas) and breeding sites for Australian sea lions and New Zealand fur seals (DSEWPaC 2012)

10.1.3 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).

10.1.4 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.

10.1.5 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).

10.1.6 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.

10.1.7 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).

10.1.8 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).

10.1.9 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).

10.1.10 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).

10.1.11 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**.

10.1.12 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).

10.1.13 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).

10.1.14 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**).

10.1.15 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).

10.1.16 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).

10.1.17 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).

10.1.18 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).

10.1.19 Continental Slope Demersal Fish Communities

The Australian Continental Slope provides important habitat for demersal fish communities, characterised by high endemism and species diversity. Specifically, the continental slope between North West Cape and the Montebello Trough is the most diverse slope bioregion in Australia with more than 500 fish species, 76 of which are endemic (Last *et al*. 2005 in DSEWPaC 2012).

The Continental Slope consists of two distinct community types, associated with the upper and mid slope, 225 – 500 m and 750 – 1000 m respectively. The Timor Province and Northwest Transition bioregions are the second-richest areas for demersal fish across the entire continental slope (DSEWPaC 2012). The bacteria and fauna that is present in the system on the Continental Slope are the basis for the food web for demersal fish and higher order consumers in the system. Further information of this system has been poorly researched, though it has been suggested that it is a detritus-based system, where infauna and epifauna become prey for a range of teleost fish, molluscs and crustaceans (Brewer *et al.* 2007). The higher order consumers supported by this system are likely to be carnivorous fish, deep water sharks, large squid and toothed whales (Brewer *et al.* 2007). The pelagic production is known to be phytoplankton based, with hotspots located around oceanic reefs and islands (Brewer *et al.* 2007).

It is believed that the loss of the benthic habitat along this continental shelf region would likely lead to a decline in the species diversity and endemism that this feature is associated with (DoEE 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).

10.1.20 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**.

10.1.21 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).

10.1.22 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).

10.1.23 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.

10.1.24 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.

10.1.25 Demersal Slope and Associated Fish Communities of the Central Western Province

The demersal slope and associated fish communities of the Central Western Province 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 area supports a diverse demersal fish species assemblage of relatively small benthic species (e.g. grenadier, dogfish and cucumber fish) at depths greater than 400 m. Fish species within this area have adapted physically to feed on the seafloor and do not appear to migrate vertically to feed (Williams et al. 2001).

According to DSEWPaC (2012), the demersal slope and associated fish communities of the Central Western Province are recognised as a KEF for their high levels of biodiversity and endemism. 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. 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).

10.1.26 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).

10.1.27 Carbonate Bank and Terrace System of the Van Diemen Rise

The bank and terrace system of the Van Diemen Rise covers approximately 31,278 km^2 and forms part of the larger system associated with the Sahul Banks to the north and Londonderry Rise to the east. The feature is characterised by carbonate terrace, banks, channels and valleys, with variability in water depth and substrate composition considered to contribute to the presence of unique ecosystems in the channels. The variability in water depth and substrate composition across the feature may contribute to the presence of unique ecosystems in the channels. The carbonate banks and shoals found within the Van Diemen Rise make up 80% of the banks and shoals, 79% of the cannels and valleys, and 63% of the terrace found across the North Marine Region. The carbonate banks and shoals rise from depths of 100 m- 200 m to withing 10 m -40 m of the sea surface (Anderson et al. 2011).

The feature provides habitat for a high diversity of sponges, soft corals and other sessile filter feeders; epifauna and infauna; and olive ridley turtles, sea snakes and sharks. Rich sponge gardens and octocorals have been identified on the eastern Joseph Bonaparte Gulf along the banks, ridges and some terraces. Plains in deep hole/valleys are characterised by scattered epifauna and infauna that include polychaetes and ascidians. Epibenthic communities such as the sponges found in the channels are likely to support fish and second-order consumers. Pelagic fish such as mackerel, red snapper and a distinct gene pool of gold band snapper are found in the Van Diemen Rise.

10.1.28 Gulf of Carpentaria Basin

The Gulf of Carpentaria basin is defined as a key ecological feature for its regional importance for biodiversity, endemism and aggregations of marine life. These values apply to both the benthic and the pelagic habitats within the feature.

The Gulf of Carpentaria is believed to be one of the few remaining near-pristine marine environments in the world (Wightman et al. 2004). Primary productivity in the basin is mainly driven by cyanobacteria that fix nitrogen (Burford et al. 2009), but is also strongly influenced by seasonal processes. The soft sediments of the basin are characterised by moderately abundant and diverse communities of infauna and mobile epifauna dominated by polychaetes, crustaceans, molluscs and echinoderms.

The Gulf of Carpentaria basin also supports assemblages of pelagic fish species including planktivorous and schooling fish, and top predators such as shark, snapper, tuna and mackerel (Smith et al. 2006). The Gulf is also an important migratory route for seabirds, shore birds and marine turtles.

10.1.29 Shelf Break and Slope of the Arafura Shelf

The Shelf Break and Slope of the Arafura Shelf is an important ecological feature that creates a unique seafloor which enhances biological productivity on the edge of the shelf and attracts feeding aggregations of pelagic marine organisms. The productivity of this area has been recognised as nationally and/or regionally important (Last et al. 2005).

Although the ecosystem processes in this area are largely unknown it is thought that the oceanographic processes associated with the Indonesian Throughflow current and monsoonal winds are strong influence (DEWHA, 2007).

The physical characteristics of the Shelf Break and Slope of the Arafura Shelf comprise of continental slope, patch reefs and hard substrate pinnacles (Harris et al. 2005).

Phytoplankton and invertebrates have been sampled at this KEF and the primary production of phytoplankton is thought to be the basis for offshore food webs in the area (DEWHA, 2007). Records show approximately 284 demersal fish species in the area (Last et al. 2005) and other marine species that have been recorded include marine turtles, whale sharks and predatory fish species including sharks (DEWHA, 2008a).

10.1.30 Tributary Canyons of the Arafura Depression

The Tributary Canyons of the Arafura Depression is an important ecological feature characterised by high nutrients from upwellings of deep ocean water, which enhance productivity of the area (DEWHA, 2008a). This is thought to occur as a result of movements of water through the canyons and surface water circulating as a result of monsoonal winds (Wilson, 2005).

Surveys of the area identified around 245 macroscopic species including a variety of invertebrates and six small fish species (Wilson, 2005). The area also contains coral communities and attract aggregations of marine life (DEWHA, 2008a). Larger species found at this key ecological feature include predatory fish, whale sharks, sawfish and marine turtles (mostly olive ridley) (DEWHA, 2008a).

The national and/or regional importance of the Tributary Canyons of the Arafura Depression is associated with its high productivity, high levels of biodiversity and endemism.

11. State Marine Conservation Reserves

11.1 Introduction

Marine parks and reserves have been progressively established in Western Australia since 1987 and the Northern Territory since 1983. 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 25 marine parks within the combined EMBA (refer **Figure 9-2**, **Figure 9-3** **Figure 9-4** and **Figure 9-4**).

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 combined 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**).

Within the NT component of the combined EMBA, there are no marine based conservation reserves. There were three coastal reserves (Channel Point Coastal Reserve, Casuarina Coastal Reserve and Shoal Bay Coastal Reserve), one conservation area (Tree Point Conservation Area) and two national parks (Djukbinj National Park Garig Gunak Barlu National Park) identified in the PMST report as being situated adjacent to the combined EMBA. Three more were identified as being present (Mary River National Park, Keep River National Park, Charles Darwin National Park) in the combined EMBA from mapping. However, these are all terrestrial based reserves and have not been discussed in further detail.

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 9-2, Figure 9-3** and **Figure 9-4**). 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 combined 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 combined 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
+ Eastern Recherche Marine Park

The North-West Marine Parks Network comprises 13 marine parks which all occur in West Australian waters pertinent to the combined 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. Four of these occur in Western Australian or Northern Territory waters within the combined EMBA:

+ Oceanic Shoals Marine Park;
+ Arafura Marine Park;
+ Arnhem Marine Park; and
+ Joseph Bonaparte Gulf Marine Park.

the combined EMBAThe 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.

the combined EMBAThe 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).

Five types of zones are represented within the North Marine Parks Network:

+ National Park Zone (IUCN Category II)
+ Habitat protection zone (IUCN Category IV)
+ Multiple use zone (IUCN Category VI)
+ Special Purpose Zone (Trawl) (IUCN Category VI)
+ Special Purpose Zone (IUCN Category VI)

A summary of the South-West, North-West and North 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 combined EMBA is provided below.

12.2.1 Abrolhos Marine Park

The Abrolhos Marine Park (including zones within the combined 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 combined 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 combined 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 combined 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 combined 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 combined 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 combined 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.

12.2.8 Eastern Recherche Marine Park

The Eastern Recherche Marine Park (Special Use Zone – IUCN Category V) is part of the South-West Marine Park Network. It lies adjacent to the Recherche Archipelago about 135km east of Esperance and includesimportant foraging areas for:

+ Threatened white shark;
+ Threatened Australian sea lion
+ Pygmy blue whales are distributed across the marine park
+ Southern right whales migrate through the region to important nursery areas in coastal waters.

The marine park does not contain any international, Commonwealth or National heritage listings (Director of National Parks 2018a) but it is adjacent to the Recherche Archipelago which is home to the only breeding population of great-winged petrels in Australia.

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 combined 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 Marine Park. It covers an area of 540 km² 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 Marine Parks 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) and is wholly contained within the combined 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).

12.4.2 Arafura Marine Park

The Arafura marine park covers 22,924 km^2 and is comprised of a Multiple Use Zone and Special Purpose Zone (Trawl). The marine park is wholly contained within the combined EMBA. It is located approximately 256 km from Darwin and extends to the outer edge of the Exclusive Economic Zone and the water depth ranges from 15 m to 500 m (Director of National Parks 2018c).

The Arafura Marine Park has been deemed significant because "*it contains habitats, species and ecological communities associated with the Northern Shelf Province and Timor Transition. It includes one key ecological feature: the tributary canyons of the Arafura Depression (valued as a unique seafloor feature with ecological properties of regional significance). It is near to important wetland systems including the Cobourg Peninsula Ramsar site, and provides important foraging habitat for seabirds"* (Director of National Parks, 2018c)

The Arafura Marine Park has both cultural and natural values.

The marine park protects the following natural values (Director of National Parks, 2018c):

- Ecosystems representative of the Northern Shelf Province
- Ecosystems representative of the Timor Transition
- BIAs for Marine Turtles
- BIAs for Seabirds
- Tributary canyons of the Arafura Depression key ecological features.

The sea country of the marine park is part of the responsibility of the Yuwurrumu members of the Mandilarri-Ilduji, the Mangalara, the Murran, the Gadura-Minaga and the Ngaynjaharr clans. Sea country is valued for Indigenous cultural identity and Indigenous people have been sustainably using and managing their sea country, including the sea country within the Arafura Marine Park for tens of thousands of years (Director of National Parks, 2018c).

12.4.3 Arnhem Marine Park

The Arnhem Marine Park covers an area of 7125 km^2 and water depth ranges from less than 15 m to 70 m. The marine park is entirely comprised of a Special Purpose Zone (VI) and the majorityof the marine park is contained within the combined EMBA. It is located approximately 100 km south-east of Croker Island and 60 km south-east of the Arafura Marine Park. It extends from Northern Territory waters surrounding the Goulburn Islands, to the waters north of Maningrida (Director of National Parks 2018c).

The Arnhem Marine Park has been deemed significant because "*it contains habitats, species and ecological communities associated with the Northern Shelf Province. It includes dynamic habitats due to gently sloping shelf topped with a number of pinnacles, at depths ranging from 5 m to 30 m. It is near to important wetland systems including the Blyth-Cadell Floodplain and Boucaut Bay Nationally Important Wetland and provides important foraging habitat for seabirds*" (Director of National Parks 2018c).

The Arnhem Marine Park has both cultural and natural values.

The marine park protects the following natural values (Director of National Parks, 2018c):

+ Ecosystems representative of the Northern Shelf Province
+ Nutrient-rich coastal water contributing to high biological biodiversity
+ BIAs for Marine Turtles
+ BIAs for Seabirds

The sea country of the marine park is part of the responsibility of the coastal Aboriginal people of West Arnhem land. Sea country is valued for Indigenous cultural identity and Indigenous people have been sustainably using and managing their sea country, including the sea country within the Arnhem Marine Park for tens of thousands of years (Director of National Parks, 2018c).

No heritage listings apply to the marine park. Commercial fishing, tourism and recreation are important socio-economic values for the park (Director of National Parks 2018c).

12.4.4 Joseph Bonaparte Marine Park

The Joseph Bonaparte Gulf Marine Park is located approximately 15 km west of Wadeye, Northern Territory, and approximately 90 km north of Wyndham, Western Australia, in the Joseph Bonaparte Gulf. It is adjacent to the Western Australian North Kimberley Marine Park. The marine park covers an area of 8597 km² and water depth ranges between less than 15 m and 100 m, and is wholly contained within the combined EMBA. The marine park is comprised of two zones; Special Purpose Zone (VI) and Multiple Use Zone (VI) (Director of National Parks, 2018c).

The Joseph Bonaparte Marine Park has been deemed significant because "*it contains habitats, species and ecological communities associated with the Northwest Shelf Transition bioregion. It includes one key ecological feature: the carbonate bank and terrace system of the Sahul Shelf (valued as a unique seafloor feature with ecological properties of regional significance). The Marine Park contains a number of prominent shallow seafloor features including an emergent reef system, shoals, and sand banks. It is near an important wetland systems including the Ord River floodplain Ramsar site and provides connectivity between the nearshore and sea environments. The Marine Park includes habitats connecting to and complementing the adjacent Western Australian North Kimberley Marine Park*" (Director of National Parks, 2018c).

The Joseph Bonaparte Marine Park has both cultural and natural values.

The marine park protects the following natural values (Director of National Parks, 2018c):

+ Ecosystems representative of the Northwest Shelf Transition
+ BIAs for Marine Turtles
+ BIA for the Australian Snubfin Dolphin
+ KEFs represented in the park are:
  - Carbonate bank and terrace system of the Sahul Shelf (unique sea-floor feature)

The sea country of the marine park is part of the responsibility of the Miriuwung, Gajerrong, Doolboong, Wardenybeng and Gija and Balangarra people. Sea country is valued for Indigenous cultural identify and

Indigenous people have been sustainably using and managing their sea country, including the sea country within the Arnhem Marine Park for tens of thousands of years (Director of National Parks, 2018c).

No heritage listings apply to the marine park, however the marine park is adjacent to the West Kimberly National Heritage Place. Tourism, commercial fishing, mining and recreation are important socio-economic values for the park (Director of National Parks 2018c).

Table 12-1 Summary of marine network values, pressures, management programs and actions applicable to the combined 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 combined 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 combined EMBA: + Asian dowitcher; + Bar-tailed godwit; + Black-tailed godwit; + Broad-billed sandpiper; + Common greenshank; + Common redshank; + Common sandpiper; + Curlew Sandpiper; + Double-banded plover; + Eastern Curlew; + 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;	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
	+ Red-necked stint; + Red knot; + Ruddy turnstone; + 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

Santos

Taxa	Common name	Recovery Plan / Conservation Advice	Threats
			Predation by introduced vertebrate pests such as foxes and cats
	Red knot	Approved Conservation Advice for *Calidris canutus* (Red knot) (2016) Wildlife Conservation Plan for Migratory Shorebirds (2015)	Habitat loss and habitat degradation
			Over-exploitation of shellfish
			Pollution/contamination impacts
			Disturbance
			Direct mortality (hunting)
			Diseases
			Extreme weather events
			Climate change impacts
	Curlew sandpiper	Approved Conservation Advice for *Calidris ferruginea* (Curlew Sandpiper) (2015)	Ongoing human disturbance
			Habitat loss and degradation from pollution
			Changes to the water regime
			Invasive plants
	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)

Taxa	Common name	Recovery Plan / Conservation Advice	Threats
			Diseases
			Climate change impacts
	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

Taxa	Common name	Recovery Plan / Conservation Advice	Threats
			Climate change
			Intentional shooting/killing
			Feral pest species
			Human disturbance at the nest
			Parasites and diseases
			Loss of nesting habitat
			Competition for nest space
	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

Taxa	Common name	Recovery Plan / Conservation Advice	Threats
			Intentional shooting/killing
			Feral pest species
			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

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
	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

Taxa	Common name	Recovery Plan / Conservation Advice	Threats
	Southern giant petrel	National recovery plan for threatened albatrosses and giant petrels 2011-2016 (2011)	Incidental catch resulting from fishing operations
			Competition with fisheries for marine resources
			Dependence on discards
			Marine pollution
			Climate change
			Intentional shooting/killing
			Feral pest species
			Human disturbance at the nest
			Parasites and diseases
			Loss of nesting habitat
			Competition for nest space
	Northern giant petrel	National recovery plan for threatened albatrosses and giant petrels 2011-2016 (2011)	Incidental catch resulting from fishing operations
			Competition with fisheries for marine resources
			Dependence on discards
			Marine pollution
			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		Ongoing human disturbance

Taxa	Common name	Recovery Plan / Conservation Advice	Threats
		Approved Conservation Advice *for Numenius madagascariensis* (eastern curlew) (2015)	Habitat loss and degradation from pollution
			Changes to the water regime
			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

Taxa	Common name	Recovery Plan / Conservation Advice	Threats
			Parasites and diseases
			Loss of nesting habitat
			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

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
	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

Taxa	Common name	Recovery Plan / Conservation Advice	Threats
	Campbell 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
	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		Climate and oceanographic variability and change

Taxa	Common name	Recovery Plan / Conservation Advice	Threats
		Approved Conservation Advice for *Balaenoptera borealis* (sei whale) (2015)	Anthropogenic noise and acoustic disturbance
			Habitat degradation including pollution (increasing port expansion and coastal development)
			Pollution (persistent toxic pollutants)
			Vessel strike
			Prey depletion due to fisheries (potential threat)
			Resumption of commercial whaling (potential threat)
	Blue whale	Blue Whale Conservation Management Plan 2015 - 2025 (2015)	Whaling
			Climate Variability and Change
			Noise Interference
			Habitat Modification
			Vessel Disturbance
			Overharvesting of prey
	Fin whale	Approved Conservation Advice for *Balaenoptera physalus* (fin whale) (2015)	Climate and oceanographic variability and change
			Anthropogenic noise and acoustic disturbance
			Habitat degradation including coastal development, port expansion and aquaculture
			Pollution (persistent toxic pollutants)
			Fisheries catch, entanglement and bycatch
			Vessel strike
			Resource depletion due to fisheries (potential threat)
			Resumption of commercial whaling (potential threat)
	Southern right whale	Conservation Management Plan for the Southern Right Whale 2011 – 2021 (2012)	Entanglement
			Vessel disturbance
			Whaling

Taxa	Common name	Recovery Plan / Conservation Advice	Threats
			Climate variability and change
			Noise interference
			Habitat modification
			Overharvesting of prey
	Humpback whale	Approved Conservation Advice for *Megaptera novaeangliae* (humpback whale) (2015)	Whaling
			Climate and Oceanographic Variability and Change
			Overharvesting of Prey
			Noise Interference
			Habitat degradation including coastal development and port expansion
			Entanglement
			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

Taxa	Common name	Recovery Plan / Conservation Advice	Threats
Reptiles	Short-nosed seasnake	Approved Conservation Advice on *Aipysurus apraefrontalis* (Short-nosed 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
	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)

Taxa	Common name	Recovery Plan / Conservation Advice	Threats
			Cumulative impacts of 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

Taxa	Common name	Recovery Plan / Conservation Advice	Threats
			Degradation of foraging areas
			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)

Taxa	Common name	Recovery Plan / Conservation Advice	Threats
			Chemical and terrestrial discharge – acute (moderate), chronic (moderate)
			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)

Taxa	Common name	Recovery Plan / Conservation Advice	Threats
			Diseases and pathogens (low; unknown)
			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, Figure 14-2** and **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 combined EMBA. Existing petroleum infrastructure, permits and licences are shown in **Figure 14-1, Figure 14-2** and **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.

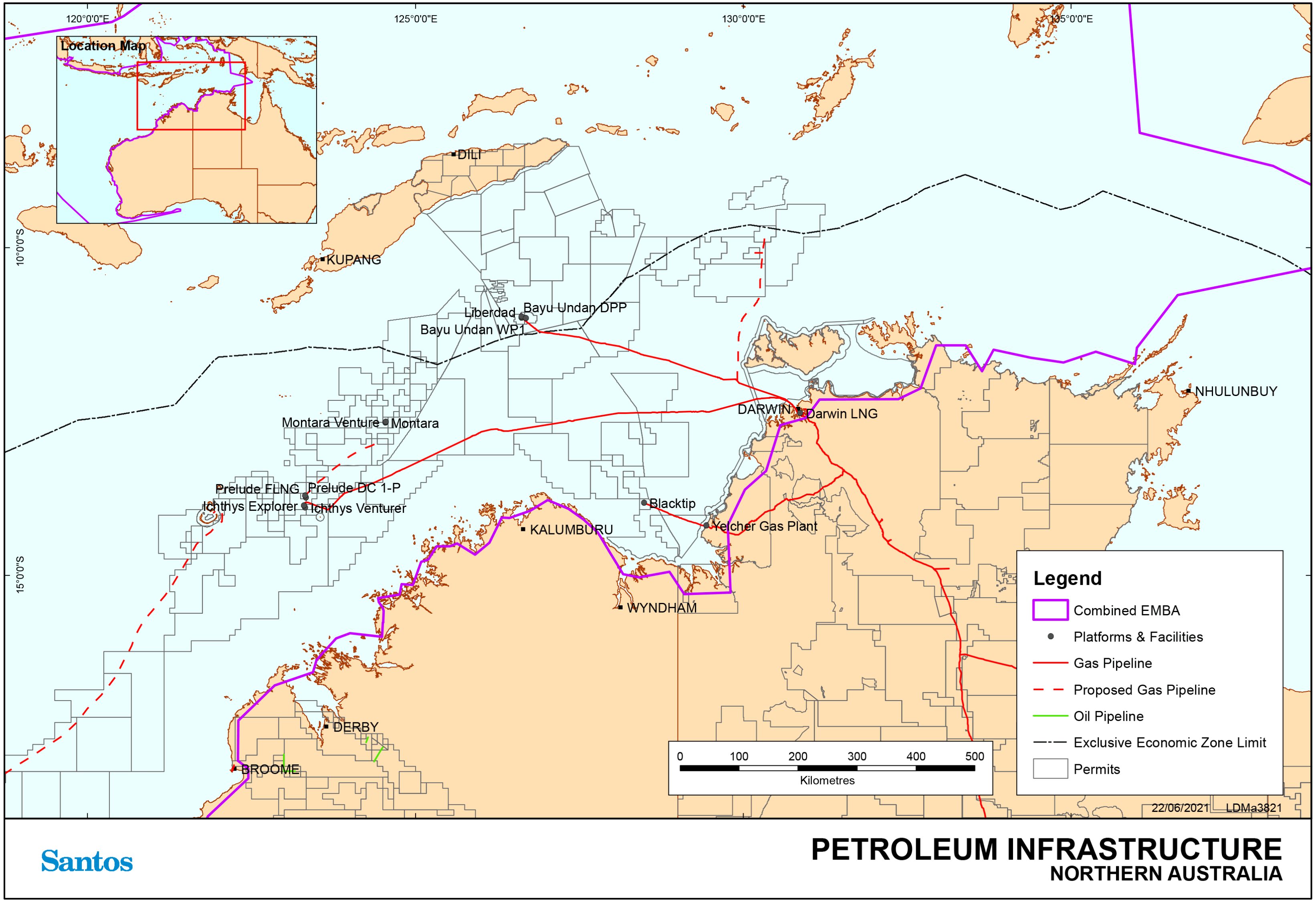


Figure 14-1: Existing petroleum infrastructure, permits and licences – Northern WA

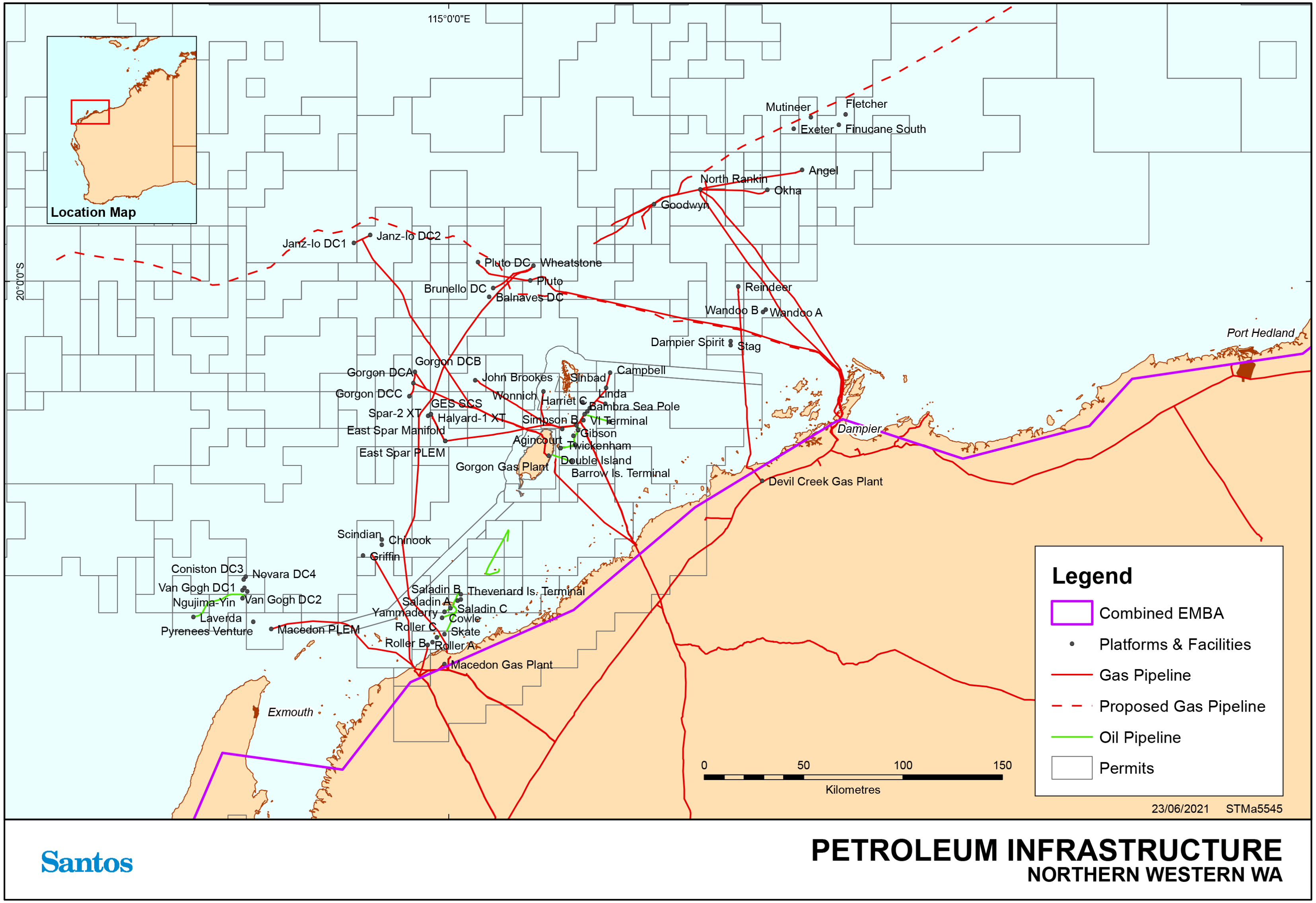


Figure 14-2: Existing petroleum infrastructure, permits and licences – Northern Western WA

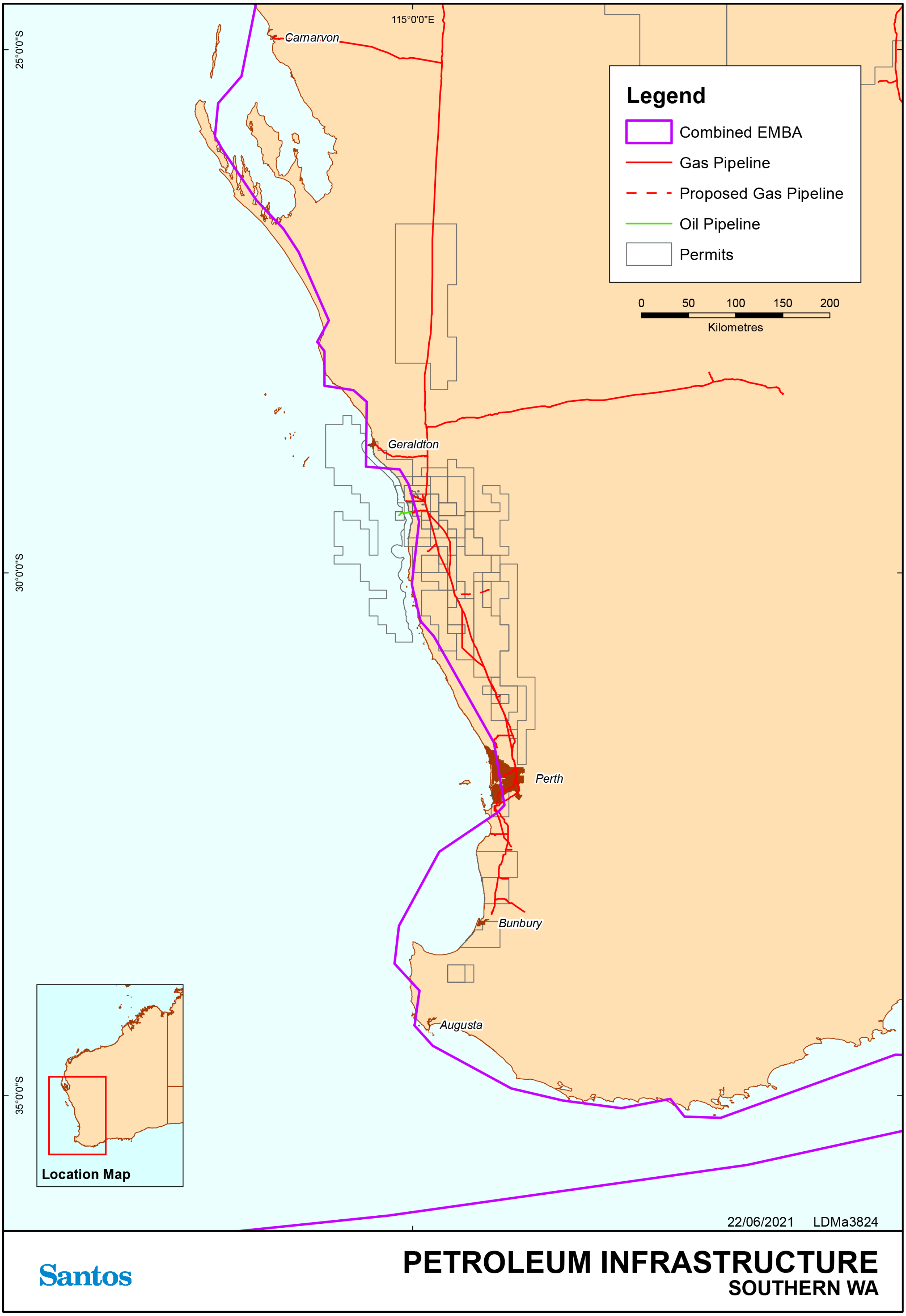


Figure 14-3: Existing petroleum infrastructure, permits and licences –Southern WA

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 combined EMBA through the AUSREP system in 2021 are shown in **Figure 14-4**.

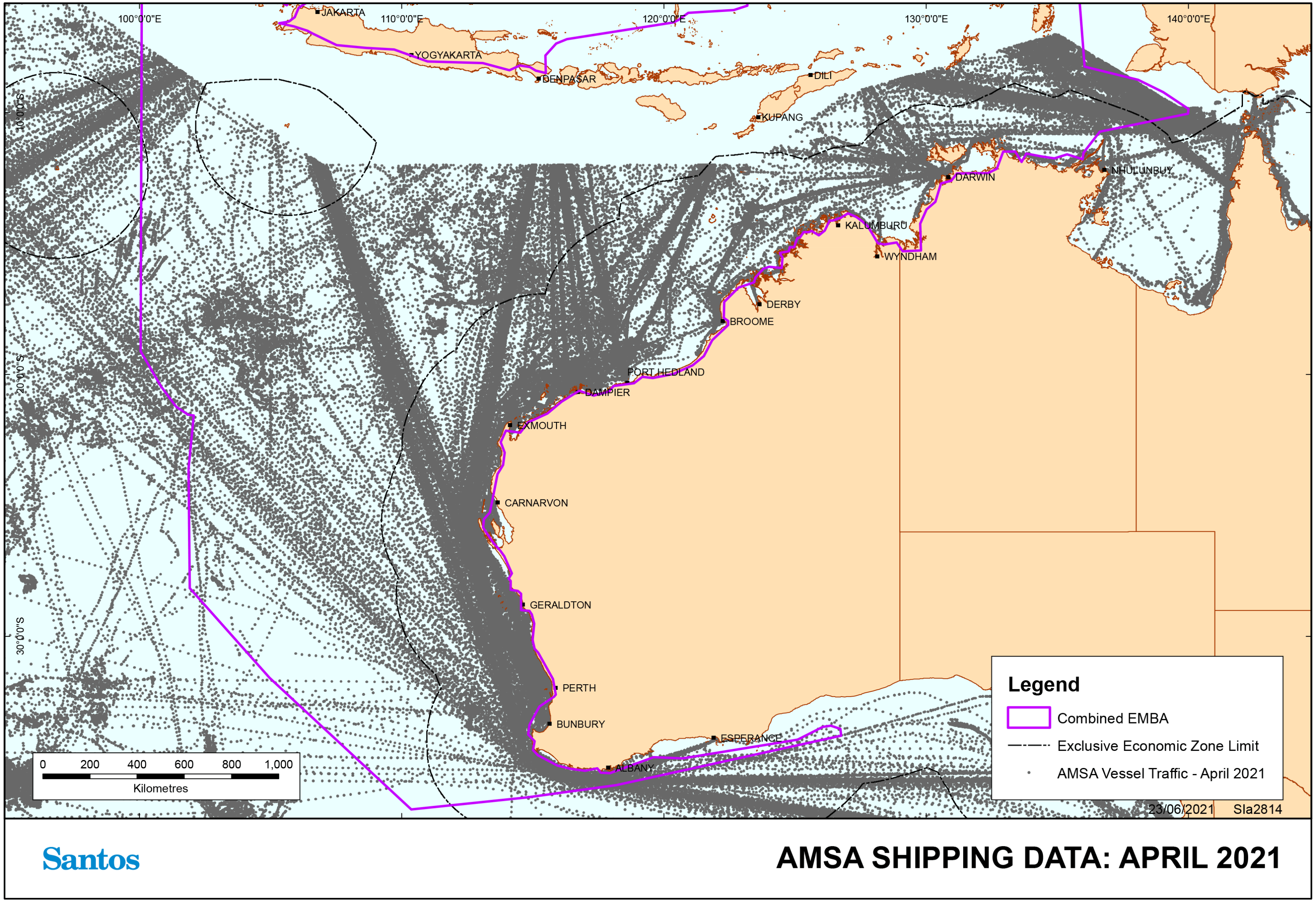


Figure 14-4:AMSA ship locations and shipping routes

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 combined 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.
+ Bradshaw Defence field training area
+ Artillery Barracks – Fremantle
+ Camble Barracks- Swanborne
+ Irwin Barracks – Karrakatta
+ Lancelin Training Area
+ Leeuwin Barracks- East Fremantle
+ Preston Point Training Depot
+ Rockingham – Navy CPSO
+ Swanbourne Rifle Range

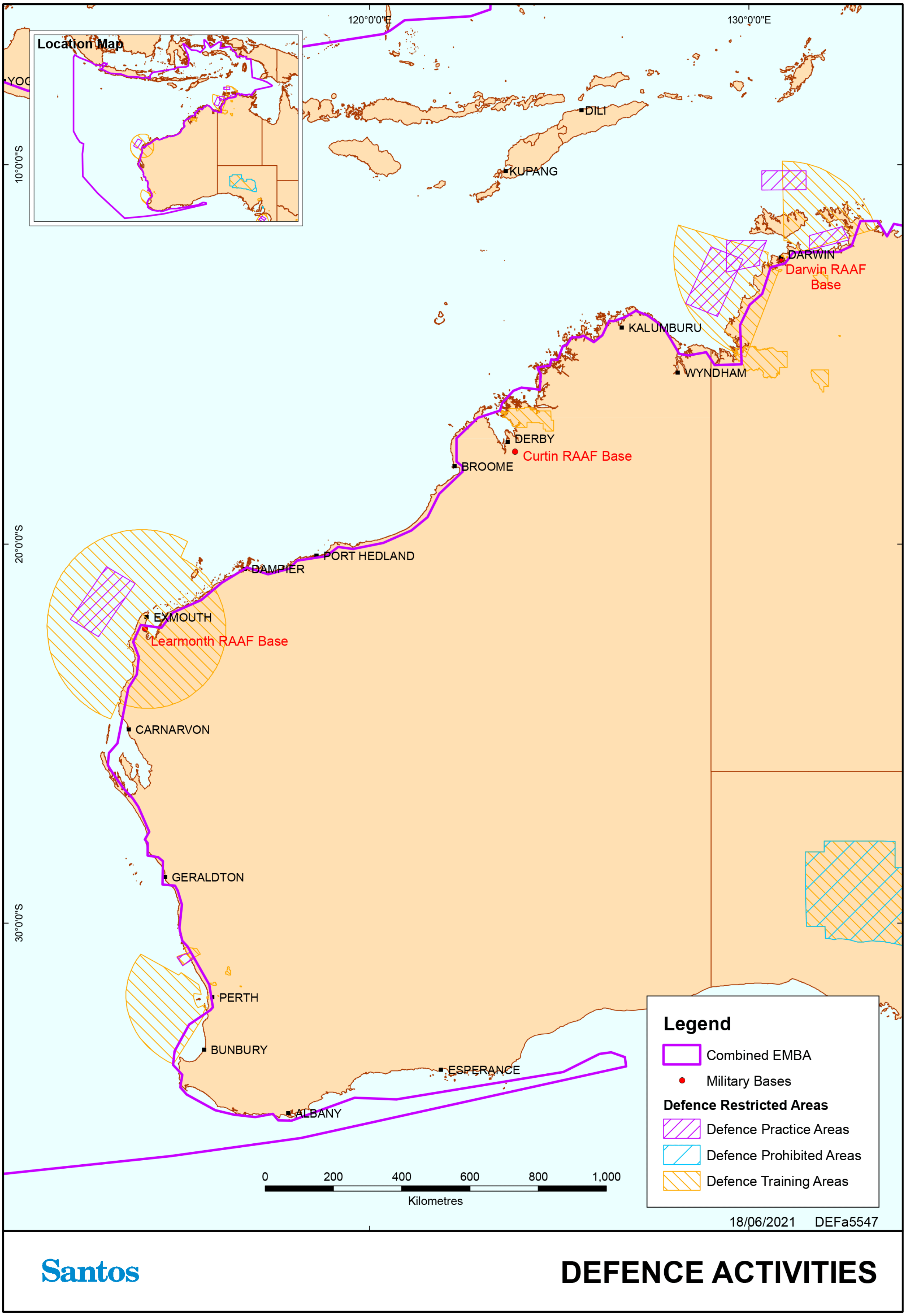


Figure 14-5: Defence activities

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. 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 combined 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). Within the combined 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).

In the Northern Territory there are a number of sacred and significant sites located on the Tiwi Islands. There are currently four registered sacred sites on the Tiwi Islands (Aboriginal Areas Protection Authority, 2016). Another 56 sites of significance to Tiwi Islanders have been recorded, including two sites on the NT mainland (Tiwi Land Council, 2003). The Tiwi Islands sites hold importance as they have high spiritual and cultural history value (Tiwi Land Council 2003).

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. the combined EMBA. Key shipwrecks in the North West Marine Region are shown in **Figure 14-10** to **Figure 14-6**, 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 combined EMBA, there are 1033 shipwrecks known to be in excess of 75 years old.

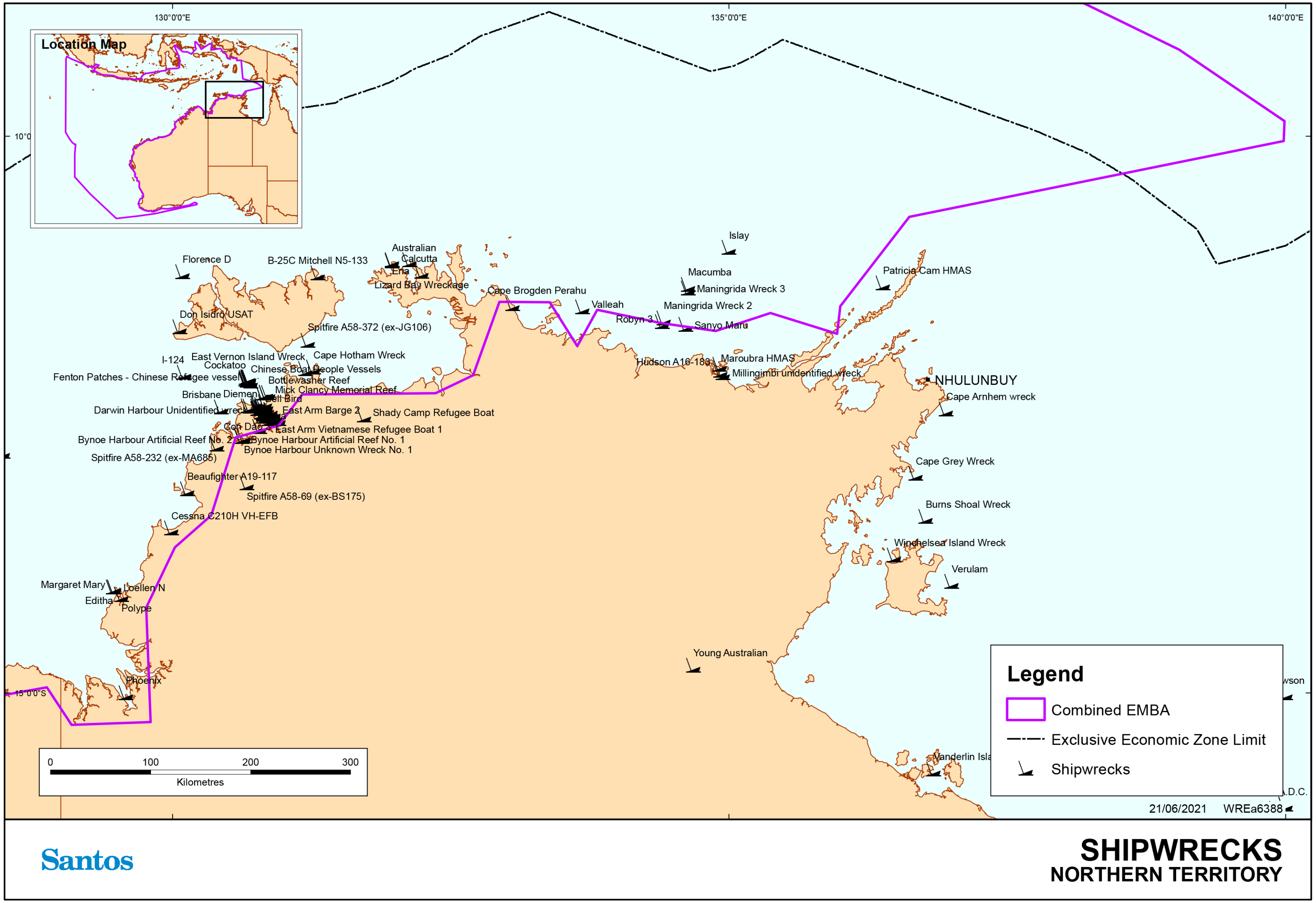


Figure 14-6: Shipwrecks –NT

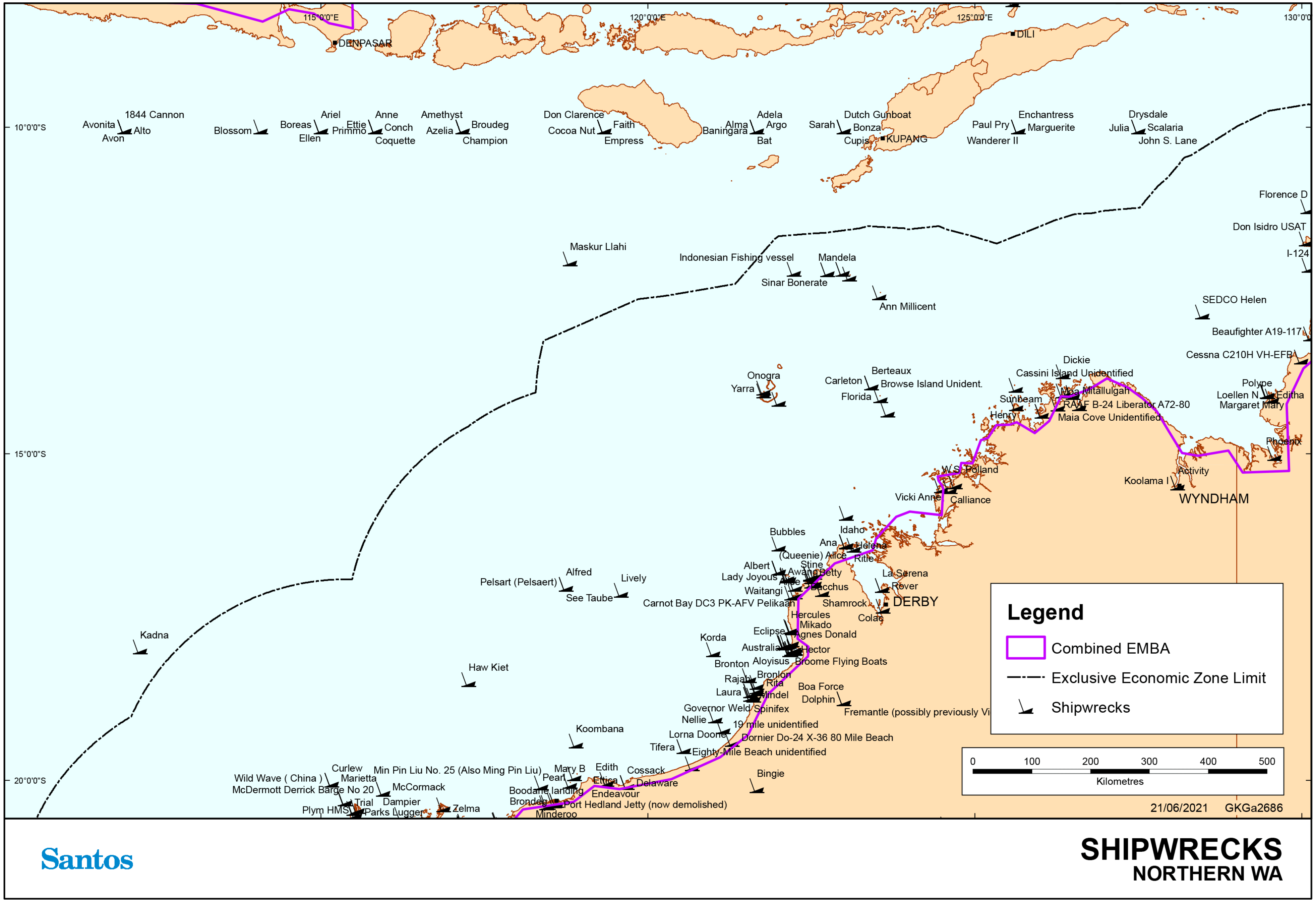


Figure 14-7: Shipwrecks – Northern WA

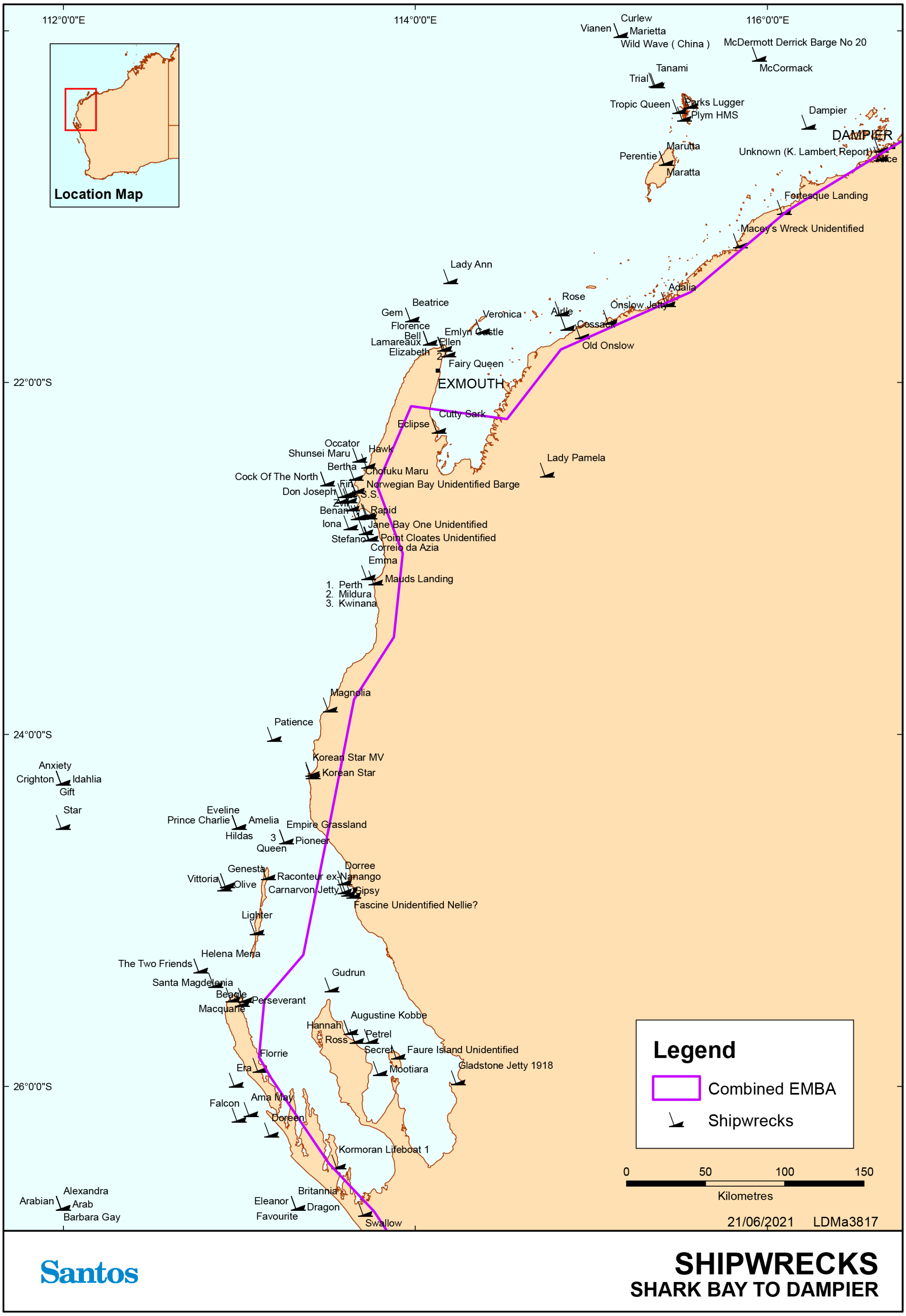


Figure 14-8: Shipwrecks – Shark Bay – Dampier

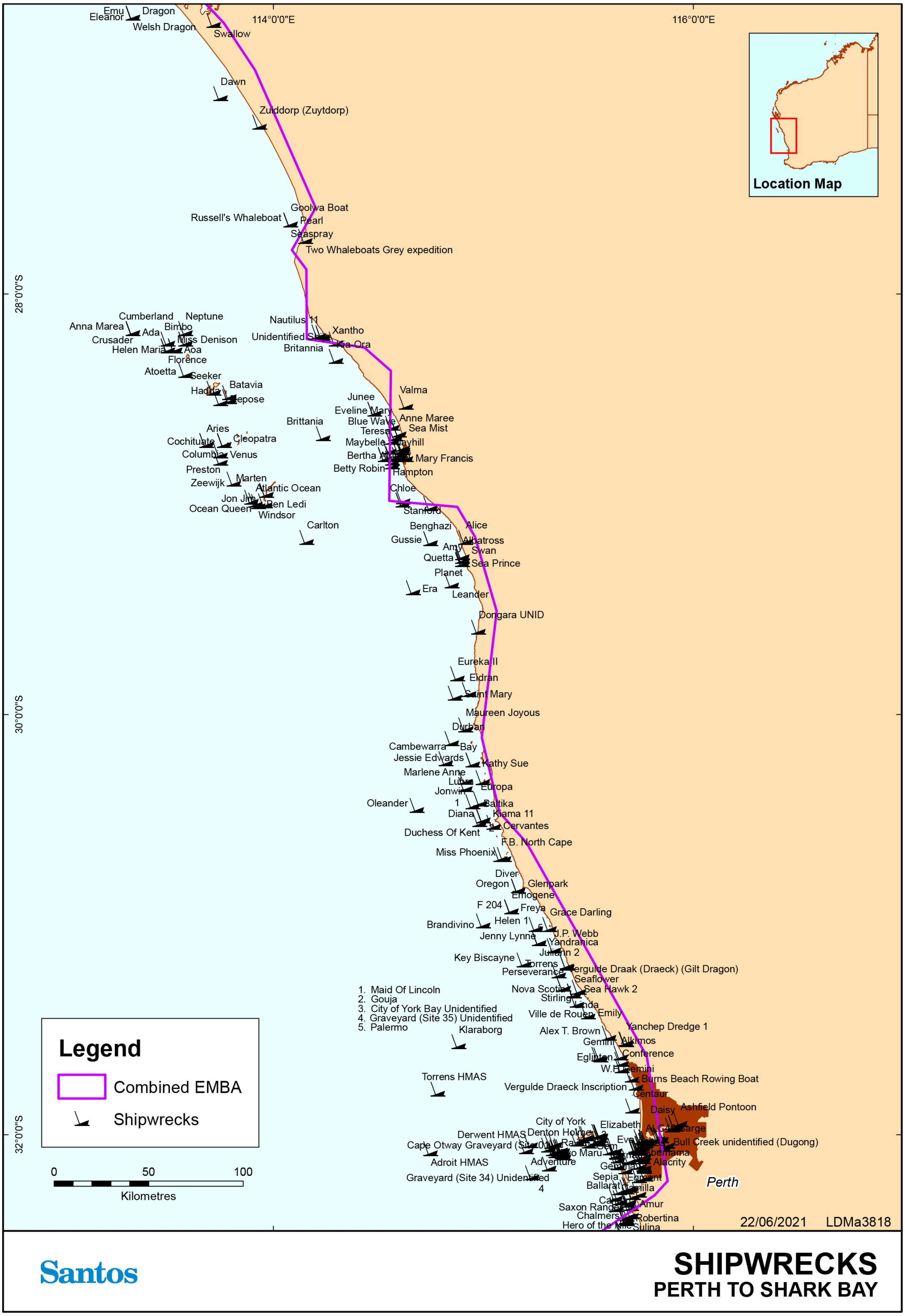


Figure 14-9: Shipwrecks – Perth – Shark Bay

Santos

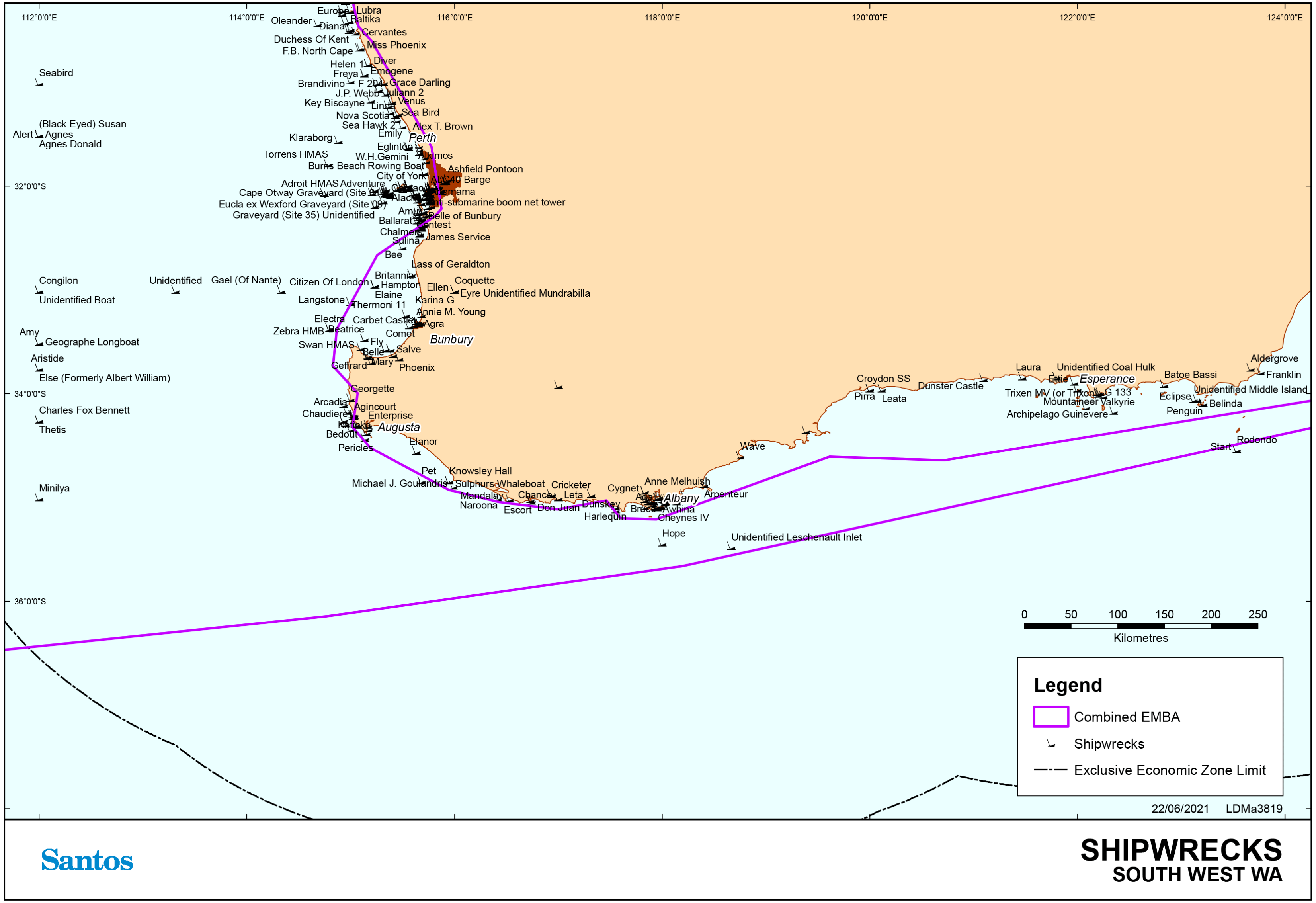


Figure 14-10: Shipwrecks – South West WA

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 14-12**. Fisheries in the Northern Territory are shown in **Figure 14-11**. A summary of all commercial fisheries in the area is also provided in **Table 14-1**. 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 14-12;**
- Broome Prawn Managed Fishery (BPMF);
- Kimberley Prawn Managed Fishery (KPMF);
- Kimberley Gillnet & Barramundi Managed Fishery (KGBF);
- Kimberley Developing Mud Crab Fishery[15]**;**
- Northern Demersal Scalefish Managed Fishery (NDSF);
- North Coast Traditional Trochus Fishery[15];
- Pilbara Demersal Scalefish Fisheries[15]**;**
- Pilbara Developing Crab Fishery[15]**;**
- Pilbara Fish Trawl (Interim) Managed Fishery (PFTIMF);
- Pilbara Trap Managed Fishery (PTMF);
- Pilbara Line Fishery;
- Western Australian Sea Cucumber Fishery;
- Mackerel Managed Fishery (Area 1 – Kimberley and Area 2 – Pilbara);
- Western Australian Pearl Oyster Fishery – referred to as Pearl Oyster Managed Fishery in **Figure 14-12;**
- Northern Shark Fisheries (closed[15]**)** including:

[15] Not shown in **Figure 14-12**

- Western Australian North Coast Shark Fishery[15]; and
- Joint Authority Northern Shark Fishery[15]
- North Coast Trochus Fishery[15]; and
- Pilbara Developing Crab Fishery[15].

Northern Territory

- Coastal Line Fishery;
- Aquarium Fishery;
- Trepang Fishery;
- Development Small Pelagic Fishery;
- Coastal Net Fishery;
- Spanish Mackerel Fishery;
- Offshore Net and Line Fishery;
- Timor Reef Fishery;
- Demersal Fishery; and
- Barramundi Fishery.

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 14-12;**
- Shark Bay Prawn Managed Fishery – referred to as Shark Bay Prawn Limited Entry Fishery on **Figure 14-12;**
- Shark Bay Beach Seine and Mesh Net Managed Fishery[15]**;**
- Shark Bay Crab Interim Managed Fishery; and
- Mackerel Fishery (Area 3 – Gascoyne/West Coast).

West Coast Bioregion

- Roe's Abalone[15]**;**
- Abrolhos Islands and Mid-West Trawl Managed Fishery (AIMWRMF) (Closed) – referred to as Abrolhos Islands and Mid-West Trawl Limited Entry Fishery in **Figure 14-12;**
- West Coast Demersal Scalefish Interim Managed Fishery (WCDSIMF);
- South West Trawl Managed Fishery – referred to as South West Trawl Limited Entry Fishery in **Figure 14-12;**
- Mandurah to Bunbury Developing Crab Fishery[15]**;**
- Cockburn Sound Crab Managed Fishery[15]**;**
- Cockburn Sound Line and Pot Managed Fishery[15]**;**
- Cockburn Sound Mussel Managed Fishery[15]**;**

- Warnbro Sound Crab Managed Fishery (closed) [15];
- West Coast Nearshore and Estuarine Finfish Fisheries, including:
- Cockburn Sound Fish Net Managed Fishery[15];
- West Coast Beach Baited Managed Fishery[15];
- South West Beach Seine Fishery[15]; and
- West Coast Estuarine Managed Fishery[15];
- Temperate Demersal Gillnet and Demersal Longline Fisheries, including:

- West Coast Demersal Gillnet and Demersal Longline (Interim) Managed Fishery (West Coast Bioregion) [15];

- West Coast Deep Sea Crab (Interim) Managed Fishery – referred to as West Coast Deep Sea Crustacean Managed Fishery in **Figure 14-12;**
- West Coast Nearshore Net Managed Fishery [15];
- Octopus Interim Managed Fishery [15];
- West Coast Rock Lobster Managed Fishery; and
- West Coast Purse Seine Fishery [15].

South Coast Bioregion

- Greenlip/Brownlip Abalone Fishery [15];
- South Coast Crustacean Managed Fishery [15];
- South Coast Deep-Sea Crab Fishery [15];
- South Coast Estuarine Managed Fishery[15];
- South Coast Open Access Netting Fishery [15]; and
- South West Coast Beach Net [15].
- South Coast Salmon Managed Fishery;
- South Coast Trawl Fishery;
- South West Coast Salmon Managed Fishery [15];
- 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 Coast Trawl Limited Entry Fishery in **Figure 14-12**; and
- Windy Harbour/Augusta Rock Lobster Managed Fishery [15].

Whole of State Fisheries

- Marine Aquarium Fish Managed Fishery (MAFMF);
- Specimen Shell Managed Fishery; and
- Hermit Crab Fishery (HCF) [15].

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 combined EMBA include as shown in **Figure 14-13**:

+ 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);
+ Small Pelagic Fishery (SPF);
+ Southern and Eastern Scalefish and Shark Fishery (SESSF) – not shown in **Figure 14-13**;
+ Skipjack Tuna Fishery (STF) (referred to as Western Skipjack Tuna Fishery in **Figure 14-13**)**;** and
+ Western Deepwater Trawl (WDTF) (referred to as Western Deepwater Trawl Fishery in **Figure 14-13**).

Commonwealth commercial fisheries between Kalbarri (WA) and the NT Border are shown **Figure 14-13** and summarised in **Table 14-1**.

14.7.3 Indonesian Commercial and Subsistence Fishing

Within the northern and north-western extent of the combined 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 14-13**) 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 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).

14.8.2 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).

14.8.3 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.

14.8.4 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).

14.8.5 Northern Territory

The Northern Territory boasts a diverse and vibrant aquaculture industry. An extensive range of commercial activity includes barramundi farming, trepang (sea cucumber), pearling and the collection of marine fish and coral for the tropical aquarium market. A pond-based barramundi farm on the Adelaide River produces more than 1,000 tonnes of Barramundi a year (Northern Territory Government, 2016). Giant clams are also farmed with trials on Groote Eylandt and Goulburn Island growing sea clams in sea-based cages. The silver-lipped pearl oyster is farmed in four main areas of the NT: Bynoe Harbour, Beagle Gulf, Cobourg Peninsula and Croker Island around the islands north west of Nhulunbuy.

14.8.6 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 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).

14.9.2 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).

14.9.3 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).

14.9.4 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).

14.9.5 Northern Territory

The most recent available data on recreational fishing in the Greater Darwin area indicates that line fishing (using bait, lures or flies) was the most common fishing method used, accounting for 72% of the total effort, followed by Mud Crab potting (23%). The use of cast nets and other fishing methods was far less common. Approximately 70% of all recreational fishing effort occurred in estuarine waters (Matthews et al, 2019). The Darwin Harbour region and its associated arms and creeks supported 40% of the total fishing effort, followed by Bynoe Harbour (14%) and Shoal Bay (6%). The offshore regions seaward of Bynoe Harbour and Dundee were the most popular sites for those fishers venturing beyond estuarine waters. Most of the catch (84%) comprised of fish species (i.e. bony fish and sharks/rays) with the bulk of the remaining catch consisting of crabs and prawns.

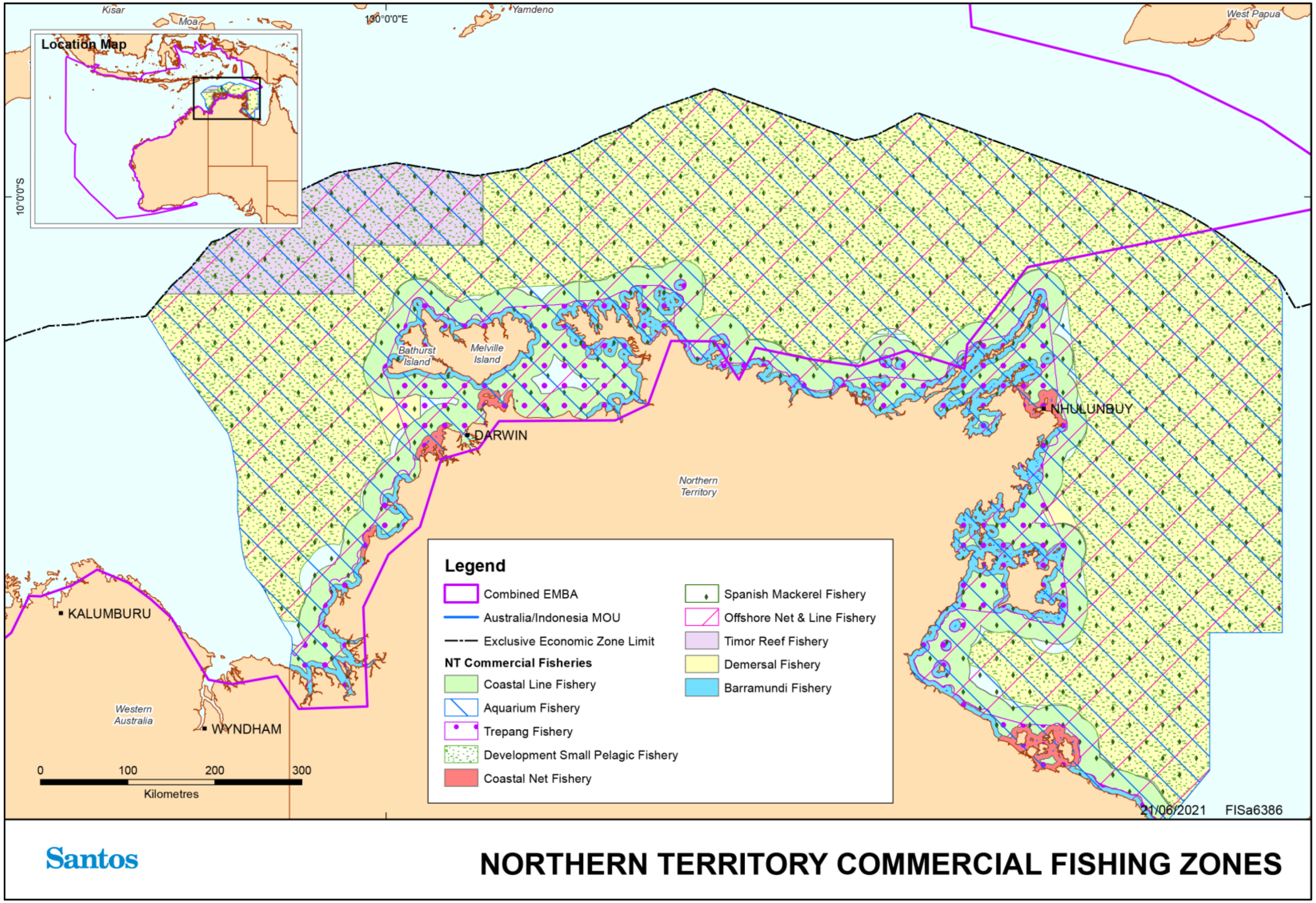


Figure 14-11:NT state commercial fishing zones

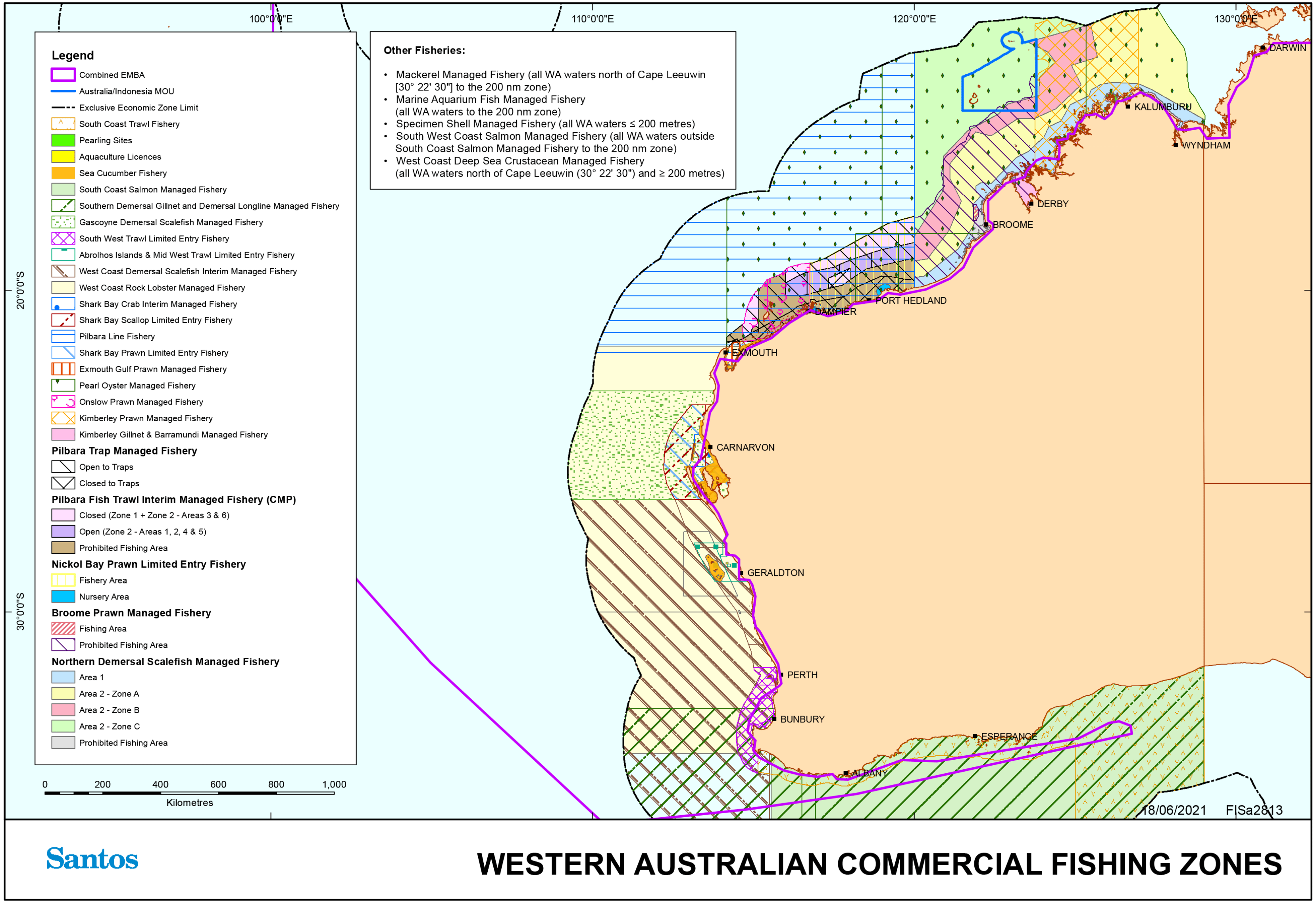


Figure 14-12:WA state commercial fishing zones

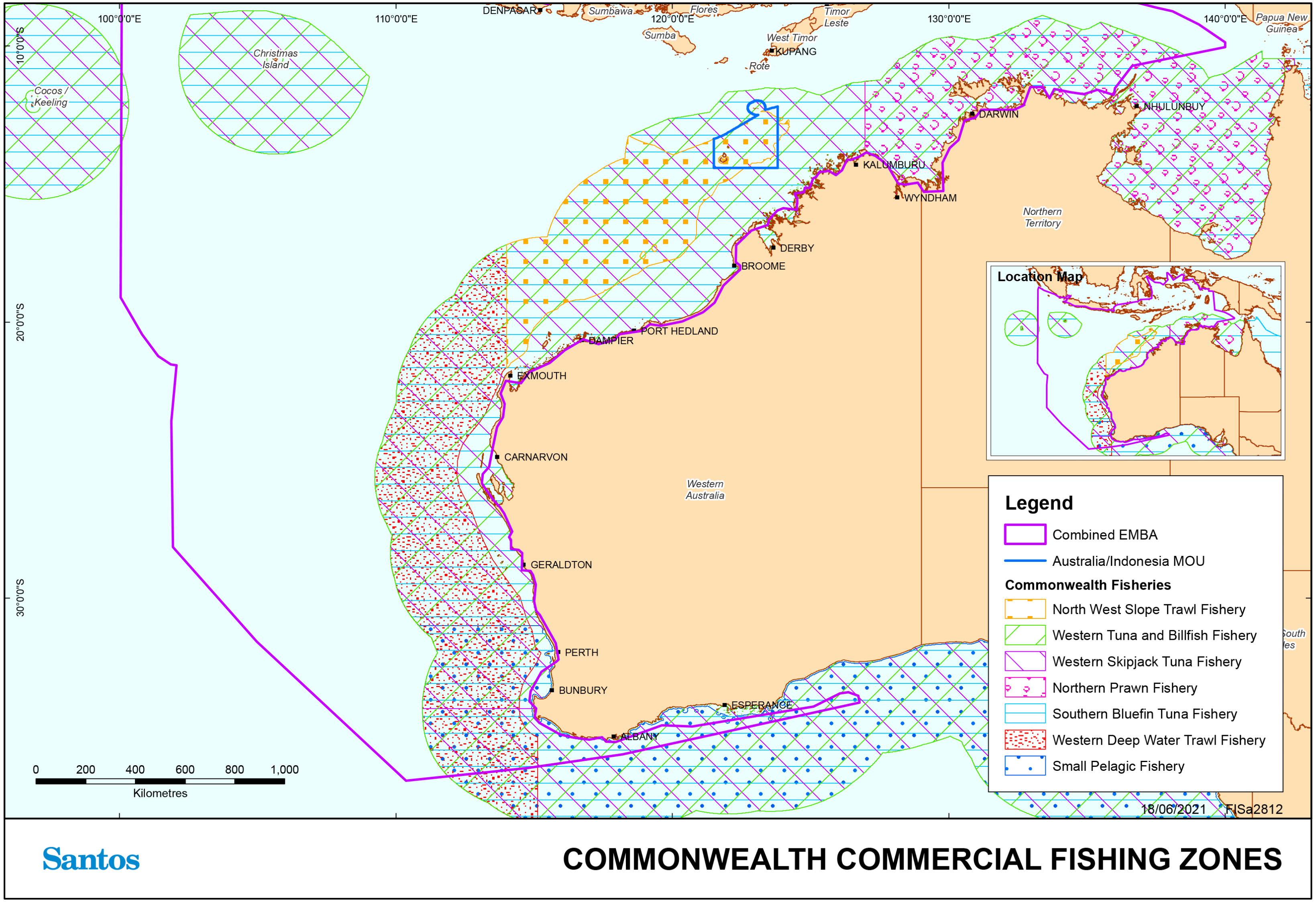


Figure 14-13: Commonwealth commercial fishing zones

Table 14-1: Commercial fisheries with permits to operate within the combined 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'.
Aquarium Fishery	Multi-species catch including; invertebtrates (hermit crabs, various snails, whelks and hard and soft corals) and finfish (rainbowfish, catfishes and scats).	Unknown	Dive-based method of collection, using barrier, cast, scoop, drag and skimmer nets, hand pumps, freshwater pumps and handheld instruments.	The Aquarium fishery is a small-scale, multi-species fishery that prospects freshwater, estuarine and marine habitats to the outer boundary of the AFZ. Most of the harvest occurs within 100km of Darwin, though one license holder does collect from two offshore locations; Evans Shoal and Lynedoch Bank. Fishing activities may occur year round.
Barramundi Fishery	Barramundi King threadfin	The fishery is restricted to 14 licences all of which are currently allocated to fishers.	Gill nets	The annual commercial barramundi fishing season in the NT is from 1 February to 30 September. Fishing is allowed from the high water mark to three nautical miles seaward of the low water mark. The area is restricted to waters seaward from the coast, river mouths and legislated closed lines
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.

Fishery	Target Species	Catch[1]	Fishing Method	Area Description
Coastal Line Fishery	Black jewfish Golden snapper	Fishery is restricted to 52 licenses, with approximately one third of these being active in 2015.	Lines, nets and traps	Fishing occurs along the NT coast between high water marks and 15 nm from low water mark. Majority of activity is concentrated around rocky reefs along the coastline within 100km from Darwin. Fishing activities occur year-round.
Coastal Net Fishery	Mullet	This fishery is restricted to five licences, all of which are allocated.	Nets	The fishery extends from the high water mark to three nautical miles out from the low water mark. The fishery is divided into regions including: • Darwin – from Cape Hotham to Native Point and Cape Ford to Cape Dooley • Gove – between Cape Arnhem and Cape Wilberforce • Borroloola – from Bing Bong Creek and Pelican Spit.
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
Demersal Fishery	Red snappers Goldband snappers	There are currently 19 licenses issued for the fishery, with around 9 active.	Handline Dropline Fish traps Although, essentially trap-based since 2002	This fishery extends from waters 15nm from the coastal waters mark to the outer limit of the AFZ, excluding the area of the Timor Reef Fishery.
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	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

Fishery	Target Species	Catch[1]	Fishing Method	Area Description
			'iron' to prise the shellfish off rocks – both commercial and recreational divers employ this method.	greenlip/brownlip abalone is managed in three separate areas.
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.

Fishery	Target Species	Catch[1]	Fishing Method	Area Description
Kimberley Prawn Managed Fishery (KPMF)	Banana prawns (*Penaeus merguiensis*) Tiger prawns (*Penaeus esculentus*) Endeavour prawns (*Metapenaeus endeavouri*) Western king prawns (*Penaeus latisulcatus*)	2017/2018: 269 tonnes	Otter trawl	The KPMF operates off the north of the state between Koolan Island and Cape Londonderry. 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).

Fishery	Target Species	Catch[1]	Fishing Method	Area Description
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 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*	2017/2018:	Line and pots	Fishery in development phase. Four main categories in WA waters. Octopus are

Fishery	Target Species	Catch[1]	Fishing Method	Area Description
	in the northern parts of the fishery, and *O.maorum* in the southern and deeper sectors.	Commercial: 257 tonnes Recreational: 1 tonne	Trawl and trap (land Octopus as byproduct)	primarily caught in the Developing Octopus Interim Managed Fishery (largest fishery) are 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.
Offshore Net and Line Fishery	Blacktip sharks Grey mackerel,	The number of licences for the fishery is restricted to 17 and only 10 boats operated in 2015. Limited effort was undertaken in the outer offshore area of the fishery during 2012.	Lines and nets	The fishery covers an area of over 522,000 km2 and extends from the NT high water mark to the boundary of the AFZ. Majority of the fishing effort is in the coastal zone (within 12 nm of the coast) and immediately offshore in the Gulf of Carpentaria.
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)	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

Fishery	Target Species	Catch[1]	Fishing Method	Area Description
			Recreational fishers use drop nets or scoop nets, with diving for crabs becoming increasingly popular	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 (*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*).	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 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	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

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 snapper (*Argyrops spinifer*), Ruby snapper (*Etelis carbunculus*) and eightbar grouper (*Hyporthodus octofasciatus)*			isobath and seaward of a line generally following the 30 m isobath.
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	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

Fishery	Target Species	Catch[1]	Fishing Method	Area Description
	endeavour prawns (*Metapenaeus* spp.) and coral prawns (various species).			
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
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

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Fishery	Target Species	Catch[1]	Fishing Method	Area Description
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.
Spanish Mackerel Fishery	Narrow-barred spanish Mackerel	In 2012, there were 16 fishery licences of which 12 were actively operating (DPIF 2014). The 2012 fishing effort was 719 boat-days; a decrease from 813 boat-days in 2011 but an increase from the 672 boat-days in 2010.	Near-surface trolling gear from vessels or handline.	The fishery extends from the NT waters seaward off the coast and river mouths to the outer limit of the AFZ. The majority of the fishing effort occurs coastal areas around reefs, shoals and headlands. The majority of the catch is taken in the Kimberley Area and north of Port Hedland.
Temperate Demersal Gillnet and Demersal Longline Fisheries (TDGDLF)	Gummy shark (*Mustelus antarcticus*), dusky shark (*Carcharhinus obscurus*), whiskery shark (*Furgaleus macki*) and sandbar shark (*Carcharhinus plumbeus*).	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 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

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Fishery	Target Species	Catch[1]	Fishing Method	Area Description
				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.
Trepang Fishery	Sea cucumber (sandfish species)	The fishery is restricted to six licences, all of which are currently allocated.	Trepang are harvested by hand, either on foot or by diving.	Commercial fishing for sea cucumber is allowed from the high water mark to three nautical miles seaward from the territorial sea baseline. Most sea cucumbers are collected along the Arnhem Land coast, mainly around the Cobourg Peninsula and Groote Eylandt
Timor Reef Fishery	Goldband snapper	Consultation undertaken in 2016 confirmed there are only two active fishers currently operating in the fishery	Drop lines primarily in the 100 m–200 m depth range	Operates in remote offshore waters in the Timor Sea in a defined area approximately 370 km north-west of Darwin.
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 (Interim) Managed Fishery	West Coast Inshore Demersals: 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*).	2017/2018: 248 tonnes	Handline and drop line	The WCDSIMF encompasses the waters of the Indian Ocean just south of Shark Bay (at 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

Fishery	Target Species	Catch[1]	Fishing Method	Area Description
	West Coast Offshore Demersals: Eightbar Grouper *Hyporthodus octofasciatus*, Hapuku *Polyprion oxygeneios*, Blue-eye Trevalla *Hyperoglyphe antarctica* and Ruby Snapper *Etelis carbunculus*.			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	<u>Nearshore:</u> 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*). <u>Estuarine:</u> sea mullet (*Mugil cephalus*), estuary cobbler (*Cnidoglanis macrocephalus*) and black bream (*Acanthopagrus butcheri*).	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. <u>Nearshore:</u> 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 various beaches from Tim's Thicket southwards to Port Geographe Bay Marina. <u>Estuarine:</u> 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

Fishery	Target Species	Catch[1]	Fishing Method	Area Description
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. 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).

Fishery	Target Species	Catch[1]	Fishing Method	Area Description
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 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				

Fishery	Target Species	Catch[1]	Fishing Method	Area Description
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 (*Trachurus declivis*) and redbait (*Emmelichthys nitidus*).	2018-19: 9,424 tonnes	Purse-seine and midwater trawling	Extends from Queensland to southern Western Australia.
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.	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

Fishery	Target Species	Catch[1]	Fishing Method	Area Description
			Around 98% of Australia's SBT quota is taken by 5–10 purse seine vessels fishing for 13–25 kg southern bluefin tuna.	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 combined 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**).

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16.10 Key Ecological Features

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Appendix A: EPBC Act Protected Matters 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.

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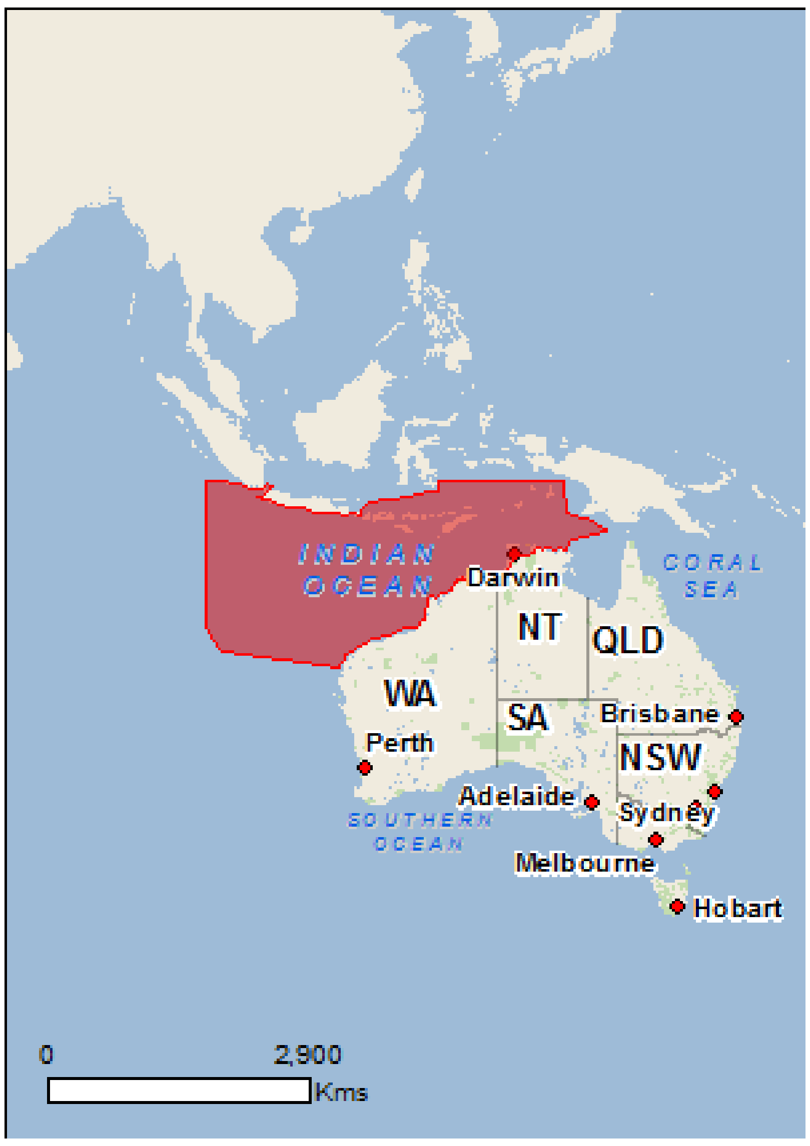

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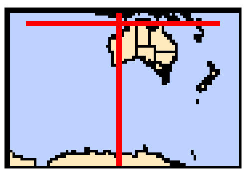

Summary

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:	3
Wetlands of International Importance:	6
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	2
Listed Threatened Ecological Communities:	3
Listed Threatened Species:	103
Listed Migratory Species:	92

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:	33
Commonwealth Heritage Places:	23
Listed Marine Species:	164
Whales and Other Cetaceans:	32
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	2
Australian Marine Parks:	27

Extra Information

This part of the report provides information that may also be relevant to the area you have nominated.

State and Territory Reserves:	45
Regional Forest Agreements:	None
Invasive Species:	47
Nationally Important Wetlands:	17
Key Ecological Features (Marine)	17

Details

Matters of National Environmental Significance

World Heritage Properties [Resource Information]

Name	State	Status
Kakadu National Park	NT	Declared property
The Ningaloo Coast	WA	Declared property

National Heritage Properties [Resource Information]

Name	State	Status
Natural		
Kakadu National Park	NT	Listed place
The Ningaloo Coast	WA	Listed place
The West Kimberley	WA	Listed place

Wetlands of International Importance (Ramsar) [Resource Information]

Name	Proximity
Ashmore reef national nature reserve	Within Ramsar site
Cobourg peninsula	Within Ramsar site
Hosnies spring	Within Ramsar site
Kakadu national park	Within Ramsar site
Ord river floodplain	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

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
Monsoon vine thickets on the coastal sand dunes of Dampier Peninsula	Endangered	Community likely to occur within area
Monsoon vine thickets on the coastal sand dunes of Dampier Peninsula	Endangered	Community likely to occur within area
Monsoon vine thickets on the coastal sand dunes of Dampier Peninsula	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

Name	Status	Type of Presence
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 habitat known to occur within area
Calidris tenuirostris Great Knot [862]	Critically Endangered	Roosting 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
Epthianura crocea tunneyi Alligator Rivers Yellow Chat, Yellow Chat (Alligator Rivers) [67089]	Endangered	Species or species habitat known to occur within area
Erythrotriorchis radiatus Red Goshawk [942]	Vulnerable	Species or species habitat known 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
Geophaps smithii smithii Partridge Pigeon (eastern) [64441]	Vulnerable	Species or species habitat known to occur within area
Limosa lapponica baueri Nunivak Bar-tailed Godwit, Western Alaskan Bar-tailed Godwit [86380]	Vulnerable	Species or species habitat known 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
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
Melanodryas cucullata melvillensis Tiwi Islands Hooded Robin, Hooded Robin (Tiwi	Critically Endangered	Species or species

Name	Status	Type of Presence
Islands) [67092]		habitat known to occur within area
Mirafra javanica melvillensis Horsfield's Bushlark (Tiwi Islands) [81011]	Vulnerable	Species or species habitat known 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
Papasula abbotti Abbott's Booby [59297]	Endangered	Species or species habitat known to 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
Pterodroma arminjoniana Round Island Petrel, Trinidade Petrel [89284]	Critically Endangered	Species or species habitat may occur within area
Pterodroma mollis Soft-plumaged Petrel [1036]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Rostratula australis Australian Painted Snipe [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 impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area
Turdus poliocephalus erythropleurus Christmas Island Thrush [67122]	Endangered	Species or species habitat likely to occur within area
Tyto novaehollandiae kimberli Masked Owl (northern) [26048]	Vulnerable	Species or species habitat known to occur within area
Tyto novaehollandiae melvillensis Tiwi Masked Owl, Tiwi Islands Masked Owl [26049]	Endangered	Species or species habitat known 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		
Antechinus bellus Fawn Antechinus [344]	Vulnerable	Species or species habitat known to occur within area
Balaenoptera borealis Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour likely

Name	Status	Type of Presence
		to occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Migration route known to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Bettongia lesueur Barrow and Boodie Islands subspecies Boodie, Burrowing Bettong (Barrow and Boodie Islands) [88021]	Vulnerable	Species or species habitat known to occur within area
Conilurus penicillatus Brush-tailed Rabbit-rat, Brush-tailed Tree-rat, Pakooma [132]	Vulnerable	Species or species habitat known to occur within area
Crocidura trichura Christmas Island Shrew [86568]	Critically Endangered	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 known to occur within area
Eubalaena australis Southern Right Whale [40]	Endangered	Species or species habitat likely 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
Macroderma gigas Ghost Bat [174]	Vulnerable	Breeding likely to occur within area
Macrotis lagotis Greater Bilby [282]	Vulnerable	Species or species habitat may 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 known to occur within area
Mesembriomys gouldii melvillensis Black-footed Tree-rat (Melville Island) [87619]	Vulnerable	Species or species habitat known to occur within area
Osphranter robustus isabellinus Barrow Island Wallaroo, Barrow Island Euro [89262]	Vulnerable	Species or species habitat likely to occur within area
Petrogale concinna canescens Nabarlek (Top End) [87606]	Endangered	Species or species habitat likely to occur within area
Petrogale concinna concinna Nabarlek (Victoria River District) [87605]	Critically Endangered	Species or species habitat likely to occur

Name	Status	Type of Presence
		within area
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 pirata Northern Brush-tailed Phascogale [82954]	Vulnerable	Species or species habitat known to occur within area
Phascogale tapoatafa kimberleyensis Kimberley brush-tailed phascogale, Brush-tailed Phascogale (Kimberley) [88453]	Vulnerable	Species or species habitat known to 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 known to occur within area
Sminthopsis butleri Butler's Dunnart [302]	Vulnerable	Species or species habitat known to occur within area
Trichosurus vulpecula arnhemensis Northern Brushtail Possum [83091]	Vulnerable	Species or species habitat known to occur within area
Xeromys myoides Water Mouse, False Water Rat, Yirrkoo [66]	Vulnerable	Species or species habitat known to occur within area
Plants		
Asplenium listeri Christmas Island Spleenwort [65865]	Critically Endangered	Species or species habitat known to occur within area
Burmannia sp. Bathurst Island (R.Fensham 1021) [82017]	Endangered	Species or species habitat likely to occur within area
Hoya australis subsp. oramicola a vine [55436]	Vulnerable	Species or species habitat known to occur within area
Mitrella tiwiensis a vine [82029]	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
Stylidium ensatum a triggerplant [86366]	Endangered	Species or species habitat known to occur within area
Tectaria devexa [14767]	Endangered	Species or species habitat likely to occur within area
Typhonium jonesii a herb [62412]	Endangered	Species or species habitat known to occur within area

Name	Status	Type of Presence
Typhonium mirabile a herb [79227]	Endangered	Species or species habitat known to occur within area
Typhonium taylori a herb [65904]	Endangered	Species or species habitat likely to occur within area
Xylopia monosperma a shrub [82030]	Endangered	Species or species habitat known to occur within area
Reptiles		
Acanthophis hawkei Plains Death Adder [83821]	Vulnerable	Species or species habitat known to occur within area
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
Cryptoblepharus gurrmul Arafura Snake-eyed Skink [83106]	Endangered	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
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Breeding known to occur within area
Lepidochelys olivacea Olive Ridley Turtle, Pacific Ridley Turtle [1767]	Endangered	Breeding 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
Lucasium occultum Yellow-snouted Gecko, Yellow-snouted Ground Gecko [82993]	Endangered	Species or species habitat likely 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		

Name	Status	Type of Presence
Carcharias taurus (west coast population) Grey Nurse Shark (west coast population) [68752]	Vulnerable	Species or species habitat known to occur within area
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat known to occur within area
Glyphis garricki Northern River Shark, New Guinea River Shark [82454]	Endangered	Breeding known to occur within area
Glyphis glyphis Speartooth Shark [82453]	Critically Endangered	Species or species habitat 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 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]		Breeding 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]		Species or species habitat likely to occur within area
Ardenna pacifica Wedge-tailed Shearwater [84292]		Breeding known to occur within area
Calonectris leucomelas Streaked Shearwater [1077]		Species or species habitat 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
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
Onychoprion anaethetus Bridled Tern [82845]		Breeding known to occur within area

Name	Threatened	Type of Presence
Phaethon lepturus White-tailed Tropicbird [1014]		Breeding known to occur within area
Phaethon rubricauda Red-tailed Tropicbird [994]		Breeding known to occur within area
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 impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area
Migratory Marine Species		
Anoxypristis cuspidata Narrow Sawfish, Knifetooth Sawfish [68448]		Species or species habitat known to occur within area
Balaena glacialis australis Southern Right Whale [75529]	Endangered*	Species or species habitat likely to occur within area
Balaenoptera bonaerensis Antarctic Minke Whale, Dark-shoulder Minke Whale [67812]		Species or species habitat likely to occur within area
Balaenoptera borealis Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Balaenoptera edeni Bryde's Whale [35]		Species or species habitat likely to occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Migration route known to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Carcharhinus longimanus Oceanic Whitetip Shark [84108]		Species or species habitat likely to occur within area
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat known to occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Breeding known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Breeding known to occur within area
Crocodylus porosus Salt-water Crocodile, Estuarine Crocodile [1774]		Species or species habitat likely to occur within area

Name	Threatened	Type of Presence
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	Breeding 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]		Species or species habitat may 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	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]		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

Name	Threatened	Type of Presence
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 within area
Calidris subminuta Long-toed Stint [861]		Roosting known to occur within area
Calidris tenuirostris Great Knot [862]	Critically Endangered	Roosting known to occur within area
Charadrius dubius Little Ringed Plover [896]		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

Name	Threatened	Type of Presence
		within area
Charadrius veredus Oriental Plover, Oriental Dotterel [882]		Roosting known to occur within area
Gallinago megala Swinhoe's Snipe [864]		Roosting known 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
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 Greater Crested Tern [83000]		Breeding known to occur within area
Tringa brevipes Grey-tailed Tattler [851]		Roosting known to occur within area
Tringa glareola Wood Sandpiper [829]		Roosting known to occur within area
Tringa incana Wandering Tattler [831]		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
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 - Australian Customs Service
Commonwealth Land - Australian Government Solicitor
Commonwealth Land - Christmas Island National Park
Commonwealth Land - Department of Administrative Services
Commonwealth Land - Department of Community Services & Health
Commonwealth Land - Department of Immigration Local Government & Ethnic Affairs
Commonwealth Land - Department of Transport & Regional Development
Commonwealth Land - Deputy Crown Solicitor
Commonwealth Land - Director of Property Services Defence Estate
Commonwealth Land - Kakadu National Park
Defence - AUSTRALIAN ARMY BAND - DARWIN
Defence - BERRIMAH ONE
Defence - BRADSHAW FIELD TRAINING AREA
Defence - DARWIN - AP10 RADAR SITE - LEE POINT
Defence - DARWIN - AP3 RECEIVING STATION - LEE POINT
Defence - DARWIN - TRANSMITTING STATION '11 MILE'
Defence - DARWIN RELOCATIONS CENTRE
Defence - DEFENCE FORCE CAREERS REFERENCE CENTRE
Defence - Esanda Builidng
Defence - HMAS COONAWARRA (Berrimah)
Defence - KOWANDI NORTH COMMUNICATION STATION
Defence - LARRAKEYAH BARRACKS
Defence - LEANYER BOMBING RANGE
Defence - MT GOODWIN RADAR SITE
Defence - Patrol Boat Base (DARWIN NAVAL BASE)
Defence - QUAIL ISLAND BOMBING RANGE
Defence - RAAF BASE DARWIN
Defence - ROBERTSON BARRACKS (Waler Barracks)
Defence - SHOAL BAY RECEIVING STATION
Defence - STOKES HILL OIL FUEL INSTALLATION
Defence - WINNELLIE ONE
Defence - WINNELLIE TWO

Commonwealth Heritage Places [Resource Information]

Name	State	Status
Natural		
Ashmore Reef National Nature Reserve	EXT	Listed place
Bradshaw Defence Area	NT	Listed place
Christmas Island Natural Areas	EXT	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		
Administrators House Precinct	EXT	Listed place
Bungalow 702	EXT	Listed place
Drumsite Industrial Area	EXT	Listed place
Industrial and Administrative Group	EXT	Listed place
Larrakeyah Barracks Headquarters Building	NT	Listed place
Larrakeyah Barracks Precinct	NT	Listed place
Larrakeyah Barracks Sergeants Mess	NT	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
RAAF Base Commanding Officers Residence	NT	Listed place
RAAF Base Precinct	NT	Listed place
RAAF Base Tropical Housing Type 2	NT	Listed place
RAAF Base Tropical Housing Type 3	NT	Listed place

Name	State	Status
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 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]		Roosting 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
Charadrius dubius Little Ringed Plover [896]		Roosting known to occur

Name	Threatened	Type of Presence
		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
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 known 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 habitat known to occur within area
Heteroscelus brevipes Grey-tailed Tattler [59311]		Roosting known to occur within area
Heteroscelus incanus Wandering Tattler [59547]		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 novaehollandiae Silver Gull [810]		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

Name	Threatened	Type of Presence
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	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
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
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
Pluvialis fulva Pacific Golden Plover [25545]		Roosting known to occur within area
Pluvialis squatarola Grey Plover [865]		Roosting known to occur within area
Pterodroma mollis Soft-plumaged Petrel [1036]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Puffinus carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [1043]		Species or species habitat likely to occur within area
Puffinus pacificus Wedge-tailed Shearwater [1027]		Breeding known to occur within area
Rhipidura rufifrons Rufous Fantail [592]		Species or species habitat 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]		Breeding known to occur within area
Sterna anaethetus Bridled Tern [814]		Breeding known to occur within area

Name	Threatened	Type of Presence
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 impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may 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
Tringa stagnatilis Marsh Sandpiper, Little Greenshank [833]		Roosting known to occur within area
Xenus cinereus Terek Sandpiper [59300]		Roosting known to occur within area
Fish		
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 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

Name	Threatened	Type of Presence
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 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 cinctus Girdled Pipefish [66214]		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

Name	Threatened	Type of Presence
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
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 parvicarinatus Short-keel Pipefish, Short-keeled Pipefish [66230]		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 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

Name	Threatened	Type of Presence
Hippocampus trimaculatus Three-spot Seahorse, Low-crowned Seahorse, Flat-faced Seahorse [66720]		Species or species habitat may occur within area
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
Phoxocampus belcheri Black Rock Pipefish [66719]		Species or species habitat may occur within area
Solegnathus hardwickii Pallid Pipehorse, Hardwick's Pipehorse [66272]		Species or species habitat may occur within area
Solegnathus lettiensis Gunther's Pipehorse, Indonesian Pipefish [66273]		Species or species habitat may occur within area
Solenostomus cyanopterus Robust Ghostpipefish, Blue-finned Ghost Pipefish, [66183]		Species or species habitat may occur within area
Syngnathoides biaculeatus Double-end Pipehorse, Double-ended Pipehorse, Alligator Pipefish [66279]		Species or species habitat may occur within area
Trachyrhamphus bicoarctatus Bentstick Pipefish, Bend Stick Pipefish, Short-tailed Pipefish [66280]		Species or species habitat may occur within area
Trachyrhamphus longirostris Straightstick Pipefish, Long-nosed Pipefish, Straight Stick Pipefish [66281]		Species or species habitat may occur within area
Mammals		
Dugong dugon Dugong [28]		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 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, Johnstone's Crocodile [1773]		Species or species habitat may 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
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

Name	Threatened	Type of Presence
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
Hydrophis pacificus Large-headed Seasnake, Pacific Seasnake [1112]		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	Breeding known to occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Breeding known to occur within area
Parahydrophis mertoni Northern Mangrove Seasnake [1090]		Species or species habitat may 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	Migration route known to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Delphinus delphis Common 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

Name	Status	Type of Presence
Grampus griseus Risso's Dolphin, Grampus [64]		Species or species habitat may occur within area
Indopacetus pacificus Longman's Beaked Whale [72]		Species or species habitat may occur within area
Kogia breviceps Pygmy Sperm Whale [57]		Species or species habitat may occur within area
Kogia simus Dwarf Sperm Whale [58]		Species or species habitat may occur within area
Lagenodelphis hosei Fraser's Dolphin, Sarawak Dolphin [41]		Species or species habitat may occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Breeding known to occur within area
Mesoplodon densirostris Blainville's Beaked Whale, Dense-beaked Whale [74]		Species or species habitat may occur within area
Mesoplodon ginkgodens Gingko-toothed Beaked Whale, Gingko-toothed Whale, Gingko Beaked Whale [59564]		Species or species habitat may occur within area
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]		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]		Breeding known to occur within area
Stenella attenuata Spotted Dolphin, Pantropical Spotted Dolphin [51]		Species or species habitat may occur within area
Stenella coeruleoalba Striped Dolphin, Euphrosyne Dolphin [52]		Species or species habitat may occur within area
Stenella longirostris Long-snouted Spinner Dolphin [29]		Species or species habitat may occur within area
Steno bredanensis Rough-toothed Dolphin [30]		Species or species habitat may occur within area
Tursiops aduncus Indian Ocean Bottlenose Dolphin, Spotted Bottlenose Dolphin [68418]		Species or species habitat likely to occur

Name	Status	Type of Presence
		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)
Kakadu	NT	National Park (Commonwealth)

Australian Marine Parks [Resource Information]

Name	Label
Arafura	Multiple Use Zone (IUCN VI)
Arafura	Special Purpose Zone (IUCN VI)
Arafura	Special Purpose Zone (Trawl) (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)
Arnhem	Special Purpose Zone (IUCN VI)
Ashmore Reef	Recreational Use Zone (IUCN IV)
Ashmore Reef	Sanctuary Zone (IUCN Ia)
Cartier Island	Sanctuary Zone (IUCN Ia)
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)
Joseph Bonaparte Gulf	Multiple Use Zone (IUCN VI)
Joseph Bonaparte Gulf	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	Habitat Protection Zone (IUCN IV)
Oceanic Shoals	Multiple Use Zone (IUCN VI)
Oceanic Shoals	National Park Zone (IUCN II)
Oceanic Shoals	Special Purpose Zone (Trawl) (IUCN VI)

Extra Information

State and Territory Reserves [Resource Information]

Name	State
Adele Island	WA
Balanggarra	WA
Bardi Jawi	WA
Barrow Island	WA
Bedout Island	WA
Boodie, Double Middle Islands	WA
Browse Island	WA
Buffalo Creek	NT
Cape Range	WA
Casuarina	NT
Channel Point	NT
Charles Darwin	NT

Name	State
Dambimangari	WA
Djukbinj	NT
Garig Gunak Barlu	NT
George Brown Darwin	NT
Holmes Jungle	NT
Howard Springs	NT
Howard Springs	NT
Keep River	NT
Knuckey Lagoons	NT
Lawley River	WA
Lesueur Island	WA
Low Rocks	WA
Lowendal Islands	WA
Marri-Jabin (Thamurrurr - Stage 1)	NT
Marthakal	NT
Mary River	NT
Mijing	WA
Mitchell River	WA
Montebello Islands	WA
Niiwalarra Islands	WA
Ord River	WA
Pelican Island	WA
Shoal Bay	NT
Swan Island	WA
Tree Point Conservation Area	NT
Unnamed WA28968	WA
Unnamed WA40828	WA
Unnamed WA41080	WA
Unnamed WA41775	WA
Unnamed WA44672	WA
Unnamed WA44673	WA
Unnamed WA44677	WA
Uunguu	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		
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
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
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

Name	Status	Type of Presence
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
Sturnus vulgaris Common Starling [389]		Species or species habitat likely to occur within area
Frogs		
Rhinella marina Cane Toad [83218]		Species or species habitat known to occur within area
Mammals		
Bos javanicus Banteng, Bali Cattle [15]		Species or species habitat likely to occur within area
Bos taurus Domestic Cattle [16]		Species or species habitat likely to occur within area
Bubalus bubalis Water Buffalo, Swamp Buffalo [1]		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 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 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

Name	Status	Type of Presence
		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
Annona glabra Pond Apple, Pond-apple Tree, Alligator Apple, Bullock's Heart, Cherimoya, Monkey Apple, Bobwood, Corkwood [6311]		Species or species habitat may occur within area
Brachiaria mutica Para Grass [5879]		Species or species habitat likely to occur within area
Cabomba caroliniana Cabomba, Fanwort, Carolina Watershield, Fish Grass, Washington Grass, Watershield, Carolina Fanwort, Common Cabomba [5171]		Species or species habitat likely to occur within area
Cenchrus ciliaris Buffel-grass, Black Buffel-grass [20213]		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
Eichhornia crassipes Water Hyacinth, Water Orchid, Nile Lily [13466]		Species or species habitat likely to occur within area
Hymenachne amplexicaulis Hymenachne, Olive Hymenachne, Water Stargrass, West Indian Grass, West Indian Marsh Grass [31754]		Species or species habitat likely to occur within area
Jatropha gossypifolia Cotton-leaved Physic-Nut, Bellyache Bush, Cotton-leaf Physic Nut, Cotton-leaf Jatropha, Black Physic Nut [7507]		Species or species habitat likely to occur within area
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
Mimosa pigra Mimosa, Giant Mimosa, Giant Sensitive Plant, ThornySensitive Plant, Black Mimosa, Catclaw Mimosa, Bashful Plant [11223]		Species or species habitat likely to 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
Pennisetum polystachyon Mission Grass, Perennial Mission Grass, Missiongrass, Feathery Pennisetum, Feather Pennisetum, Thin Napier Grass, West Indian Pennisetum, Blue Buffel Grass [21194]		Species or species habitat likely to occur within area
Sagittaria platyphylla Delta Arrowhead, Arrowhead, Slender Arrowhead [68483]		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

Name	Status	Type of Presence
Vachellia nilotica Prickly Acacia, Blackthorn, Prickly Mimosa, Black Piquant, Babul [84351]		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
Lepidodactylus lugubris Mourning Gecko [1712]		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 known to occur within area

Nationally Important Wetlands [Resource Information]

Name	State
"The Dales", Christmas Island	EXT
Adelaide River Floodplain System	NT
Ashmore Reef	EXT
Cape Range Subterranean Waterways	WA
Cobourg Peninsula System	NT
Daly-Reynolds Floodplain-Estuary System	NT
Finniss Floodplain and Fog Bay Systems	NT
Hosine's Spring, Christmas Island	EXT
Kakadu National Park	NT
Legune Wetlands	NT
Mary Floodplain System	NT
Mermaid Reef	EXT
Moyle Floodplain and Hyland Bay System	NT
Murgenella-Cooper Floodplain System	NT
Ord Estuary System	WA
Port Darwin	NT
Shoal Bay - Micket Creek	NT

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
Carbonate bank and terrace system of the Van	North
Gulf of Carpentaria basin	North
Pinnacles of the Bonaparte Basin	North
Shelf break and slope of the Arafura Shelf	North
Tributary Canyons of the Arafura Depression	North
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

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

-7.36981 115.89261,-7.19135 116.29949,-6.55485 120.37194,-6.45848 120.55397,-6.19436 120.92517,-6.09044 122.66372,-5.91198 123.1872,-5.19516 123.20505,-5.0 123.30171,-5.0 135.75335,-8.24306 136.04424,-8.60962 137.51393,-8.75048 138.07868,-9.22161 139.04237,-9.86407 139.99177,-10.04253 139.98463,-10.72382 136.62178,-11.52618 135.99955,-11.77364 135.96981,-11.58685 135.37375,-11.74851 134.8812,-11.67712 134.38627,-11.55815 133.8152,-11.88652 133.63912,-11.48968 133.38979,-11.48677 132.93956,-12.14826 132.70162,-12.30784 132.365,-12.31736 131.16575,-12.59747 130.95403,-12.70638 130.56727,-13.40612 130.3488,-13.69213 130.02282,-14.23465 129.76584,-15.26257 129.80391,-15.28538 129.09681,-14.94928 128.87374,-15.03207 128.41037,-14.98497 128.16585,-14.62508 127.94872,-14.35212 127.78478,-14.14918 127.56355,-13.98357 127.33702,-13.84842 127.01722,-14.01273 126.7518,-14.12444 126.43663,-14.11902 126.31522,-14.49944 126.13206,-14.68485 125.91315,-14.51543 125.63714,-14.55422 125.52746,-14.55822 125.32684,-14.75504 125.19884,-14.81285 125.02928,-14.97063 124.91824,-15.02928 124.81225,-15.29304 124.7617,-15.34812 124.43249,-15.71938 124.51209,-15.84727 124.1046,-15.85025 123.58112,-16.31722 123.12308,-16.43833 122.97091,-16.30699 122.7639,-16.31841 122.51405,-16.58681 122.22566,-16.84665 122.02293,-18.11788 121.96844,-18.38967 121.84471,-18.49318 121.56274,-19.1856 121.16656,-19.32182 119.91259,-20.05946 118.11371,-20.23125 117.09824,-20.27051 116.58428,-20.6203 116.24164,-21.34484 115.08522,-21.58695 114.57006,-21.61586 114.38411,-21.70533 114.09667,-21.81336 113.98512,-21.90758 113.92516,-22.26736 113.89946,-22.41013 113.67246,-22.97204 113.32089,-21.53425 101.85645,-21.22968 101.3996,-20.44921 100.82852,-19.1072 100.04806,-5.0 100.09375,-5.0 101.31603,-5.13788 103.52417,-5.69943 104.43788,-5.75654 105.3516,-5.90168 105.61809,-5.59254 105.83277,-5.32348 106.26055,-5.43055 106.79236,-5.54834 106.78165,-5.99448 106.07852,-6.3514 105.92861,-6.52077 105.69911,-6.59054 105.32899,-6.71546 105.90363,-6.87964 106.41045,-6.99029 106.6139,-7.4293 107.52047,-7.52805 108.64596,-7.58515 109.71196,-8.04867 111.00163,-8.10578 113.10031,-8.38465 114.10801,-8.1943 114.5149,-8.25854 114.89323,-8.40488 115.12166,-8.48697 115.49286,-7.81953 115.47858,-7.36981 115.89261

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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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.

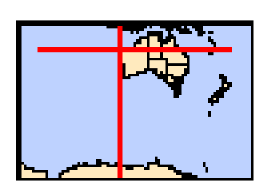
Information is available about Environment Assessments and the EPBC Act including significance guidelines, forms and application process details.

Report created: 18/12/20 15:00:04

This map may contain data which are ©Commonwealth of Australia (Geoscience Australia), ©PSMA 2015

Coordinates

Buffer: 0.0Km



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:	4
National Heritage Places:	9
Wetlands of International Importance:	8
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	2
Listed Threatened Ecological Communities:	10
Listed Threatened Species:	175
Listed Migratory Species:	110

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:	18
Commonwealth Heritage Places:	24
Listed Marine Species:	215
Whales and Other Cetaceans:	44
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	1
Australian Marine Parks:	44

Extra Information

This part of the report provides information that may also be relevant to the area you have nominated.

State and Territory Reserves:	144
Regional Forest Agreements:	1
Invasive Species:	65
Nationally Important Wetlands:	27
Key Ecological Features (Marine)	23

Details

Matters of National Environmental Significance

World Heritage Properties
[Resource Information]

Name	State	Status
Australian Convict Sites (Fremantle Prison Buffer Zone)	WA	Buffer zone
Australian Convict Sites (Fremantle Prison)	WA	Declared property
Shark Bay, Western Australia	WA	Declared property
The Ningaloo Coast	WA	Declared property

National Heritage Properties
[Resource Information]

Name	State	Status
Natural		
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
Fremantle Prison (former)	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
Forrestdale and thomsons lakes	Within Ramsar site
Hosnies spring	Within Ramsar site
Peel-yalgorup system	20 - 30km upstream
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-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
Aquatic Root Mat Community 3 in Caves of the	Endangered	Community known to

Name	Status	Type of Presence
Leeuwin Naturaliste Ridge		occur within area
Aquatic Root Mat Community 4 in Caves of the Leeuwin Naturaliste Ridge	Endangered	Community known to occur within area
Aquatic Root Mat Community in Caves of the Swan Coastal Plain	Endangered	Community known to occur within area
Banksia Woodlands of the Swan Coastal Plain ecological community	Endangered	Community likely to occur within area
Monsoon vine thickets on the coastal sand dunes of Dampier Peninsula	Endangered	Community likely to occur within area
Proteaceae Dominated Kwongkan Shrublands of the Southeast Coastal Floristic Province of Western Australia	Endangered	Community may occur within area
Sedgelands in Holocene dune swales of the southern Swan Coastal Plain	Endangered	Community known to occur within area
Subtropical and Temperate Coastal Saltmarsh	Vulnerable	Community likely to occur within area
Thrombolite (microbial) community of coastal freshwater lakes of the Swan Coastal Plain (Lake Richmond)	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
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	Breeding known to occur within area
Cereopsis novaehollandiae grisea		
Cape Barren Goose (south-western), Recherche Cape Barren Goose [25978]	Vulnerable	Species or species habitat likely 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

Name	Status	Type of Presence
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
Erythrotriorchis radiatus Red Goshawk [942]	Vulnerable	Species or species habitat may 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 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
Malurus leucopterus leucopterus White-winged Fairy-wren (Dirk Hartog Island),	Vulnerable	Species or species

Name	Status	Type of Presence
Dirk Hartog Black-and-White Fairy-wren [26004]		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 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
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 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

Name	Status	Type of Presence
Tyto novaehollandiae kimberli Masked Owl (northern) [26048]	Vulnerable	Species or species habitat likely to occur within area
Crustaceans		
Cherax tenuimanus Hairy Marron, Margaret River Hairy Marron, Margaret River Marron [78931]	Critically Endangered	Species or species habitat may occur within area
Fish		
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 likely 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
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
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

Name	Status	Type of Presence
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
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
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
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 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
Pseudocheirus occidentalis Western Ringtail Possum, Ngwayir, Womp, Woder, Ngoor, Ngoolangit [25911]	Critically Endangered	Species or species habitat known to occur

Name	Status	Type of Presence
		within area
Pseudomys fieldi Shark Bay Mouse, Djoongari, Alice Springs Mouse [113]	Vulnerable	Species or species habitat likely to 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 known to occur within area
Kumonga exleyi Cape Range Remipede [86875]	Vulnerable	Species or species habitat known to occur within area
Westralunio carteri Carter's Freshwater Mussel, Freshwater Mussel [86266]	Vulnerable	Species or species habitat known to occur within area
Plants		
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 likely to occur within area
Anigozanthos viridis subsp. terraspectans Dwarf Green Kangaroo Paw [3435]	Vulnerable	Species or species habitat likely to occur within area
Asplenium listeri Christmas Island Spleenwort [65865]	Critically Endangered	Species or species habitat known to occur within area
Banksia nivea subsp. uliginosa Swamp Honeypot [82766]	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
Beyeria lepidopetala Small-petalled Beyeria, Short-petalled Beyeria [18362]	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

Name	Status	Type of Presence
		within area
Caladenia elegans Elegant Spider-orchid [56775]	Endangered	Species or species habitat known to occur within area
Caladenia excelsa Giant Spider-orchid [56717]	Endangered	Species or species habitat likely to occur within area
Caladenia hoffmanii Hoffman's Spider-orchid [56719]	Endangered	Species or species habitat known to occur within area
Caladenia huegelii King Spider-orchid, Grand Spider-orchid, Rusty Spider-orchid [7309]	Endangered	Species or species habitat known to occur within area
Caladenia lodgeana Lodge's Spider-orchid [68664]	Critically Endangered	Species or species habitat likely to occur within area
Calectasia cyanea Blue Tinsel Lily [7669]	Critically Endangered	Species or species habitat likely to occur within area
Chorizema varium Limestone Pea [16981]	Endangered	Species or species habitat known to occur within area
Conostylis dielsii subsp. teres Irwin's Conostylis [3614]	Endangered	Species or species habitat may occur within area
Conostylis micrantha Small-flowered Conostylis [17635]	Endangered	Species or species habitat may occur within area
Diuris drummondii Tall Donkey Orchid [4365]	Vulnerable	Species or species habitat likely to occur within area
Diuris micrantha Dwarf Bee-orchid [55082]	Vulnerable	Species or species habitat known to occur within area
Diuris purdiei Purdie's Donkey-orchid [12950]	Endangered	Species or species habitat likely to occur within area
Drakaea concolor Kneeling Hammer-orchid [56777]	Vulnerable	Species or species habitat likely to occur within area
Drakaea elastica Glossy-leafed Hammer Orchid, Glossy-leaved Hammer Orchid, Warty Hammer Orchid [16753]	Endangered	Species or species habitat known 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 may occur within area
Eleocharis keigheryi Keighery's Eleocharis [64893]	Vulnerable	Species or species habitat likely to occur within area
Eucalyptus argutifolia Yanchep Mallee, Wabling Hill Mallee [24263]	Vulnerable	Species or species habitat known to occur within area

Name	Status	Type of Presence
Eucalyptus beardiana Beard's Mallee [18933]	Vulnerable	Species or species habitat may occur within area
Eucalyptus cuprea Mallee Box [56773]	Endangered	Species or species habitat likely 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 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 likely to occur within area
Kennedia glabrata Northcliffe Kennedia [16452]	Vulnerable	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
Lechenaultia chlorantha Kalbarri Leschenaultia [16763]	Vulnerable	Species or species habitat likely to occur within area
Leucopogon marginatus Thick-margined Leucopogon [12527]	Endangered	Species or species habitat likely to occur within area
Leucopogon obtectus Hidden Beard-heath [19614]	Endangered	Species or species habitat may occur within area
Macarthuria keigheryi Keighery's Macarthuria [64930]	Endangered	Species or species habitat likely to occur within area
Marianthus paralius [83925]	Endangered	Species or species habitat known to occur within area
Melaleuca sp. Wanneroo (G.J. Keighery 16705) [89456]	Endangered	Species or species habitat known to occur within area
Paracaleana dixonii Sandplain Duck Orchid [86882]	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

Name	Status	Type of Presence
Pterostylis sinuata Northampton Midget Greenhood, Western Swan Grrenhood [84991]	Endangered	Species or species habitat known to occur within area
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 may occur within area
Stachystemon nematophorus Three-flowered Stachystemon [81447]	Vulnerable	Species or species habitat may occur within area
Synaphea sp. Serpentine (G.R. Brand 103) [86879]	Critically Endangered	Species or species habitat may occur within area
Tectaria devexa [14767]	Endangered	Species or species habitat likely to occur within area
Tetratheca nephelioides [83217]	Critically Endangered	Species or species habitat may occur within area
Thelymitra stellata Star Sun-orchid [7060]	Endangered	Species or species habitat may 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
Ardenna tenuirostris Short-tailed Shearwater [82652]		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

Name	Threatened	Type of Presence
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat likely to occur within area
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

Name	Threatened	Type of Presence
		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
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

Name	Threatened	Type of Presence
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
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
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

Name	Threatened	Type of Presence
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
Charadrius bicinctus Double-banded Plover [895]		Roosting known to occur within area
Charadrius dubius Little Ringed Plover [896]		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
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

Name	Threatened	Type of Presence
		within area
Thalasseus bergii Crested Tern [83000]		Breeding known to occur within area
Tringa brevipes Grey-tailed Tattler [851]		Roosting 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
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 - ARTILLERY BARRACKS - FREMANTLE
Defence - BROOME TRAINING DEPOT
Defence - CAMPBELL BARRACKS - SWANBOURNE
Defence - EAST FREMANTLE SMALL CRAFT BASE
Defence - EXMOUTH ADMIN & HF TRANSMITTING
Defence - EXMOUTH VLF TRANSMITTER STATION
Defence - HMAS STIRLING-ROCKINGHAM ;HMAS STIRLING - GARDEN ISLAND
Defence - IRWIN BARRACKS - KARRAKATTA
Defence - LANCELIN TRAINING AREA
Defence - LEARMONTH - AIR WEAPONS RANGE
Defence - LEARMONTH RADAR SITE - TWIN TANKS EXMOUTH
Defence - LEARMONTH RADAR SITE - VLAMING HEAD EXMOUTH
Defence - LEEUWIN BARRACKS - EAST FREMANTLE
Defence - PRESTON POINT TRAINING DEPOT
Defence - ROCKINGHAM - NAVY CPSO
Defence - SWANBOURNE RIFLE RANGE

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
Historic		
Administrators House Precinct	EXT	Listed place
Army Magazine Buildings Irwin Barracks	WA	Listed place
Artillery Barracks	WA	Listed place
Bungalow 702	EXT	Listed place
Claremont Post Office	WA	Listed place

Name	State	Status
Cliff Point Historic Site	WA	Listed place
Drumsite Industrial Area	EXT	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

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
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
Cereopsis novaehollandiae grisea Cape Barren Goose (south-western), Recherche Cape Barren Goose [25978]	Vulnerable	Species or species habitat likely to occur within area
Charadrius bicinctus Double-banded Plover [895]		Roosting known to occur within area
Charadrius dubius Little Ringed Plover [896]		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
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

Name	Threatened	Type of Presence
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 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 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

Name	Threatened	Type of Presence
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
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

Name	Threatened	Type of Presence
		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
Puffinus tenuirostris Short-tailed Shearwater [1029]		Breeding known to occur within area
Recurvirostra novaehollandiae Red-necked Avocet [871]		Roosting known to occur 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

Name	Threatened	Type of Presence
		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
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

Name	Threatened	Type of Presence
		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 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

Name	Threatened	Type of Presence
		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
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

Name	Threatened	Type of Presence
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
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

Name	Threatened	Type of Presence
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
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

Name	Threatened	Type of Presence
		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
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 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

Name	Threatened	Type of Presence
		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 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

Name	Status	Type of Presence
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
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

Name	Status	Type of Presence
		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 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)
Eastern Recherche	National Park Zone (IUCN II)

Name	Label
Eastern Recherche	Special Purpose Zone (IUCN VI)
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	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
Alfred Cove	WA
Bardi Jawi	WA
Barrow Island	WA
Bedout Island	WA
Beekeepers	WA
Bernier And Dorre Islands	WA
Bessieres Island	WA
Bold Park	WA
Boodie, Double Middle Islands	WA
Boullanger, Whitlock, Favourite, Tern And Osprey Islands	WA
Broome Bird Observatory	WA
Broome Wildlife Centre	WA
Browse Island	WA
Bundegi Coastal Park	WA
Burnside And Simpson Island	WA
Cape Range	WA
Carnac Island	WA
Coulomb Point	WA
Dambimangari	WA
Dambimangari	WA
Dirk Hartog Island	WA
Dongara	WA
Escape Island	WA
Freycinet, Double Islands etc	WA
Gnandaroo Island	WA
Hamelin Island	WA
Harry Waring Marsupial Reserve	WA
Jarrkunpungu	WA
Jinmarnkur	WA
Jinmarnkur Kulja	WA
Jurabi Coastal Park	WA
Kalbarri	WA

Name	State
Karajarri	WA
Keanes Point Reserve	WA
Kings Park	WA
Koks Island	WA
Kujungurru Warrarn	WA
Kujungurru Warrarn	WA
Lacepede Islands	WA
Lake Joondalup	WA
Lancelin And Edwards Islands	WA
Leda	WA
Leeuwin-Naturaliste	WA
Lesueur	WA
Little Rocky Island	WA
Locker Island	WA
Lowendal Islands	WA
Matilda Bay Reserve	WA
Montebello Islands	WA
Muiron Islands	WA
Murujuga	WA
NTWA Bushland covenant (0144)	WA
Nambung	WA
Nanga Station	WA
Neerabup	WA
Neerabup	WA
Nilgen	WA
North Sandy Island	WA
North Turtle Island	WA
Nyangumarta Warrarn	WA
Part Murchison house	WA
Penguin Island	WA
Port Gregory	WA
Prince Regent	WA
Recherche Archipelago	WA
Rottnest Island	WA
Round Island	WA
Serrurier Island	WA
Southern Beekeepers	WA
Swan Island	WA
Swan River	WA
Tamala Pastoral Lease (Part)	WA
Tanner Island	WA
Tent Island	WA
Thomsons Lake	WA
Unnamed WA21176	WA
Unnamed WA26400	WA
Unnamed WA28968	WA
Unnamed WA31906	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 WA39584	WA
Unnamed WA39752	WA
Unnamed WA40322	WA
Unnamed WA40828	WA
Unnamed WA40877	WA
Unnamed WA41080	WA
Unnamed WA41775	WA
Unnamed WA42469	WA
Unnamed WA43290	WA

Name	State
Unnamed WA43903	WA
Unnamed WA44414	WA
Unnamed WA44665	WA
Unnamed WA44667	WA
Unnamed WA44669	WA
Unnamed WA44672	WA
Unnamed WA44673	WA
Unnamed WA44682	WA
Unnamed WA44688	WA
Unnamed WA45772	WA
Unnamed WA45773	WA
Unnamed WA46926	WA
Unnamed WA46982	WA
Unnamed WA46983	WA
Unnamed WA46984	WA
Unnamed WA48291	WA
Unnamed WA48858	WA
Unnamed WA48968	WA
Unnamed WA49220	WA
Unnamed WA49561	WA
Unnamed WA49994	WA
Unnamed WA50067	WA
Unnamed WA51105	WA
Unnamed WA51162	WA
Unnamed WA51497	WA
Unnamed WA51583	WA
Unnamed WA51617	WA
Unnamed WA51658	WA
Unnamed WA51932	WA
Unnamed WA52237	WA
Unnamed WA52354	WA
Unnamed WA52366	WA
Unnamed WA53015	WA
Uunguu	WA
Victor Island	WA
Wanagarren	WA
Wandi	WA
Wedge Island	WA
Weld Island	WA
Woodvale	WA
Y Island	WA
Yanchep	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

Name	Status	Type of Presence
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
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 may 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

Name	Status	Type of Presence
		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 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
Anredera cordifolia Madeira Vine, Jalap, Lamb's-tail, Mignonette Vine, Anredera, Gulf Madeiravine, Heartleaf Madeiravine, Potato Vine [2643]		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 plumosus Climbing Asparagus-fern [48993]		Species or species habitat likely to occur

Name	Status	Type of Presence
		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 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

Name	Status	Type of Presence
		within area
Sagittaria platyphylla Delta Arrowhead, Arrowhead, Slender Arrowhead [68483]		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 Cypress, Salt Cedar [16018]		Species or species habitat likely to occur 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 known to occur within area

Nationally Important Wetlands [Resource Information]

Name	State
"The Dales", Christmas Island	EXT
Ashmore Reef	EXT
Booragoon Swamp	WA
Bunda-Bunda Mound Springs	WA
Bundera Sinkhole	WA
Cape Range Subterranean Waterways	WA
De Grey River	WA
Eighty Mile Beach System	WA
Exmouth Gulf East	WA
Gibbs Road Swamp System	WA
Herdsman Lake	WA
Hosine's Spring, Christmas Island	EXT
Joondalup Lake	WA
Karakin Lakes	WA
Lake MacLeod	WA
Lake Thetis	WA
Learmonth Air Weapons Range - Saline Coastal Flats	WA
Leslie (Port Hedland) Saltfields System	WA
Loch McNess System	WA
Mermaid Reef	EXT
Roebuck Bay	WA
Rottnest Island Lakes	WA
Shark Bay East	WA
Spectacles Swamp	WA
Swan-Canning Estuary	WA
Thomsons Lake	WA
Willie Creek Wetlands	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
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
Commonwealth marine environment surrounding	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

-8.110051 120.376181,-8.413432 119.686137,-8.976808 119.872067,-8.857075 120.295123,-8.748104 120.365003,-8.944443 121.387017,-8.896056 121.73862,-8.77642 121.87834,-8.752625 122.125804,-8.691748 123.110175,-8.687346 123.482423,-9.75854 123.516666,-10.383148 123.263849,-10.567755 123.03086,-10.658619 122.803699,-10.808072 122.716331,-10.890417 122.798676,-10.786665 122.978512,-10.944817 123.205601,-10.818947 123.821447,-10.988525 125.037471,-11.913499 126.641108,-12.448877 127.200281,-13.147091 126.715455,-13.318401 126.494889,-14.227094 125.717017,-14.343262 125.111429,-14.575878 125.169519,-15.146948 124.962506,-15.13404 124.72429,-15.340607 124.400669,-15.498246 124.50395,-15.543968 124.516619,-15.936579 124.492348,-15.883041 124.006938,-15.964387 123.794187,-16.292067 123.493814,-16.479298 123.438507,-16.679321 122.85478,-17.217961 122.29943,-17.829879 122.291578,-17.954801 122.452192,-18.100415 122.450351,-18.679346 121.838291,-19.299554 121.531765,-19.644576 121.103462,-19.9777 120.359881,-20.133753 119.569602,-20.082028 119.18133,-20.326489 118.862903,-20.440596 118.092132,-20.654766 117.898254,-20.801688 117.32701,-20.62405 116.78223,-20.634023 116.752999,-21.023086 116.114577,-21.485594 115.564995,-21.81298 114.827666,-22.208356 114.521006,-22.133497 113.977382,-22.585628 113.781286,-22.971101 113.927623,-23.445803 113.877654,-23.801236 113.652646,-24.50168 113.514146,-25.252995 113.363645,-25.510993 113.142207,-25.833347 113.111916,-25.952346 113.179916,-26.437668 113.50771,-26.712407 113.765502,-26.934213 113.913108,-27.591313 114.201271,-27.792218 114.089596,-27.883892 114.157798,-28.214768 114.158935,-28.255736 114.432758,-28.365415 114.560728,-28.984599 114.552035,-29.012543 114.875396,-29.154795 114.96022,-29.509539 115.062795,-30.110359 114.992653,-30.197812 115.013206,-30.465331 115.0763,-30.60938 115.205131,-31.625489 115.777608,-32.220354 115.876139,-32.289384 115.812959,-32.667715 115.254594,-33.37603 114.869555,-33.736593 114.828494,-33.995457 115.066998,-34.32194 115.017795,-34.324079 115.017205,-34.522746 115.19192,-34.928478 115.943279,-35.044299 116.433171,-35.116634 116.994723,-35.031112 117.460781,-35.199211 117.598659,-35.210207 117.943954,-34.605829 119.612364,-34.641803 120.712898,-33.927965 125.103003,-33.445529 126.058654,-33.403888 126.367984,-33.52881 126.724904,-33.778653 126.760595,-35.660569 118.196677,-36.144352 114.765123,-36.602661 110.370604,-31.572685 104.971902,-28.146261 101.926192,-23.586421 101.882172,-16.27751 102.557939,-9.716324 103.455669,-8.002934 107.563135,-8.535209 111.991021,-8.455371 112.785888,-8.327118 112.865283,-8.464486 113.085367,-8.457829 113.730901,-8.559822 113.900249,-8.573748 114.394216,-8.822094 114.947409,-8.748677 115.119112,-8.858564 115.464227,-8.750721 115.752243,-8.830925 115.831405,-8.793232 115.941134,-8.910794 116.496366,-8.823057 116.584103,-8.94709 116.667788,-9.000602 116.92052,-9.0984 117.015989,-9.106275 117.556779,-8.987189 117.986975,-8.802474 118.393495,-8.802441 119.052454,-8.59679 119.258104,-8.339112 119.324791,-8.378125 119.467189,-7.878053 120.310745,-8.110051 120.376181

Acknowledgements

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-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 B: MNES Review Register

Table B-1: Review Register

Taxon	2021 Review (Rev 9 09/07/21)	Reason for Change	Sections Updated within this Document
Threatened Species			
Sharks	Speartooth shark *(Glyphis glyphis)*	Included with new PMST search for Stairway EMBA based on Stairway TFN Rev 0 (SO-91-RZ-20027)	Table 5-1, Section 5.3, Section 5.3.5
Birds	Addition of *Territory Parks and Wildlife Conservation Act* 1976 conservation status	Included with new PMST search for Stairway EMBA based on Stairway TFN Rev 0 (SO-91-RZ-20027)	Table 8-1, Section 8.2
Birds	Greater crested tern (*Thalasseus bergii)*	Included with new PMST search for Stairway EMBA based on Stairway TFN Rev 0 (SO-91-RZ-20027)	Table 8-3
Birds	Little curlew (*Numenius minutus)*	Included with new PMST search for Stairway EMBA based on Stairway TFN Rev 0 (SO-91-RZ-20027)	Table 8-3
Birds	Swinhoe's snipe (*Gallinago magala)*	Included with new PMST search for Stairway EMBA based on Stairway TFN Rev 0 (SO-91-RZ-20027)	Table 8-3
Birds	Wandering Tattler (*Tringa glareola)*	Included with new PMST search for Stairway EMBA based on Stairway TFN Rev 0 (SO-91-RZ-20027)	Table 8-3
Birds	Bar-tailed godwit	NT sites of international importance added	Table 8-5
Birds	Common greenshank	NT sites of international importance added	Table 8-5
Birds	Common sandpiper	NT sites of international importance added	Table 8-5
Birds	Fork-tailed swift	NT sites of international importance added	Table 8-5
Birds	Oriental pratincole	NT sites of international importance added	Table 8-5
Migratory Species-			
Reptiles	Salt-water crocodile *(Crocodylus porosus)*	Included with new PMST search for Stairway EMBA based on Stairway TFN Rev 0 (SO-91-RZ-20027)	Table 6-1, Section 6.3

Taxon	2021 Review (Rev 9 09/07/21)	Reason for Change	Sections Updated within this Document
Provinces			
Provincial Bioregions	Timor Province	Included with new PMST search for Stairway EMBA based on Stairway TFN Rev 0 (SO-91-RZ-20027)	Section 2.1
	Northwest Shelf Transition	Included with new PMST search for Stairway EMBA based on Stairway TFN Rev 0 (SO-91-RZ-20027)	Section 2.1
	Timor Transition	Included with new PMST search for Stairway EMBA based on Stairway TFN Rev 0 (SO-91-RZ-20027)	Section 2.1, 3.1, 3.3, 3.4, 4.1, 5.1
	Northern Shelf Province	Included with new PMST search for Stairway EMBA based on Stairway TFN Rev 0 (SO-91-RZ-20027)	Section 2.1, 3.1, 3.2, 3.3, 3.4, 4.1, 4.2, 5.1
Protected Areas			
World Heritage Areas	Kakadu National Park	Included with new PMST search for Stairway EMBA based on Stairway TFN Rev 0 (SO-91-RZ-20027)	Table 9-1, Section 9.1.3
Wetlands of International Importance	Cobourg Peninsula	Included with new PMST search for Stairway EMBA based on Stairway TFN Rev 0 (SO-91-RZ-20027)	Table 9-1, Section 9.2.9
	Kakadu National Park	Included with new PMST search for Stairway EMBA based on Stairway TFN Rev 0 (SO-91-RZ-20027)	Table 9-1, Section 9.2.10
	Ord River Floodplain	Included with new PMST search for Stairway EMBA based on Stairway TFN Rev 0 (SO-91-RZ-20027)	Table 9-1, Section 9.2.11
Wetlands of National Importance	Adelaide River Floodplain System	Included with new PMST search for Stairway EMBA based on Stairway TFN Rev 0 (SO-91-RZ-20027)	Table 9-1, Section 9.3.21

Taxon	2021 Review (Rev 9 09/07/21)	Reason for Change	Sections Updated within this Document
	Kakadu National Park	Included with new PMST search for Stairway EMBA based on Stairway TFN Rev 0 (SO-91-RZ-20027)	Table 9-1, Section 9.3.22
	Mary Floodplain System	Included with new PMST search for Stairway EMBA based on Stairway TFN Rev 0 (SO-91-RZ-20027)	Table 9-1, Section 9.3.23
	Cobourg Peninsula System	Included with new PMST search for Stairway EMBA based on Stairway TFN Rev 0 (SO-91-RZ-20027)	Table 9-1, Section 9.3.24
	Daly-Reynolds Floodplain-Estuary System	Included with new PMST search for Stairway EMBA based on Stairway TFN Rev 0 (SO-91-RZ-20027)	Table 9-1, Section 9.3.25
	Finniss Floodplain and Fog Bay Systems	Included with new PMST search for Stairway EMBA based on Stairway TFN Rev 0 (SO-91-RZ-20027)	Table 9-1, Section 9.3.26
	Moyle Floodplain and Hyland Bay System	Included with new PMST search for Stairway EMBA based on Stairway TFN Rev 0 (SO-91-RZ-20027)	Table 9-1, Section 9.3.27
	Murgenella-Cooper Floodplain System	Included with new PMST search for Stairway EMBA based on Stairway TFN Rev 0 (SO-91-RZ-20027)	Table 9-1, Section 9.3.28
	Ord Estuary System	Included with new PMST search for Stairway EMBA based on Stairway TFN Rev 0 (SO-91-RZ-20027)	Table 9-1, Section 9.3.29
	Port Darwin	Included with new PMST search for Stairway EMBA based on Stairway TFN Rev 0 (SO-91-RZ-20027)	Table 9-1, Section 9.3.30
	Shoal Bay - Micket Creek	Included with new PMST search for Stairway EMBA based on Stairway TFN Rev 0 (SO-91-RZ-20027)	Table 9-1, Section 9.3.31

Taxon	2021 Review (Rev 9 09/07/21)	Reason for Change	Sections Updated within this Document
National Heritage Place	Kakadu National Park	Included with new PMST search for Stairway EMBA based on Stairway TFN Rev 0 (SO-91-RZ-20027)	Table 9-1, 9.4.10
Commonwealth Heritage Place	Bradshaw Defence Area	Included with new PMST search for Stairway EMBA based on Stairway TFN Rev 0 (SO-91-RZ-20027)	Table 9-1, 9.5.10 Section 14.4
Coastal terrestrial Conservation Reserves	Five additional national parks included and four reserves	Included with new PMST search for Stairway EMBA based on Stairway TFN Rev 0 (SO-91-RZ-20027)	Table 9-2 and 9-3
KEFs	Shelf Break and Slope of the Arafura Shelf	Included with new PMST search for Stairway EMBA based on Stairway TFN Rev 0 (SO-91-RZ-20027)	Section 10.1.29
	Tributary Canyons of the Arafura Depression	Included with new PMST search for Stairway EMBA based on Stairway TFN Rev 0 (SO-91-RZ-20027)	Section 10.1.30
Australian Marine Parks	Arafura Marine Park	Included with new PMST search for Stairway EMBA based on Stairway TFN Rev 0 (SO-91-RZ-20027)	12.4.2
	Arnhem Marine Park	Included with new PMST search for Stairway EMBA based on Stairway TFN Rev 0 (SO-91-RZ-20027)	12.4.3
	Joseph Bonaparte Marine Park	Included with new PMST search for Stairway EMBA based on Stairway TFN Rev 0 (SO-91-RZ-20027)	12.4.4
International Protected Areas	Additional international areas included	Included with new PMST search for Stairway EMBA based on Stairway TFN Rev 0 (SO-91-RZ-20027)	Section 9.8
Social, Economic and Cultural Features			
Defence Activities	Bradshaw defence training area	Included with new PMST search for Stairway EMBA based on Stairway TFN Rev 0 (SO-91-RZ-20027)	Section 14.4

Taxon	2021 Review (Rev 9 09/07/21)	Reason for Change	Sections Updated within this Document
Indigenous heritage	Tiwi Islands significant sites	Included with new PMST search for Stairway EMBA based on Stairway TFN Rev 0 (SO-91-RZ-20027)	Section 14.6.1
Maritime heritage	Additional shipwrecks within EMBA, new figure provided	Included with new PMST search for Stairway EMBA based on Stairway TFN Rev 0 (SO-91-RZ-20027)	Section 14.6.2
Fisheries	Additional NT fisheries	Included with new PMST search for Stairway EMBA based on Stairway TFN Rev 0 (SO-91-RZ-20027)	Section 14.7.1 and 14.8
Legislation			
Conservation Status Legislation	Addition of *Territory Parks and Wildlife Conservation Act* 1976 conservation status to all species	Included with new PMST search for Stairway EMBA based on Stairway TFN Rev 0 (SO-91-RZ-20027)	Table 5-1, 6-1, 7-1, 8-1
Other edits			
-	Figures updated throughout to represent new EMBA	Included with revised EMBA based on Stairway TFN Rev 0 (SO-91-RZ-20027)	All figures in document
-	Text updated throughout to reflect new EMBA entering NT waters	Included with revised r Stairway EMBA based on Stairway TFN Rev 0 (SO-91-RZ-20027)	All text in document

Appendix E: EPBC PMST Reports

Australian Government
Department of Agriculture, Water and the Environment

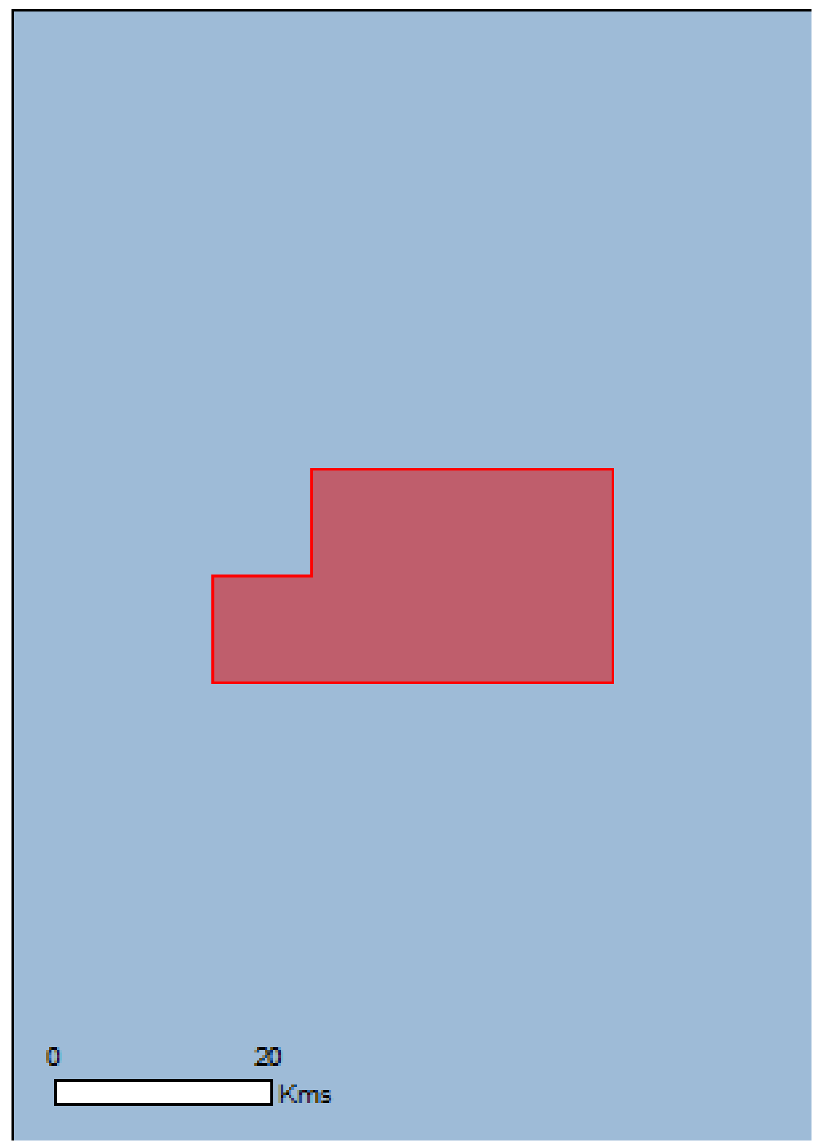
EPBC Act Protected Matters Report

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: 19/08/21 18:15:37



Coordinates
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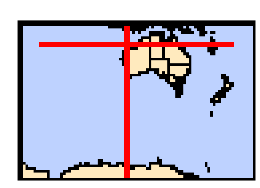

Summary

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:	None
National Heritage Places:	None
Wetlands of International Importance:	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	1
Listed Threatened Ecological Communities:	None
Listed Threatened Species:	14
Listed Migratory Species:	31

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at http://www.environment.gov.au/heritage

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Land:	None
Commonwealth Heritage Places:	None
Listed Marine Species:	53
Whales and Other Cetaceans:	22
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	None

Extra Information

This part of the report provides information that may also be relevant to the area you have nominated.

State and Territory Reserves:	None
Regional Forest Agreements:	None
Invasive Species:	None
Nationally Important Wetlands:	None
Key Ecological Features (Marine)	1

Details

Matters of National Environmental Significance

Commonwealth Marine Area [Resource Information]

Approval is required for a proposed activity that is located within the Commonwealth Marine Area which has, will have, or is likely to have a significant impact on the environment. Approval may be required for a proposed action taken outside the Commonwealth Marine Area but which has, may have or is likely to have a significant impact on the environment in the Commonwealth Marine Area. Generally the Commonwealth Marine Area stretches from three nautical miles to two hundred nautical miles from the coast.

Name
EEZ and Territorial Sea

Marine Regions [Resource Information]

If you are planning to undertake action in an area in or close to the Commonwealth Marine Area, and a marine bioregional plan has been prepared for the Commonwealth Marine Area in that area, the marine bioregional plan may inform your decision as to whether to refer your proposed action under the EPBC Act.

Name
North-west

Listed Threatened Species [Resource Information]

Name	Status	Type of Presence
Birds		
Calidris canutus		
Red Knot, Knot [855]	Endangered	Species or species habitat may occur within area
Numenius madagascariensis		
Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Mammals		
Balaenoptera borealis		
Sei Whale [34]	Vulnerable	Species or species habitat likely to occur within area
Balaenoptera musculus		
Blue Whale [36]	Endangered	Species or species habitat likely to occur within area
Balaenoptera physalus		
Fin Whale [37]	Vulnerable	Species or species habitat likely to occur within area
Megaptera novaeangliae		
Humpback Whale [38]	Vulnerable	Species or species habitat known to occur within area
Reptiles		
Caretta caretta		
Loggerhead Turtle [1763]	Endangered	Species or species habitat likely to occur within area
Chelonia mydas		
Green Turtle [1765]	Vulnerable	Species or species habitat likely to occur within area

Name	Status	Type of Presence
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat likely to occur within area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Species or species habitat likely to occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Species or species habitat likely to occur within area
Sharks		
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat may occur within area
Pristis zijsron Green Sawfish, Dindagubba, Narrowsnout Sawfish [68442]	Vulnerable	Species or species habitat known to occur within area
Rhincodon typus Whale Shark [66680]	Vulnerable	Foraging, feeding or related behaviour known to occur within area

Listed Migratory Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Migratory Marine Birds		
Anous stolidus Common Noddy [825]		Species or species habitat may occur within area
Calonectris leucomelas Streaked Shearwater [1077]		Species or species habitat likely to occur within area
Fregata ariel Lesser Frigatebird, Least Frigatebird [1012]		Species or species habitat likely to occur within area
Fregata minor Great Frigatebird, Greater Frigatebird [1013]		Species or species habitat may occur within area
Migratory Marine Species		
Anoxypristis cuspidata Narrow Sawfish, Knifetooth Sawfish [68448]		Species or species habitat known to occur within area
Balaenoptera borealis Sei Whale [34]	Vulnerable	Species or species habitat 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	Species or species habitat likely to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Species or species habitat likely to occur within area
Carcharhinus longimanus Oceanic Whitetip Shark [84108]		Species or species habitat likely to occur within area

Name	Threatened	Type of Presence
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat may occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Species or species habitat likely to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Species or species habitat likely to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat likely to occur within area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Species or species habitat likely to occur within area
Isurus oxyrinchus Shortfin Mako, Mako Shark [79073]		Species or species habitat likely to occur within area
Isurus paucus Longfin Mako [82947]		Species or species habitat likely to occur within area
Manta alfredi Reef Manta Ray, Coastal Manta Ray, Inshore Manta Ray, Prince Alfred's Ray, Resident Manta Ray [84994]		Species or species habitat likely to occur within area
Manta birostris Giant Manta Ray, Chevron Manta Ray, Pacific Manta Ray, Pelagic Manta Ray, Oceanic Manta Ray [84995]		Species or species habitat likely to occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Species or species habitat known to occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Species or species habitat likely to occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat may occur within area
Physeter macrocephalus Sperm Whale [59]		Species or species habitat may occur within area
Pristis 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
Tursiops aduncus (Arafura/Timor Sea populations) Spotted Bottlenose Dolphin (Arafura/Timor Sea populations) [78900]		Species or species habitat may occur within area
Migratory Wetlands Species		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat may occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat may occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area

Other Matters Protected by the EPBC Act

Listed Marine Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Birds		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat may occur within area
Anous stolidus Common Noddy [825]		Species or species habitat may occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat may occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat may occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area
Calonectris leucomelas Streaked Shearwater [1077]		Species or species habitat likely to occur within area
Fregata ariel Lesser Frigatebird, Least Frigatebird [1012]		Species or species habitat likely to occur within area
Fregata minor Great Frigatebird, Greater Frigatebird [1013]		Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Fish		
Campichthys tricarinatus Three-keel Pipefish [66192]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
Choeroichthys brachysoma Pacific Short-bodied Pipefish, Short-bodied Pipefish [66194]		Species or species habitat may occur within area
Choeroichthys suillus Pig-snouted Pipefish [66198]		Species or species habitat may occur within area
Corythoichthys flavofasciatus Reticulate Pipefish, Yellow-banded Pipefish, Network Pipefish [66200]		Species or species habitat may occur within area
Cosmocampus banneri Roughridge Pipefish [66206]		Species or species habitat may occur within area
Doryrhamphus dactyliophorus Banded Pipefish, Ringed Pipefish [66210]		Species or species habitat may occur within area
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
Filicampus tigris Tiger Pipefish [66217]		Species or species habitat may occur within area
Halicampus brocki Brock's Pipefish [66219]		Species or species habitat may occur within area
Halicampus grayi Mud Pipefish, Gray's Pipefish [66221]		Species or species habitat may occur within area
Halicampus spinirostris Spiny-snout Pipefish [66225]		Species or species habitat may occur within area
Haliichthys taeniophorus Ribboned Pipehorse, Ribboned Seadragon [66226]		Species or species habitat may occur within area
Hippichthys penicillus Beady Pipefish, Steep-nosed Pipefish [66231]		Species or species habitat may occur within area
Hippocampus angustus Western Spiny Seahorse, Narrow-bellied Seahorse [66234]		Species or species habitat may occur within area
Hippocampus histrix Spiny Seahorse, Thorny Seahorse [66236]		Species or species habitat may occur within area
Hippocampus kuda Spotted Seahorse, Yellow Seahorse [66237]		Species or species habitat may occur within area
Hippocampus planifrons Flat-face Seahorse [66238]		Species or species habitat may occur within area
Hippocampus spinosissimus Hedgehog Seahorse [66239]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
Micrognathus micronotopterus Tidepool Pipefish [66255]		Species or species habitat may occur within area
Solegnathus hardwickii Pallid Pipehorse, Hardwick's Pipehorse [66272]		Species or species habitat may occur within area
Solegnathus lettiensis Gunther's Pipehorse, Indonesian Pipefish [66273]		Species or species habitat may occur within area
Solenostomus cyanopterus Robust Ghostpipefish, Blue-finned Ghost Pipefish, [66183]		Species or species habitat may occur within area
Syngnathoides biaculeatus Double-end Pipehorse, Double-ended Pipehorse, Alligator Pipefish [66279]		Species or species habitat may occur within area
Trachyrhamphus bicoarctatus Bentstick Pipefish, Bend Stick Pipefish, Short-tailed Pipefish [66280]		Species or species habitat may occur within area
Trachyrhamphus longirostris Straightstick Pipefish, Long-nosed Pipefish, Straight Stick Pipefish [66281]		Species or species habitat may occur within area
Reptiles		
Acalyptophis peronii Horned Seasnake [1114]		Species or species habitat may occur within area
Aipysurus duboisii Dubois' Seasnake [1116]		Species or species habitat may occur within area
Aipysurus eydouxii Spine-tailed Seasnake [1117]		Species or species habitat may occur within area
Aipysurus laevis Olive Seasnake [1120]		Species or species habitat may occur within area
Astrotia stokesii Stokes' Seasnake [1122]		Species or species habitat may occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Species or species habitat likely to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Species or species habitat likely to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat likely to occur within area
Disteira kingii Spectacled Seasnake [1123]		Species or species habitat may occur within area
Disteira major Olive-headed Seasnake [1124]		Species or species habitat may occur within area
Ephalophis greyi North-western Mangrove Seasnake [1127]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Species or species habitat likely to occur within area
Hydrophis czeblukovi Fine-spined Seasnake [59233]		Species or species habitat may occur within area
Hydrophis elegans Elegant Seasnake [1104]		Species or species habitat may occur within area
Hydrophis mcdowelli null [25926]		Species or species habitat may occur within area
Hydrophis ornatus Spotted Seasnake, Ornate Reef Seasnake [1111]		Species or species habitat may occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Species or species habitat likely 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 borealis Sei Whale [34]	Vulnerable	Species or species habitat 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	Species or species habitat likely to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Species or species habitat likely to occur within area
Delphinus delphis Common Dolphin, Short-beaked Common Dolphin [60]		Species or species habitat may occur within area
Feresa attenuata Pygmy Killer Whale [61]		Species or species habitat may occur within area
Globicephala macrorhynchus Short-finned Pilot Whale [62]		Species or species habitat may occur within area
Grampus griseus Risso's Dolphin, Grampus [64]		Species or species habitat may occur within area
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

Name	Status	Type of Presence
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Species or species habitat known to occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat may occur within area
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
Stenella attenuata Spotted Dolphin, Pantropical Spotted Dolphin [51]		Species or species habitat may occur within area
Stenella coeruleoalba Striped Dolphin, Euphrosyne Dolphin [52]		Species or species habitat may occur within area
Stenella longirostris Long-snouted Spinner Dolphin [29]		Species or species habitat may occur within area
Steno bredanensis Rough-toothed Dolphin [30]		Species or species habitat may occur within area
Tursiops aduncus (Arafura/Timor Sea populations) Spotted Bottlenose Dolphin (Arafura/Timor Sea populations) [78900]		Species or species habitat may 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

Extra Information

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

Name	Region
Ancient coastline at 125 m depth contour	North-west

Caveat

The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the Environment Protection and Biodiversity Conservation Act 1999. It holds mapped locations of World and National Heritage properties, Wetlands of International and National Importance, Commonwealth and State/Territory reserves, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various resolutions.

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the qualifications below and may need to seek and consider other information sources.

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Threatened, migratory and marine species distributions have been derived through a variety of methods. Where distributions are well known and if time permits, maps are derived using either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc) together with point locations and described habitat; or environmental modelling (MAXENT or BIOCLIM habitat modelling) using point locations and environmental data layers.

Where very little information is available for species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc). In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More reliable distribution mapping methods are used to update these distributions as time permits.

Only selected species covered by the following provisions of the EPBC Act have been mapped:

- migratory and
- marine

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:

- threatened species listed as extinct or considered as vagrants
- some species and ecological communities that have only recently been listed
- some terrestrial species that overfly the Commonwealth marine area
- migratory species that are very widespread, vagrant, or only occur in small numbers

The following groups have been mapped, but may not cover the complete distribution of the species:

- non-threatened seabirds which have only been mapped for recorded breeding sites
- seals which have only been mapped for breeding sites near the Australian continent

Such breeding sites may be important for the protection of the Commonwealth Marine environment.

Coordinates

-19.1653 116.5846,-19.1653 116.8346,-19.332 116.8346,-19.332 116.5013,-19.2487 116.5013,-19.2487 116.5846,-19.1653 116.5846

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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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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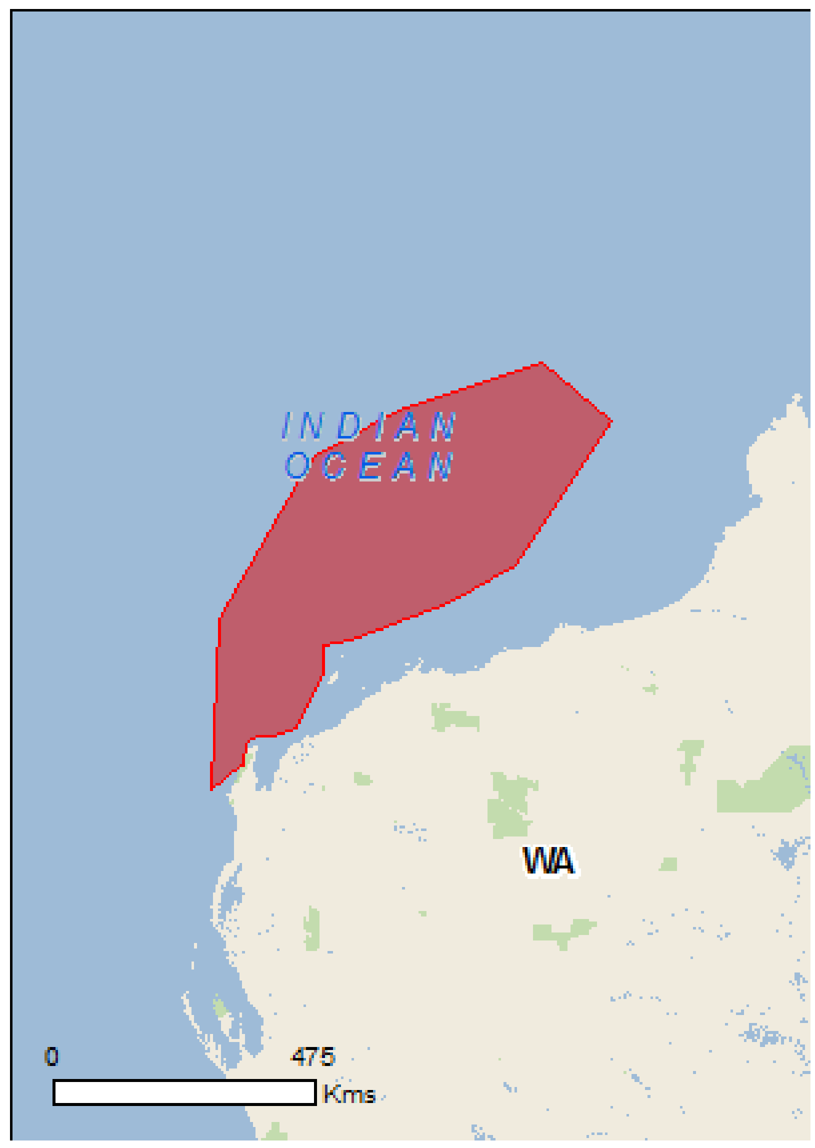
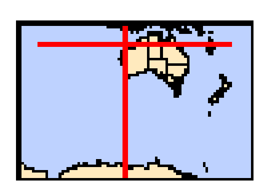


Coordinates

Buffer: 0.0Km



Summary

Matters of National Environmental Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

World Heritage Properties:	1
National Heritage Places:	1
Wetlands of International Importance:	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	1
Listed Threatened Ecological Communities:	None
Listed Threatened Species:	34
Listed Migratory Species:	56

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at http://www.environment.gov.au/heritage

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Land:	None
Commonwealth Heritage Places:	2
Listed Marine Species:	104
Whales and Other Cetaceans:	31
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	6

Extra Information

This part of the report provides information that may also be relevant to the area you have nominated.

State and Territory Reserves:	5
Regional Forest Agreements:	None
Invasive Species:	11
Nationally Important Wetlands:	2
Key Ecological Features (Marine)	7

Details

Matters of National Environmental Significance

World Heritage Properties [Resource Information]

Name	State	Status
The Ningaloo Coast	WA	Declared property

National Heritage Properties [Resource Information]

Name	State	Status
Natural		
The Ningaloo Coast	WA	Listed place

Commonwealth Marine Area [Resource Information]

Approval is required for a proposed activity that is located within the Commonwealth Marine Area which has, will have, or is likely to have a significant impact on the environment. Approval may be required for a proposed action taken outside the Commonwealth Marine Area but which has, may have or is likely to have a significant impact on the environment in the Commonwealth Marine Area. Generally the Commonwealth Marine Area stretches from three nautical miles to two hundred nautical miles from the coast.

Name
EEZ and Territorial Sea

Marine Regions [Resource Information]

If you are planning to undertake action in an area in or close to the Commonwealth Marine Area, and a marine bioregional plan has been prepared for the Commonwealth Marine Area in that area, the marine bioregional plan may inform your decision as to whether to refer your proposed action under the EPBC Act.

Name
North-west

Listed Threatened Species [Resource Information]

Name	Status	Type of Presence
Birds		
Calidris canutus		
Red Knot, Knot [855]	Endangered	Species or species habitat likely to occur within area
Calidris ferruginea		
Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Charadrius leschenaultii		
Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Species or species habitat known to occur within area
Falco hypoleucos		
Grey Falcon [929]	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
Numenius madagascariensis		
Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area

Name	Status	Type of Presence
Papasula abbotti Abbott's Booby [59297]	Endangered	Species or species habitat may occur within area
Pezoporus occidentalis Night Parrot [59350]	Endangered	Species or species habitat may occur within area
Pterodroma mollis Soft-plumaged Petrel [1036]	Vulnerable	Species or species habitat may 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 impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area
Fish		
Milyeringa veritas Blind Gudgeon [66676]	Vulnerable	Species or species habitat known to occur within area
Mammals		
Balaenoptera borealis Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Migration route known to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Dasyurus hallucatus Northern Quoll, Digul [Gogo-Yimidir], Wijingadda [Dambimangari], Wiminji [Martu] [331]	Endangered	Species or species habitat may occur within area
Eubalaena australis Southern Right Whale [40]	Endangered	Species or species habitat likely to occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Breeding 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 may 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

Name	Status	Type of Presence
Chelonia mydas		
Green Turtle [1765]	Vulnerable	Breeding known to occur within area
Dermochelys coriacea		
Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat known to occur within area
Eretmochelys imbricata		
Hawksbill Turtle [1766]	Vulnerable	Breeding known 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	Species or species habitat known to occur within area
Pristis clavata		
Dwarf Sawfish, Queensland Sawfish [68447]	Vulnerable	Species or species habitat known to occur within area
Pristis zijsron		
Green Sawfish, Dindagubba, Narrowsnout Sawfish [68442]	Vulnerable	Species or species habitat known to occur within area
Rhincodon typus		
Whale Shark [66680]	Vulnerable	Foraging, feeding or related behaviour known to occur within area

Listed Migratory Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Migratory Marine Birds		
Anous stolidus		
Common Noddy [825]		Species or species habitat likely to occur within area
Apus pacificus		
Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardenna carneipes		
Flesh-footed Shearwater, Fleshy-footed Shearwater [82404]		Species or species habitat likely to occur within area
Ardenna pacifica		
Wedge-tailed Shearwater [84292]		Breeding known to occur within area
Calonectris leucomelas		
Streaked Shearwater [1077]		Species or species habitat likely to occur within area
Fregata ariel		
Lesser Frigatebird, Least Frigatebird [1012]		Species or species habitat likely to occur within area
Fregata minor		
Great Frigatebird, Greater Frigatebird [1013]		Species or species habitat may occur within area
Macronectes giganteus		
Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Phaethon lepturus		
White-tailed Tropicbird [1014]		Breeding likely to occur

Name	Threatened	Type of Presence
		within area
Phaethon rubricauda Red-tailed Tropicbird [994]		Breeding known to occur within area
Sterna dougallii Roseate Tern [817]		Foraging, feeding or related behaviour likely to occur within area
Sternula albifrons Little Tern [82849]		Congregation or aggregation known to occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area
Migratory Marine Species		
Anoxypristis cuspidata Narrow Sawfish, Knifetooth Sawfish [68448]		Species or species habitat known to occur within area
Balaena glacialis australis Southern Right Whale [75529]	Endangered*	Species or species habitat likely to occur within area
Balaenoptera bonaerensis Antarctic Minke Whale, Dark-shoulder Minke Whale [67812]		Species or species habitat likely to occur within area
Balaenoptera borealis Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Balaenoptera edeni Bryde's Whale [35]		Species or species habitat likely to occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Migration route known to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Carcharhinus longimanus Oceanic Whitetip Shark [84108]		Species or species habitat likely to occur within area
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat known to occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Breeding known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Breeding known to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat 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

Name	Threatened	Type of Presence
Isurus paucus Longfin Mako [82947]		Species or species habitat likely to occur within area
Manta alfredi Reef Manta Ray, Coastal Manta Ray, Inshore Manta Ray, Prince Alfred's Ray, Resident Manta Ray [84994]		Species or species habitat known to occur within area
Manta birostris Giant Manta Ray, Chevron Manta Ray, Pacific Manta Ray, Pelagic Manta Ray, Oceanic Manta Ray [84995]		Species or species habitat 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
Orcinus orca Killer Whale, Orca [46]		Species or species habitat may occur within area
Physeter macrocephalus Sperm Whale [59]		Species or species habitat may occur within area
Pristis clavata Dwarf Sawfish, Queensland Sawfish [68447]	Vulnerable	Species or species habitat known to occur within area
Pristis zijsron Green Sawfish, Dindagubba, Narrowsnout Sawfish [68442]	Vulnerable	Species or species habitat known to occur within area
Rhincodon typus Whale Shark [66680]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Sousa chinensis Indo-Pacific Humpback Dolphin [50]		Species or species habitat known to occur within area
Tursiops aduncus (Arafura/Timor Sea populations) Spotted Bottlenose Dolphin (Arafura/Timor Sea populations) [78900]		Species or species habitat known to occur within area
Migratory Terrestrial Species		
Hirundo rustica Barn Swallow [662]		Species or species habitat may occur within area
Motacilla cinerea Grey Wagtail [642]		Species or species habitat may occur within area
Motacilla flava Yellow Wagtail [644]		Species or species habitat may occur within area
Migratory Wetlands Species		
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 likely to occur within area

Name	Threatened	Type of Presence
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area
Charadrius 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
Glareola maldivarum Oriental Pratincole [840]		Species or species habitat may occur within area
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat known to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area
Pandion haliaetus Osprey [952]		Breeding known to occur within area
Thalasseus bergii 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 Heritage Places [Resource Information]

Name	State	Status
Natural		
Mermaid Reef - Rowley Shoals	WA	Listed place
Ningaloo Marine Area - Commonwealth Waters	WA	Listed place

Listed Marine Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Birds		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat known to occur within area
Anous stolidus Common Noddy [825]		Species or species habitat likely to occur within area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardea 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

Name	Threatened	Type of Presence
		within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat likely to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area
Calonectris leucomelas Streaked Shearwater [1077]		Species or species habitat likely to occur within area
Charadrius 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 likely to occur within area
Fregata ariel Lesser Frigatebird, Least Frigatebird [1012]		Species or species habitat likely to occur within area
Fregata minor Great Frigatebird, Greater Frigatebird [1013]		Species or species habitat may occur within area
Glareola maldivarum Oriental Pratincole [840]		Species or species habitat may occur within area
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat known to occur within area
Hirundo rustica Barn Swallow [662]		Species or species habitat may occur within area
Larus novaehollandiae Silver Gull [810]		Breeding known to occur within area
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
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

Name	Threatened	Type of Presence
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area
Pandion haliaetus Osprey [952]		Breeding known to occur within area
Papasula abbotti Abbott's Booby [59297]	Endangered	Species or species habitat may occur within area
Phaethon lepturus White-tailed Tropicbird [1014]		Breeding likely to occur within area
Phaethon rubricauda Red-tailed Tropicbird [994]		Breeding known to occur within area
Pterodroma mollis Soft-plumaged Petrel [1036]	Vulnerable	Species or species habitat may occur within area
Puffinus carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [1043]		Species or species habitat likely to occur within area
Puffinus pacificus Wedge-tailed Shearwater [1027]		Breeding known to occur within area
Rostratula benghalensis (sensu lato) Painted Snipe [889]	Endangered*	Species or species habitat likely to occur within area
Sterna albifrons Little Tern [813]		Congregation or aggregation 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 dougallii Roseate Tern [817]		Foraging, feeding or related behaviour likely 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
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat likely to occur within area
Fish		
Acentronura larsonae Helen's Pygmy Pipehorse [66186]		Species or species habitat may occur within area
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

Name	Threatened	Type of Presence
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
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

Name	Threatened	Type of Presence
Halicampus grayi Mud Pipefish, Gray's Pipefish [66221]		Species or species habitat may occur within area
Halicampus nitidus Glittering Pipefish [66224]		Species or species habitat may occur within area
Halicampus spinirostris Spiny-snout Pipefish [66225]		Species or species habitat may occur within area
Haliichthys taeniophorus Ribboned Pipehorse, Ribboned Seadragon [66226]		Species or species habitat may occur within area
Hippichthys penicillus Beady Pipefish, Steep-nosed Pipefish [66231]		Species or species habitat may occur within area
Hippocampus angustus Western Spiny Seahorse, Narrow-bellied Seahorse [66234]		Species or species habitat may occur within area
Hippocampus histrix Spiny Seahorse, Thorny Seahorse [66236]		Species or species habitat may occur within area
Hippocampus kuda Spotted Seahorse, Yellow Seahorse [66237]		Species or species habitat may occur within area
Hippocampus planifrons Flat-face Seahorse [66238]		Species or species habitat may occur within area
Hippocampus spinosissimus Hedgehog Seahorse [66239]		Species or species habitat may occur within area
Hippocampus trimaculatus Three-spot Seahorse, Low-crowned Seahorse, Flat-faced Seahorse [66720]		Species or species habitat may occur within area
Micrognathus micronotopterus Tidepool Pipefish [66255]		Species or species habitat may occur within area
Phoxocampus belcheri Black Rock Pipefish [66719]		Species or species habitat may occur within area
Solegnathus hardwickii Pallid Pipehorse, Hardwick's Pipehorse [66272]		Species or species habitat may occur within area
Solegnathus lettiensis Gunther's Pipehorse, Indonesian Pipefish [66273]		Species or species habitat may occur within area
Solenostomus cyanopterus Robust Ghostpipefish, Blue-finned Ghost Pipefish, [66183]		Species or species habitat may occur within area
Syngnathoides biaculeatus Double-end Pipehorse, Double-ended Pipehorse, Alligator Pipefish [66279]		Species or species habitat may occur within area
Trachyrhamphus bicoarctatus Bentstick Pipefish, Bend Stick Pipefish, Short-tailed Pipefish [66280]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
Trachyrhamphus longirostris Straightstick Pipefish, Long-nosed Pipefish, Straight Stick Pipefish [66281]		Species or species habitat may occur within area
Mammals		
Dugong dugon Dugong [28]		Breeding known to occur within area
Reptiles		
Acalyptophis peronii Horned Seasnake [1114]		Species or species habitat may occur within area
Aipysurus apraefrontalis Short-nosed Seasnake [1115]	Critically Endangered	Species or species habitat known to occur within area
Aipysurus duboisii Dubois' Seasnake [1116]		Species or species habitat may occur within area
Aipysurus eydouxii Spine-tailed Seasnake [1117]		Species or species habitat may occur within area
Aipysurus foliosquama Leaf-scaled Seasnake [1118]	Critically Endangered	Species or species habitat known to occur within area
Aipysurus laevis Olive Seasnake [1120]		Species or species habitat may occur within area
Aipysurus tenuis Brown-lined Seasnake [1121]		Species or species habitat may occur within area
Astrotia stokesii Stokes' Seasnake [1122]		Species or species habitat may occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	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	Species or species habitat known to occur within area
Disteira kingii Spectacled Seasnake [1123]		Species or species habitat may occur within area
Disteira major Olive-headed Seasnake [1124]		Species or species habitat may occur within area
Emydocephalus annulatus Turtle-headed Seasnake [1125]		Species or species habitat may occur within area
Ephalophis greyi North-western Mangrove Seasnake [1127]		Species or species habitat may occur within area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Breeding known to occur within area
Hydrelaps darwiniensis Black-ringed Seasnake [1100]		Species or species habitat may occur within

Name	Threatened	Type of Presence
		area
Hydrophis czeblukovi Fine-spined Seasnake [59233]		Species or species habitat may occur within area
Hydrophis elegans Elegant Seasnake [1104]		Species or species habitat may occur within area
Hydrophis mcdowelli null [25926]		Species or species habitat may occur within area
Hydrophis ornatus Spotted Seasnake, Ornate Reef Seasnake [1111]		Species or species habitat may occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Breeding known to occur within area
Pelamis platurus Yellow-bellied Seasnake [1091]		Species or species habitat may occur within area

Whales and other Cetaceans [Resource Information]

Name	Status	Type of Presence
Mammals		
Balaenoptera acutorostrata Minke Whale [33]		Species or species habitat may occur within area
Balaenoptera bonaerensis Antarctic Minke Whale, Dark-shoulder Minke Whale [67812]		Species or species habitat likely to occur within area
Balaenoptera borealis Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Balaenoptera edeni Bryde's Whale [35]		Species or species habitat likely to occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Migration route known to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Delphinus delphis Common 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
Grampus griseus Risso's Dolphin, Grampus [64]		Species or species habitat may occur within area

Name	Status	Type of Presence
Indopacetus pacificus Longman's Beaked Whale [72]		Species or species habitat may occur within area
Kogia breviceps Pygmy Sperm Whale [57]		Species or species habitat may occur within area
Kogia simus Dwarf Sperm Whale [58]		Species or species habitat may occur within area
Lagenodelphis hosei Fraser's Dolphin, Sarawak Dolphin [41]		Species or species habitat may occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Breeding known to occur within area
Mesoplodon densirostris Blainville's Beaked Whale, Dense-beaked Whale [74]		Species or species habitat may occur within area
Mesoplodon ginkgodens Gingko-toothed Beaked Whale, Gingko-toothed Whale, Gingko Beaked Whale [59564]		Species or species habitat may occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat may occur within area
Peponocephala electra Melon-headed Whale [47]		Species or species habitat may occur within area
Physeter macrocephalus Sperm Whale [59]		Species or species habitat may occur within area
Pseudorca crassidens False Killer Whale [48]		Species or species habitat likely to occur within area
Sousa chinensis Indo-Pacific Humpback Dolphin [50]		Species or species habitat known to occur within area
Stenella attenuata Spotted Dolphin, Pantropical Spotted Dolphin [51]		Species or species habitat may occur within area
Stenella coeruleoalba Striped Dolphin, Euphrosyne Dolphin [52]		Species or species habitat may occur within area
Stenella longirostris Long-snouted Spinner Dolphin [29]		Species or species habitat may occur within area
Steno bredanensis Rough-toothed Dolphin [30]		Species or species habitat may occur within area
Tursiops aduncus Indian Ocean Bottlenose Dolphin, Spotted Bottlenose Dolphin [68418]		Species or species habitat likely to occur within area
Tursiops aduncus (Arafura/Timor Sea populations) Spotted Bottlenose Dolphin (Arafura/Timor Sea populations) [78900]		Species or species habitat known to occur within area
Tursiops truncatus s. str. Bottlenose Dolphin [68417]		Species or species

Name	Status	Type of Presence
		habitat may occur within area
Ziphius cavirostris Cuvier's Beaked Whale, Goose-beaked Whale [56]		Species or species habitat may occur within area

Australian Marine Parks [Resource Information]

Name	Label
Argo-Rowley Terrace	Multiple Use Zone (IUCN VI)
Argo-Rowley Terrace	Special Purpose Zone (Trawl) (IUCN VI)
Gascoyne	Multiple Use Zone (IUCN VI)
Mermaid Reef	National Park Zone (IUCN II)
Montebello	Multiple Use Zone (IUCN VI)
Ningaloo	Recreational Use Zone (IUCN IV)

Extra Information

State and Territory Reserves [Resource Information]

Name	State
Bessieres Island	WA
Cape Range	WA
Muiron Islands	WA
Serrurier Island	WA
Unnamed WA44665	WA

Invasive Species [Resource Information]

Weeds reported here are the 20 species of national significance (WoNS), along with other introduced plants that are considered by the States and Territories to pose a particularly significant threat to biodiversity. The following feral animals are reported: Goat, Red Fox, Cat, Rabbit, Pig, Water Buffalo and Cane Toad. Maps from Landscape Health Project, National Land and Water Resouces Audit, 2001.

Name	Status	Type of Presence
Birds		
Columba livia Rock Pigeon, Rock Dove, Domestic Pigeon [803]		Species or species habitat likely to occur within area
Mammals		
Canis lupus familiaris Domestic Dog [82654]		Species or species habitat likely to occur within area
Capra hircus Goat [2]		Species or species habitat likely to occur within area
Equus caballus Horse [5]		Species or species habitat likely to occur within area
Felis catus Cat, House Cat, Domestic Cat [19]		Species or species habitat likely to occur within area
Mus musculus House Mouse [120]		Species or species habitat likely to occur within area
Oryctolagus cuniculus Rabbit, European Rabbit [128]		Species or species habitat likely to occur within area

Name	Status	Type of Presence
Rattus rattus Black Rat, Ship Rat [84]		Species or species habitat likely to occur within area
Vulpes vulpes Red Fox, Fox [18]		Species or species habitat likely to occur within area
Plants		
Cenchrus ciliaris Buffel-grass, Black Buffel-grass [20213]		Species or species habitat likely to occur within area
Reptiles		
Hemidactylus frenatus Asian House Gecko [1708]		Species or species habitat likely to occur within area

Nationally Important Wetlands [Resource Information]

Name	State
Cape Range Subterranean Waterways	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
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

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

-19.8556552318034 113.501021672013,-17.7319768689373 114.839756993391,-17.3508931062318 115.077143295227,-16.6572289276728 116.452732786389,-15.8870795278979 118.779658405611,-16.7960153608202 119.916740186211,-19.0404549722192 118.329380515099,-19.6301250675178 117.26258883101,-20.1742959019343 115.792462643236,-20.2079652746776 115.66742196715,-20.2967191704533 115.197621186269,-20.7303759392981 115.217251738977,-21.5278047058225 114.770103427132,-21.5984022157896 114.684014334094,-21.6519995749204 114.380228547709,-21.646201622307 114.107256781176,-21.7943032404022 113.929441642718,-22.0855096103801 113.887107066438,-22.0932428581713 113.911793973713,-22.111088815996 113.911496540933,-22.1134682773391 113.879076384967,-22.4716644054879 113.400697647379,-22.4716644054879 113.38320860889,-19.8556552318034 113.501021672013

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 F: Environment Plan Consultation for Decommissioning

From: Consultation, Santos
To: [redacted]
Cc: Consultation, Santos
Subject: Santos Consultation - Mutineer-Exeter Decommissioning Environment Plans
Date: Wednesday, 1 June 2022 4:17:18 PM
Attachments: MEFF Consultation Information - P&A Actvities.pdf
MEFF Consultation Information - Decommissiong Activities.pdf

Dear stakeholder

Santos is preparing for the final stages of its decommissioning of the Mutineer Exeter Fletcher Finucane fields, located in Commonwealth Waters approximately 160 km north of Dampier, Western Australia.

These activities comprise:

- Plug and permanently abandonment (P&A) of 12 subsea wells, including removal of subsea wellhead infrastructure. Where recovery is not feasible, some equipment may be temporarily stored on the seabed and will be recovered during the MEFF field decommissioning.
- Removal of the majority of seabed infrastructure from the operational area including plastics from the ocean through the removal of the 12" Rigid Flowline, 2" coiled tubing, all (four) production manifolds and their mudmats/bases.
- Preparation for, and abandonment of, select seabed infrastructure to remain *in situ* on title, comprising:
  - Two steel, epoxy coated gravity bases (approximately 19m x 6m x 3,1m high) complete with concrete ballast (approximately 6m x 1.4m x 2.35m high) weighing about 330t each set) and their associated tether chains (approximately 80m each); and
  - Six deeply buried steel anchors and the six corresponding steel mooring chains of approximately 710 m / ~190t per mooring leg (each chain is partially buried) and the expectation is that the length buried, will increase overtime.

These activities are proposed to be managed under two separate Environments Plan (EP) developed in accordance with the Commonwealth Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009.

Santos is undertaking a single consultation in preparation of both EPs to minimise consultation fatigue for stakeholders, and we are seeking your feedback on each of these work scopes by the following dates:

- Mutineer Exeter Plug and Abandonment EP – feedback by **29 June 2022**
- Mutineer Exeter Cessation of Operations and Decommissioning EP – feedback by **13 July 2022**

P&A activities are expected to commence between July and December 2023 with a planned campaign duration of 230 days but could take up to 12 months.

Decommissioning activities are expected to commence in the second half of 2024 with an estimated duration of 170 days and a planned completion date by the end of 2025.

More detail on each the work scopes for each EP is provided in the attached fact sheets.

Your feedback

The Environment Regulations require NOPSEMA to publish the environment plan submitted by the titleholder for assessment, and to publish the final accepted version of an environment plan.

Environment plans are published in full, with the exception of sensitive information from the consultation process and transcripts of correspondence between stakeholders and the titleholder. This information is used by NOPSEMA during the assessment but is not published for wider review.

If you do not wish for your comments to be published in this environment plan, or wish to provide your comments anonymously, please make this known to Santos as soon as possible.

We look forward to hearing from you and please get back to us if you need any additional information.

Regards

[redacted]

[redacted]

As a service provider to

Santos Limited, Level 7, 100 St Georges Tce
Perth WA 6000
[redacted]

https://www.santos.com/

STAKEHOLDER CONSULTATION

Mutineer, Exeter, Fletcher and Finucane (MEFF)

Cessation of Operations and Decommissioning Environment Plan

Santos

Overview

Santos Ltd (Santos) is preparing for the final phase of decommissioning of the Mutineer, Exeter, Fletcher and Finucane (MEFF) field and is planning for the removal of most of the seabed infrastructure within production licences WA-26-L, WA-27-L & WA-54-L, with some select infrastructure proposed to be left *in situ*. The MEFF field is in Commonwealth waters approximately 160 km north of Dampier, in water depth ranging between approximately 130m – 160m. **Figure 1** shows the location operational area for the final decommissioning activities with location coordinates in **Table 1**.

The MEFF Development ceased production in 2018, following which the floating, production, storage and offtake vessel (FPSO) departed the field. All that remains are 12 subsea wells, a mid-water disconnectable turret mooring (DTM) and two midwater arches (MWA), and a subsea production system. The subsea production system has been flushed of hydrocarbons with treated seawater and is in a preservation state.

The MWAs and DTM are planned to be removed Q3/Q4 2022, under the MEFF Cessation of Production EP (9885-650-PLN-0001) Rev 4, as accepted by NOPSEMA in March 2022.

Santos will then, subject to acceptance of a separate EP, permanently plug and abandon the 12 wells between July 2023 and December 2024, with an estimated campaign duration of 230 days but could take up to 12 months.

The final phase of decommissioning will be the removal of most of the seabed infrastructure as outlined in the activity description below, with some select infrastructure proposed to be left *in situ*. All activities are proposed to be managed under the revised MEFF Cessation of Production EP (9885-650-PLN-0001). Santos plans to submit the EP in August 2022 to National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) for assessment.

Activities

The final field decommissioning activities will be addressed through a final revision of the MEFF Cessation of Production EP (CoP EP). The MEFF CoP EP will retain the previously consulted activities for cessation of operations and removal of floating assets, and include new activities specific to decommissioning, comprising of:

+ the removal of the majority of seabed infrastructure from the operational area including plastics from the ocean through the removal of the 12" Rigid Flowline, 2" coiled tubing, all (four) production manifolds and their mudmats/bases;
+ preparation for, and abandonment of, select seabed infrastructure to remain *in situ* on title, comprising:
  - two steel, epoxy coated gravity bases (approximately 19m x 6m x 3,1m high) complete with concrete ballast (approximately 6m x 1.4m x 2.35m high) weighing about 330t each set) and their associated tether chains (approximately 80m each); and
  - Six deeply buried steel anchors and the six corresponding steel mooring chains of approximately 710 m / ~190t per mooring leg (each chain is partially buried) and the expectation is that the buried length will increase overtime.

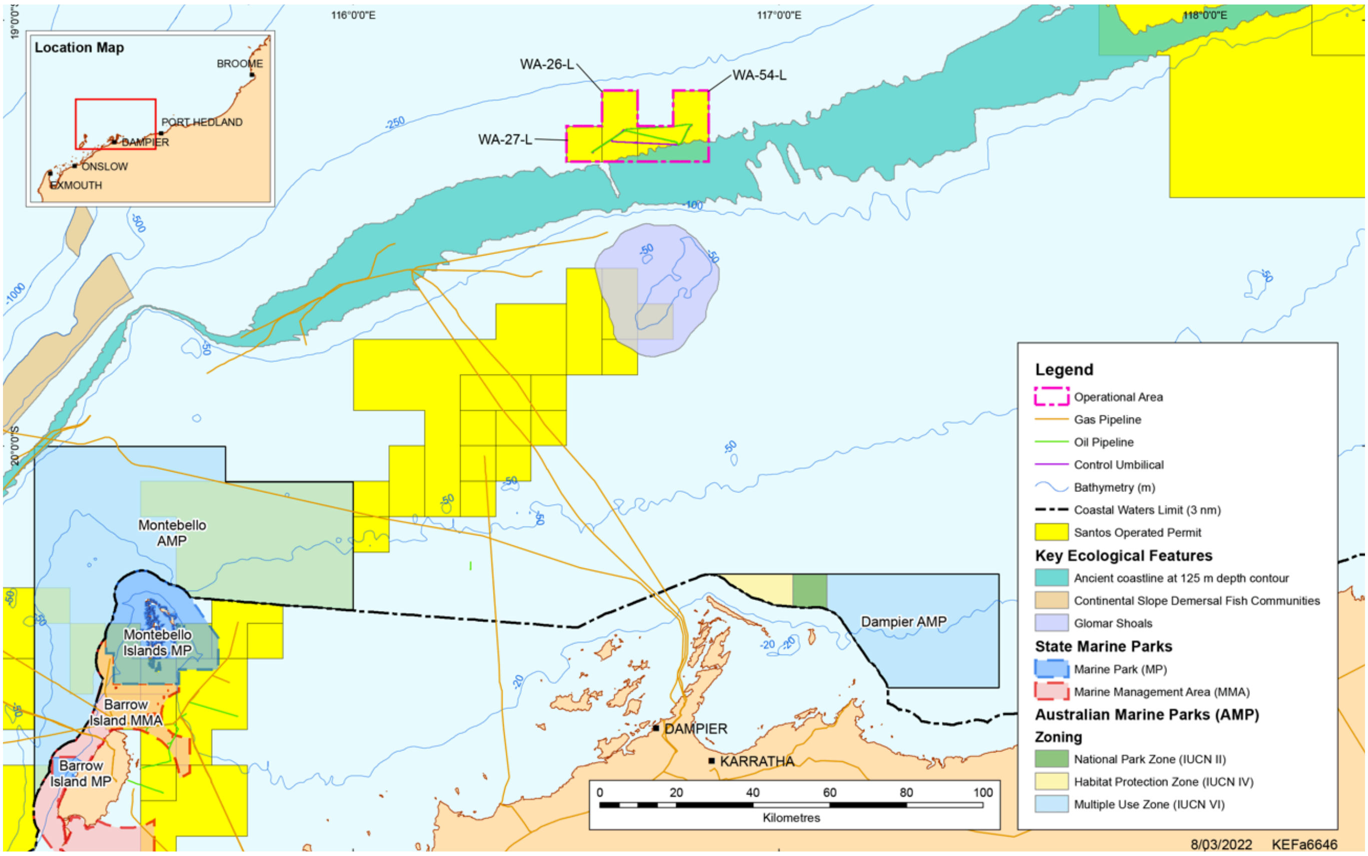
The potential environmental impacts and risks under consideration in the EP for the removal of some infrastructure and leaving some infrastructure on the seabed in perpetuity are summarised in **Table 2** and shown in **Figure 2**. The proposed control measures to mitigate the key risks are described in **Table 3**.

Consultation

Please contact Santos on the contact details below if you wish to provide feedback on this consultation advice or require additional information. Santos would appreciate your feedback by **13 July 2022**.

Consultation Adviser
Santos
PO Box 5624, Perth, 6831
Telephone: 08 6218 7095
Email: Offshore.Consultation@Santos.com

Figure 1: Mutineer, Exeter, Fletcher, Finucane Field location map



Gravity base/ballast module and a steel anchor being installed

Figure 2: MEFF assets being removed and those to remain in-situ

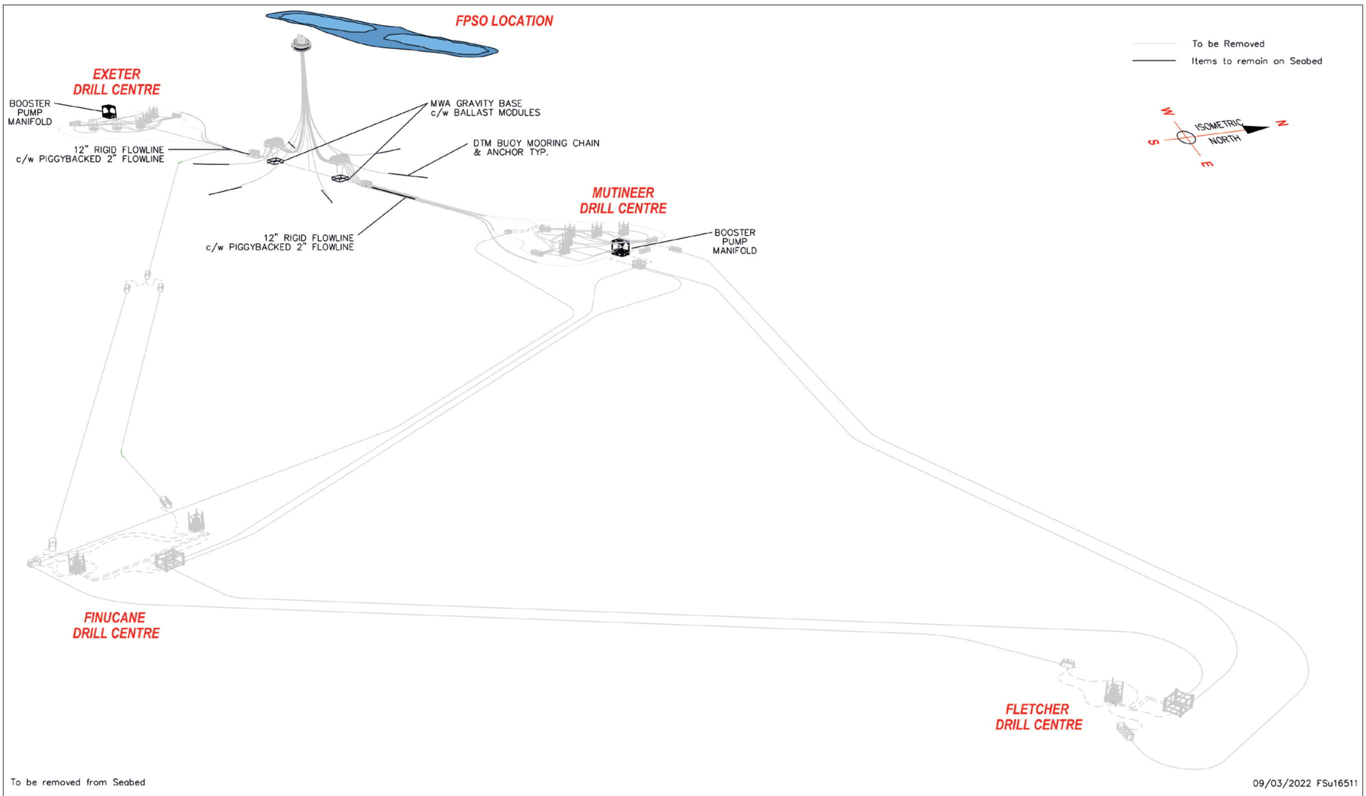


Table 1: Activity summary

ACTIVITY INFORMATION				
Location	**Aspect**	**Latitude**	**Longitude**	**Water depth**
	Operational Area	19º 9' 55.21" S	116º 35' 4.72" E	Approximately 130 – 160 m
		19º 9' 55.21" S	116º 40' 4.72" E	
		19º 14' 55.21" S	116º 40' 4.72" E	
		19º 14' 55.21" S	116º 45' 4.72" E	
		19º 9' 55.21" S	116º 45' 4.72" E	
		19º 9' 55.20" S	116º 50' 4.72" E	
		19º 19' 55.21" S	116º 50' 4.72" E	
		19º 19' 55.22" S	116º 35' 4.72" E	
		19º 19' 55.22" S	116º 30' 4.72" E	
		19º 14' 55.22" S	116º 30' 4.72" E	
		19º 14' 55.21" S	116º 35' 4.72" E	
Equipment	A multipurpose support vessel (MPSV) will be the primary vessel undertaken removal activities. However, up to four vessels may be present in the operational area at any one time.			
Timing and duration	Execution of decommissioning is estimated to take approximately 170 days but may take up to 12 months cumulative duration (potentially with multiple campaigns) occurring at any time of year, commencing in the second half of 2024 with a planned completion date of the end of 2025.			
Distance and direction from operational area to key regional features	**Regional Feature**			
	Dampier Archipelago		113km to south	
	Karratha		155km to southeast	
	Closest mainland point (Burrup Peninsula)		135km to south	
	Montebello Marine Park		99km to southwest	
	Dampier Marine Park		105km to southeast	
	Ancient coastline 125m Depth contour KEF		Occurs within operational area	
Description of natural existing environment	The seabed in permit areas is generally flat and featureless and water depth ranges from 130 – 160m. Located within the Northwest Shelf Province and the in the North-West Transition Bioregion. These regions are described in the Integrated Marine and Coastal Regionalisation (IMCRA) of Australia, version 4.0. The operational area does not overlap any Australian or State Marine Parks. In total, 14 listed threatened species and 31 migratory species may be present within the operational area, and Biologically Important Areas (BIA) of three species listed under the *Environment Protection and Biodiversity Conservation Act 1999*, cover the operational area. Whale sharks (foraging), Humpback whale (migration), pygmy blue whale (migration, foraging and distribution)			
Relevant fisheries	There are three Commonwealth fisheries that overlap the operational area but are not actively fished. There are 11 State commercial fisheries that overlap the operational area. The Pilbara Fish Interim Trawl Managed Fishery has a Closed Area that overlaps the operational area but has been active to the south of the operational area. The Mackerel Managed Fishery (Area 2) has seen historic fishing in the operational area. Marine users are currently excluded within 500m of existing subsea manifolds and the centre of the DTM via the presence of a series of 500m Petroleum Safety Zones (PSZ). Infrastructure is marked on the Australian Hydrographic Service nautical charts along with the PSZ's and wider cautionary zones.			
Worst case hydrocarbon spill scenario	All wells will be plugged and abandoned before decommissioning of the flowlines commences as part of a separate EP. A worst-case diesel spill resulting from a vessel collision during vessel-based decommissioning activities, of 604m^3, has been assessed in the EP.			

Table 2: Key impacts and risks assessed in the MEFF decommissioning EP

ASPECT	DESCRIPTION
Interaction with marine users	+ Physical presence of vessels and ROVs for surveys, seabed asset removal and other activities. + Continued presence of subsea assets abandoned in situ as the decommissioning end state.
Seabed and benthic habitat disturbance	+ Sediment grab samples for environmental analysis. + Deburial of seabed assets and seabed asset removal. + Continued presence of subsea assets abandoned in situ.
Operational discharges	+ Sewage and grey water disposal; putrescible waste disposal; desalination brine disposal; cooling water disposal; boiler blowdown water; deck drainage disposal; bilge water disposal. + Transport of recovered assets to the port of landing and onshore disposal.
Planned chemical and hydrocarbon discharges	+ There may be potential for minor discharge from ROV or tooling hydraulics (typically mineral oil) during subsea operations. + The discharge of up to approximately 2250m^3 of treated seawater with <40 ppm oil in water content, along with residual hydrocarbons from the rough-bore carcass of flexible flowlines during disconnection and removal of seabed infrastructure or discharge overtime from infrastructure left in situ (e.g. rigid flowlines). + Scale inhibitor, hydraulic control fluid and glycol discharges during disconnection and removal of EFLs and HFLs. + Santos does not anticipate any other contaminants (e.g. NORM and mercury).
Degradation of abandoned seabed infrastructure	+ Degradation of the steel mooring chains and anchors, gravity bases and concrete ballast, and the two steel base/mudmats (from the manifolds which are being removed). + Release of treated seawater and residual hydrocarbons from degradation of abandoned seabed infrastructure.
Contingency spill response operations	+ Light, noise and atmospheric emissions. + Operational discharges and waste. + Potential for chemical dispersant application. + Physical presence and disturbance to marine users and coastal areas and townships.

Table 3: Typical measures in place or proposed to manage key environmental risks and impacts of the activity

KEY POTENTIAL RISKS AND/OR IMPACTS	PROPOSED MANAGEMENT MEASURES
Interaction with other marine users and Commercial Fishers	+ If requested, stakeholders will be notified prior to the commencement and on cessation of each activity. + Relevant maritime notices issued. + A visual and radar watch will be maintained on the vessel bridge. + Santos will not restrict commercial fishing access to the operational area and is committed to concurrent operations, where safety of either vessel is not compromised. + Support vessels will be prohibited from recreational fishing within the operational area. + Santos commits to reducing impacts on commercial fishers through the provision of timely activity information to enable advance planning and avoidance of unexpected interference.
Seabed and benthic habitat disturbance	+ Objects dropped overboard are recovered (where possible) to mitigate the environmental consequences from objects remaining in the marine environment.
Operational discharges	+ Onshore disposal of decommissioned assets by experienced contractors and only at suitably licensed waste facilities. + Routine vessel discharge (sewage, bilge water, food waste) will meet MARPOL requirements. + Deck cleaning products that may be discharged to the ocean will meet MARPOL requirements.
Planned chemical and hydrocarbon discharges	+ Chemical Selection Procedure during operations phase used environmentally acceptable products. + Previous flushing of the subsea system to as low as reasonably practicable (ALARP).
Degradation of abandoned seabed infrastructure including plastics	+ Consultation with persons relevant to end state during decision making to inform end state as the subject of the EP. + Detailed Environment Impact Assessment using a multi criteria analysis to help inform end state risk and impact assessment. + Infrastructure left in situ marked on nautical charts. + Application is made to DAWE for a sea dumping permit for infrastructure left on title (legal requirement).
Contingency Spill Response Operations (when executing in field)	+ In the event of a hydrocarbon spill, the Santos OPEP requirements are implemented to mitigate environmental impacts.

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Santos

Santos Consultation

2 June 2022

Dear Fishery Licence Holder

Santos is preparing for the final stages of its decommissioning of the Mutineer Exeter Fletcher Finucane fields, located in Commonwealth Waters approximately 160 km north of Dampier, Western Australia.

These activities comprise:

- Plug and permanently abandonment (P&A) of 12 subsea wells, including removal of subsea wellhead infrastructure. Where recovery is not feasible, some equipment may be temporarily stored on the seabed and will be recovered during the MEFF field decommissioning.
- Removal of the majority of seabed infrastructure from the operational area including plastics from the ocean through the removal of the 12” Rigid Flowline, 2” coiled tubing, all (four) production manifolds and their mudmats/bases.
- Preparation for, and abandonment of, select seabed infrastructure to remain *in situ* on title, comprising:
  - Two steel, epoxy coated gravity bases (approximately 19m x 6m x 3,1m high) complete with concrete ballast (approximately 6m x 1.4m x 2.35m high) weighing about 330t each set) and their associated tether chains (approximately 80m each); and
  - Six deeply buried steel anchors and the six corresponding steel mooring chains of approximately 710 m / ~190t per mooring leg (each chain is partially buried) and the expectation is that the length buried, will increase overtime.

These activities are proposed to be managed under two separate Environments Plan (EP) developed in accordance with the Commonwealth Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009.

Santos is undertaking a single consultation in preparation of both EPs to minimise consultation fatigue for stakeholders, and we are seeking your feedback on each of these work scopes by the following dates:

- Mutineer Exeter Plug and Abandonment EP – **feedback by 29 June 2022**
- Mutineer Exeter Cessation of Operations and Decommissioning EP – **feedback by 13 July 2022**

P&A activities are expected to commence between July and December 2023 with a planned campaign duration of 230 days but could take up to 12 months.

Decommissioning activities are expected to commence in the second half of 2024 with an estimated duration of 170 days and a planned completion date by the end of 2025.

More detail on each the work scopes for each EP is provided in the attached fact sheets.

Commercial Fishing

There are three Commonwealth commercial fisheries that overlap the operational area but are not actively fished - Southern Bluefin Tuna Fishery, Western Skipjack Tuna Fishery, and Western Tuna and Billfish Fishery. Santos is consulting representative organisations on behalf of licence holders given this absence of activity.

There are 11 State commercial fisheries that overlap the operational area, with no recent commercial fishing activity recorded in the operational area.

The Pilbara Fish Interim Trawl Managed Fishery has a Closed Area that overlaps the operational area but has been active to the south of the operational area. The Mackerel Managed Fishery (Area 2) has seen historic fishing (2011) in the operational area.

Santos is consulting licence holders in these two State fisheries given its proposal to leave select seabed infrastructure *in situ*.

Your feedback
The Environment Regulations require NOPSEMA to publish the environment plan submitted by the titleholder for assessment, and to publish the final accepted version of an environment plan.

Environment plans are published in full, with the exception of sensitive information from the consultation process and transcripts of correspondence between stakeholders and the titleholder. This information is used by NOPSEMA during the assessment but is not published for wider review.

If you do not wish for your comments to be published in this environment plan, or wish to provide your comments anonymously, please make this known to Santos as soon as possible.

We look forward to hearing from you and please get back to us if you need any additional information.

Regards

[redacted]

[redacted]
e: offshore.consultation@Santos.com

Santos

Santos Consultation

11 July 2022

Dear Fishery Licence Holder

Santos is sending this letter by way of a reminder to commercial fishery licence holders as we will be submitting in the coming weeks Environment Plans (EP) for proposed final decommissioning activities at the Mutineer Exeter Field.

Activity Overview
These activities comprise:

- Plug and permanently abandonment (P&A) of 12 subsea wells, including removal of subsea wellhead infrastructure. Where recovery is not feasible, some equipment may be temporarily stored on the seabed and will be recovered during the MEFF field decommissioning.
- Removal of the majority of seabed infrastructure from the operational area including plastics from the ocean through the removal of the 12” Rigid Flowline, 2” coiled tubing, all (four) production manifolds and their mudmats/bases.
- Preparation for, and abandonment of, select seabed infrastructure to remain *in situ* on title, comprising:
  - Two steel, epoxy coated gravity bases (approximately 19m x 6m x 3,1m high) complete with concrete ballast (approximately 6m x 1.4m x 2.35m high) weighing about 330t each set) and their associated tether chains (approximately 80m each); and
  - Six deeply buried steel anchors and the six corresponding steel mooring chains of approximately 710 m / ~190t per mooring leg (each chain is partially buried) and the expectation is that the length buried, will increase overtime.

These activities are proposed to be managed under two separate EPs developed in accordance with the Commonwealth Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009. The EPs are:

- Mutineer Exeter Plug and Abandonment EP
- Mutineer Exeter Cessation of Operations and Decommissioning EP

Activity timing
P&A activities are expected to commence between July and December 2023 with a planned campaign duration of 230 days but could take up to 12 months.

Decommissioning activities are expected to commence in the second half of 2024 with an estimated duration of 170 days and a planned completion date by the end of 2025.

More detail on each the work scopes for each EP is provided in the attached fact sheets.

Commercial Fishing
There are 11 State commercial fisheries that overlap the operational area, with no recent commercial fishing activity recorded in the operational area.

The Pilbara Fish Interim Trawl Managed Fishery has a Closed Area that overlaps the operational area but has been active to the south of the operational area. The Mackerel Managed Fishery (Area 2) has seen historic fishing (2011) in the operational area.

Santos is consulting licence holders in these two State fisheries given its proposal to leave select seabed infrastructure *in situ.*

Your feedback
The Environment Regulations require NOPSEMA to publish the environment plan submitted by the titleholder for assessment, and to publish the final accepted version of an environment plan.

Environment plans are published in full, with the exception of sensitive information from the consultation process and transcripts of correspondence between stakeholders and the titleholder. This information is used by NOPSEMA during the assessment but is not published for wider review.

If you do not wish for your comments to be published in this environment plan, or wish to provide your comments anonymously, please make this known to Santos as soon as possible.

We look forward to hearing from you and please get back to us if you need any additional information.

Regards

[redacted]

[redacted]

e: offshore.consultation@Santos.com

Environment Plan Consultation for FAR (As per EP Rev 4, accepted by NOSPEMA March 2022)

[redacted]

From: Consultation, Santos
Sent: Tuesday, 31 August 2021 9:35 PM
To: [redacted]
Subject: Santos Consultation - Revision of Mutineer-Exeter Cessation of Operations Environment Plan
Attachments: MEFF Consultation Information.pdf

Dear stakeholder

Santos is preparing a revision of its current Mutineer-Exeter Cessation of Operations Environment Plan (EP) as part of Santos' future plans for decommissioning the Mutineer, Exeter, Fletcher, and Finucane (MEFF) fields and associated subsea infrastructure.

The current EP includes management measures for the inspection and monitoring of the former production and facility mooring systems ahead of full field decommissioning. The revision to this EP is to allow for removal of floating (submerged) infrastructure, as well ongoing inspections and monitoring of remaining equipment. The decommissioning of remaining equipment will be subject to separate and future EPs.

This EP is being developed in accordance with the Commonwealth Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009 and we are seeking your feedback on our proposed activities.

The information attached provides more detail on the proposed activities, including a location map and a summary of potential risks, impacts and management measures.

Activity Summary

Activity Name	Mutineer-Exeter Cessation of Operations Environment Plan Revision		
Activity Summary	Santos is proposing a revision of its existing Mutineer-Exeter Cessation of Operations Environment Plan to include the removal of the following floating (submerged) infrastructure using a multipurpose support vessel (MPSV) and up to four secondary support vessels: • 1 x Disconnectable Turret Mooring (approximately 30 m below sea surface) • 2 x Mid-Water Arches (approximately 82 m below sea surface)		
Estimated Start Date	The activity is planned to take place from mid-2022 and could be undertaken at any time of the year.		
Total Duration	Allowing for potential down time, for example due to weather, the activity may extend to up to 90 days, and may be conducted in multiple campaigns over this time. Activities will be undertaken 24 hours per day.		
Permit Number	WA-26-L, WA-27-L and WA-54-L		
Location	Approx. 155 km north of Karratha. Please see attached Consultation Information for location map.		
Approximate Water Depth	Approx. 130 m to 160 m		
Operational Coordinates	Point 1	19° 09' 55.21" S	116° 35' 04.72" E
	Point 2	19° 09' 55.20" S	116° 50' 04.72" E
	Point 3	19° 19' 55.21" S	116° 50' 04.72" E
	Point 4	19° 19' 55.22" S	116° 30' 04.72" E
	Point 5	19° 14' 55.22" S	116° 30' 04.72" E
	Point 6	19° 14' 55.21" S	116° 35' 04.72" E
Exclusion Zone	A 500m petroleum safety zone (PSZ) will exist around the MPSV during asset removal activities. However, there may be a time when two vessels operating in the operational area will each need a 500m PSZ.		

Please contact Santos by **15 October 2021** if you wish to comment on Santos' proposed activities or if you require additional information about the proposed activities.

The Environment Regulations require NOPSEMA to publish the environment plan submitted by the titleholder for assessment, and to publish the final accepted version of an environment plan. Environment plans are published in full, with the exception of sensitive information from the consultation process and transcripts of correspondence between stakeholders and the titleholder. This information is used by NOPSEMA during the assessment, but is not published for wider review.

If you do not wish for your comments to be published in this environment plan, or wish to provide your comments anonymously, please make this known to Santos as soon as possible.

We look forward to hearing from you.

Regards

[redacted]

[redacted]
Stakeholder Adviser

As a service provider to

Santos Limited, Level 7, 100 St Georges Tce
Perth WA 6000
[redacted]

https://www.santos.com/

STAKEHOLDER CONSULTATION

Santos

Mutineer-Exeter

Cessation of Operations Environment Plan Revision

Overview

Santos is currently planning for the decommissioning of the Mutineer, Exeter, Fletcher, and Finucane (MEFF) fields and associated subsea infrastructure. These fields are located approximately 160 km North of Dampier in production licenses WA-26-L, WA-27-L and WA-54-L. **Figure 1** provides the MEFF Cessation of Production (CoP) location map. As part of decommissioning planning for the MEFF fields and infrastructure, the existing Mutineer-Exeter CoP Environment Plan (EP) accepted by the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) in 2018 and valid for five years is being revised by Santos to allow for removal of some equipment used for production and associated activities (prior to full field decommissioning at a later date and subject to a separate EP).

Mutineer-Exeter produced from 2005 until May 2018 and the Fletcher and Finucane fields produced between March 2013 and May 2018. The Floating Production Storage and Offtake (FPSO) facility departed the field in July 2018 following completion of subsea flushing activities and shut-in and isolation of the wells. FPSO departure marked the end of the Operations Phase and commencement of the Cessation of Production Phase.

Santos is now proposing to remove the following floating (submerged) infrastructure:

+ 1 x Disconnectable Turret Mooring (DTM) (approximately 30m below sea surface)
+ 2 x Mid-Water Arches (MWA) (approximately 82m below sea surface)

The EP will be developed as a revision to the existing, in force Mutineer-Exeter CoP EP to include equipment removal activities and will be implemented in accordance with the Commonwealth Offshore *Petroleum and Greenhouse Gas Storage (Environment)* Regulations 2009 (OPGGS(E)R) for acceptance by NOPSEMA. The revised Mutineer-Exeter CoP EP will remain valid until May 2023.

Before Santos can submit the EP for assessment, Santos will be undertaking stakeholder consultation to inform activity planning and development of the Environment Plan.

Activity Description

Equipment Removal

The equipment removal activities will be undertaken using a multipurpose support vessel (MPSV) primary vessel and up to four secondary support vessels. Typically two vessels will be present within the operational area, however up to four vessels may be present in the operational area at any one time.

Activities could be undertaken at any time of the year and would be continuous over a 24-hour period. It is envisaged that the total duration of all activities covered by this environment plan revision will be up to 45 days in the operational area. However, with potential for weather and operational delays this could extend the project duration to a period of 90 days in the operational area. Activities are expected to be conducted over multiple campaigns during these time frames, and the MPSV therefore is expected to depart and then re-enter the operational area multiple times.

The equipment removal activities will include the following:

+ Barrier testing - Santos plans to undertake a pre-removal campaign where barrier testing will be performed on the subsea production Xmas Trees (XTs) to prove primary and secondary isolations to allow safe disconnection of production flowline segments such as the risers and spools.
+ Flowline flushing - Santos plans to undertake a pre-removal campaign to clean, by flushing with chemically treated seawater, the flowlines and risers to minimise the potential risk of residual hydrocarbons before riser disconnection and recovery.
+ Subsea equipment is planned to be removed using a MPSV. The following equipment will be recovered from the field:
  - 1 x Disconnectable Turret Mooring (DTM)
  - 2 x Mid-Water Arches (MWA).
+ Temporary storage of equipment on the seabed, which will be recovered at a later date during full field decommissioning.

Inspection, Maintenance and Repair (IMR) activities may continue as per the current in-force Mutineer-Exeter CoP EP. These activities will be vessel based and include:

+ Subsea equipment inspections using equipment such as Remotely Operated Vehicle (ROV), Autonomous Underwater Vehicle (AUV), Multi-beam echo sounder (MBES), Side scan sonar (SSS)
+ Maintenance and repair activities, such as replacing anodes or installing anode skids.
+ Recovery of dropped objects (where safe and practicable to do so).
+ Clearing debris using tools such as a high-pressure water jetter and/or flapper tool

An activity summary is provided in **Table 1** Potential risks and management measures are provided in **Table 2**.

Figure 1: Proposed location map

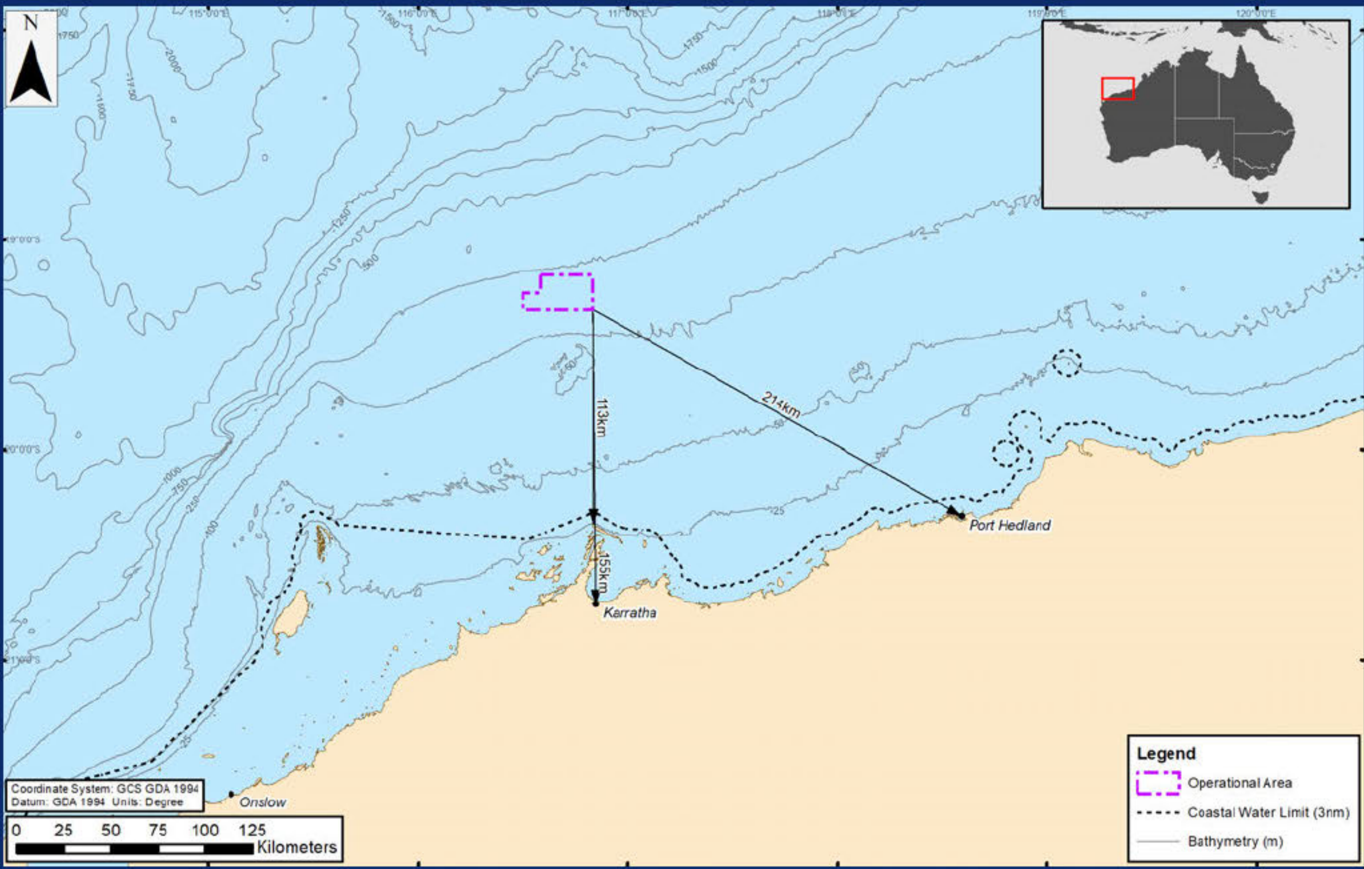


Table 1: Activity Summary

ACTIVITY DETAILS			
Permit number	WA-26-L, WA-27-L and WA-54-L.		
Water depth	Approx. 130m to 160m.		
Exclusion zone	A 500m petroleum safety zone will exist around the MPSV during asset removal activities. However, there may be a time when two vessels operating in the operational area will each need a 500m PSZ.		
Operational area	Points	Latitude (GDA 94)	Longitude (GDA 94)
	Point 1	19° 09' 55.21" S	116° 35' 04.72" E
	Point 2	19° 09' 55.20" S	116° 50' 04.72" E
	Point 3	19° 19' 55.21" S	116° 50' 04.72" E
	Point 4	19° 19' 55.22" S	116° 30' 04.72" E
	Point 5	19° 14' 55.22" S	116° 30' 04.72" E
	Point 6	19° 14' 55.21" S	116° 35' 04.72" E
Equipment	A multipurpose support vessel (MPSV) will be the primary vessel undertaking asset removal activities. However, up to four vessels may be present in the operational area at any one time.		
Description of natural environment	The Operational Area overlaps the Northwest Shelf Province of the Northwest Shelf Provincial Bioregion (based on the Integrated Marine and Coastal Regionalisation of Australia (IMCRA) Version 4.0).		
Timing and duration	The activity is planned to take place from mid-2022, and could be undertaken at any time of the year. Allowing for potential down time, for example due to weather, the activity may extend to up to 90 days, and may be conducted in multiple campaigns over this time. Activities will be undertaken 24 hours per day.		
Proximity to key regional features	Regional feature		Approximate distance from the operational area
	Dampier Archipelago		113 km
	Karratha		155 km
	Closest mainland point (Burrup Peninsula)		135 km
	Montebello Marine Park (Australian Marine Park)		99 km
	Dampier Marine Park (Australia Marine Park)		105 km
	Argo-Rowley Terrace (Australian Marine Park)		158 km
	Ancient Coastline at 125 m Depth Contour Key Ecological Feature (KEF)		Occurs within the Operational Area
Worst case hydrocarbon spill scenario	604 m^3 marine diesel or heavy fuel oil.		
Response tier required	In the event of a diesel or heavy fuel oil spill, a Tier 3 response would be implemented as defined in the activity-specific Oil Pollution Emergency Plan.		

Santos has conducted the following assessment of potential environmental risks and impacts from the activity.

Table 2: Potential risks and management measures

POTENTIAL RISKS AND IMPACTS	MANAGEMENT MEASURES
Interaction with other commercial fishers and other marine users	• If requested, stakeholders will be notified prior to the commencement and on cessation of each activity. • Relevant maritime notices issued. • A visual and radar watch will be maintained on the vessel bridge. • Santos will not restrict commercial fishing access to the operational area and is committed to concurrent operations, where safety of either vessel is not compromised. • Santos vessels will be prohibited from recreational fishing within the operational area. • Santos commits to reducing impacts on commercial fishers through the provision of timely activity information to enable advance planning and avoidance of unexpected interference.
Marine fauna interactions	• Implementation of EPBC Regulations (Part 8) for interacting with cetaceans to minimise the disturbance to fauna caused by marine vessels and helicopters.
Light emissions	• Vessel navigation lighting and equipment is compliant with COLREGS / Marine Orders 30: Prevention of Collisions, and with Marine Orders 21: Safety of Navigation and Emergency Procedures.
Atmospheric emissions	• Vessel fuel oil sulphur content is compliant with MARPOL. • Pursuant to MARPOL Annex VI, vessels will maintain a current International Air Pollution Prevention (IAPP) Certificate as relevant to vessel class
Seabed disturbance	• No vessel anchoring, unless in an emergency. • Objects dropped overboard are recovered where possible and safe to do so) to mitigate the environmental consequences from objects remaining in the marine environment
Operational vessel discharges	• Routine vessel discharge (sewage, bilge water, food waste) will meet MARPOL requirements. • Deck cleaning products that may be discharged to the ocean will meet MARPOL requirements.
Biosecurity risk management	• Vessel and immersible equipment is managed to low risk in accordance with the Santos Invasive Marine Species Management Plan prior to movement/transit into or within the invasive marine species management zone, which requires: - assessment of applicable vessels using the DPIRD Vessel Check Tool; and - the management of immersible equipment to low risk.
Spill response operations	• In the event of a hydrocarbon spill, the Oil Pollution Emergency Plan requirements are implemented to mitigate environmental impacts.

Consultation

If you wish to comment on Santos' Revision to the MEFF CoP EP, or if you require additional information, please contact Santos on the contact details below. Santos would appreciate your feedback by **15 October 2021**.

Santos
PO Box 5624, Perth, 6831
Telephone: 08 6218 7095
Email: Offshore.Consultation@Santos.com

[redacted]

From:	Consultation, Santos
Sent:	Thursday, 14 October 2021 2:05 PM
To:	'marinetourismwa@gmail.com'
Subject:	Santos Consultation - Revision of Mutineer-Exeter (MEFF) Cessation of Operations Environment Plan and Revision to the Varanus Island Hub Operations Environment Plan
Attachments:	MEFF Consultation Information.pdf; Spartan Development Consultation Information.pdf

[redacted]

Hi [redacted]

Thank you for your time today with respect to the activities of the WA charter boat industry. Much appreciated in helping us better understand the reach of charter licence holders and to frame our assessment of activities and potential interactions with other marine users.

As discussed, we have undertaken consultation recently for two activities that, further to our discussion, may have implications for charter operators. By way of context:

- The MEFF activities are approximately 113 km north of Dampier and are focused on removal of equipment as part of decommissioning activities. Water depth is approximately 130 m to 160 m.
- The Spartan activities are approximately 154 km west of Dampier and include the drilling of a development well and tie back to the John Brookes platform. Water depth is approximately 50 m.

I have attached consultation fact sheets for the two activities, which include maps of the proposed operational areas for the planned activities. Let me know if you need any further information about these planned activities. We would also be happy to contact licence holders direct if you feel there is potential for on-water interactions.

More broadly I would be keen to catch up when you are back in Perth with a map or two to review where charter fishing effort is typically focused. It would certainly help us manage operator expectations for consultation for future activities.

Regards

[redacted]

[redacted]
Stakeholder Adviser

As a service provider to

Santos Limited, Level 7, 100 St Georges Tce
Perth WA 6000
[redacted]

https://www.santos.com/

[redacted]

From:	Consultation, Santos
Sent:	Monday, 29 November 2021 2:27 PM
To:	'pestmarine@agriculture.gov.au'; 'seaports@agriculture.gov.au'
Subject:	FW: Santos Consultation - Revision of Mutineer-Exeter Cessation of Operations Environment Plan
Attachments:	MEFF Consultation Information.pdf

Dear DAWE

Apologies but we appear to have overlooked consulting DAWE on biosecurity matters with respect to the Revision of Santos' Mutineer-Exeter Cessation of Operations Environment Plan in our initial consultation and also in an activity update provided to stakeholders last week.

We have attached the original consultation material, but please note the advice below as there has been a change to activities as previously communicated to stakeholders.

Please get back to us if you require any additional information about proposed activities.

Regards

[redacted]

[redacted]
Stakeholder Adviser

As a service provider to

Santos Limited, Level 7, 100 St Georges Tce
Perth WA 6000
t: +61 439 500 799

https://www.santos.com/

From: Consultation, Santos <Offshore.consultation@santos.com>
Sent: Monday, 22 November 2021 3:12 PM
To: 'Petroleum&Fisheries@agriculture.gov.au' <Petroleum&Fisheries@agriculture.gov.au>
Subject: Re: Santos Consultation - Revision of Mutineer-Exeter Cessation of Operations Environment Plan

Dear Stakeholder

Santos wishes to provide an activity update further to previously provided advice about the revision of its current Mutineer-Exeter Cessation of Operations Environment Plan (EP).

The current EP includes management measures for the inspection and monitoring of the former production and facility mooring systems ahead of full-field decommissioning. The revision to this EP is to allow for removal of floating (submerged) infrastructure, as well ongoing inspections and monitoring of remaining equipment.

In our consultation pack previously sent to you, we advised that a pre-removal campaign would be undertaken under the revised EP to clean the flowlines by flushing them with chemically treated seawater. Santos advises that flushing is not required following a review of historical flushing records from subsea flushing activities conducted in July 2018 and further engineering studies.

All other activities remain unchanged.

Please let us know if you have any additional feedback or questions about the proposed activity by **13 December 2021**.

Regards

[redacted]

[redacted]
Stakeholder Adviser

As a service provider to

Santos Limited, Level 7, 100 St Georges Tce
Perth WA 6000
t: +61 439 500 799

https://www.santos.com/

From: Consultation, Santos
Sent: 31 August 2021 21:42
To: 'Petroleum&Fisheries@agriculture.gov.au' <Petroleum&Fisheries@agriculture.gov.au>
Subject: Santos Consultation - Revision of Mutineer-Exeter Cessation of Operations Environment Plan

Dear stakeholder

Santos is preparing a revision of its current Mutineer-Exeter Cessation of Operations Environment Plan (EP) as part of Santos' future plans for decommissioning the Mutineer, Exeter, Fletcher, and Finucane (MEFF) fields and associated subsea infrastructure

The current EP includes management measures for the inspection and monitoring of the former production and facility mooring systems ahead of full field decommissioning. The revision to this EP is to allow for removal of floating (submerged) infrastructure, as well ongoing inspections and monitoring of remaining equipment. The decommissioning of remaining equipment will be subject to separate and future EPs.

This EP is being developed in accordance with the Commonwealth Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009 and we are seeking your feedback on our proposed activities.

The information attached provides more detail on the proposed activities, including a location map and a summary of potential risks, impacts and management measures.

Also attached is a map showing the proposed operational area in relation to Commonwealth fisheries. Our assessment of these fisheries is that there has been no active fishing in the Operational Area.

We have, however, provided information about the proposed activities to commercial fishing representative organisations relevant to the MEFF fields and associated subsea infrastructure as part of our broader engagement program.

Activity Summary

<table>
<tr><td>Activity Name</td><td colspan="3">Mutineer-Exeter Cessation of Operations Environment Plan Revision</td></tr>
<tr><td>Activity Summary</td><td colspan="3">Santos is proposing a revision of its existing Mutineer-Exeter Cessation of Operations Environment Plan to include the removal of the following floating (submerged) infrastructure using a multipurpose support vessel (MPSV) and up to four secondary support vessels:
• 1 x Disconnectable Turret Mooring (approximately 30 m below sea surface)
• 2 x Mid-Water Arches (approximately 82 m below sea surface)</td></tr>
<tr><td>Estimated Start Date</td><td colspan="3">The activity is planned to take place from mid-2022 and could be undertaken at any time of the year.</td></tr>
<tr><td>Total Duration</td><td colspan="3">Allowing for potential down time, for example due to weather, the activity may extend to up to 90 days, and may be conducted in multiple campaigns over this time. Activities will be undertaken 24 hours per day.</td></tr>
<tr><td>Permit Number</td><td colspan="3">WA-26-L, WA-27-L and WA-54-L</td></tr>
<tr><td>Location</td><td colspan="3">Approx. 155 km north of Karratha. Please see attached Consultation Information for location map.</td></tr>
<tr><td>Approximate Water Depth</td><td colspan="3">Approx. 130 m to 160 m</td></tr>
<tr><td rowspan="6">Operational Coordinates</td><td>Point 1</td><td>19° 09' 55.21" S</td><td>116° 35' 04.72" E</td></tr>
<tr><td>Point 2</td><td>19° 09' 55.20" S</td><td>116° 50' 04.72" E</td></tr>
<tr><td>Point 3</td><td>19° 19' 55.21" S</td><td>116° 50' 04.72" E</td></tr>
<tr><td>Point 4</td><td>19° 19' 55.22" S</td><td>116° 30' 04.72" E</td></tr>
<tr><td>Point 5</td><td>19° 14' 55.22" S</td><td>116° 30' 04.72" E</td></tr>
<tr><td>Point 6</td><td>19° 14' 55.21" S</td><td>116° 35' 04.72" E</td></tr>
<tr><td>Exclusion Zone</td><td colspan="3">A 500m petroleum safety zone (PSZ) will exist around the MPSV during asset removal activities. However, there may be a time when two vessels operating in the operational area will each need a 500m PSZ.</td></tr>
</table>

Please contact Santos by **15 October 2021** if you wish to comment on Santos' proposed activities or if you require additional information about the proposed activities.

The Environment Regulations require NOPSEMA to publish the environment plan submitted by the titleholder for assessment, and to publish the final accepted version of an environment plan. Environment plans are published in full, with the exception of sensitive information from the consultation process and transcripts of correspondence between stakeholders and the titleholder. This information is used by NOPSEMA during the assessment, but is not published for wider review.

If you do not wish for your comments to be published in this environment plan, or wish to provide your comments anonymously, please make this known to Santos as soon as possible.

We look forward to hearing from you.
Regards
[redacted]

[redacted]
Stakeholder Adviser
As a service provider to

Santos Limited, Level 7, 100 St Georges Tce
Perth WA 6000
[redacted]

https://www.santos.com/

Santos Consultation

31 August 2021

Dear Fishery Licence Holder

Santos is preparing a revision of its current Mutineer-Exeter Cessation of Operations Environment Plan (EP) as part of Santos' future plans for decommissioning the Mutineer, Exeter, Fletcher, and Finucane (MEFF) fields and associated subsea infrastructure.

The current EP includes management measures for the inspection and monitoring of the former production and facility mooring systems ahead of full field decommissioning. The revision to this EP is to allow for removal of floating (submerged) infrastructure, as well ongoing inspections and monitoring of remaining equipment. The decommissioning of remaining equipment will be subject to separate and future EPs.

Location:	Approx. 155 km north of Karratha. Please see attached Consultation Information for location map.
Water Depth:	Approx. 130 m to 160 m
Schedule:	The activity is planned to take place from mid-2022 and could be undertaken at any time of the year.
Activity Duration:	Allowing for potential down time, for example due to weather, the activity may extend to up to 90 days, and may be conducted in multiple campaigns over this time.
Support Vessels:	A multipurpose support vessel (MPSV) and up to four secondary support vessels.
Exclusion Zone:	A 500m petroleum safety zone (PSZ) will exist around the MPSV during asset removal activities. However, there may be a time when two vessels operating in the operational area will each need a 500m PSZ.

Please be in contact via the phone or email details below if you have any questions on any of the activities outlined in the attached Consultation Information.

Kind regards

[redacted]

Stakeholder Adviser

Santos Limited,

Level 7 100 St Georges Tce, Perth WA 6000

[redacted]

e: offshore.consultation@Santos.com

Santos

Santos Consultation

22 November 2021

Dear Fishery Licence Holder

Santos wishes to provide an activity update further to previously provided advice about the revision of its current Mutineer-Exeter Cessation of Operations Environment Plan (EP).

The current EP includes management measures for the inspection and monitoring of the former production and facility mooring systems ahead of full-field decommissioning. The revision to this EP is to allow for removal of floating (submerged) infrastructure, as well ongoing inspections and monitoring of remaining equipment.

In our consultation pack previously sent to you, we advised that a pre-removal campaign would be undertaken under the revised EP to clean the flowlines by flushing them with chemically treated seawater. Santos advises that flushing is not required following a review of historical flushing records from subsea flushing activities conducted in July 2018 and further engineering studies.

All other activities remain unchanged, and a summary is outlined below.

Location:	Approx. 155 km north of Karratha. Please see attached Consultation Information for location map.
Water Depth:	Approx. 130 m to 160 m
Schedule:	The activity is planned to take place from mid-2022 and could be undertaken at any time of the year.
Activity Duration:	Allowing for potential down time, for example due to weather, the activity may extend to up to 90 days, and may be conducted in multiple campaigns over this time.
Support Vessels:	A multipurpose support vessel (MPSV) and up to four secondary support vessels.
Exclusion Zone:	A 500m petroleum safety zone (PSZ) will exist around the MPSV during asset removal activities. However, there may be a time when two vessels operating in the operational area will each need a 500m PSZ.

Please be in contact via the phone or email details below if you have any questions on any of the proposed activities. Also, the consultation feedback period has been extended from that indicated in the enclosed Consultation Information to **13 December 2021** to allow for additional feedback on the activity update.

Kind regards

[redacted]
Stakeholder Adviser Santos Limited,
Level 7 100 St Georges Tce, Perth WA 6000
t: +61 439 500 799

e: offshore.consultation@Santos.com

Santos

Santos Consultation

22 November 2021

Dear Fishery Licence Holder

Santos is preparing a revision of its current Mutineer-Exeter Cessation of Operations Environment Plan (EP) as part of Santos' future plans for decommissioning the Mutineer, Exeter, Fletcher, and Finucane (MEFF) fields and associated subsea infrastructure.

The current EP includes management measures for the inspection and monitoring of the former production and facility mooring systems ahead of full field decommissioning. The revision to this EP is to allow for removal of floating (submerged) infrastructure, as well ongoing inspections and monitoring of remaining equipment. The decommissioning of remaining equipment will be subject to separate and future EPs.

Please note we have recently identified licence holders in the Mackerel Managed Fishery (Area 2) as being potentially impacted following further review of DPIRD FishCube data in planning the Environment Plan for this activity. The DPIRD data indicated fishing effort in the area in 2011. As a result, we have chosen to provide information to Mackerel Fishery licence holders, WAFIC and DPIRD, in addition to those stakeholders already consulted for the activity.

Please also note that there has been an update to planned activities as outlined in the enclosed Stakeholder Consultation Information. The Information indicated that a pre-removal campaign would be undertaken under the revised EP to clean the flowlines by flushing them with chemically treated seawater. Santos advises that flushing is not required following a review of historical flushing records from subsea flushing activities conducted in July 2018 and further engineering studies.

All other activities remain unchanged, and a summary is outlined below.

Location:	Approx. 155 km north of Karratha. Please see attached Consultation Information for location map.
Water Depth:	Approx. 130 m to 160 m
Schedule:	The activity is planned to take place from mid-2022 and could be undertaken at any time of the year.
Activity Duration:	Allowing for potential down time, for example due to weather, the activity may extend to up to 90 days, and may be conducted in multiple campaigns over this time.
Support Vessels:	A multipurpose support vessel (MPSV) and up to four secondary support vessels.
Exclusion Zone:	A 500m petroleum safety zone (PSZ) will exist around the MPSV during asset removal activities. However, there may be a time when two vessels operating in the operational area will each need a 500m PSZ.

Please be in contact via the phone or email details below if you have any questions on any of the proposed activities. Also, the consultation feedback period has been extended from that indicated in the enclosed Consultation Information to **13 December 2021**.

Kind regards

[redacted]
Stakeholder Adviser Santos Limited,
Level 7 100 St Georges Tce, Perth WA 6000
[redacted]

e: offshore.consultation@Santos.com

Santos

Santos Consultation

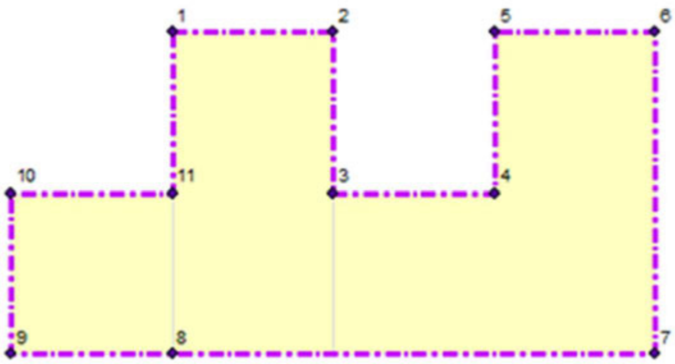
10 December 2021

Dear Fishery Licence Holder

Santos wishes to advise that we have identified you as a relevant stakeholder based on a reduction in the size of the Operational Area for proposed activities to be managed under the Revision of Santos' Mutineer-Exeter Cessation of Operations Environment Plan (EP).

The Operational Area has been reduced following an internal business review. New Coordinates for the updated Operational Area are provided below and a figure is attached showing the updated Operational Area in relation to Commonwealth and State marine reserves, ports and offshore infrastructure. For comparison purposes, we have also attached the initial Operational Area as shown in the information sheet sent to you previously.

All activities to be managed under the EP remain unchanged further to our activity update on 22 November 2021.



Number		North_GDA
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2	116.667977	-19.165336
3	116.667978	-19.24867
4	116.751311	-19.248669
5	116.751311	-19.165335
6	116.834644	-19.165335
7	116.834645	-19.332002
8	116.584646	-19.332004
9	116.501312	-19.332005
10	116.501312	-19.248671
11	116.584645	-19.24867
12	116.584644	-19.165337

Please get back to us if you need any additional information.

Regards

[redacted]

[redacted]
Stakeholder Adviser Santos Limited,
Level 7 100 St Georges Tce, Perth WA 6000
t: +61 439 500 799

e: offshore.consultation@Santos.com

Santos Consultation

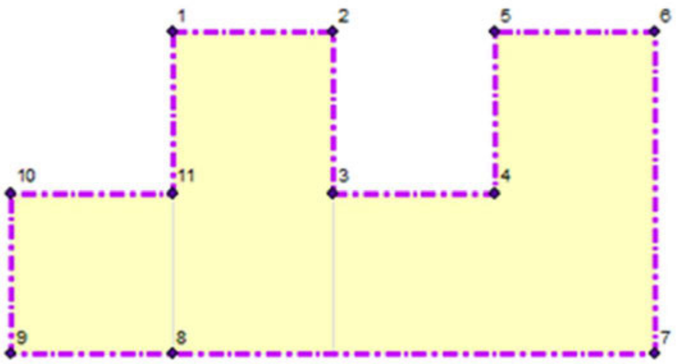
16 December 2021

Dear Fishery Licence Holder

Santos wishes to advise that we have identified you as a relevant stakeholder based on a reduction in the size of the Operational Area for proposed activities to be managed under the Revision of Santos' Mutineer-Exeter Cessation of Operations Environment Plan (EP).

The Operational Area has been reduced following an internal business review. New Coordinates for the updated Operational Area are provided below and a figure is attached showing the updated Operational Area in relation to Commonwealth and State marine reserves, ports and offshore infrastructure. For comparison purposes, we have also attached the initial Operational Area as shown in the information sheet sent to you previously.

All activities to be managed under the EP remain unchanged further to our activity update on 22 November 2021.



Number		North_GDA
1	116.584644	-19.165337
2	116.667977	-19.165336
3	116.667978	-19.24867
4	116.751311	-19.248669
5	116.751311	-19.165335
6	116.834644	-19.165335
7	116.834645	-19.332002
8	116.584646	-19.332004
9	116.501312	-19.332005
10	116.501312	-19.248671
11	116.584645	-19.24867
12	116.584644	-19.165337

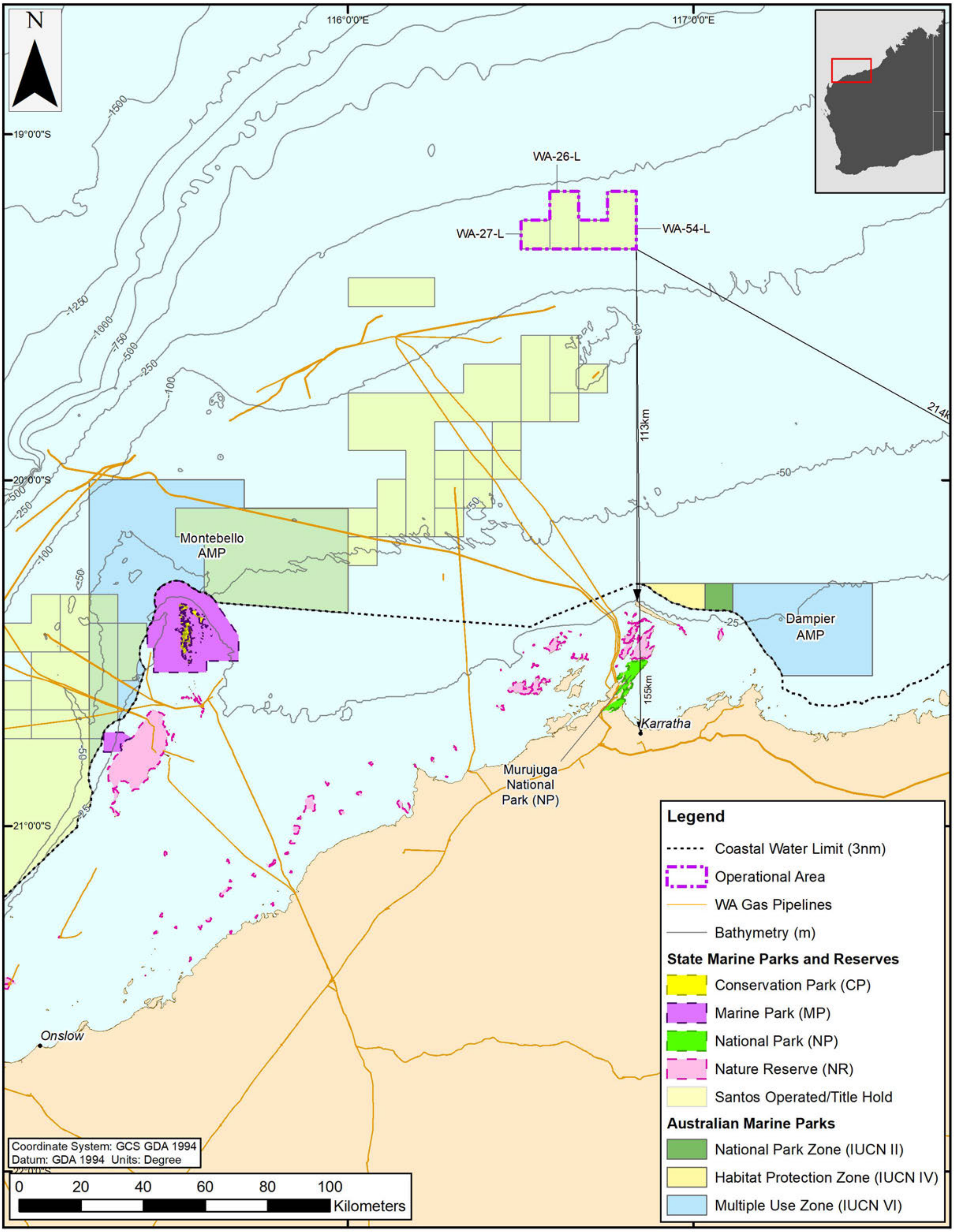
Please get back to us if you need any additional information.

Regards

[redacted]

[redacted]
Stakeholder Adviser Santos Limited,
Level 7 100 St Georges Tce, Perth WA 6000
t: +61 439 500 799

e: offshore.consultation@Santos.com

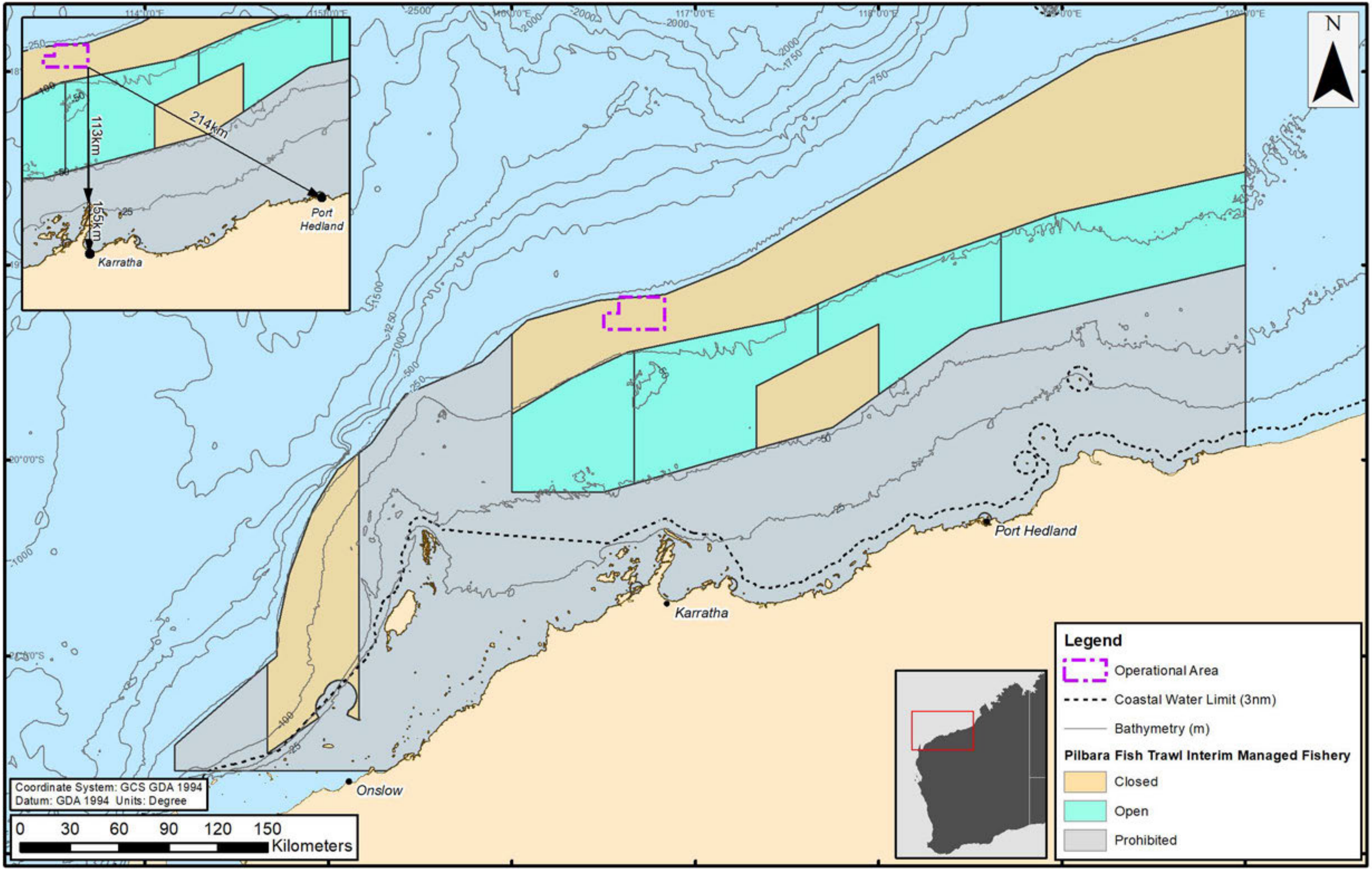


Santos

MEFF

LOCATION FIGURE

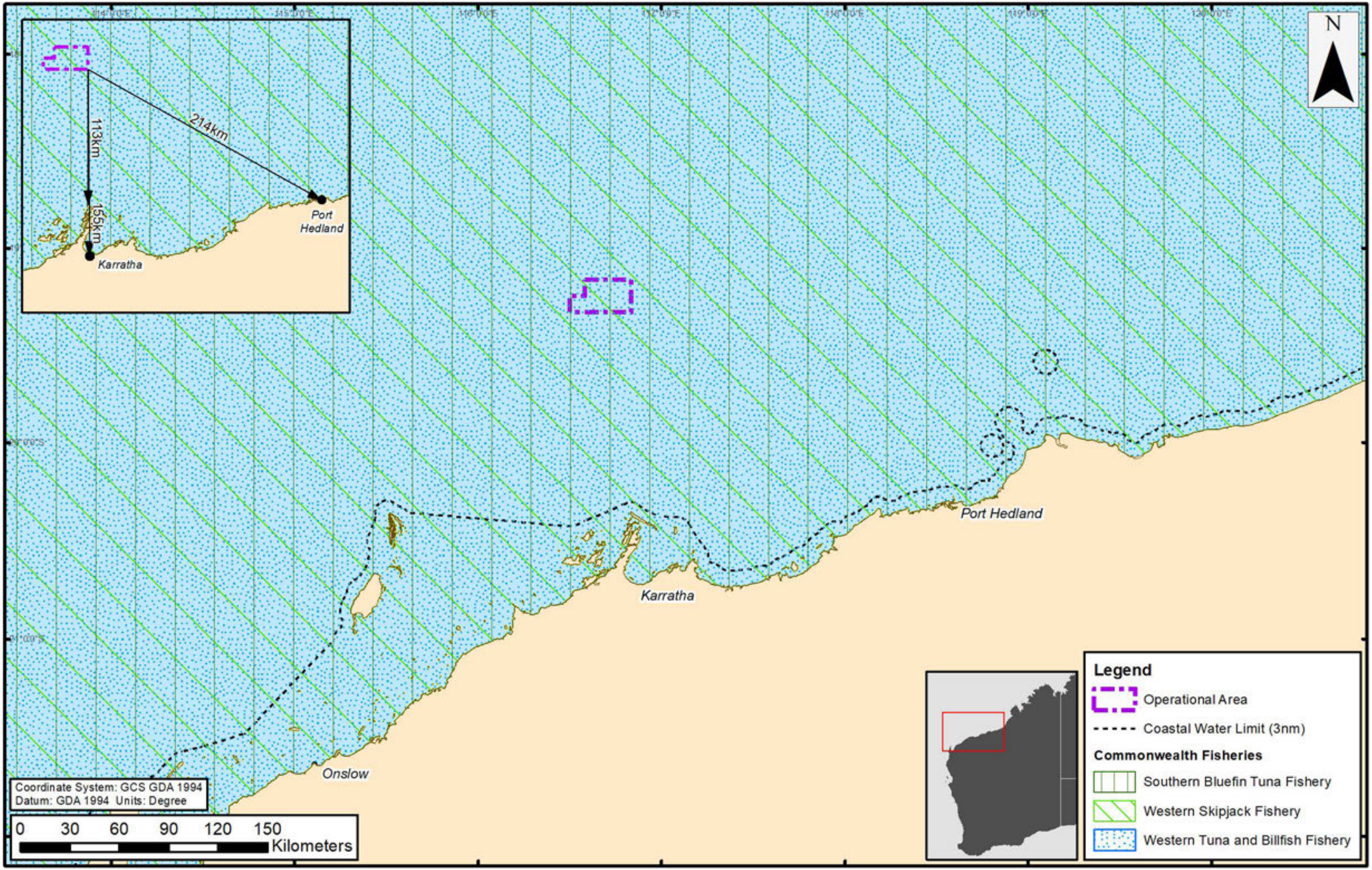
06/12/2021
411012-00326-1-1



Santos

MEFF

PILBARA FISH TRAWL INTERIM MANAGED FISHERY



Santos

MEFF

COMMONWEALTH FISHERIES

Appendix G: Environment Consequence Descriptors

Excerpt from Offshore Division Environmental Hazard Identification and Assessment Guideline (EA-91-IG-00004), Revision 5 (Issued October 2020)

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. Widespread (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[5]; habitat within a protected area; habitats that include benthic primary producers[6] and/ or epi-fauna[7]	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 around two years (two season recovery)	Significant loss of area and/or function of local physical environment/habitat. Recovery over medium term (two to ten 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 widespread 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	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	Major, long-term decline in threatened ecological	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.

[5] As defined by the Department of Climate Change, Energy, the Environment and Water (DCCEEW)
[6] Benthic photosynthetic organisms such as seagrass, algae, hard corals and mangroves
[7] Fauna attached to the substrate including sponges, soft corals and crinoids.

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.***
		threatened ecological community population size, diversity or function.		threatened ecological community population size, diversity or function.	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.		
	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 H: Spill Modelling Results

Appendix H1: Stochastic Spill Modelling Results for 604 m³ MDO release and subsea release of hydrocarbons in the event of a loss of well control

Appendix H2: High Environmental Value Consequence Summary

Appendix H1: Stochastic Spill Modelling Results for 604 m³ MDO release and subsea release of hydrocarbons in the event of a loss of well control

Spill modelling results for surface release of MDO

Receptor	Receptor Type	Minimum time to contact (days)							Maximum hydrocarbon concentration							Maximum oil ashore (tonnes)	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 hydrocarbons (50 ppb)	Entrained Hydrocarbons (100 ppb)	Dissolved hydrocarbons (400 ppb)	Shoreline accumulation (1000 g/m²)	Surface hydrocarbons (50 g/m²)	Shoreline accumulation (100 gm²)	Surface hydrocarbons (10 g/m²)	Dissolved hydrocarbons (50 ppb)	Entrained Hydrocarbons (100 ppb)	Dissolved hydrocarbons (400 ppb)	Shoreline accumulation (1000 g/m²)	Surface hydrocarbons (50 g/m²)	Shoreline accumulation (100 g/m²)	Shoreline accumulation (100 g/m²)
Clerke Reef MP	Emergent	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
Imperieuse Reef MP	Emergent	11.7	NC	NC	NC	NC	NC	NC	888.9	NC	NC	NC	NC	NC	NC	12.4	11.0
Southern Islands Coast	Intertidal	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
Glomar Shoals	Submerged	NC	0.4	0.5	0.5	NC	NC	0.5	NC	217.4	265.6	449.2	NC	NC	0.5	NC	NC
Montebello MP	Submerged	NC	5.1	NC	NC	NC	NC	NC	NC	11.4	NC	NC	NC	NC	NC	NC	NC
Rowley Shoals Surrounds	Submerged	NC	6.8	NC	NC	NC	NC	NC	NC	21.3	NC	NC	NC	NC	NC	NC	NC
Ningaloo – offshore	Submerged	NC	4.9	NC	NC	NC	NC	NC	NC	29.1	NC	NC	NC	NC	NC	NC	NC

Spill modelling results for subsea LOWC

Receptor	Receptor Type	Minimum time to contact (days)							Maximum hydrocarbon concentration							Maximum oil ashore (tonnes)	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 hydrocarbons (50 ppb)	Entrained Hydrocarbons (100 ppb)	Dissolved hydrocarbons (400 ppb)	Shoreline accumulation (1000 g/m^2)	Surface hydrocarbons (50 g/m^2)	Shoreline accumulation (100 gm^2)	Surface hydrocarbons (10 g/m^2)	Dissolved hydrocarbons (50 ppb)	Entrained Hydrocarbons (100 ppb)	Dissolved hydrocarbons (400 ppb)	Shoreline accumulation (1000 g/m^2)	Surface hydrocarbons (50 g/m^2)	Shoreline accumulation (100 g/m^2)	Shoreline accumulation (100 g/m^2)
Clerke Reef MP	Emergent	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
Imperieuse Reef MP	Emergent	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
Southern Islands Coast	Intertidal	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
Glomar Shoals	Submerged	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
Montebello MP	Submerged	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
Rowley Shoals Surrounds	Submerged	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
Ningaloo – offshore	Submerged	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC

Appendix H2: High Environmental Value Consequence Summary

Receptor (hotspot) name	HEV Ranking	Values	Oil Spill Modelling Parameter NC = No Contact		Subsea	Surface	Consequence Category	Consequence Ranking	Final
Imperieuse Reef Marine Park (Emergent)	3	The Rowley Shoals comprise three reef systems 30 to 40 km apart: Mermaid Reef, Clerke Reef and Imperieuse Reef Physical habitats Coral reefs + Exceptionally rich and diverse intertidal and subtidal reefs + Provide a source of invertebrate and fish recruits for reefs further south and are therefore regionally significant Seagrasses + Sparse seagrass found within subtidal areas in Rowley Shoals Macroalgae + Small patches may be present in lagoonal area Sandy beaches + Area of sand banks (intertidal) and Cunningham Island (an unvegetated sand cay) Marine fauna Invertebrates + A number of invertebrate (echinoderms, cnidarians, molluscs and crustaceans) species commonly found at Scott Reef are also found here	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 IV	IV
			Minimum time to contact by floating oil 10 g/m²	Time (days)	NC	NC			
			Maximum accumulated oil ashore >100 g/m²	tonnes	NC	12.4			
			Maximum accumulated concentration >100 g/m²	g/m²	NC	889			
			Maximum length of shoreline oiled (>100 g/m²)	(km)	NC	11			
			Maximum concentration of total submerged oil >100 ppb	(ppb)	NC	NC			
			Maximum concentration of dissolved hydrocarbon >50 ppb	(ppb)	NC	NC			

Receptor (hotspot) name	HEV Ranking	Values	Oil Spill Modelling Parameter NC = No Contact		Subsea	Surface	Consequence Category	Consequence Ranking	Final
		although in higher densities due to lack of fishing/collection (Commercial collection is prohibited) Fish and sharks + Fish populations similar to those on shelf edge reefs in the Indo-Pacific region but unique in WA waters + Rich diversity of fish (500+ species) Birds + Wide range of seabirds observed at Rowley Shoals Marine reptiles + Green and hawksbill turtles are present at the Rowley Shoals + Reefs not known to be regionally significant turtle habitats Marine mammals + Northward humpback whale migration pathway adjacent to Rowley Shoals; therefore, individuals may be present + Variety of toothed and baleen whales likely to be visitors to the area but not Rowley Shoals are not a key aggregation/calving/mating/ foraging area							

Receptor (hotspot) name	HEV Ranking	Values	Oil Spill Modelling Parameter NC = No Contact		Subsea	Surface	Consequence Category	Consequence Ranking	Final
		Protected areas + Rowley Shoals Commonwealth Marine Reserve in place to protect migratory seabirds and endangered loggerhead turtle, sharks, communities and habitats of 220 m to 5000 m, seafloor features, two KEFS and provides connectivity between Mermaid Reef Marine National Nature Reserve and reefs of the Western Australian Rowley Shoals Marine Park and the deeper waters of the region. It is an IUCN category zoning of II and VI. Socio-economic and heritage values + Tourism: nature-based tourism (charter boats, diving, snorkeling) and recreational fishing (although prohibited in certain zones) low usage, given distance to mainland; around 300 visitors per season (DoE, 2007) + Sanctuary zone within marine park + Indigenous values: none identified + Heritage values: none identified							

Receptor (hotspot) name	HEV Ranking	Values	Oil Spill Modelling Parameter NC = No Contact		Subsea	Surface	Consequence Category	Consequence Ranking	Final
		+ Prohibition on commercial fishing and a ban on the take of key demersal fish by recreational fishers since 1987 + Low level of pressures on shoals make them an important global benchmark for Indo-West pacific reefs + 'Mermaid Reef and the Commonwealth waters surrounding Rowley Shoals' are a designated KEF (an area of high biodiversity with enhanced productivity and feeding and breeding aggregations) + Rowley Shoals also have the KEF 'canyons linking the Argo Abyssal Plain with the Scott Plateau' (unique seafloor feature with enhanced productivity and feeding aggregations of species							