Yoorn-1 Geophysical Survey Environment Plan (State and Commonwealth Waters)

PROJECT / FACILITY	Drilling and Completions
REVIEW INTERVAL (MONTHS)	No Review Required
SAFETY CRITICAL DOCUMENT	NO

Rev	Owner	Reviewer/s *Managerial/Technical/Site*	Approver
1	Drilling Superintendent	HSE Team Lead – Offshore Drilling and Completions	Manager – Offshore Drilling and Completions

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	23/12/19	Jacobs / Santos WA	Issued for internal review
B	14/02/20	Jacobs	Re-issued for internal review
0	05/03/20	Santos WA	Issued to NOPSEMA and DMIRS
1	07/05/20	Jasco / Jacobs / Santos WA	Issued to DMIRS in response to comments

Contents

Tables

Figures

List of Acronyms

Abbreviation	Description
AFMA	Australian Fisheries Management Authority
AHS	Australian Hydrographic Service
AIS	Automatic Identification System
ALARP	As low as reasonably practicable
AMOSC	Australian Marine Oil Spill Centre Pty Ltd
AMP	Australian Marine Park
AMSA	Australian Marine Safety Authority
APASA	Asia-Pacific Applied Sciences Associates
APPEA	Australian Petroleum Production & Exploration Association
API	American Petroleum Institute
AUV	Autonomous Underwater Vehicle
BIA	Biologically Important Area
CHARM	Chemical Hazard and Risk Management
CM	Control Measure
CMMS	Computerised Maintenance Management System
CPI	Corrugated Plate Interceptor
DAH	Dissolved Aromatic Hydrocarbons
DAWR	Department of Agriculture and Water Resources
DBCA	Department of Biodiversity, Conservation and Attractions
DoE	(Australian) Department of the Environment (now DoEE)
DoEE	(Australian) Department of the Environment and Energy (now DAWE)
DAWE	(Australian) Department of Agriculture, Water and Environment
DoF	Department of Fisheries
DoT	Department of Transport
DPaW	Department of Parks and Wildlife (now DBCA)
DPIRD	Department of Primary Industries and Regional Development
DWER	Department of Water and Environment Regulation
EMBA	Environment that May Be Affected
EP	Environment Plan
EPA	West Australian (WA) Environmental Protection Authority
EPBC Act	Environmental Protection and Biodiversity Conservation Act 1999
EPO	Environmental performance outcome/objective
EPS	Environmental performance standard
ESD	Ecologically sustainable development

Abbreviation	Description
GHG	Greenhouse gases
HFC	Hydroflourocarbons
HFO	Heavy Fuel Oil
IFO	Intermediate Fuel Oil
IMMR	Inspection, Maintenance, Monitoring and Repair
IMS	Invasive Marine Species
KEF	Key Ecological Feature
LMS	Listed Migratory Species
LTS	Listed Threatened Species
MBES	Multi-beam echo sounding
MFO	Marine Fauna Observer
MNES	Matters of National Environmental Significance
MODU	Mobile Offshore Drilling Unit
MOU	Memorandum of Understanding
MP	Marine Park
NEBA	Net Environmental Benefit Analysis
NOPSEMA	National Offshore Petroleum Safety and Environment Management Authority
NWS	Western Australia's North West Shelf
ODS	Ozone depleting substances
OPEP	Oil Pollution Emergency Plan
OPGGS(E)(R)	Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009
OSRL	Oil Spill Response Limited
P(SL)(E)R	State Petroleum (Submerged Lands) (Environment) Regulations 2012
PFC	Perflourocarbons
SBP	Sub-bottom profiling
SF_6	Sulphur hexaflouride
SSS	Side-scan sonar
WAFIC	Western Australian Fishing Industry Council
WAOWRP	WA Oiled Wildlife Response Plan

1 Introduction

1.1 EP Summary

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

Environment Plan (EP) Summary material requirement	Relevant section of EP containing EP Summary material
The location of the activity	**Section 2.1**
A description of the receiving environment	**Section 3** and **B**
A description of the activity	**Section 2**
Details of the environmental impacts and risks	**Sections 6** and **7**
The control measures for the activity	**Sections 6** and **7** and **Table 8-2**
The arrangements for ongoing monitoring of the titleholder's environmental performance	**Section 8**
The response arrangements in the oil pollution emergency plan (OPEP)	**Section 6.7** and OPEP
Details of consultation already undertaken and plans for ongoing consultation	**Section 4**
Details of the titleholder's nominated liaison person for the activity	**Section 1.3.2**

PSL(E)R 2012 Requirements
Regulation 7
Within 10 days after receiving a notification that the Minister has approved an environment plan under subregulation (5)(a), the operator must submit to the Minister for public disclosure a summary of the plan.

Santos WA Northwest Pty Ltd (Santos WA) opts to submit this EP in full for public disclosure on the DMIRS website upon submission of the EP. The full EP is provided in lieu of providing an EP summary, as allowed for by the DMIRS *EP Summary Submission Process* guidance note (DMPMAY17_4757).

1.2 Activity overview

Santos WA proposes to conduct exploration drilling in permit area WA-499-P, located in Commonwealth waters. As part of the drilling preparatory work, a vessel-based site survey will be undertaken involving geophysical survey techniques to assess the shallow seabed soils suitability to provide a safe foundation for a jack-up mobile offshore drilling unit (MODU). The survey activity ('the activity') which is the subject of this environment plan (EP) will involve surveying the planned drilling location and tie-in lines extending from the proposed drilling location to existing data points in the nearby area. The survey tie-in lines intersect both Commonwealth and state waters.

This EP has therefore been prepared to address the environmental requirements of activities undertaken in accordance with the following:

+ Commonwealth Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009 (OPGGS(E)R), for acceptance by the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA); and
+ WA State Petroleum (Submerged Lands) (Environment) Regulations 2012 (P(SL)(E)R) for acceptance by the Department of Mines, Industry Regulation and Safety (DMIRS).

The survey location is shown in **Figure 1-1**.

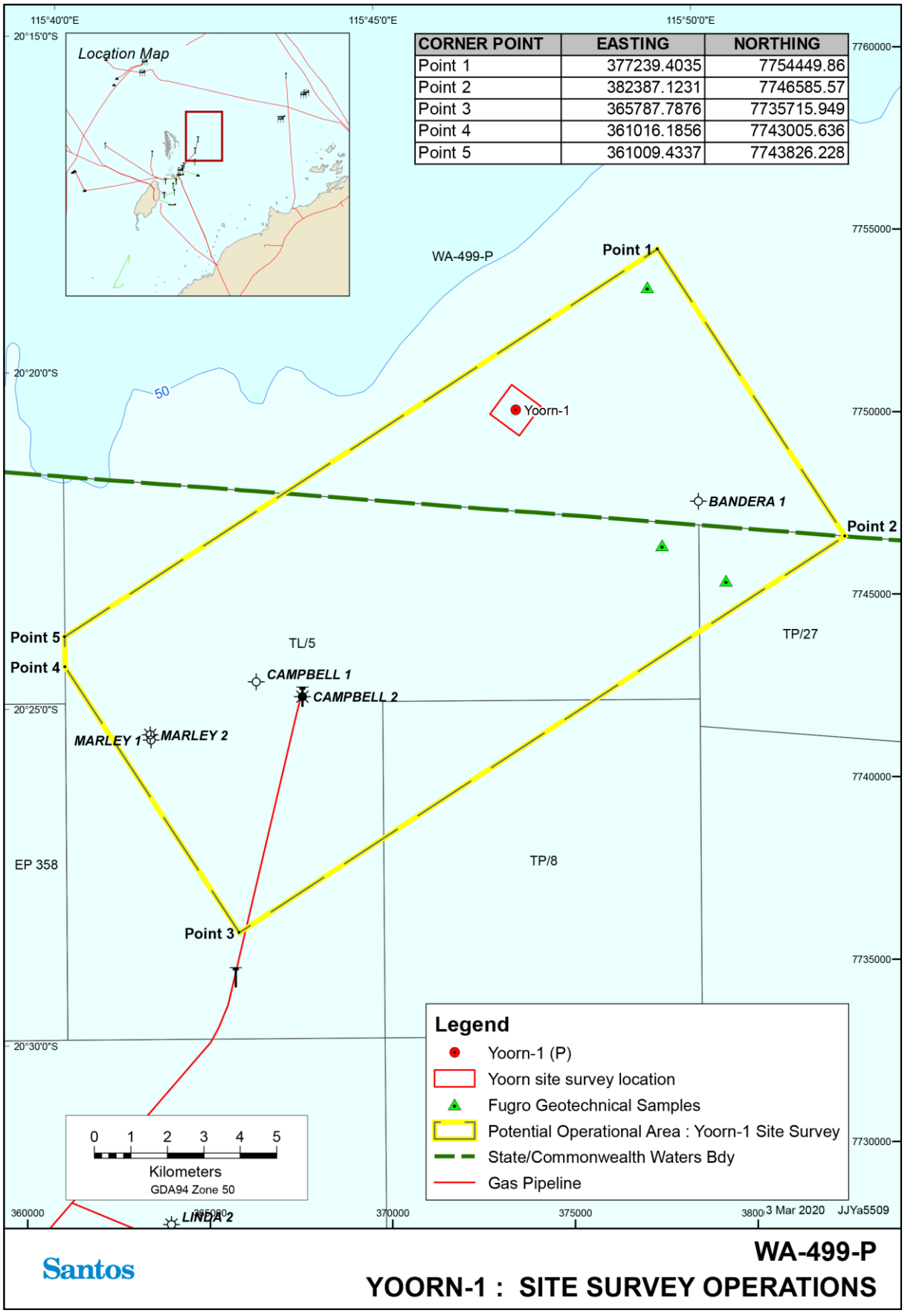


Figure 1-1: Survey Location

1.3 Purpose of the Environment Plan

In accordance with the OPGGS(E)R and P(SL)(E)R, this EP details the environmental impacts and risks associated with the activity and demonstrates how these will be reduced to as low as reasonably practicable (ALARP) and to an acceptable level. The EP provides an implementation strategy that will be used to measure and report on environmental performance during planned activities and unplanned events to ensure impacts and risks are continuously reduced to ALARP and are at an acceptable level. The environmental management of the activity described in the EP complies with the Santos WA Environmental Management Policy (**Appendix A1**) and with all relevant legislation (**Appendix A2**). This EP documents and considers all relevant stakeholder consultation performed during the planning of the activity.

1.3.1 Operator and Titleholder details

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

Santos WA Northwest Pty Ltd is the operator of the activity proposed within this EP. The operational area overlaps permit TP/27 which is not operated by Santos WA. If survey activities (i.e. not just vessel transit) will be undertaken in this permit, access authority will be applied for prior to undertaking the activity

Table 1-1: Titleholder details for WA-499-P, TL/5 and TP/8

Title	Titleholder (Operators in bold)	ABN	Interest (%)	Address
WA-499-P	**Santos WA Northwest Pty Ltd**	58 009 140 854	55	Business Address: Level 7, 100 St Georges Terrace, Perth, Western Australia, 6000 Telephone number:

	Santos Offshore Pty Ltd	38 005 475 589	45	(08) 6218 7100 Fax number: (08) 6218 7200 Email address: offshore.environment.admin@santos.com
TL/5 and TP/8	**Santos WA Northwest Pty Ltd**	58 009 140 854	87.7771	
	Harriet (Onyx) Pty Ltd	70 009 396 954	12.2229	

1.3.2 Details of nominated liaison person

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

Name: Jason J. Young (Manager – Offshore Drilling and Completions)

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

Telephone number: (08) 6218 7100

Email address: offshore.environment.admin@santos.com

1.3.3 Notification procedure in the event of changed details

In the event that there is a change in the nominated operator, the operator's nominated liaison person, or a change in the contact details for the operator or liaison person, Santos WA will notify NOPSEMA and DMIRS and provide the updated details.

1.4 Environmental management framework

OPGGS(E)R 2009 Requirements
Regulation 13. Environmental assessment
Description of the activity 13(4) The environment plan must: (a) describe the requirements, including legislative requirements, that apply to the activity and are relevant to the environmental management of the activity; and (b) demonstrate how those requirements will be met.
Regulation 16(a). Other information in the environment plan
The environment plan must contain the following: (a) a statement of the titleholder's corporate environmental policy;

P(SL)(E)R 2012 Requirements
Regulation 14 (6) Environmental assessment
The environment plan must describe the requirements that — (a) apply to the petroleum activity under legislation (including conditions imposed under legislation), international conventions or agreements, or applicable codes of practice; and

(b) are relevant to the environmental management of the petroleum activity.
Regulation 17 (1) Other information in the environment plan
The environment plan must contain the following: (a) statement of the titleholder's corporate environmental policy;

1.4.1 Santos WA Environmental Management Policy

The activity will be conducted in accordance with the Santos WA Environmental Management Policy presented in **Appendix A1** and relevant legislative requirements presented in **Appendix A2**, inclusive of the relevant EP sections where the legislation may prescribe or control how an activity is undertaken.

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

1.4.2 Relevant environmental legislation

Australia is a signatory to numerous international conventions and agreements that obligate the Commonwealth government to prevent pollution and protect specified habitats, flora and fauna. Those that are relevant to the operational activities are detailed in **Appendix A2**. As the activity will occur in both Commonwealth and WA State Waters, the activity will comply with applicable legislative requirements, also as detailed in **Appendix A2**.

Under the Environmental Protection and Biodiversity Conservation Act 1999 (EPBC Act), an action requires approval from the Minister of the Environment if it will have, or is likely to have, a significant impact on a matter of national environmental significance (MNES).

The potential impacts and risks of the Yoorn geophysical survey were considered, and the significant impact criteria were applied to determine whether the action will have, or is likely to have, a significant impact on MNES; this assessment is described in detail in the environment plan for both planned and unplanned events. For the proposed activity, impacts arising from planned events were all deemed to have a 'negligible' residual consequence level, defined as: 'No impact or negligible impact - Environmental impact lasting days up to 1 week'. For unplanned events, two potential events: introduction of invasive marine species and a spill of diesel arising from vessel collision, were deemed to have 'major' potential consequences, defined as: 'Major long-term effect on local population, industry or ecosystem factors. Environmental impact lasting 10 to 20 years'. However, the events were deemed 'rare' and 'very unlikely' respectively (ie no more than 1 in a thousand year probability based on industry data), and are therefore considered so remote as to be 'not likely' in EPBC terms. This determination is further supported by the intended duration of the survey of only 2 days (with up to 10 days allowed for weather / downtime).

Santos have therefore not referred this activity to the DAWE, as the activity was not determined to have a significant impact on MNES.

2 Activity description

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

P(SL)(E)R 2012
Regulation 14 (1)
The environment plan must include a comprehensive description of the petroleum activity including the following : (a) the location or locations of the petroleum activity; (b) details of the construction and layout of any facility; (c) a description of the operational details of the petroleum activity and proposed timetables; (d) any additional information relevant to consideration of the environmental impacts and environmental risks of the petroleum activity.

2.1 Activity overview

The activity will be undertaken using geophysical survey techniques and will include surveying an approximate 1 km x 1 km grid at the planned Yoorn-1 well location in Commonwealth waters, plus tie-in lines extending from the proposed drilling location to other existing data points within the operational area.

The survey will involve the following key activities and objectives:

+ Acquisition of multi-beam echo sounding (MBES) and side-scan sonar (SSS) data to define the bathymetry / seafloor morphology (e.g. depth, bedform character) and confirm the absence of debris or other anomalous seabed features within Commonwealth and State waters.
+ Identification of any hazards that may impact the location of a MODU through sub-bottom profiling (SBP), including shallow gas, lateral variability in layer properties, adverse near-seabed stratigraphy, anomalous layers of hard/soft formations, localised/regional outcrops or sub-crops, mobile bedforms and impediments to providing adequate foundations for supporting the rig when it is elevated above the water within Commonwealth and State waters.
+ Grab sampling or drop cores for ground-truthing the surficial geophysics and to support MODU spud-can penetration assessments within Commonwealth waters only.

Data acquired from the site survey will subsequently be processed to generate site survey reports for use in drilling the well. This data is required up to six months prior to drilling to inform planning for drilling the well.

2.2 Location and extent

The activity will be conducted entirely within a defined operational area as shown in **Figure 1-1**. The operational area overlaps permit areas WA-499-P in Commonwealth waters and TL/5, TP/8 and TP/27 in State waters. Water depth in the operational area ranges from approximately 40 m to 50 m.

A site survey at the proposed Yoorn-1 drilling location will be undertaken over an approximate 1 km x 1 km grid, as shown in **Figure 2-1**. Tie-in lines to nearby reference data points, for the purpose of enhancing understanding of the shallow geological conditions, will be surveyed along lines emanating from the Yoorn-1 drilling location, including to the following potential locations:

+ Campbell Field;
+ Marley Field; and
+ Previous geotechnical boreholes.

All of these potential data points and tie-in lines fall within the defined operational area (**Figure 1-1**). The approximate total linear distance of the tie-in lines is 25 km.

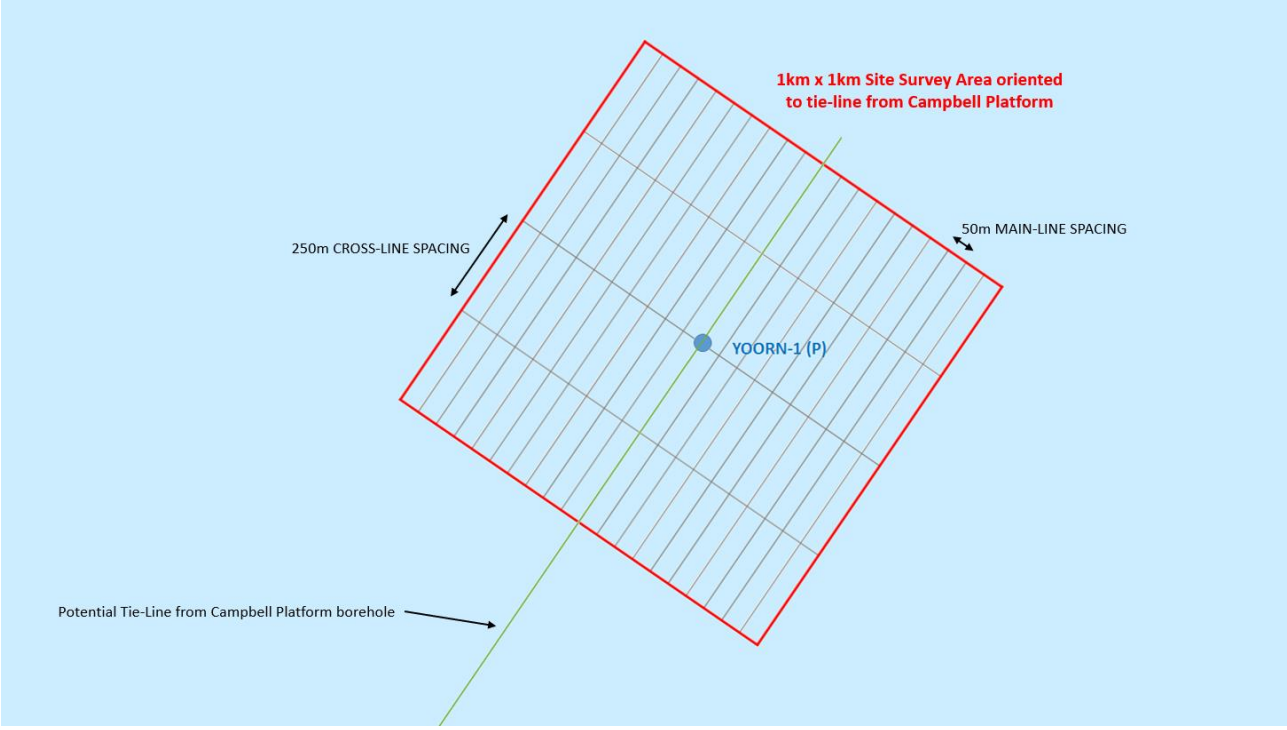


Figure 2-1: Site survey grid at Yoorn-1 proposed well location

2.3 Timing and duration

The activity will take place in 2021-22. Allowing for potential down time, for example due to weather or vessel operability issues, the activity may extend to up to 10 days.

Activities will be undertaken up to 24 hours per day.

2.4 Survey vessel

A single survey vessel will be utilised to undertake the activity. The actual vessel will be determined in later planning stages. For environmental assessment purposes, a vessel such as the *Mermaid Searcher* has been considered, noting that the actual vessel to be used may be smaller; the intent being to assess impacts and risks of the largest typical vessel so that the assessment is conservative and allows for flexibility.

The Mermaid Searcher (see **Figure 2-2**) is a 54-m long, 950-tonne multi-purpose support vessel with accommodation for up to 34 people.

Figure 2-2: Indicative survey vessel – The Mermaid Searcher

Vessel speeds will be approximately 4 knots during geophysical surveying and the vessel will be temporarily stationary when taking seabed samples. No anchoring will take place unless in an emergency (e.g. loss of power).

Aqueous discharges from the vessel may include treated sewage, greywater, cooling water, oily water (bilge), deck run-off and desalination brine (if reverse osmosis system used). Atmospheric emissions will include exhaust gases from fuel combustion. Other environmental emissions include light emissions from vessel decks, accommodation, navigation and safety systems; and noise emissions from above and below the water (e.g. engine noise, survey equipment).

2.5 Survey Equipment

Survey techniques will include equipment such as multibeam echo sounder (MBES), side-scan sonar (SSS), sub-bottom profiling (SBP) and seabed sampling as described below.

2.5.1 Multibeam echo sounder

MBES surveys will enable the collection of bathymetry data and the correlation of depth information. This type of survey uses a sonar system to transmit short pulses of sound energy, analysing the return signal from the seafloor or other objects.

2.5.2 Side-scan sonar

SSS identifies any sea floor debris which may cause damage to the jack up MODU support legs. SSS involves towing a set of transducers mounted on either side of a 'tow fish' approximately 10-20 m above the seabed, producing pulses at high frequencies.

2.5.3 Sub-bottom profiling

SBP allows the near-seabed stratigraphy to be evaluated for hazards and to confirm it will be providing adequate foundations for supporting the MODU when it is elevated above the water. SBP utilises an acoustic source typically towed just behind the vessel, with a hydrophone towed approximately 25 m behind the vessel to record the reflected sound waves.

2.5.4 Acoustic positioning system (Commonwealth waters only)

USBL (Ultra-short Base Line) acoustic positioning system will be utilised on board the survey vessel. This tool is used to locate the position of a single subsea transponder that will be placed temporarily on the seabed and subsequently recovered. The USBL system uses a vessel mounted transceiver to detect the range and bearing to a target using acoustic signals.

2.5.5 Sampling (Commonwealth waters only)

Seabed samples will be taken at points along the survey lines using a sampler lowered by a winch or crane from the survey vessel. Samples will extend up to 1.5 m deep into the seabed, with an areal disturbance of the seabed by each sample of approximately 1 m^2. Approximately four seabed samples are planned, and these will confirm the seafloor soil.

3 Description of the environment

OPGGS(E)R 2009 Requirements
Regulation 13(1)(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. Without limiting paragraph (1)(b), particular relevant values and sensitivities may include the following: (a) the world heritage values of a declared World Heritage property within the meaning of the EPBC Act; (b) the national heritage values of a National Heritage place within the meaning of that Act; (c) the ecological character of a declared Ramsar wetland within the meaning of that Act; (d) threatened; (e) migratory; (f) any values and sensitivities that exist in, or in relation to, part or all of: (i) a Commonwealth marine area within the meaning of that Act; or (ii) Commonwealth land within the meaning of that Act

P(SL)(E)R 2012 Requirements
Regulation 14 (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.

3.1 Environment that may be affected (EMBA)

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

+ The operational area, which is the area within which planned activities will occur; and
+ The environment that may be affected (EMBA), as shown in **Figure 3-1**.

A detailed and comprehensive description of the environment in the operational area and EMBA is provided in Section **3** and **Appendix B - Description of the Existing Environment**. Copies of the Department of the Environment and Energy (DoEE) Protected Matters Search Tool outputs for the operational area and the EMBA are also available in **Appendix B**.

The EMBA encompasses the full range of environmental receptors that might be contacted by surface and subsurface hydrocarbons in the highly unlikely event of a worst case oil spill. Most planned and unplanned events associated with the activity may affect the environment up to a few kilometres from the operational area e.g. from noise impacts (as identified in **Section 6**). A large unplanned hydrocarbon spill would extend substantially beyond this (**Section 7.4**).

3.1.1 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 7.4**), 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 7-6** for the exposure values used and to **Section 7.4** for further information on the reasons why these exposure values have been selected and how they relate to the risk assessment.

The EMBA is based on stochastic modelling, using the low exposure values (**Table 7-6**). The EMBA encompasses the outer most boundary of the overlaid worst-case spatial extent of the four hydrocarbon phases listed above for the credible spill scenario. The EMBA is illustrated in **Figure 3-1**.

The low exposure values are used as a predictive tool to set the outer boundaries of an EMBA and may not necessarily result in ecologically significant impacts. To inform the evaluation of potential environmental consequences of a hydrocarbon release (impact assessment), modelling is undertaken using higher exposure values (i.e. the concentrations at which environmental consequences may result). The higher exposure values are known as 'moderate' and 'high' are described within **Table 7-6** and further explained in **Section 7.4**.

A low exposure threshold, which represents a visible oil (rainbow) sheen, has been used to provide an indication of the extent to which stakeholders may visually observe oil on the sear surface. This is considered to provide a conservative extent of potential impacts to visual amenity. Biological impacts are expected to occur within the moderate and high exposure values which represent a subset of the EMBA. Refer to **Section 7.4.1** for further information on the spill trajectory modelling thresholds that have been selected.

3.2 Environmental Values and Sensitivities

This section summarises environmental values and sensitivities including physical, biological, social, economic and cultural features within the marine and coastal environment that are relevant to the operational area and EMBA.

A summary of the information derived from the DAWE PMST, Bioregional Plans and Fauna Recovery Plans relevant to the operational area and the EMBA is provided in this section. A detailed and comprehensive description of the environment (in accordance with regulation 14(2) of the P(SL)(E)R and regulation 13(1)(2) of the OPGGS(E)R is available in **Appendix B - Description of the Existing Environment**

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

3.2.1 Physical environment

3.2.1.1 Bioregions

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

+ Northwest Province;
+ Northwest Shelf Province; and
+ Central Western Shelf Transition (**Figure 3-2**).

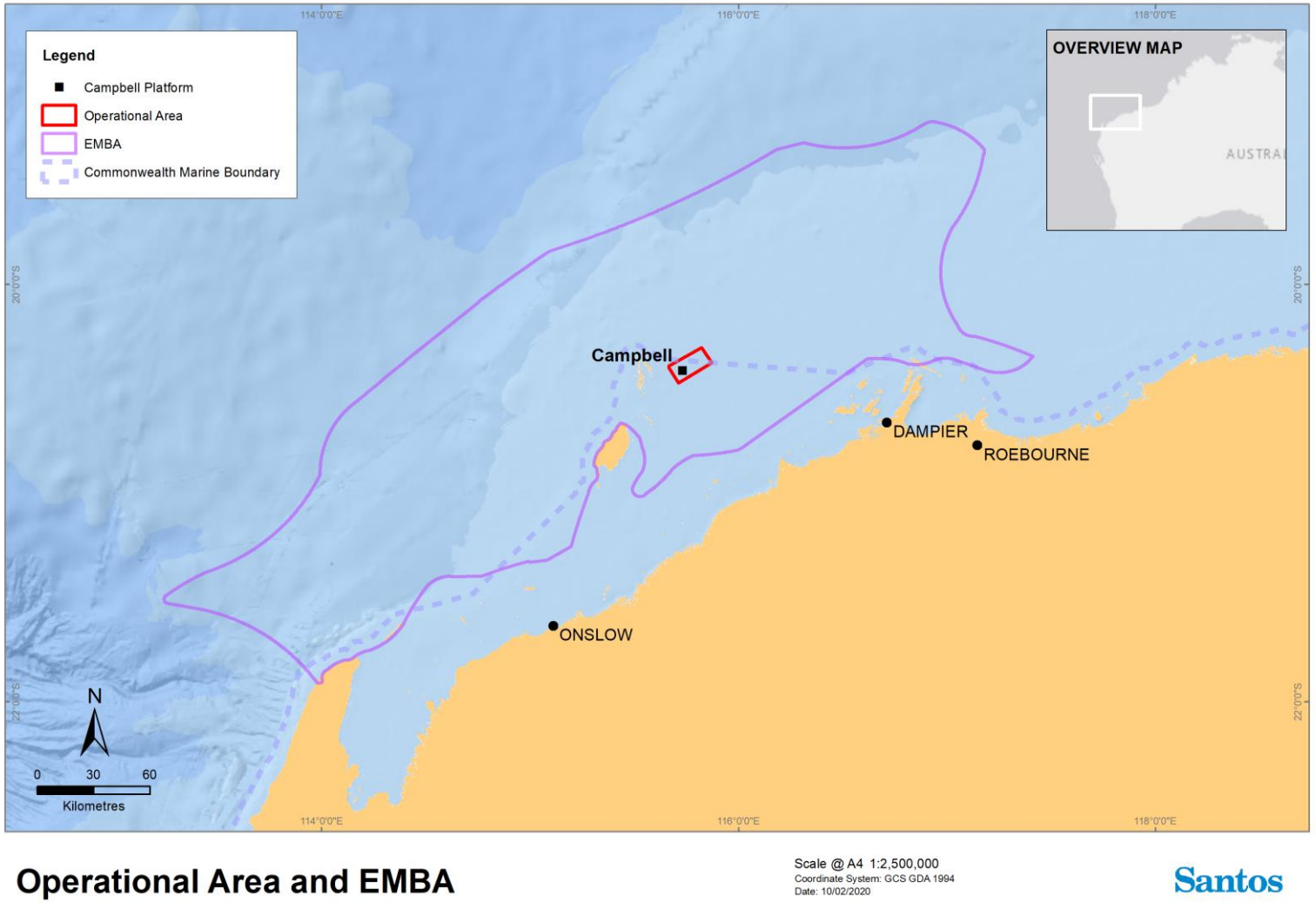


Figure 3-1: Operational area and EMBA (State and Commonwealth)

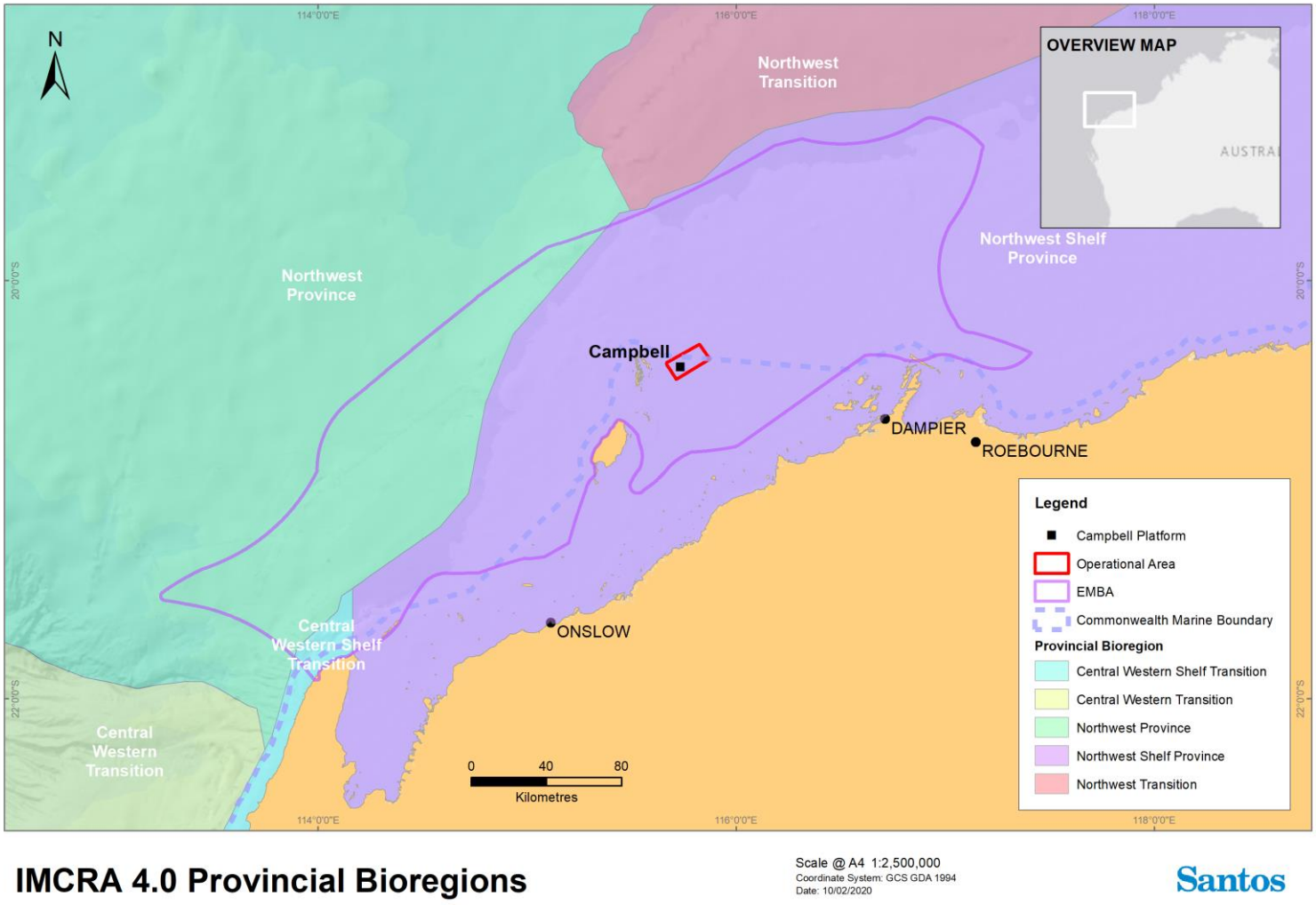


Figure 3-2: IMCRA 4.0 Provincial Bioregions within the EMBA and operational area

3.2.1.2 Benthic habitats

The presence of marine, coastal and terrestrial habitats within the operational area and EMBA are shown in **Figure 3-3**, and a detailed description of these habitats with reference to the IMCRA provincial bioregions is provided in **Appendix B - Description of the Existing Environment.**

The operational area does not contain any shoreline habitat; the nearest land is Trimouille, Lowendal and Barrow islands located approximately 22.3 km, 40.3 km and 50.2 km, respectively, from the Yoorn-1 well location.

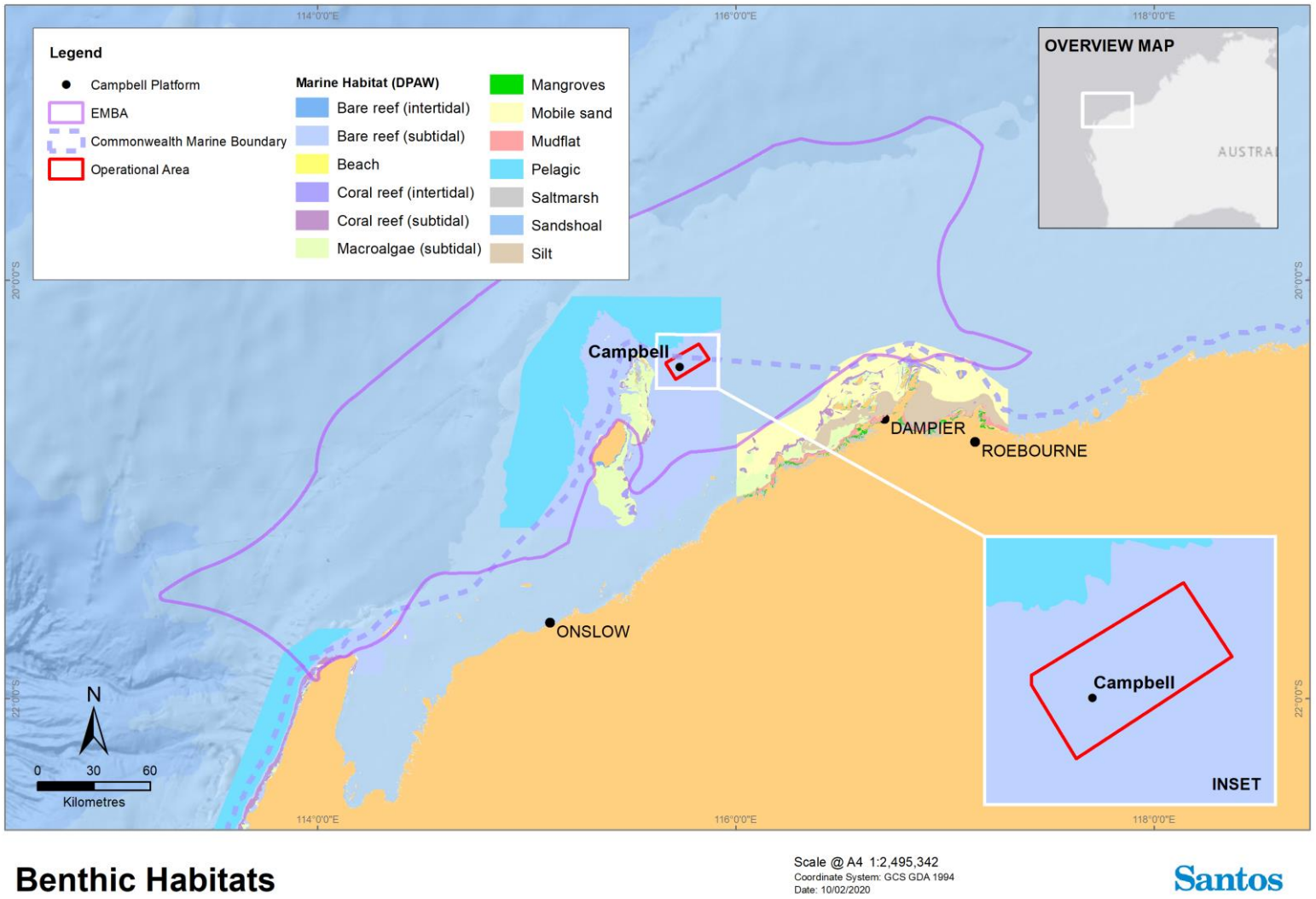
According to the CAMRIS Marine Benthic Substrate Database – Marsed (IMAS, 2017) the benthic substrate within the operational area is made up of calcareous gravel, sand and silt. The subtidal benthic habitats in the NWS province include coral reefs, macroalgae, seagrasses, hard substrates and supported assemblages, and soft sediment and associated benthic fauna. Given the water depth within the operational area is approximately 40-50 m, benthic primary producers habitat (e.g., seagrass, macroalgae and hard corals) is unlikely to be present due to insufficient light availability, or if present will occur in low densities.

Benthic habitats within the EMBA are dominated by subtidal, bare reef; other habitats include coral reefs, seagrasses and macroalgae, which are associated with hard substrate around the Montebello and Lowendal Islands, as well as the mainland shore (Cardno 2011, Chevron 2005). The closest location to the operational area with a significant amount of benthic habitat biodiversity is the Montebello Islands. The subtidal coral reef community around the Montebello Islands are very diverse with over 150 species of hard corals recorded (DEC & MPRA 2007a). Seagrasses grow on soft substrates and sand veneers in the intertidal zone surrounding the Montebello/Barrow Islands, sparsely interspersed between macroalgae (DEC & MPRA 2007a).

Dominant shoreline habitats within the remainder of the EMBA include sandy beaches interspersed with hard substrate and intertidal platforms, which provide breeding and nesting grounds for marine turtles and seabirds (Astron 2012, Garnet and Crowley 2000).

Mangroves occur as discrete patches within the tidal and supratidal (immediately above the high tide mark) zone in communities throughout the Montebello Islands, and are found in lagoons of offshore islands (DEC 2007).

Benthic habitats that could potentially be impacted in a major spill event are shown in **Figure 3-1** and further detailed in **Table 3-1**.



Benthic Habitats

Scale @ A4 1:2,495,342
Coordinate System: GCS GDA 1994
Date: 10/02/2020

Santos

Figure 3-3: Benthic habitats within the EMBA and operational area

Table 3-1: Habitats within the EMBA listed according to presence within the operational area and IMCRA Provincial Bioregions of Australia

Category	Receptor	Operational area presence	EMBA Presence				Relevant events that may impact on the receptors
			Northwest Province	Northwest Shelf Province	Northwest Transition	Central Western Shelf Transition	
Benthic habitats	Coral reefs	✗	✗	✓	✗	✓	Unplanned: Introduction of Invasive Marine Species (IMS) Hydrocarbon release from vessel collision Hydrocarbon release from survey vessel
	Seagrass	✗	✗	✓	✗	✓	Unplanned: Hydrocarbon release from vessel collision Hydrocarbon release from survey vessel
	Macroalgae	✗	✗	✓	✗	✓	Unplanned: Introduction of IMS Hydrocarbon release from vessel collision Hydrocarbon release from survey vessel
	Non-coral benthic invertebrates	✓	✓	✓	✓	✓	Planned: Seabed disturbance Planned operational discharges Unplanned:

Category	Receptor	Operational area presence	EMBA Presence				Relevant events that may impact on the receptors
			Northwest Province	Northwest Shelf Province	Northwest Transition	Central Western Shelf Transition	
							Introduction of IMS Hydrocarbon release from vessel collision Hydrocarbon release from survey vessel
Shoreline habitats	Mangroves	✗	✗	✓	✗	✓	Unplanned: Hydrocarbon release from vessel collision Hydrocarbon release from survey vessel
	Intertidal platforms	✗	✗	✓	✗	✓	
	Sandy beaches	✗	✗	✓	✗	✓	
	Rocky shorelines	✗	✗	✓	✗	✓	
	Saline mudflats	✗	✗	✓	✗	✗	Unplanned: Hydrocarbon release from vessel collision Hydrocarbon release from survey vessel

3.2.2 Protected/significant areas

Protected/significant areas identified in the operational area and EMBA are detailed in **Table 3-2,** and shown in **Figure 3-4** and **Figure 3-5**. These areas are further discussed in **Appendix B - Description of the Existing Environment**. The management zones, associated with the Australian Marine Parks identified in the EMBA, and the relevant objectives are detailed in **Table 3-3.** Distances shown are from the closest point of the operational area to the nearest feature.

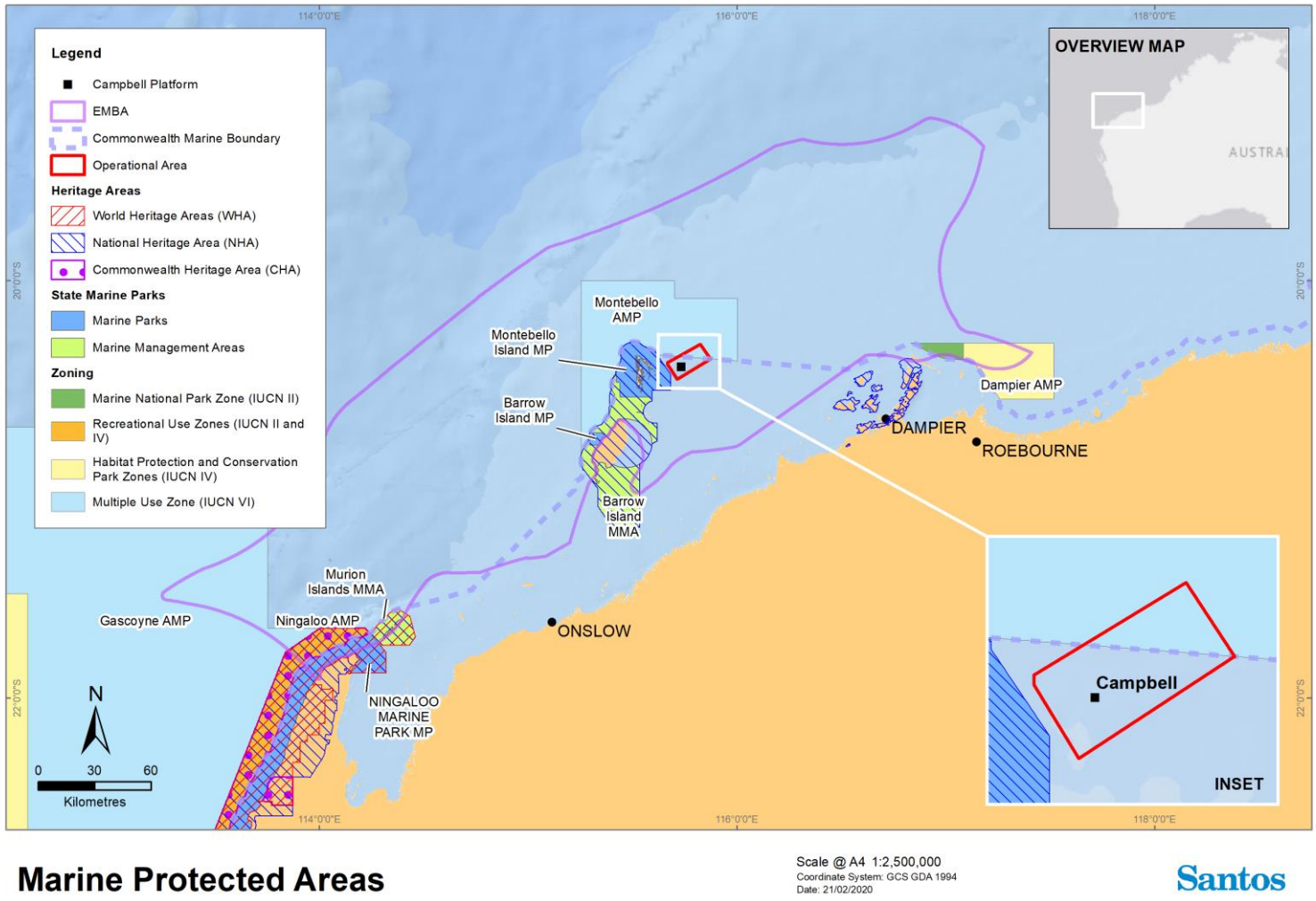
Table 3-2: Distance from operational area boundary to protected areas, key ecological features and threatened ecological communities within the EMBA

Value/sensitivity	Name	Within operational area	Distance to operational area	Protection classification/zone
Australian Marine Parks	Montebello Marine Park	✓	Intersects	Multiple Use Zone (IUCN VI) General Use Zone
	Dampier Marine Park	X	101 km	Marine National Park Zone (IUCN I) Habitat Protection Zone (IUCN IV) Special Purpose Zone (IUCN VI))
	Gascoyne Marine Park	X	215 km	Multiple Use Zone (IUCN VI)
State Marine Parks and Marine Management Areas	Montebello Islands Marine Park	X	1 km	Sanctuary Zones, Recreation Zones, Special Purpose Zones
	Barrow Island Marine Management Area	X	16 km	-
	Barrow Island Marine Park	X	47 km	Sanctuary Zone
	Muiron Islands Marine Management Area	X	184 km	-
	Ningaloo Marine Park	X	205 km	Recreational Use Zone (IUCN IV) General Use Zone Special Purpose Zone
World Heritage Areas	The Ningaloo Coast	X	184 km	-
National Heritage Areas	Barrow Island and the Montebello-Barrow Island Marine Conservation Reserves	X	1 km	-
	Dampier Archipelago (including Burrup Peninsula)	X	98 km	-
	The Ningaloo Coast	X	183 km	-
Key Ecological Features	Ancient Coastline at 125 m Depth Contour	X	58 km	-
	Commonwealth Waters adjacent to Ningaloo Reef	X	180 km	-
	Continental Slope Demersal Fish Communities	X	69 km	-

Value/sensitivity	Name	Within operational area	Distance to operational area	Protection classification/zone
	Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula	X	16 km	-
	Glomar Shoals	X	103 km	-

Table 3-3: Management zones for the Australian and State Marine Parks found within the EMBA and the associated objectives

Management zones	Objective
Australian Marine Parks	
Multiple Use (IUCN VI)	Managed to allow ecologically sustainable use while conserving ecosystems, habitats and native species. The zone allows for a range of sustainable uses, including commercial fishing and mining where they are consistent with park values.
Recreational Use (IUCN IV)	Managed to allow recreational use while conserving ecosystems, habitats and native species in as natural a state as possible. The zone allows for recreational fishing, but not commercial fishing.
Habitat Species Management Area (IUCN IV)	Managed primarily, including (if necessary) through active intervention, to ensure the maintenance of habitats or to meet the requirements of specific species
State Marine Park	
Sanctuary Zone	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 Zone	*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 Zone	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 Zone	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.



Marine Protected Areas

Scale @ A4 1:2,500,000
Coordinate System: GCS GDA 1994
Date: 21/02/2020

Santos

Figure 3-4: Protected areas within and near the EMBA and operational area

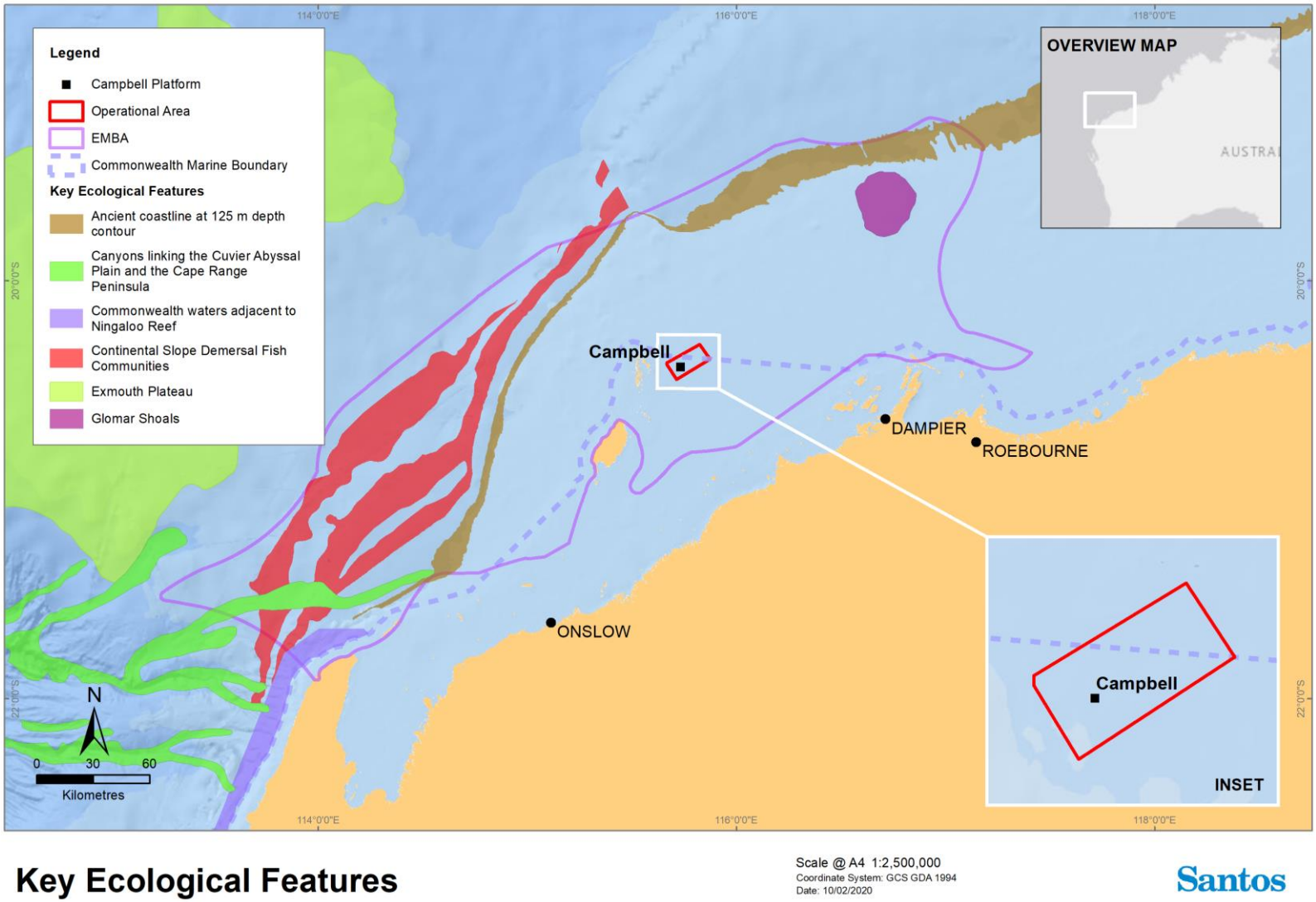


Figure 3-5: Key ecological features within and near the EMBA and operational area

3.2.3 Threatened and migratory fauna

3.2.3.1 Marine fauna

The PMST for the operational area identified 25 Listed Threatened Species (LTS) and 38 Listed Migratory Species (LMS).An additional 3 LTS and 11 LMS were identified as potentially occurring within the EMBA (**Table 3-4**).

An examination of the species profile and threats database showed that three LTS, identified within the EMBA, are not expected to occur in the marine and coastal environments due to their terrestrial and subterranean distribution. These species will not come into contact with any potential oil spill and therefore are not discussed further.

Those listed as threatened or migratory species groups and which have been identified as potentially being present within the operational area or EMBA, and the relevant planned and unplanned events that may impact them, are discussed in **Table 3-4**. Threatened and migratory species within these species' groups are further described in **Appendix B - Description of the Existing Environment**.

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 3-6** to **Figure 3-12** and are also described in **Appendix B - Description of the Existing Environment**. The relevant BIAs that occur within the operational area are listed below:

+ Internesting (internesting buffer) (loggerhead, green, hawksbill and flatback turtles);
+ Migration (humpback whale and pygmy blue whale);
+ Foraging (whale shark) and
+ Breeding (wedge-tailed shearwater, Australian fairy tern, lesser crested tern and roseate tern).

Relevant conservation advices, recovery plans and management plans for marine fauna identified in the PMST are provided in **Section 3.2.3.3**.

Table 3-4: Environmental values and sensitivities within the EMBA and Operational Area – threatened and migratory marine fauna

Value/sensitivity		EPBC Act Status	Operational area presence	Particular values or sensitivities within operational area	Particular values or sensitivities within EMBA	Relevant events
Common name	**Scientific name**					
Protected Species and Communities: Fish and Sharks						
Whale shark	*Rhincodon typus*	Vulnerable, Migratory	✓	Species or species habitat may occur within area.	Foraging, feeding or related behaviour known to occur within area. Overlap with foraging BIA.	<u>Planned</u> + Light emissions + Noise emissions + Seabed and benthic habitat disturbance + Planned vessel discharges + Spill response operations + Dropped objects <u>Unplanned</u> + Hydrocarbon releases + Marine fauna collisions + Introduction of invasive marine species (IMS)
Grey nurse shark (west coast population)	*Carcharias taurus (west coast population)*	Vulnerable	✓	Species or species habitat known to occur within area.	Species or species habitat known to occur within area.	
Great white shark	*Carcharodon carcharias*	Vulnerable, Migratory	✓	Species or species habitat may occur within area.	Species or species habitat known to occur within area.	
Dwarf sawfish	*Pristis clavata*	Vulnerable, Migratory	✓	Species or species habitat known to occur within area.	Species or species habitat known to occur within area.	
Green sawfish	*Pristis zijsron*	Vulnerable, Migratory	✓	Species or species habitat known to occur within area.	Species or species habitat known to occur within area.	
Narrow sawfish	*Anoxypristis cuspidata*	Migratory	✓	Species or species habitat likely to occur within area.	Species or species habitat known to occur within area.	

Value/sensitivity		EPBC Act Status	Operational area presence	Particular values or sensitivities within operational area	Particular values or sensitivities within EMBA	Relevant events
Common name	Scientific name					
Reef manta ray	*Manta alfredi*	Migratory	✓	Species or species habitat known to occur within area.	Species or species habitat known to occur within area.	
Giant manta ray	*Manta birostris*	Migratory	✓	Species or species habitat likely to occur within area.	Species or species habitat known to occur within area.	
Shortfin mako	*Isurus oxyrinchus*	Migratory	X	N/A	Species or species habitat likely to occur within area.	
Longfin mako	*Isurus paucus*	Migratory	X	N/A	Species or species habitat likely to occur within area.	
Protected Species and Communities: Marine Mammals						
Humpback whale	*Megaptera novaeangliae*	Vulnerable, Migratory	✓	Species or species habitat known to occur within area. Overlap with BIA for migration.	Congregation or aggregation known to occur within area. Overlap with BIA for migration.	<u>Planned</u> + Noise emissions + Planned vessel discharges + Spill response operations + Dropped objects <u>Unplanned</u> + Hydrocarbon releases
Blue whale	*Balaenoptera musculus*	Endangered, Migratory	✓	Species or species habitat likely to occur within area. Overlap with BIA for distribution.	Migration route known to occur within area. Overlap with BIA for migration.	
Bryde's whale	*Balaenoptera edeni*	Migratory	✓	Species or species habitat may occur within area.	Species or species habitat likely to occur within area.	

Value/sensitivity		EPBC Act Status	Operational area presence	Particular values or sensitivities within operational area	Particular values or sensitivities within EMBA	Relevant events
Common name	Scientific name					
Orca, killer whale	*Orcinus orca*	Migratory	✓	Species or species habitat may occur within area.	Species or species habitat may occur within area.	+ Marine fauna interaction
Spotted bottlenose dolphin	*Tursiops aduncus (Arafura/Timor Sea Populations)*	Migratory	✓	Species or species habitat likely to occur within area.	Species or species habitat likely to occur within area.	
Dugong	*Dugong dugon*	Migratory	✓	Species or species habitat known to occur within area.	Breeding known to occur within area. Overlap with BIA for foraging and breeding / calving / nursing.	
Indo-Pacific humpback dolphin	*Sousa chinensis*	Migratory	✓	Species or species habitat likely to occur within area.	Species or species habitat known to occur within area.	
Southern Right Whale	*Eubalaena australia*	Endangered	X	N/A	Species or species habitat likely to occur within area.	
Antarctic Minke Whale	*Balaenoptera bonaerensis*	Migratory	X	N/A	Species or species habitat likely to occur within area.	
Sei whale	*Balaenoptera borealis*	Vulnerable, Migratory	✓	Species or species habitat known to occur within area.	Foraging, feeding or related behaviour likely to occur within area.	
Fin whale	*Balaenoptera physalusk*	Vulnerable, Migratory	X	N/A	Foraging, feeding or related behaviour likely to occur within area.	
Sperm whale	*Physeter macrocephalus*	Migratory	X	N/A	Species or species habitat may occur within area.	
Protected Species and Communities: Marine Reptiles						

Value/sensitivity		EPBC Act Status	Operational area presence	Particular values or sensitivities within operational area	Particular values or sensitivities within EMBA	Relevant events
Common name	Scientific name					
Short-nosed seasnake	*Aipysurus apraefrontalis*	Critically Endangered	✓	Species or species habitat known to occur within area.	Species or species habitat known to occur within area.	Planned + Light emissions + Noise emissions + Seabed and benthic habitat disturbance + Dropped objects + Planned vessel discharges + Spill response operations Unplanned + Hydrocarbon releases + Marine fauna interactions + Introduction of invasive marine species (IMS)
Loggerhead turtle	*Caretta caretta*	E, Migratory	✓	Foraging, feeding or related behaviour known to occur within area. Overlap with internesting BIA.	Breeding known to occur within area. Overlap with BIAs for nesting and internesting.	
Green turtle	*Chelonia mydas*	Vulnerable, Migratory	✓	Breeding known to occur within area. Overlap with BIAs for internesting. Overlap with critical nesting habitat.	Breeding known to occur within area. Overlap with BIAs for mating/nesting, foraging, basking, aggregation and internesting. Overlap with habitat critical to the survival of a species nesting habitat.	
Leatherback turtle	*Dermochelys coriacea*	Endangered, Migratory	✓	Breeding likely to occur within area.	Foraging, feeding or related behaviour known to occur within area.	
Hawksbill turtle	*Eretmochelys imbricata*	Vulnerable, Migratory	✓	Breeding known to occur within area. Overlap with BIAs for internesting. Overlap with critical nesting habitat.	Breeding known to occur within area. Overlap with BIAs for mating/nesting, foraging and internesting habitat. Overlap with habitat critical to the survival of a species nesting habitat.	
Flatback turtle	*Natator depressus*	Vulnerable, Migratory	✓	Breeding known to occur within area. Overlap with BIAs for internesting.	Breeding known to occur within area. Overlap with BIAs for mating/nesting, foraging, aggregation and internesting. Overlap with critical nesting habitat.	

Value/sensitivity		EPBC Act Status	Operational area presence	Particular values or sensitivities within operational area	Particular values or sensitivities within EMBA	Relevant events
Common name	Scientific name					
				Overlap with critical nesting habitat.		
Protected Species and Communities: Marine Birds						
Roseate tern	*Stern dougallii*	Migratory	✓	Breeding known to occur within area. Overlap with breeding BIA.	Breeding known to occur within area. Overlap with breeding BIA.	<u>Planned</u> + Light emissions + Planned vessel discharges + Dropped objects + Spill response operations <u>Unplanned</u> + Hydrocarbon releases + Marine fauna interactions
Curlew sandpiper	*Calidris ferruginea*	Critically Endangered, Migratory	✓	Species or species habitat known to occur within area.	Species or species habitat known to occur within area.	
Red knot	*Calidris canutus*	E, Migratory	✓	Species or species habitat known to occur within area.	Species or species habitat known to occur within area.	
Southern giant petrel	*Macronectes giganteus*	Endangered, Migratory	✓	Species or species habitat may occur within area.	Species or species habitat may occur within area.	
Eastern curlew	*Numenius madagascariensis*	Critically Endangered, Migratory	✓	Species or species habitat known to occur within area.	Species or species habitat known to occur within area.	
Common noddy	*Anous stolidus*	Migratory	✓	Species or species habitat likely to occur within area.	Species or species habitat likely to occur within area.	
Streaked shearwater	*Calonectris leucomelas*	Migratory	✓	Species or species habitat likely to occur within area.	Species or species habitat likely to occur within area.	

Value/sensitivity		EPBC Act Status	Operational area presence	Particular values or sensitivities within operational area	Particular values or sensitivities within EMBA	Relevant events
Common name	Scientific name					
Lesser frigatebird	*Fregata ariel*	Migratory	✓	Species or species habitat likely to occur within area.	Species or species habitat known to occur within area.	
Common sandpiper	*Actitis hypoleucos*	Migratory	✓	Species or species habitat known to occur within area.	Species or species habitat known to occur within area.	
Sharp-tailed sandpiper	*Calidris acuminata*	Migratory	✓	Species or species habitat known to occur within area.	Species or species habitat known to occur within area.	
Pectoral sandpiper	*Calidris melanotos*	Migratory	✓	Species or species habitat may occur within area.	Species or species habitat may occur within area.	
Osprey	*Pandion haliaetus*	Migratory	✓	Breeding known to occur within area.	Breeding known to occur within area.	
Australian fairy tern	*Sternula nereis nereis*	Vulnerable	✓	Breeding known to occur within area. Overlap with breeding BIA.	Breeding known to occur within area. Overlap with breeding BIA.	
Fork-tailed swift	*Apus pacificus*	Migratory	X	N/A.	Species or species habitat likely to occur within area.	<u>Unplanned</u> + Hydrocarbon releases + Non-hydrocarbon releases
Bar-tailed godwit	*Limosa lapponica baueri*	Vulnerable, Migratory	X	N/A	Species or species habitat known to occur within area.	
Northern Siberian bar-tailed godwit	*Limosa lapponica menzbierii*	Critically Endangered, Migratory	X	N/A	Species or species habitat may occur within area.	

Value/sensitivity		EPBC Act Status	Operational area presence	Particular values or sensitivities within operational area	Particular values or sensitivities within EMBA	Relevant events
Common name	Scientific name					
Wedge-tailed shearwater	*Ardenna pacifca*	Migratory	X	N/A	Breeding known to occur within area. Overlap with breeding BIA.	+ Introduction of non-indigenous flora and fauna.
Capsian tern	*Hydroprogne caspia*	Migratory	X	N/A	Breeding known to occur within area.	
Bridled tern	*Onychoprion anaethetus*	Migratory	X	N/A	Breeding known to occur within area.	
Oriental plover	*Charadrius plover*	Migratory	X	N/A	Species or species habitat may occur within area.	
Oriental pratincole	*Glareola maldivarum*	Migratory	X	N/A	Species or species habitat may occur within area.	
Crested tern	*Thalasseus bergii*	Migratory	X	N/A	Breeding known occur within area.	
Common greenshank	*Tringa nebularia*	Migratory	X	N/A	Species or species habitat likely to occur within area.	
Australian painted snipe	*Rostratula australis*	Endangered	X	N/A	Species or species habitat may occur within area.	
Greater frigatebird	*Fregata minor*	Migratory	X	N/A	Species or species habitat may occur within area.	
White-winged Fairy-wren (Barrow Island)	*Malurus leucopterus edouardi*	Vulnerable	X	N/A	Species or species habitat likely to occur within area.	
Soft-plumaged Petrel	*Pterodroma mollis*	Vulnerable	X	N/A	Foraging, feeding or related behaviour likely to occur within area.	
Flesh-footed Shearwater	*Ardenna carneipes*	Vulnerable	X	N/A	Species or species habitat likely to occur within area.	

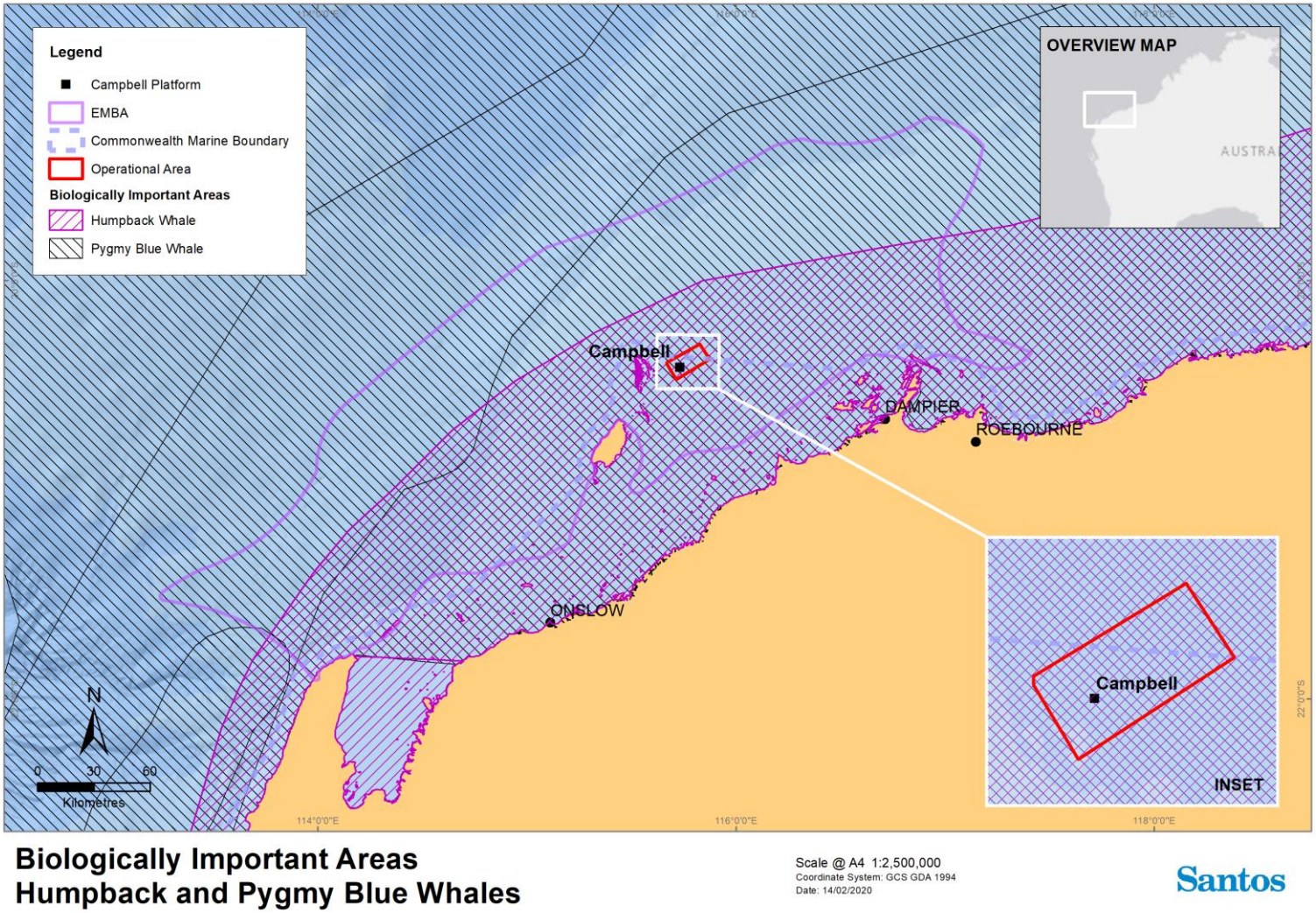


Figure 3-6: Biologically important areas for EPBC Protected whale species within the vicinity of the EMBA and operational area

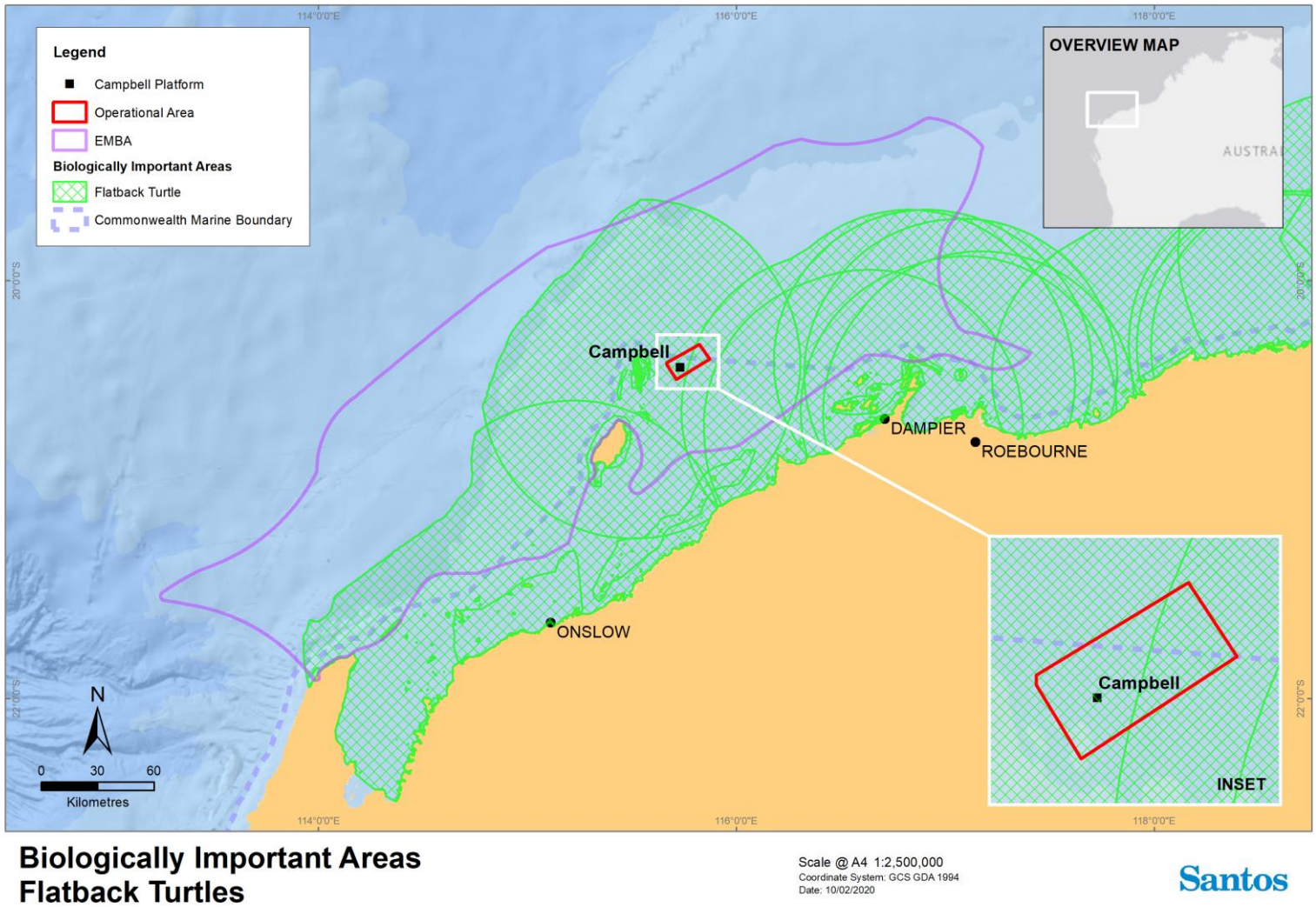


Figure 3-7: Biologically important areas for EPBC Protected flatback turtle within the vicinity of the EMBA and operational area

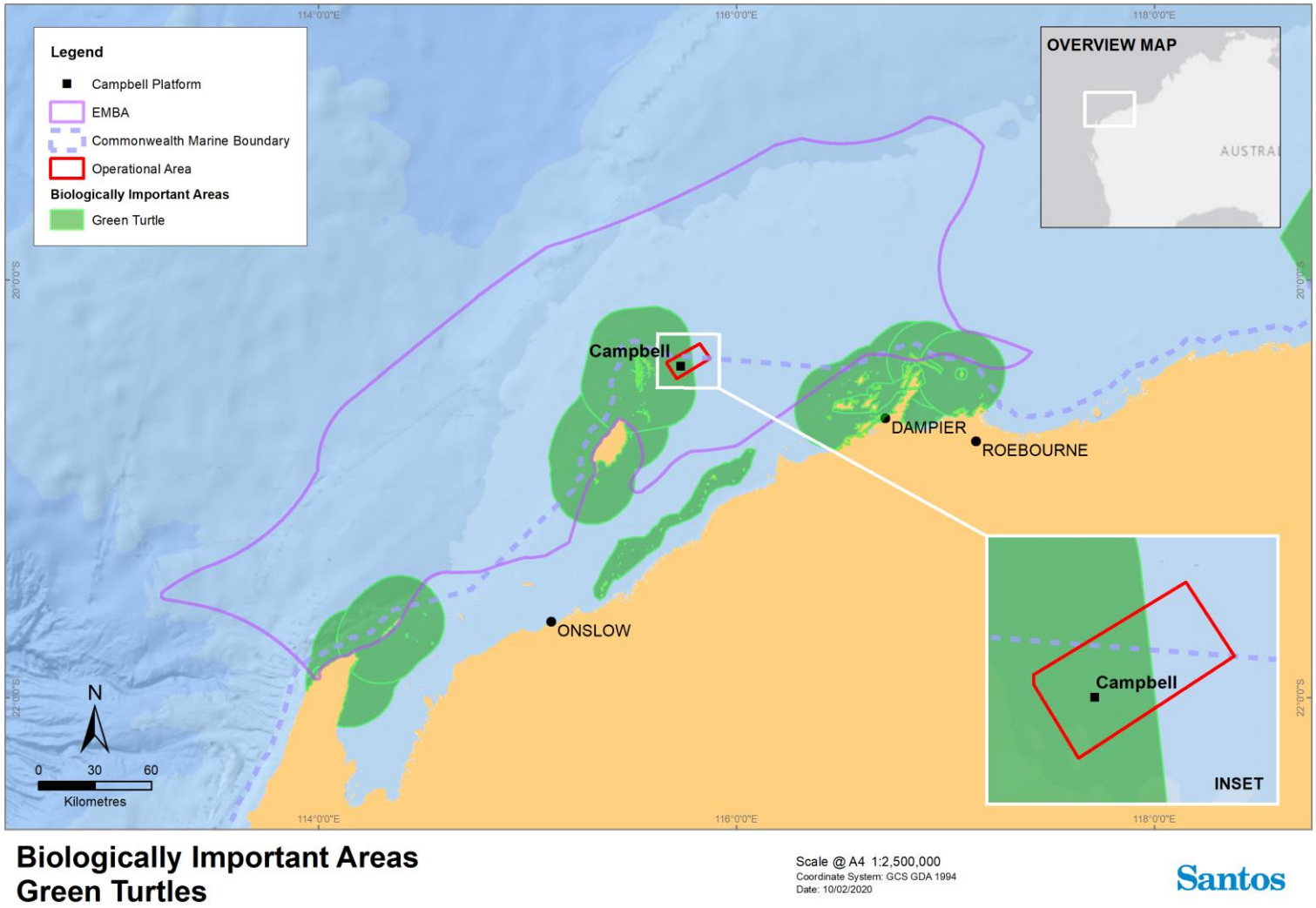


Figure 3-8: Biologically important areas for EPBC Protected green turtle within the vicinity of the EMBA and operational area

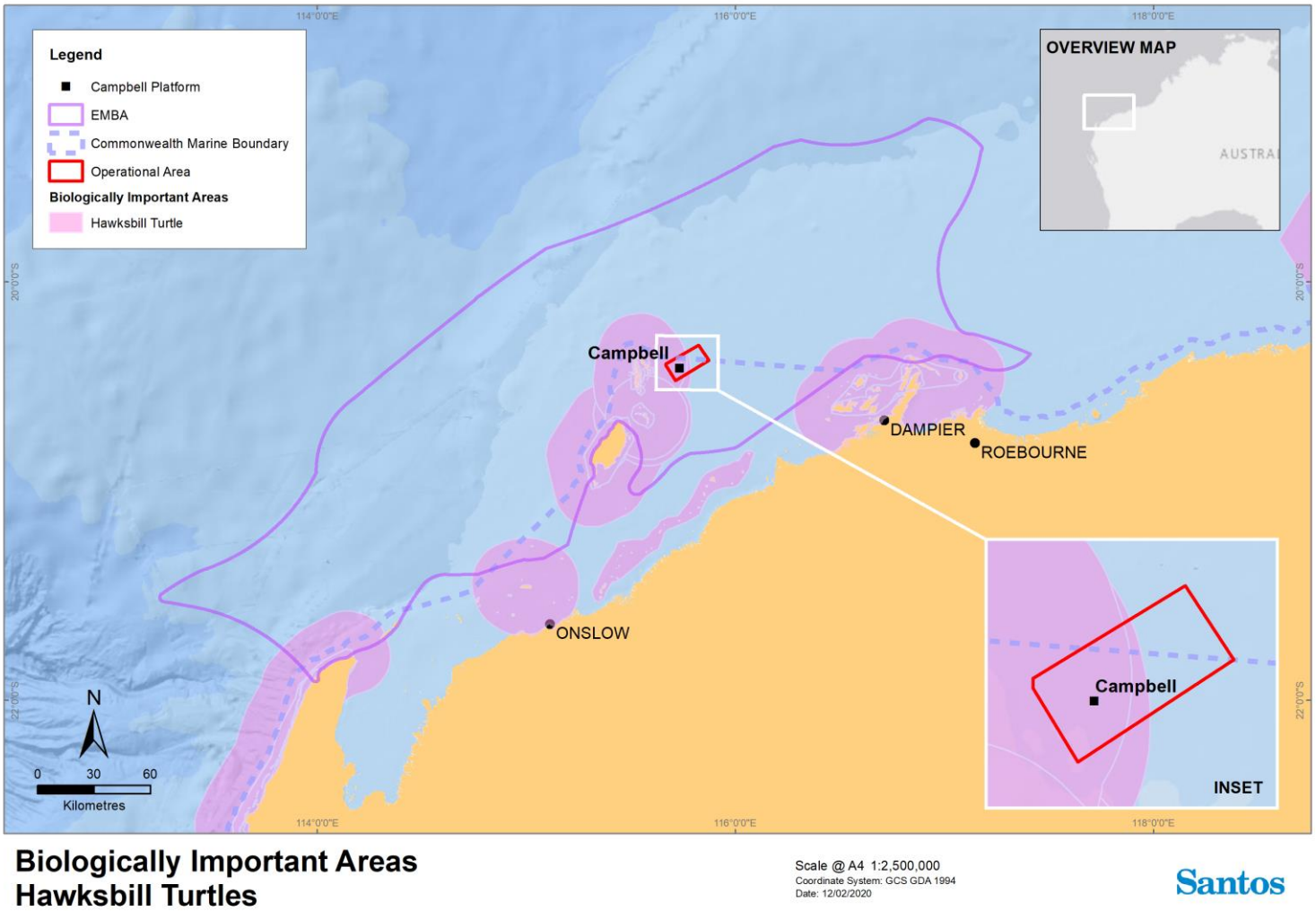


Figure 3-9: Biologically important areas for EPBC Protected hawksbill turtle within the vicinity of the EMBA and operational area

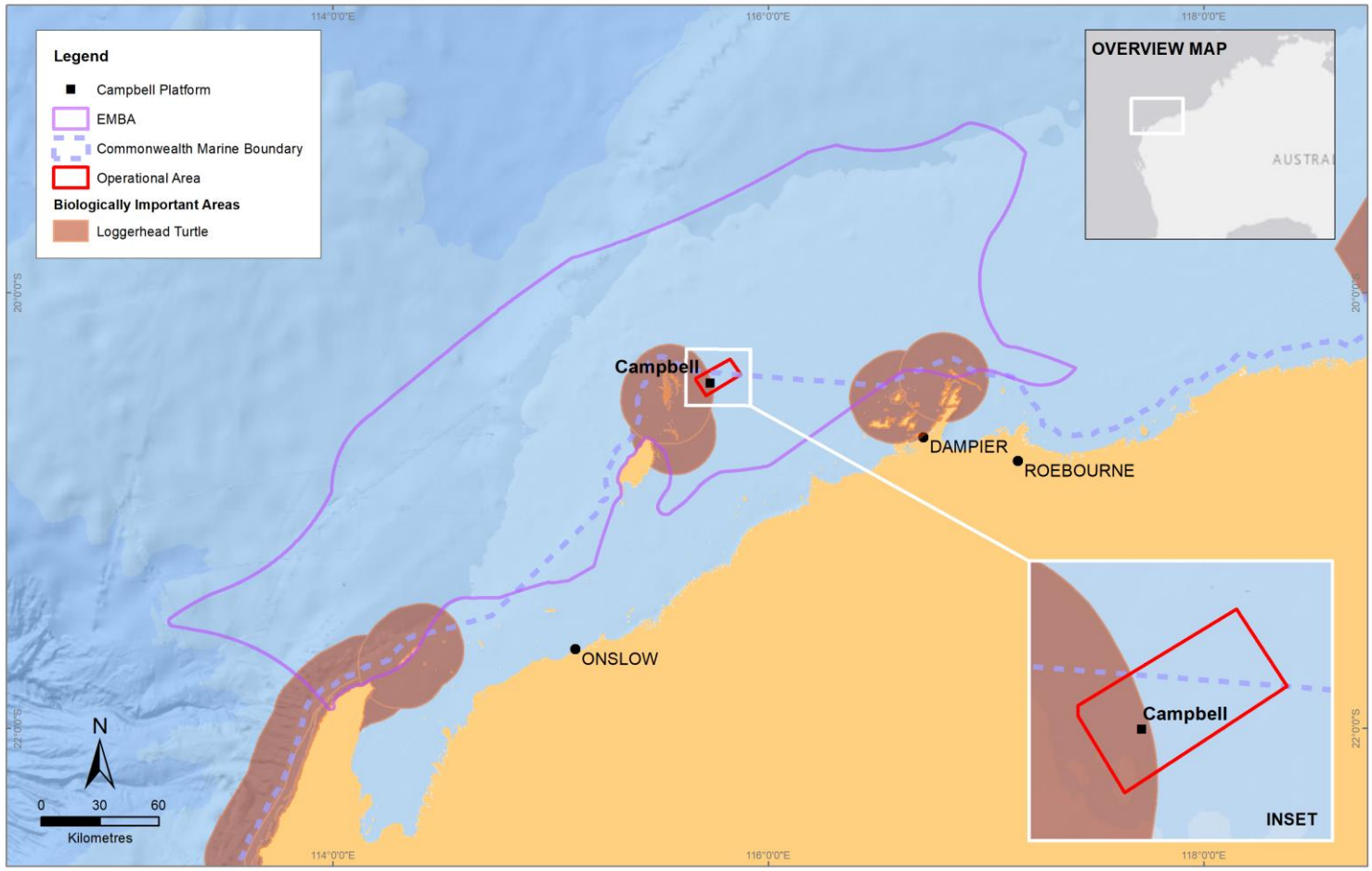


Figure 3-10: Biologically important areas for EPBC Protected loggerhead turtle within the vicinity of the EMBA and operational area

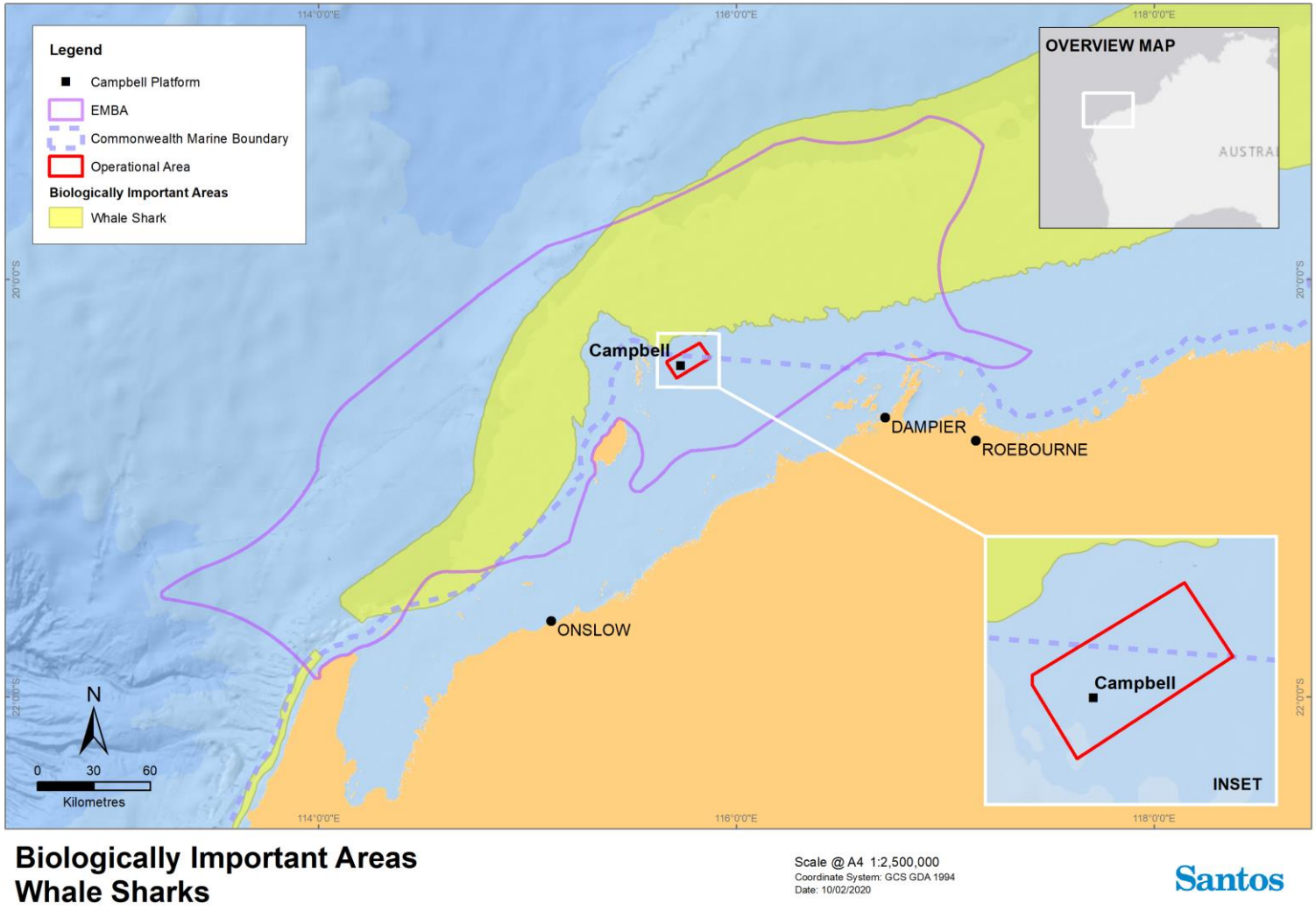


Figure 3-11: Biologically important areas for EPBC Protected whale sharks within the vicinity of the EMBA and operational area

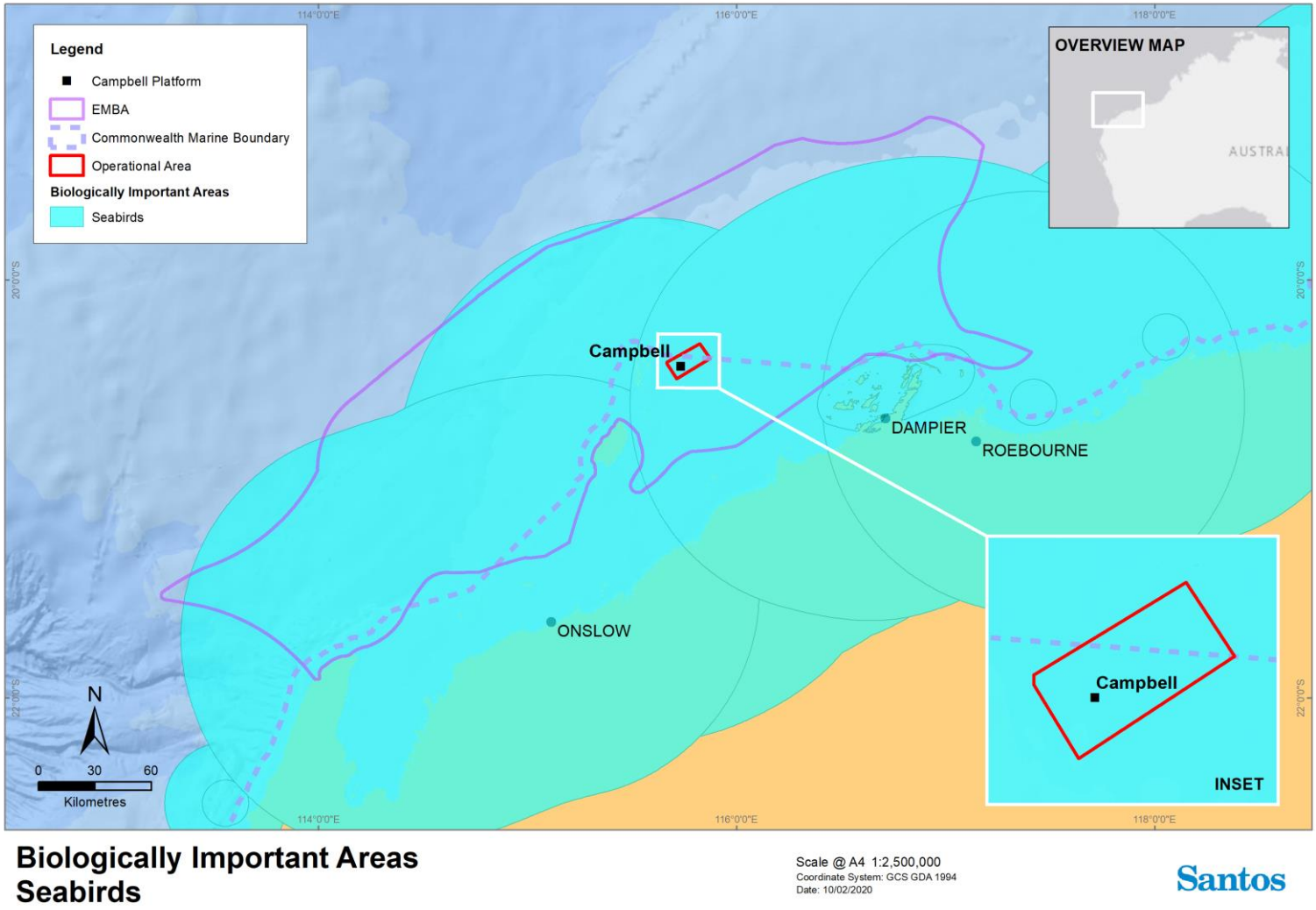


Figure 3-12: Biologically important areas for EPBC Protected seabird species within the vicinity of the EMBA and operational area

3.2.3.2 Terrestrial/subterranean fauna

The combined spill trajectory area for the worst-case accidental hydrocarbon release during the vessel survey encompasses offshore islands, however hydrocarbons will be limited to the contact margins of these islands. The PMST for the EMBA identified 11 terrestrial and two subterranean LTS as having the potential to occur within the EMBA, however these species are not expected to be impacted due to their terrestrial habitat and are therefore not discussed further.

3.2.3.3 Recovery Plans

Recovery Plans set out the research and management actions necessary to stop the decline of and support the recovery of LTS. **Table 3-5** summarises the actions relevant to the activity with more information on the specific requirements of the relevant plans of management (including Conservation Advices and Conservation Management Plans) that would be applicable to the installation activity and demonstrates where current management requirements have been considered.

Table 3-5: Threats and strategies from Recovery Plans, Conservation Advice and Management Plans relevant to the activity

Receptor	Name	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 (DoEE, 2018)	Marine debris	7.1 and 7.3
Fish and Sharks	Dwarf sawfish	Sawfish and River Sharks Multispecies Recovery Plan (2015)	Habitat degradation and modification	6.4, 7.1 – 7.4
	Green sawfish	Commonwealth Conservation Advice on *Pristis zijsron* (green sawfish) (2008)	Habitat degradation and modification	6.4, 7.1 – 7.4
		Sawfish and River Sharks Multispecies Recovery Plan (2015)		
	Narrow Sawfish	Sawfish and River Sharks Multispecies Recovery Plan (2015)	Habitat degradation and modification	6.4, 7.1 – 7.4
	Great white shark	Recovery plan for the White Shark (*Carcharodon carcharias*) (2013)	Ecosystem effects as a result of habitat modification and climate change	6.4, 7.1 – 7.4
	Grey nurse shark	Recovery Plan for the Grey Nurse Shark (*Carcharias taurus*) (2014)	Pollution and disease	6.6
			Ecosystem effects - habitat modification and climate change	6.4, 7.1 – 7.4
	Whale shark	Approved Conservation Advice for *Rhincodon typus* (whale shark) (2015)	Boat strike from large vessels	7.3
			Habitat disruption from mineral exploration, production and transportation	6.4, 7.1 – 7.4
Mammals	Blue whale	Blue Whale Conservation Management Plan 2015 - 2025 (2015)	Noise interference	6.1
			Habitat modification	6.4
			Vessel disturbance	6.5 and 7.3
	Southern right whale		Vessel disturbance	6.5 and 7.3

		Conservation Management Plan for the Southern Right Whale 2011 – 2021 (2012)	Habitat modification	7.4
			Noise interference	6.1
			Entanglement (marine debris)	7.3
	Fin whale	Approved Conservation Advice for *Balaenoptera physalus* (fin whale) (2015)	Habitat degradation including pollution (increasing port expansion and coastal development)	6.4, 7.1 – 7.4
			Pollution (persistent toxic pollutants)	7.1 - 7.4
			Noise interference	6.1
			Vessel strike	7.3
	Sei whale	Approved Conservation Advice for *Balaenoptera borealis* (sei whale) (2015)	Habitat degradation including pollution (increasing port expansion and coastal development)	6.4, 7.1 – 7.4
			Pollution (persistent toxic pollutants)	7.1 - 7.4
			Vessel strike	7.3
	Humpback whale	Approved Conservation Advice for *Megaptera novaeangliae* (humpback whale) (2015)	Noise interference	6.1
			Habitat degradation including coastal development and port expansion	6.7
Reptiles	All marine turtles	National Light Pollution Guidelines for Wildlife Including Marine Turtles, Seabirds and Migratory Shorebirds (DoEE, 2020)	Light pollution	6.2
	Loggerhead turtle	Recovery plan for marine turtles in Australia 2017 – 2027 (Commonwealth of Australia 2017)	Marine debris	7.4
			Vessel disturbance	6.1 and 7.3
			Light Pollution	6.2
	Green turtle	Recovery plan for marine turtles in Australia 2017 – 2027 (Commonwealth of Australia 2017)	Deteriorating water quality	6.6
			Marine debris	7.4
			Vessel disturbance	6.1 and 7.3

			Light Pollution	6.2
	Leatherback turtle	Commonwealth Conservation Advice on *Dermochelys coriacea* (2008)	Boat strike	7.3
			Changes to breeding sites	7.1 - 7.4
		Recovery plan for marine turtles in Australia ((Commonwealth of Australia 2017)	Deteriorating water quality	6.6, 7.1 - 7.4
			Marine debris	7.4
			Loss of habitat	7.1 – 7.4
			Vessel disturbance	6.1 and 7.3
			Light Pollution	6.2
	Hawksbill turtle	Recovery plan for marine turtles in Australia 2017 – 2027 (Commonwealth of Australia 2017)	Deteriorating water quality	6.6
			Marine debris	7.4
			Loss of habitat	6.4, 7.1 – 7.4
			Vessel disturbance	6.1 and 7.3
			Light Pollution	6.2
	Flatback turtle	Recovery plan for marine turtles in Australia 2017 – 2027 (Commonwealth of Australia 2017)	Deteriorating water quality	6.6
			Marine debris	7.4
			Loss of habitat	6.4, 7.1 – 7.4
			Vessel disturbance	6.1 and 7.3
			Light pollution	6.2
Birds	All seabirds and shorebirds	National Light Pollution Guidelines for Wildlife Including Marine Turtles, Seabirds and Migratory Shorebirds (DoEE, 2020)	Light pollution	6.2
	Australian fairy tern	Commonwealth Conservation Advice on *Sternula nereis nereis* (Fairy Tern) (2011)	Oil spills, particularly in Victoria	7.1 – 7.4
	Curlew sandpiper	Approved Conservation Advice for *Calidris ferruginea* (Curlew Sandpiper) (2015)	Habitat loss and degradation from pollution	7.1 – 7.4

	Eastern curlew	Approved Conservation Advice for *Numenius madagascariensis* (Eastern Curlew) (2015)	Habitat loss and degradation from pollution	7.1 – 7.4
	Red knot	Approved Conservation Advice for *Calidris canutus* (Red knot) (2016)	Pollution/contamination impacts	7.1 – 7.4
			Disturbance	6.1
			Habitat loss and degradation	7.1 – 7.4
	Southern giant-petrel	National recovery plan for threatened albatrosses and giant petrels 2011-2016 (2011)	Marine pollution	7.1 – 7.4
	Soft-Plumaged Petrel	Approved Conservation Advice for *Pterodroma Mollis* (soft-plumaged Petrel) (2015)	Habitat loss disturbance and modifications	7.1 – 7.4
	Northern Siberian Bar-tailed Godwit	Conservation Advice *Limosa lapponica menzbieri* (Bar-tailed godwit (northern Siberian))	Habitat loss disturbance and modifications	7.1 – 7.4
	Australian Painted Snipe	Approved Conservation Advice for *Rostratula australis* (Australian Painted Snipe) (2013)	Habitat loss disturbance and modifications	7.1 – 7.4
Protected Areas	Montebello Islands Marine Park	Management Plan for the Montebello/Barrow Islands Marine Conservation Reserves 2007–2017.	Encourage a policy of zero discharge where alternatives to discharge exist	6.6
			Develop and enforce controls on the discharge of sewage from vessels in the reserves, including the prohibition of discharge in areas designated 'Zone 1'	6.6
			Ensure relevant industry activities are undertaken at times and places that do not conflict with humpback whale migration through the reserves	6 and 7
			Maintain records of the incidence of entanglement, boat collisions and stranding of marine mammals in the reserves	8
			Maintain a database of turtle mortality and incidents of entanglement in the reserves	8

			Ensure that important seabird and shorebird breeding and feeding areas are not significantly affected by human activities	6 and 7

3.2.4 Socio-economic receptors

Socio-economic activities that may occur within the operational area and EMBA include commercial fishing, oil and gas exploration and production, and to a lesser extent, recreational fishing and tourism as summarised in **Table 3-6**.

More detailed descriptions of socio-economic consideration are provided in **Appendix B - Description of the Existing Environment**.

Table 3-6: Summary of socio-economic activities that may occur within the operational area

Value/ sensitivity	Description	Operational area presence	Relevant events within operational area	Relevant events within EMBA
Commercial fisheries - Commonwealth	Three Commonwealth fisheries overlap the operational area: the Western Tuna and Billfish Fishery, Southern Bluefin Tuna Fishery, and the Western Skipjack Tuna Fishery (**Table 3-8**). 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, 2010). Southern Bluefin Tuna Fishery is only active in waters offshore South and South Eastern Australia, confirmed in consultation with the Australia Southern Bluefin Tuna Association for previous company offshore activities (ABARES Fishery Status Reports, 2018). There has been no fishing effort in the Skipjack Tuna Fishery since the 2009 season, and in that season, activity concentrated off South Australia (ABARES Fishery Status Reports, 2018).	✓	Planned Interaction with other marine users (**Section 6.5**)	Unplanned Unplanned hydrocarbon spills (**Sections 7.1 – 7.4**)
Commercial fisheries - State	State fisheries that intersect the operational area are the Pilbara Trap, Line, Developmental Crab and Fish Trawl Managed Fisheries; the Mackerel Managed Fishery Area 2; Western Australian Pearl Oyster Fishery; Marine Aquarium Fish Managed Fishery; Specimen Shell Managed Fishery; South West Coast Salmon Managed Fishery; Western Australian Abalone Managed Fishery; West Coast Deep Sea Crustacean Managed Fishery; and the Onslow Prawn Limited Entry Fishery (**Table 3-8**). A number of fisheries are open within the operational area and EMBA, but they do not have activity in	✓	Planned Interaction with other marine users (**Section 6.5**)	Unplanned Unplanned hydrocarbon spills (**Sections 7.1 – 7.4**)

Value/ sensitivity	Description	Operational area presence	Relevant events within operational area	Relevant events within EMBA
	this area. These are the Nickol Bay Prawn Managed Fishery, Exmouth Gulf Prawn Managed Fishery, WA Sea Cucumber Fishery and West Coast Rock Lobster Managed Fishery.			
Shipping	Shipping using North West Shelf (NWS) waters includes iron ore carriers, LNG and oil tankers and other vessels proceeding to or from the ports of Barrow Island, Varanus Island, Dampier, Port Walcott and Port Hedland. The proposed operational area does not overlap any major shipping lanes (>10 km away), although vessel traffic may be encountered throughout the operational area as commercial vessels transit around the Montebello Islands and support vessel(s) conduct operations with the offshore infrastructure (**Figure 3-16**).	✓	Planned Interaction with other marine users (**Section 6.5**)	Unplanned Unplanned hydrocarbon spills (**Sections 7.1 – 7.4**)
Recreational fishing	Within the operational area, there are no known natural seabed features that would aggregate fishes and which are typically targeted by recreational fishers. It is unlikely recreational fishing would occur in the operational area, but it may occur in around the nearby Montebello Islands. Recreational fishing does occur within the EMBA, and therefore could be impacted by a spill arising from a vessel collision.	X	N/A	Unplanned Unplanned hydrocarbon spills (**Sections 7.1 – 7.4**)
Defence	In consultation, Department of Defence has advised no concerns with this proposed activity.	X	N/A	N/A
Shipwrecks	Thirty-nine (39) historic shipwrecks (>75 years) old are found within the EMBA. One shipwreck intersects the operational area near the mainland coast: *Macey's Wreck Unidentified*. The year the shipwreck was stranded is not recorded.	X	Planned Interaction with other marine users (**Section 6.5**)	Unplanned Unplanned hydrocarbon spills (**Sections 7.1 – 7.4**)
Oil and gas	Various petroleum exploration and production activities have been	X	Planned	Unplanned

Value/ sensitivity	Description	Operational area presence	Relevant events within operational area	Relevant events within EMBA
	undertaken within the northwest shelf. Vessels servicing oil and gas operations in the region may pass through the area en route to facilities, which is discussed under 'Shipping' above. Oil and gas facilities and permits are present within the EMBA, operated by other titleholders. As such, oil and gas activities could be impacted by unplanned events.		Interaction with other marine users (**Section 6.5**)	Unplanned hydrocarbon spills (**Sections 7.1 – 7.4**)
Tourism	Aquatic recreational activities such as boating, diving and fishing occur near the coast and Montebello Islands. These activities are concentrated in the vicinity of the population centres such as Exmouth, Dampier and Onslow. Planned events are not predicted to have a significant impact on tourism given that the majority of operational activities occur at a greater water depth than aquatic recreational activities. The EMBA overlaps a portion with the Montebello Marine Park and also the Barrow Island Marine Park. As such, eco-tourism based on specific local values (whale sharks, game fish, nearshore reef snorkelling and diving) could be impacted by unplanned events.	X	N/A	Unplanned Unplanned hydrocarbon spills (**Sections 7.1 – 7.4**)
Cultural Heritage	No known sites of Aboriginal Heritage significance occur within the operational area. However, there are three known heritage sites that occur within the EMBA. A search of the Department of Planning, Lands and Heritage (DPLH) Aboriginal Heritage Inquiry System was undertaken and indicated there are three registered sites recorded, including middens, burial, ceremonial, artefacts, rock shelters, mythological and engraving sites recorded on the Montebello and Legendre Islands. No known sites of Cultural Heritage significance or National Heritage places exist within the EMBA.	X	N/A	N/A

3.2.4.1 Commercial fisheries

Commonwealth and State fisheries overlapping with the operational area and the EMBA are illustrated in **Figure 3-13** and **Figure 3-14** respectively. **Table 3-7** describes each of these fisheries and indicates which events associated with the activity may impact on these.

Consultation with the Department of Primary Industries and Regional Development has previously identified commercial fishing interests that exist in, or in close proximity to, proposed activities under this EP. This includes commercial fisheries identified within **Table 3-7**. This consultation also identified key fish species that may be aggregating/spawning within the EMBA. This information is provided, together with other key periods of sensitivity for socio-economic receptors, in **Section 3.2.5.**

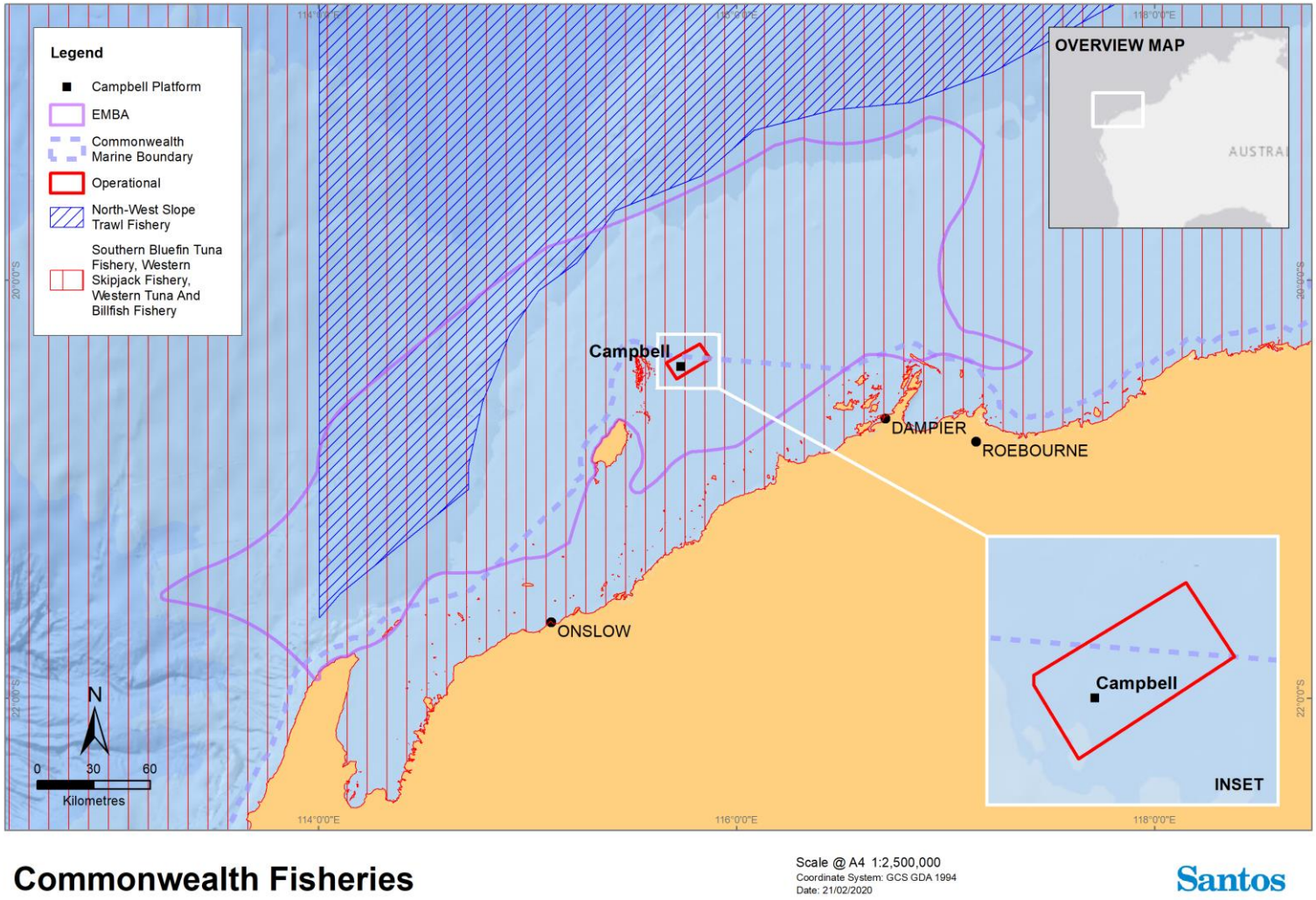


Figure 3-13: Commonwealth Commercial Fishing Zones within the EMBA and operational area

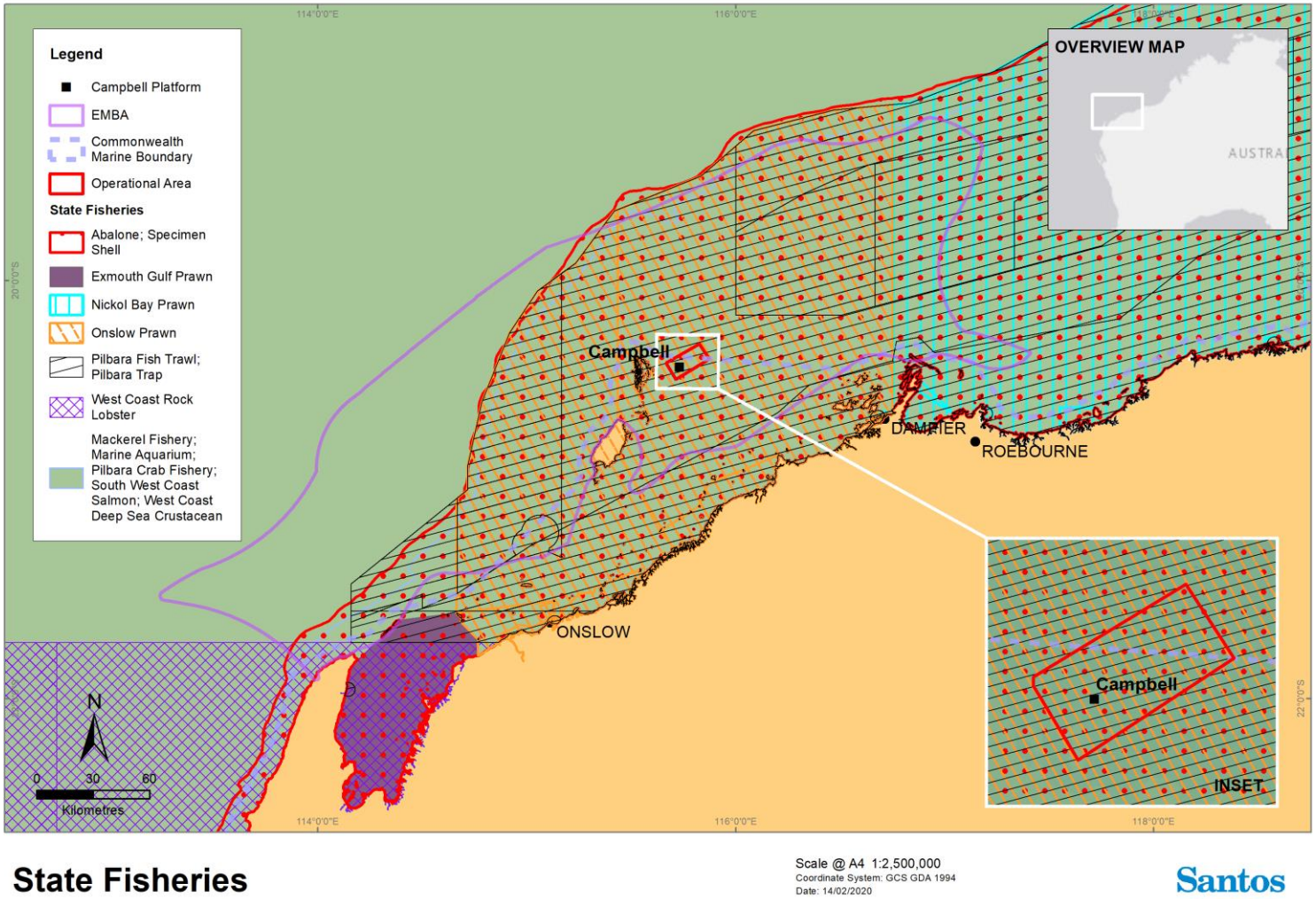


Figure 3-14: State Commercial Fishing Zones within the EMBA and operational area

Table 3-7: State and Commonwealth fisheries in the vicinity of the operational area and EMBA

Value/sensitivity	Description	Operational area overlaps Fishery boundary	EMBA overlaps Fishery boundary	Fishing activity within the operational area and 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. No current effort on NWS.	✓	✓	No active commercial fishing within the area in the past years. However, fishing vessels could be encountered in low density.
Western Skipjack Tuna Fishery	No current effort on NWS.	✓	✓	
Southern Bluefin Tuna	No current effort on NWS.	✓	✓	
Western Deepwater Trawl Fishery	Demersal trawl seaward of the 200 m isobaths. No recent fishing activity.	X	✓	
North West Slope Trawl	Extends from 114° E to approximately 125° E off the WA coast between the 200 m isobath and the outer limit of the Australian Fishing Zone (AFZ).	X	✓	Historical effort within the EMBA, targeting scampi and prawns
State Managed Fisheries				
Onslow Prawn Limited Entry Fishery	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.	✓	✓	Significant disruption unlikely to occur due to vast area fished.
Pilbara Demersal Scalefish Fisheries (includes trap, trawl and line 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	✓	✓	Disruption to fishing activities is possible but not expected. Unplanned events which may occur in the operational area and EMBA could disrupt fishing activities, but the likelihood of these events is low.

Value/sensitivity	Description	Operational area overlaps Fishery boundary	EMBA overlaps Fishery boundary	Fishing activity within the operational area and EMBA
	than 50 scalefish species. In comparison, the trap fishery retains a subset of about 45 to 50 scalefish species, and while the Line Fishery catch comprises a similar number, it also includes some deeper offshore species. Line fishing for a variety of demersal scalefish between the 30 m isobath and 200 m isobath			
Pilbara Developmental Crab 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 (DoF, 2015).	✓	✓	Disruption to fishing activities unlikely given fisheries operations are typically north of the operational area. Unplanned events which may occur in the EMBA could disrupt fishing activities, but the likelihood of these events is low.
Western Australian Pearl Oyster Fishery	Drift diving in depths up to 35 m	✓	✓	Disruption to fishing activities unlikely given water depths fisheries operate within. Nine aquaculture licences for pearl oysters occur within the EMBA, with 14 pearl farm leases occurring at the Montebello Islands. Unplanned events which may occur in the EMBA could disrupt fishing activities or aquaculture, but the likelihood of these events is low.
Exmouth Gulf Prawn Managed Fishery	Low opening otter trawls occurring in the sheltered waters of Exmouth Gulf, west to the Muiron Islands and north to Serrurier Island	X	✓	Disruption to fishing activities unlikely given boundaries that fisheries operate within. Unplanned events which may occur in the EMBA could disrupt fishing activities, but the likelihood of these events is low.

Value/sensitivity	Description	Operational area overlaps Fishery boundary	EMBA overlaps Fishery boundary	Fishing activity within the operational area and EMBA
West Coast Rock Lobster Managed Fishery	Baited traps, pots and diving (recreationally)	X	✓	Disruption to fishing activities unlikely given water depths fisheries operate within. Unplanned events which may occur in the EMBA could disrupt fishing activities, but the likelihood of these events is low.
State Managed Fisheries (Whole of State)				
Marine Aquarium Fish Fishery	All year. Effort within the operational area and EMBA is unknown, but is unlikely due to the depth and the dive-based method of collection	✓	✓	Disruption to fishing activities unlikely given water depths fisheries operate within. Unplanned events which may occur in the EMBA could disrupt fishing activities, but the likelihood of these events is low.
Specimen Shell Managed Fishery	All year. Effort within the operational area and EMBA is unknown, but it is unlikely due to the depth and the dive-based method of collection. Unlikely to occur.	✓	✓	
Western Australian Sea Cucumber Fishery (Beche-de-mer Fishery)	All year. Although permitted to fish within the operational area and EMBA, the fishery is restricted to shallow coastal waters suitable for diving and wading. Unlikely to occur.	X	✓	
Mackerel Managed Fishery	Trolling or handline. Near-surface trolling gear from vessels in coastal areas around reefs, shoals and headlands.	✓	✓	The majority of the catch is taken in the Kimberley Area and north of Port Headland, therefore disruption is unlikely.
South West Coast Salmon Managed Fishery	Beach Seine nets. Fishing on coastal beaches.	✓	✓	No fishing boats operate north of the Perth metropolitan area, so disruption is unlikely.
Western Australian Abalone Managed Fishery	All year. Although permitted to fish within the operational area and EMBA, the fishery is restricted to shallow coastal	✓	✓	Disruption to fishing activities unlikely given water depths fisheries operate within.

Value/sensitivity	Description	Operational area overlaps Fishery boundary	EMBA overlaps Fishery boundary	Fishing activity within the operational area and EMBA
	waters suitable for diving and wading. Unlikely to occur			Unplanned events which may occur in the EMBA could disrupt fishing activities, but the likelihood of these events is low.
West Coast Deep Sea Crustacean Managed Fishery	Baited pots on vessels in a longline formation on shelf edge waters that are greater than 150 m deep.	✓	✓	
Nickol Bay Prawn Managed Fishery	Vessels will target species in <45 water depth.	X	✓	Disruption to fishing activities is possible but not expected. Unplanned events which may occur in the operational area and EMBA could disrupt fishing activities, but the likelihood of these events is low.

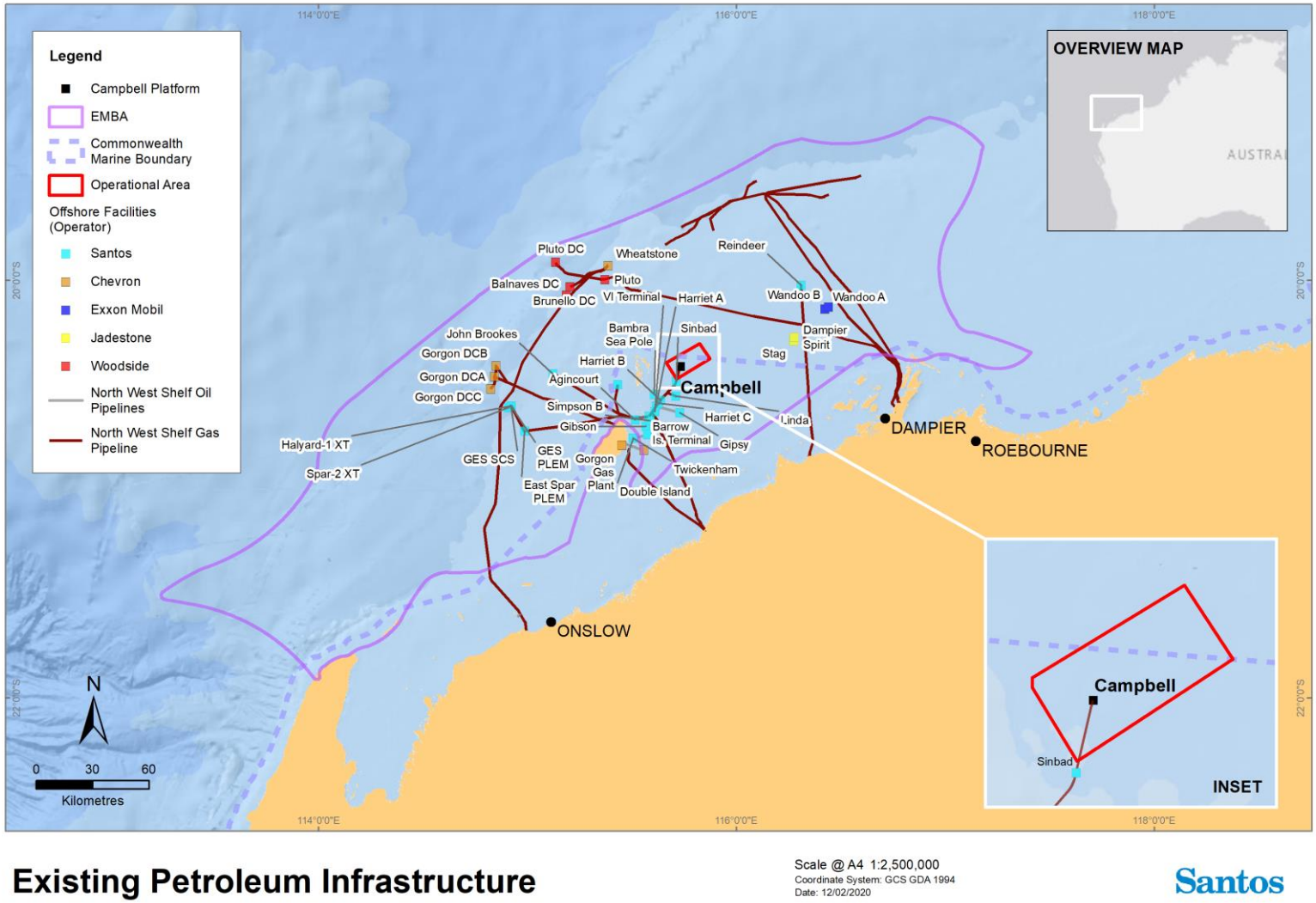
3.2.4.2 Recreational fisheries

The operational area and EMBA are located within the North Coast Bioregion, which is a focal point for winter recreational fishing and is a key component of many tourist visits. The Dampier Archipelago, Lowendal Islands and Montebello Islands are popular offshore recreational fishing locations.

The predominant target species include the tropical species such as tropical emperors, mangrove jack, trevallies, sooty grunter, threadfin, cods and catfish, and invertebrate species including blue swimmer crabs, mud crabs and squid. The offshore islands, coral reefs and continental shelf waters contain other species such as tropical snappers, cod, mackerel, sharks and tunas for recreational fishing opportunities (WAFIC 2016). The operational area does not overlap any of these mentioned fishing locations.

3.2.4.3 Petroleum industry

Santos' Campbell platform is located within the operational area in 40 m water depth. The unmanned monopod structure has ceased production activity and production flowlines are disconnected and blanked, with no hazardous substance inventory on board. The similarly designed and disconnected Sinbad platform is located to the south of the operational area with further facilities of the Harriet Joint Venture to the south as shown in **Figure 3-15**. In the EMBA, there are several exploration and production permits and leases throughout the Western Australian and Commonwealth waters which include current exploration and production activities including platforms, floating, production, storage and offloading (FPSOs), pipelines, drilling and potentially seismic activities. There are also onshore production facilities on Varanus Island and Barrow Islands .



Existing Petroleum Infrastructure

Scale @ A4 1:2,500,000
Coordinate System: GCS GDA 1994
Date: 12/02/2020

Santos

Figure 3-15: Existing petroleum infrastructure within the EMBA

3.2.4.4 Shipping

It is highly unlikely that shipping vessels will move through the operational area. However, large commercial vessels mostly associated with the oil and gas industry and Western Australian major ports move through the EMBA in transit.

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 2019). AMSA shipping routes within and in close proximity to the operational area and EMBA are shown in **Figure 3-16**.

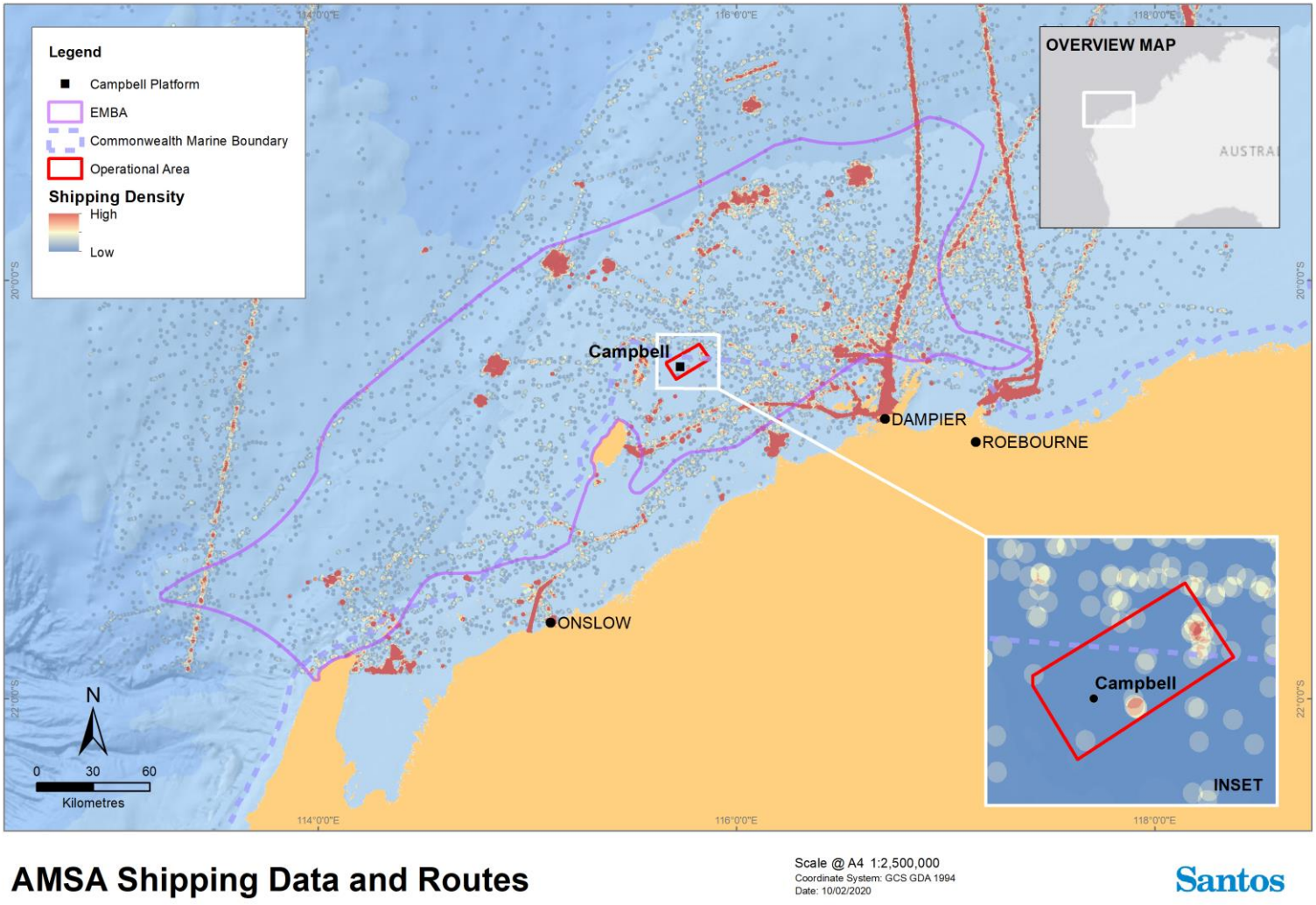


Figure *3-16*: AMSA ship locations and shipping routes within and close to the EMBA (September 2019)

3.2.4.5 Tourism

Tourism activities occur within the EMBA in areas such as Ningaloo Marine Park, North West Cape, Montebello Islands and the Dampier Archipelago. Popular water-based activities that may occur within the EMBA include fishing, swimming, snorkelling/diving, surfing/windsurfing/kiting and boating.

Seasonal nature-based tourism such as humpback whale watching, whale shark encounters and tours of turtle hatching mainly occurring around Ningaloo Reef and Cape Range National Park. 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 nearest area where recreation is likely to occur is the Montebello Islands, which are located approximately 7 km from the operational area. Given the water depths of the operational area and the lack of notable seabed features, there is unlikely to be any tourism-based activities in the surrounding waters of the operational area, however there could be seasonal tourism such as whale watching and fishing charters.

3.2.5 Windows of sensitivity

Timing of peak activity for threatened species and other relevant, significant sensitivities is given in **Table 3-8**.

Table 3-8: Windows of sensitivity in the vicinity of the EMBA

Receptors (critical life cycle stages)	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
All shoreline habitats												
Coral (spawning periods)												
Macroalgae	growing				shedding fronds				growing			
Other benthic and terrestrial habitats												
Fish/Sharks and fisheries species												
Whale sharks			Aggregations at Ningaloo Coast									
Fisheries species spawning/aggregation times [1]												
Marine Mammals												
Dugong (breeding)	breeding								breeding			
Humpback whale (migration)						northern			southern			
Blue whale (migration)					northern						southern	
Marine Reptiles												
Hawksbill turtle's 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 – 60m deep, post hatchling age classes and juveniles spread across shelf waters											
Flatback turtle (mating aggregations[2])												
Flatback turtle (nesting and internesting[2])												

Receptors (critical life cycle stages)	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Flatback turtle (hatching[2])												
Flatback turtle (nesting[2])												
Green turtles (resident adult and juveniles[2])	Widespread throughout the NWS waters, highest density associated with seagrass beds and macro algae communities, high density juveniles in shallow waters off beaches, amongst 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											
Short-nosed seasnake	Can occur at low density across the NWS year-round											
Seabirds												
Terns, shearwaters, petrels (nesting)												
Commercial Managed Fisheries												
Oil and gas												
Shipping												
Tourism/ recreational												
KEY / NOTES												
Peak activity, presence reliable and predictable						[1] Information provided from Department of Fisheries consultation						

Receptors (critical life cycle stages)	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Lower level of abundance/activity/presence						[2] Information provided by K. Pendoley						
Very low activity/presence												
Activity can occur throughout year												
Proposed timing of activity												

4 Stakeholder consultation

OPGGS(E)R 2009 Requirements
Regulation 9AB
If the Regulator's provisional decision under regulation 9AA is that the environment plan includes material apparently addressing all the provisions of Division 2.3 (Contents of an environment plan), the Regulator must publish on the Regulator's website as soon as practicable: (a) the plan with the sensitive information part removed; and (b) the name of the titleholder who submitted the plan; and (c) a description of the activity or stage of the activity to which the plan relates; and (d) the location of the activity; and (e) a link or other reference to the place where the accepted offshore project proposal (if any) is published; and (f) details of the titleholder's nominated liaison person for the activity.
Regulation 14(9)
The implementation strategy must provide for appropriate consultation with: (a) relevant authorities of the Commonwealth, a State or Territory; and (b) other relevant interested persons or organisations.
Regulation 16
The environment plan must contain the following: (b) 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.

P(SL)(E)R 2012
Regulation 17 (1)
The environment plan must include the following — (b) a report on all consultations between the operator and relevant authorities and other relevant interested persons and organisations in the course of developing the environment plan.

4.1 Summary

Santos has been active in the Varanus Island Hub for many years and has a number of operating facilities in the region. With this history, Santos is familiar with local community stakeholders and other users of the marine environment in the region.

Stakeholders were informed of activities covered in this EP via several channels of engagement commencing in January 2020, including:

- Santos' *Quarterly Consultation Update* distributed to the company's wider stakeholder cohort;
- WA-499-P Exploration Drilling and Site Survey Program Consultation package distributed to identified stakeholders;
- Commercial Fishers WA-499-P Exploration Drilling and Site Survey Program Consultation package distributed to identified fishing licence holders.

Based on Santos' experience with the Corvus-2 exploration drilling program conducted in 2019, and from subsequent stakeholder feedback and regulator discussions, the primary stakeholder issues of concern for this activity are:

- baseline survey data on the important ecological values of these areas (addressed in **Section 3.2.1**); and
- interaction with other marine users and commercial fishers addressed i**n Section 3.2.4**).

Santos has considered all stakeholder responses and assessed the merits of all objections and claims about the potential impact of the proposed activity. A summary of Santos' response statements to the objections and claims is provided in **Table 4-2** and the process adopted to assess these claims is outlined in **Section 4.4.**

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 notification and these are described in **Table 8-2** and **Section 4.5.**

During consultation on this EP, stakeholders were informed the activity would be conducted in 2020-2021, however subsequent changes to business conditions have resulted in the activity being delayed until 2021-2022. Given no concerns were raised during consultation regarding activity timing, the EP has been updated to reflect this change. Santos remains committed to the consultation and notification requirements as described in **Section 4.5** and EPS provided in **Table 8 2.**

4.2 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 and specifically the Corvus-2 drilling program. The list of stakeholders was then reviewed and refined based on the defined operational area (refer to **Section 2.2**), the EMBA (refer to **Section 7.4.1**) and the relevance of the stakeholder according to Regulation 11A of the OPGGS (E) Regulations and NOPSEMA Bulletin #2 *Clarifying statutory requirements and good practice consultation* (November 2019). More specifically, stakeholders for this EP were identified through the following:

- 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, etc.);
- Evaluation of Department of Primary Industries and Regional Development (DPIRD) Fish Cube data.
- Updated fishing licence holder contact details, from these identified fisheries, as provided by DPIRD;
- Utilisation of the WAFIC Oil and Gas consultation services to advise on 'relevant' commercial fisheries and fishers, and to review and distribute fishery-specific consultation material;
- Discussions with identified stakeholders to identify other potentially impacted persons;
- Active participation in industry bodies and collaborations (e.g., APPEA, AMOSC, NERA); and
- Records from previous consultation activities in the area.

Currently identified stakeholders and an assessment of their relevance under the OPGGS (E) Regulations for the purposes of consultation for this activity are listed in **Table 4-1**.

Table 4-1: Assessment of relevance of identified stakeholders for the proposed activity

Stakeholder	Relevant to Activity	Relevance/ Reason for Engagement
Commonwealth government departments/agencies		
Australian Hydrographic Office (AHO)	Considered relevant persons under Regulation 11A(1) (a)	The AHO is the part of the Commonwealth DoD 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)	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.
Department of Defence (DoD)	Considered relevant persons under Regulation 11A(1) (a)	DoD 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.
Australian Fisheries Management Authority (AFMA)	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 with commonwealth managed fisheries.
Department of Agriculture and Water Resources (DAWR) – Biosecurity (marine pests)	Considered relevant persons under Regulation 11A(1) (a)	The DAWR (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.
Department of Agriculture and Water Resources (DAWR) – Fisheries	Considered relevant persons under Regulation 11A(1) (a)	DAWR (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 with commonwealth managed fisheries.
Department of Agriculture and Water Resources (DAWR) –Biosecurity (vessels, aircraft and personnel)	Considered relevant persons under Regulation 11A(1) (a)	DAWR (vessels and aircraft) has inspection and reporting requirements to ensure that 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:

Stakeholder	Relevant to Activity	Relevance/ Reason for Engagement
Commonwealth government departments/agencies		
		• 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.
Director of National Parks (DoNP)	Considered relevant persons under Regulation 11A(1) (a)	The 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 activities proposed to occur outside a reserve may impact on the values within a Commonwealth marine reserve.
Department of Foreign Affairs and Trade (DFAT)	Considered relevant persons under Regulation 11A(1) (a	DFAT has no direct role in the management of commonwealth marine waters, but may be consulted where a proposed activity poses any oil spill or other environmental risks that could result in impacts to other international jurisdictions
State government departments/agencies		
Department of Transport (DoT)	Considered relevant persons under Regulation 11A(1) (b)	DoT is the control agency for marine pollution emergencies in State waters.
Department of Primary Industries and Regional Development (DPIRD)	Considered relevant persons under Regulation 11A(1) (b)	DPIRD is responsible for managed West Australian State fisheries. The operational area intersects with state managed fisheries.
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. The operational area is adjacent to state marine reserves.
Department of Mines, Industry Regulation and Safety (DMIRS)	Considered relevant persons under Regulation 11A(1) (c)	Department responsible for the management of offshore petroleum in the adjacent State waters.
Neighbouring operators / exploration companies		
Chevron	Considered relevant persons under Regulation 11A(1) (e)	Chevron is listed as the titleholder of an adjacent petroleum permit.
Industry Bodies		
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 sector. The operational area intersects with several State-managed fisheries.
Commonwealth Fisheries Association (CFA)	Considered relevant persons under Regulation 11A(1) (e)	The CFA was engaged as a representative body for Commonwealth fisheries. The operational area intersects with a number of Commonwealth-managed fisheries. The CFA is also listed on the AFMA website

Stakeholder	Relevant to Activity	Relevance/ Reason for Engagement
Commonwealth government departments/agencies		
		as a contact for petroleum operators to use when consultation with fishing operators is required.
Marine Tourism WA (MTWA)	Considered relevant persons under Regulation 11A(1) (e)	MTWA represents the charter sector in WA. Charter fishing may occur within the proposed area of activity. MTWA is identified as being able to assist in reaching its membership to inform them of activity timing should this be requested.
Pearl Producers Association (PPA)	Considered relevant persons under Regulation 11A(1) (e)	The 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.
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.
Australian Southern Bluefin Tuna Industry Association (ASBTIA)	Considered relevant persons under Regulation 11A(1) (e)	ASBTIA represents the Australian SBT 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.
Community		
Pilbara Port Authority	Considered relevant persons under Regulation 11A(1) (e)	Pilbara Ports Authority manages port land at Dampier, Port Hedland, Ashburton and Cape Preston East, and facilitates the development of land and leases to support port-related industries. Port Hedland is the nearest port to the activity.
Commercial Fisheries		
Mackerel Managed Fishery (Area 2)	Considered relevant persons under Regulation 11A(1) (d)	Based on a review of DPIRD fishery information and consultation with WAFIC, the Mackerel Managed Fishery (Area 2) boundary overlaps the proposed activity area and is therefore potentially impacted by the activity.
Pilbara Line Fishery	Considered relevant persons under Regulation 11A(1) (d)	Based on a review of DPIRD fishery information and consultation with WAFIC, the Pilbara Line Fishery boundary overlaps the proposed activity area and is therefore potentially impacted by the activity.
Pilbara Trap Managed Fishery	Considered relevant persons under Regulation 11A(1) (d)	Based on a review of DPIRD fishery information and consultation with WAFIC, the Pilbara Trap Managed Fishery boundary overlaps the proposed activity area and is therefore potentially impacted by the activity.
Pilbara Crab Managed Fishery	Considered relevant persons under Regulation 11A(1) (e)	Based on a review of DPIRD fishery information and consultation with WAFIC, the Pilbara Crab Managed Fishery boundary overlaps the proposed activity area and is therefore potentially impacted by the activity.
Onslow Prawn Managed Fishery	Considered relevant persons under Regulation 11A(1) (e)	Based on a review of DPIRD fishery information and consultation with WAFIC, the Onslow Prawn Managed Fishery boundary overlaps the proposed activity area

Stakeholder	Relevant to Activity	Relevance/ Reason for Engagement
Commonwealth government departments/agencies		
		and is therefore potentially impacted by the activity and should be consulted.
Developmental Octopus Fishery	Considered relevant persons under Regulation 11A(1) (e)	Based on consultation with WAFIC, the Developmental Octopus Fishery boundary overlaps the proposed activity area and is therefore potentially impacted by the activity and should be consulted.

4.3 Stakeholder Consultation

The approach to stakeholder consultation for this EP follows the process adopted by Santos for all its EPs. Some modifications to this approach have been made based on feedback from WAFIC, commercial fishers and NOPSEMA. These include:

+ Providing more detailed information to commercial fishers, targeted to their fishery, in the initial consultation packs;
+ Engaging WAFIC to assist in the review and distribution of commercial fisher consultation material;
+ Refinements to the stakeholder identification process to clearly identify and maintain current lists of 'relevant' persons, and
+ Clearly documenting and tracking notification commitments to relevant persons.

Key stakeholders were contacted by phone or meeting prior to providing the *WA-499-P Exploration Drilling and Site Survey Program Stakeholder Consultation* package to increase activity awareness and to encourage two-way communication. 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, vessel 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. Stakeholders were encouraged to provide feedback on the proposed activity.

Individual fishing licence holders, as identified through DPIRD data and in consultation with WAFIC, were provided the *Commercial Fishers WA-499-P Exploration Drilling and Site Survey Program Consultation package* and additional fisheries maps by email (and one by post).

Commercial fishers were provided additional information which included:

+ Maps and information relevant to a specific fishery;
+ Information about the timing and duration of the activity, and
+ Information on operational area access and concurrent operations.

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 to minimise the extent of interruption by the activity on commercial fishing operators to the lowest practicable level.

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

4.4 Assessment of stakeholder objections and claims

A summary of the stakeholder consultation undertaken for this EP, including Santos' assessment of all stakeholder comments received and how each of these comments has been addressed in the EP, is outlined in **Table 4-2**. Full transcripts between Santos and stakeholders are provided in a confidential submission to NOPSEMA and DMIRS.

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

- Santos acknowledged receipt of all comments made by stakeholders.
- Santos assessed the merits of all objections and claims made stakeholders. This included assessing all reasonably available options for resolving or mitigating the degree to which a stakeholder may be affected, particularly through the application of control measures.
- Santos responded to all stakeholder objections and claims by email and advised the stakeholder how each of their issues would be addressed in the EP.
- Santos invited the stakeholder to provide additional feedback and comment.
- As soon as possible, or on publication of the EP on the NOPSEMA website, Santos will advise any stakeholders who had made an objection or claim, where their specific objections and claims are represented in the EP and provided the appropriate cross reference in the EP to each issue raised (**Table 4-2**).
- Santos commits to addressing any additional comments received from Stakeholders.

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

Table 4-2: Consultation summary for activity

Stakeholder	Summary of stakeholder and titleholder correspondence, and any objections and claims made	Assessment of stakeholder objections and claims
Commonwealth departments/agencies		
Australian Hydrographic Office (AHO)	AHO was provided the *WA-499-P Exploration Drilling and Site Survey Program Consultation package* via email on 13 January 2020. AHO acknowledged receipt of information on 13 January 2020. This stakeholder also receives Santos' Quarterly Consultation Update for WA. The January 2020 update provided information on the WA-499-P Exploration Drilling and Site Survey Program. No further response received to date.	No response has been received by the AHO. AHO has previously requested notification once activity commences. Santos has addressed notification requirements in **Table 8-2** and **Table 8-4**. Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.
Australian Maritime Safety Authority (AMSA)	AMSA was provided the *WA-499-P Exploration Drilling and Site Survey Program Consultation package* via email on 13 January 2020. AMSA responded on 14 January 2020 advising: a. The Master should notify AMSA's Joint Rescue Coordination Centre (JRCC) for promulgation of radio-navigation warnings at least 24-48 hours before operations commence. JRCC will also need to be advised when operations start and end. b. Santos should contact the AHO at no less than four working weeks before operations, with details relevant to the operations. The AHO will promulgate the appropriate Notice to Mariners (NTM), which will ensure other vessels are informed of activities. c. To obtain a vessel traffic plot showing Automatic Identification System (AIS) traffic data for your area of interest, please visit AMSA's spatial data gateway and Spatial@AMSA portal to download digital data sets and maps. This stakeholder also receives Santos' Quarterly Consultation Update for WA. The January 2020 update provided information on the WA-499-P Exploration Drilling and Site Survey Program. Santos followed up with this stakeholder on 20th February 2020 advising their comments have been addressed in Section 8 of the EP, which will be available in full on the NOPSEMA website on submission	Santos accepts AMSA's request to provide notification to the AMSA's JRCC and AHO and in response to each comment confirms: a. Santos will notify AMSA's JRCC at least 24–48 hours before operations commence for each survey and advise when operations start and end. b. Santos will notify the AHO no less than four working weeks before operations commence. c. Santos notes the information provided on traffic data. Notification requirements are addressed in **Table 8-2** (Control Measure CM-10) and **Table 8-4**. Santos considers the level of consultation to be adequate and will address any additional comments from this stakeholder should they arise in the future.

Stakeholder	Summary of stakeholder and titleholder correspondence, and any objections and claims made	Assessment of stakeholder objections and claims
Department of Defence (DoD)	DoD was provided the *WA-499-P Exploration Drilling and Site Survey Program Consultation package* via email on 13 January 2020. This stakeholder also receives Santos' Quarterly Consultation Update for WA. The January 2020 update provided information on the WA-499-P Exploration Drilling and Site Survey Program. No response received to date.	No response has been received by the DoD. DoD has previously requested AHO notifications prior to activity commencement. Santos has addressed notification requirements in **Table 8-2** and **Table 8-4**. Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.
Australian Fisheries Management Authority (AFMA)	AFMA was provided the *WA-499-P Exploration Drilling and Site Survey Program Consultation package* via email on 13 January 2020. This stakeholder also receives Santos' Quarterly Consultation Update for WA. The January 2020 update provided information on the WA-499-P Exploration Drilling and Site Survey Program. No response received to date.	No response has been received by AFMA. This stakeholder has previously advised it is important to consult with all fishers who have entitlements to fish within the proposed area. This can be done through the relevant fishing industry associations or directly with fishers who hold entitlements in the area. Santos has consulted directly with relevant fishers and fishing industry associations. Santos has assessed the impact to fish in **Section 6**, including interaction with other users in **Section 6.5.** Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.
Department of Agriculture and Water Resources (DAWR) – Biosecurity (vessels, aircraft and personnel)	The department was provided the *WA-499-P Exploration Drilling and Site Survey Program Consultation package* via email on 13 January 2020. The department responded on 22 January 2020 providing advice on the Australian Government's biosecurity requirements. In summary, the department advised:	Santos accepts the biosecurity requirements outlined by DAWR and in response to each comment confirms: a. Santos notes Seaports comments regarding levels of risk and eligibility for exemptions.

Stakeholder	Summary of stakeholder and titleholder correspondence, and any objections and claims made	Assessment of stakeholder objections and claims
	a. It is our understanding that your intended operating practices may expose domestic conveyances (support vessels and aircraft) to interactions with the survey vessel which may pose an unacceptable level of biosecurity risk. Where domestic conveyances become exposed through interactions with persons, goods or conveyances outside Australian territory they automatically become subject to biosecurity control upon their return. If the department concludes that the level of biosecurity risk associated with the survey vessel is low, within the meaning of the *Biosecurity (Exposed Conveyances – Exceptions from Biosecurity Control) Determination 2016* (the Determination), an exposed conveyance may be eligible for an exception from biosecurity control. b. In order for exposed conveyances to be assessed as low risk, the offshore installation must demonstrate that it meets the requirements set out in the Determination. To have risk status assessed, offshore installation projects must apply to the department at least one month prior to project commencement. The department will work with installation representatives to assess the biosecurity risk of the installation and associated support conveyances (vessels and aircraft). c. Please review the department's *Offshore Installations webpage and associated Offshore Installations Biosecurity Guide* which provides specific biosecurity information for operators of offshore installations and notify the department where your project which may have conveyance interactions with Australian territory, or to discuss a biosecurity assessment, email seaports@agriculture.gov.au. d. Please also review Australian ballast water and biofouling requirements and pre-arrival reporting using MARS. Santos responded to the department on 12 February 2020 confirming DAWR requirements on biosecurity will be taken into consideration in the drafting of the environment plan.	b. Santos will be applying to the department following confirmation of the vessel c. Santos will ensure consideration of the biosecurity information d. Santos will ensure consideration of the ballast water and biofouling Santos has addressed the Department's Biosecurity requirements through implementation of Santos' *Invasive Marine Species Management Plan* (EA-00-RI-10172) as provided for in **Table 8-2** (control measure CM-18). Santos considers the level of consultation to be adequate and will address any additional comments from this stakeholder should they arise in the future.
Department of Agriculture and Water Resources (DAWR) – Biosecurity (marine pests)	The department was provided the *WA-499-P Exploration Drilling and Site Survey Program Consultation package* via email on 13 January 2020. No response received to date.	No response has been received by the Department. Biosecurity has been addressed in **Section 7.2** and in response to comments from Department of Agriculture and Water Resources (DAWR) – Biosecurity (vessels, aircraft and personnel).

Stakeholder	Summary of stakeholder and titleholder correspondence, and any objections and claims made	Assessment of stakeholder objections and claims
		Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.
Department of Agriculture and Water Resources (DAWR) – Fisheries	The department was provided the *WA-499-P Exploration Drilling and Site Survey Program Consultation package* via email on 13 January 2020. No response received to date.	No response has been received by the Department. Santos has consulted directly with relevant fishers and fishing industry associations. Santos has assessed the impact to fish in **Section 6**, including interaction with other users in **Section 6.5.** Santos considers the level of consultation to be adequate and Santos will address any comments from this stakeholder should they arise in the future.
Department of Foreign Affairs and Trade (DFAT)	The department was provided the *WA-499-P Exploration Drilling and Site Survey Program Consultation package* via email on 13 January 2020. No response received to date.	No response has been received by the DFAT. Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.
Director of National Parks (DNP)	The DNP was provided the *WA-499-P Exploration Drilling and Site Survey Program Consultation package* via email on 13 January 2020. No response received to date.	No response has been received by the DNP. Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.
State Government Departments		
Department of Transport (DoT)	DOT was provided the *WA-499-P Exploration Drilling and Site Survey Program Consultation package* via email on 13 January 2020. DoT responded on 21 January 2020 advising if there is a risk of a spill impacting State waters from the proposed activities, please ensure that the department is consulted as	Santos accepts DoTs consultation requirements and has provided DoT information requested as per the Department of Transport Offshore Petroleum Industry Guidance Note – Marine Oil Pollution:

Stakeholder	Summary of stakeholder and titleholder correspondence, and any objections and claims made	Assessment of stakeholder objections and claims
	outlined in the Department of Transport Offshore Petroleum Industry Guidance Note – Marine Oil Pollution: Response and Consultation Arrangements (September 2018). Santos responded on 12 February 2020 confirming the department's requirements will be taken into consideration in the drafting of the EP. Santos sent a follow-up email to DoT on 4 March 2020 and provided a copy of the Geophysical Survey Oil Pollution Emergency Plan for the WA-499-P Site Survey Activity and corresponding Consultation Package, as outlined in the Department of Transport Offshore Petroleum Industry Guidance Note – Marine Oil Pollution: Response and Consultation Arrangements (September 2018). Santos advised DoT the OPEP and consultation package for the WA-499-P Drilling Activity will be submitted separately. This stakeholder also receives Santos' Quarterly Consultation Update for WA. The January 2020 update provided information on the WA-499-P Exploration Drilling and Site Survey Program.	Response and Consultation Arrangements (September 2018), prior to submission of the EP. Santos considers the level of consultation to be adequate and will address any additional comments from this stakeholder should they arise in the future.
Department of Primary Industries & Regional Development (DPIRD)	DPIRD was provided the *WA-499-P Exploration Drilling and Site Survey Program Consultation package* via email on 13 January 2020. This stakeholder also receives Santos' Quarterly Consultation Update for WA. The January 2020 update provided information on the WA-499-P Exploration Drilling and Site Survey Program. No response received to date.	No response has been received by DPIRD. This stakeholder has previously requested that: *a. Santos consult with affected fishers and industry representative bodies.* Santos has consulted directly with relevant fishers and fishing industry associations and assessed the impact to fish in **Section 6**, including interaction with other users in **Section 6.5.** *b. if there is a biosecurity risk associated with the activity please act in accordance with the Fish Resources Management Regulations 1995 (FRMR) Regulation 176(1).* Biosecurity risk controls as required under the Fish Resources Management Regulations are addressed in **Section 7.2**.

Stakeholder	Summary of stakeholder and titleholder correspondence, and any objections and claims made	Assessment of stakeholder objections and claims
		c. *the suspected or confirmed presence of any organism listed on the Western Australian Prevention List for Introduced Marine Pests, and any other organism that appears to have clear negative impacts or invasive characteristics, must be reported within 24 hours to the department.* This reporting requirement is captured in **Table 8-4** Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.
Department of Biodiversity and Conservation Attractions (DBCA)	The DBCA was provided the *WA-499-P Exploration Drilling and Site Survey Program Consultation package* via email on 13 January 2020. DBCA responded on 10 February 2020 and provided the following comments: a. There are a number of ecologically important areas including marine and terrestrial conservation reserves located in the vicinity of the proposed operations, including the Montebello Islands Marine Park and Conservation Park, and Barrow Island Marine Park, Marine Management Area and Nature Reserve. Based on the information you have provided it appears that there is potential for these areas to be affected by Santos' operations if there is a substantial hydrocarbon release and subject to particular weather or other environmental conditions. b. Given the ecological importance of areas potentially affected by a hydrocarbon release from the proposed activities, it is considered important that the baseline values and state of the potentially affected environment are appropriately understood and documented prior to any operations commencing that pose a significant risk of impacting these areas. DBCA would like to have confidence that Santos has appropriate baseline survey data on the important ecological values of these areas and any current contamination if present within the area of potential impact of spills (as identified through Santos' modelling). Following desktop review and risk assessment, Santos should collect appropriate baseline abundance and distribution data for any threatened and specially protected marine fauna species in the area of potential impact, including information on the key habitats these species use for activities like foraging, breeding and aggregating. If baseline information is	Santos accepts DBCA's requirements and confirms: a. Ecologically important areas that may be impacted by proposed operations, including a substantial hydrocarbon release have been identified and described in **Section 3** and **Appendix B - Description of the Existing Environment** b. Baseline values and data are addressed in Santos' Oil Spill Scientific Monitoring Plan which has been provided separately to DBCA and is discussed further in the OPEP. c. Impacts from light emissions is discussed further in **Section 6.2**. d. Reporting requirements in the event of a spill are detailed in the OPEP e. The OPEP reflects DoT's guidance and consultation with DoT has been undertaken.

Stakeholder	Summary of stakeholder and titleholder correspondence, and any objections and claims made	Assessment of stakeholder objections and claims
	not available, Santos should thoroughly assess what baseline information is required commensurate with the level of risk associated with the proposed activities, and identify suitable sources/methods to attain that information such that Santos can ensure that any impacts on ecological values and recovery of these values can be monitored and remediated. DBCA undertakes monitoring in marine parks and reserves, and regularly publishes research which can be searched on the department's website. However, Santos should be aware that this monitoring is targeted to inform DBCA's values and objectives relating to marine park management and is not necessarily suitable to provide all baseline information required for oil spill risk assessment and management planning. DBCA encourages Santos to ensure it attains all information required to implement a Before-After, Control-Impact (BACI) framework in planning its management response. This may include independently monitoring and collecting data where required or identifying other data sources. c. In developing its Environmental Plan, DBCA also recommends that Santos refer to the Commonwealth Department of the Environment and Energy's *Draft National Light Pollution Guidelines for Wildlife* as a best-practice industry standard for managing potential impacts of light pollution on marine fauna. d. In the event of a hydrocarbon release, it is requested that Santos notify DBCA's Pilbara regional office as soon as practicable. Note however, that DBCA will not implement an oiled wildlife management response on behalf of a petroleum operator except as part of a whole of government response mandated by regulatory decision makers, and any advice or assistance from DBCA, at any scale, will occur on a full cost recovery basis. Santos should also commit to the monitoring and clean-up of any DBCA interests affected by an oil spill in consultation with DBCA. e. Santos should refer to the Department of Transport's (DoT) web content regarding marine pollution, and the Offshore Petroleum Industry Guidance Note of September 2018 titled *Marine Oil Pollution: Response and Consultation Arrangements*. These documents provide information on the Western Australian emergency management arrangements for marine oil pollution incidents in State waters, petroleum titleholders' obligations under those arrangements, and the DoT's expectations as the jurisdictional authority for such incidences.	Santos considers the level of consultation to be adequate and will address any additional comments from this stakeholder should they arise in the future.

Stakeholder	Summary of stakeholder and titleholder correspondence, and any objections and claims made	Assessment of stakeholder objections and claims
	Santos responded on 17 February 2020 and provided the following comments: a. Santos has a long history of exploration drilling in this region and hydrocarbon production from the Varanus Island Hub. In recognition of the business operating risks and environmental sensitives of this region, Santos has dedicated resources to manage environmental monitoring programs and oil spill response preparedness and response planning. The Yoorn-1 Geophysical Oil Pollution Emergency Plan (OPEP) will contain the following information: b. Details of Santos' Oil Spill Scientific Monitoring Plan including relevant subplans for the monitoring key values and sensitivities in the region (including those of Montebello Islands Marine Park and Conservation Park, and Barrow Island Marine Park, Marine Management Area and Nature Reserve). These subplans include Marine Water and Sediment Quality, Shorelines and Coastal Habitats, Benthic Habitats, Seabirds and Shorebirds, Marine Megafauna and Marine Reptiles and detail initiation criteria, sampling methodologies, study design and use of baseline data. Santos' Oil Spill Scientific Monitoring Plan outlines the use of a BACI approach with pre-impact baseline data, as well as other study design approaches. The Oil Spill Scientific Monitoring Plan is reviewed annually to ensure the plan is fit for purpose and relevant to all key sensitivities that could be impacted from an oil spill. The OPEP will also contain detail of Santos' standby services arrangements with scientific monitoring providers to enable rapid baseline monitoring where required. The readiness and implementation arrangements with these providers are outlined in a standby and response services manual which is reviewed annually and tested regularly. Santos periodically reviews and documents the status, availability and suitability of existing baseline data sources related to high biodiversity value receptors potentially contacted by an oil spill from its operations. This baseline review includes data made available by industry and government through the Industry-Government Environmental Metadata (I-GEM) Project. Santos has determined areas/values that should be sampled as a priority based on the availability and quality of baseline data. Based on the arrangements and planning detailed above, Santos is of the view that any impacts on ecological values and recovery of these values can be determined and monitored over the long term. Santos looks to continuously improve its oil spill scientific monitoring	

Stakeholder	Summary of stakeholder and titleholder correspondence, and any objections and claims made	Assessment of stakeholder objections and claims
	arrangements and welcomes feedback on its Scientific Monitoring Plan and baseline data reviews from DBCA. These documents will be provided separately. c. Santos will consider the Commonwealth Department of the Environment and Energy's Draft National Light Pollution Guidelines for Wildlife as a best-practice industry standard for managing potential impacts of light pollution on marine fauna. Such lighting management controls for marine fauna will need to be balanced against marine navigation and operational safety requirements. d. Santos will comply with DBCA's oil spill reporting and consultation requirements. e. The Yoorn-1 Geophysical Oil Pollution Emergency Plan (OPEP) will reflect Department of Transport's (DoT) marine pollution response arrangements as per the September 2018 Offshore Petroleum Industry Guidance Note. Santos will consult with DoT as per the Industry Guidance Note. This stakeholder also receives Santos' Quarterly Consultation Update for WA. The January 2020 update provided information on the WA-499-P Exploration Drilling and Site Survey Program.	
Department of Mines, Industry Regulation and Safety (DMIRS)	DMIRS was provided the *WA-499-P Exploration Drilling and Site Survey Program Consultation package* via email on 13 January 2020. DMIRS responded on 20 January 2020 acknowledging Santos' plan to: • Drill the Yoorn-1 well in Commonwealth waters and this activity will be regulated by NOPSEMA under the OPGGS(E)R. • Undertake site surveys in both State and Commonwealth waters and approvals documentation will be provided to both DMIRS and NOPSEMA for assessment. DMIRS advised they have recently requested clarification on the information on offshore geophysical surveys in the *Varanus Island Hub Operations Environment Plan* and the *Devil Creek Gas Supply Pipeline and Sales Gas Pipeline Operations Environment Plan*. DMIRS requested Santos please ensure these assessment comments are considered when developing the Environment Plan for the Yoorn-1 site surveys. Santos responded on 12 February 2020 confirming DMIRS assessment comments on offshore geophysical surveys in the *Varanus Island Hub Operations Environment Plan* and the *Devil Creek Gas Supply Pipeline and Sales Gas Pipeline Operations Environment*	Santos has incorporated the clarifications requested by DMIRS on other EPs recently assessed, within this EP. Santos considers the level of consultation to be adequate and will address any additional comments from this stakeholder should they arise in the future.

Stakeholder	Summary of stakeholder and titleholder correspondence, and any objections and claims made	Assessment of stakeholder objections and claims
	Plan are considered when developing the Environment Plan for the Yoorn-1 site surveys. This stakeholder also receives Santos' Quarterly Consultation Update for WA. The January 2020 update provided information on the WA-499-P Exploration Drilling and Site Survey Program.	
Other operators		
Chevron	Chevron was provided the *WA-499-P Exploration Drilling and Site Survey Program Consultation package* via email on 13 January 2020. No response received to date.	No response has been received by Chevron. Santos will address any comments from this stakeholder should they arise in the future.
Fishing bodies		
Western Australian Fishing Industry Council (WAFIC)	WAFIC was provided the *Commercial Fishers WA-499-P Exploration Drilling and Site Survey Program Consultation package* via email on 13 January 2020. This included maps for the relevant commercial fisheries. WAFIC responded on 14 January 2020 advising it appreciates commercial fishing specific potential risks and or impacts information. WAFIC acknowledged Santos had addressed commercial fishing concerns including: a. the removal of the temporary exclusion zone around the drilling site as soon as the MODU departs; b. fisher access to these sites whilst the work is in progress – Santos commitment to concurrent operations; c. avoiding active commercial fishing and schooling fish in the vicinity of commercial fishing activities; d. confirming that site, support vessel and survey personnel will be prohibited from recreational fishing activities; and e. activity notifications.	Santos has addressed the matters raised by WAFIC in the following sections of the EP: a. the removal of the temporary exclusion zone around the drilling site as soon as the MODU departs (through communication of NTM. Refer **Table 8-2** control measure CM-10); b. fisher access to these sites whilst the work is in progress – Adherence to standard navigational requirements, and including through communication of NTM. Refer **Table 8-2** control measure CM-10; c. avoiding active commercial fishing and schooling fish in the vicinity of commercial fishing activities. Refer **Table 8-2** control measure CM-10; d. confirming that site, support vessel and survey personnel will be prohibited from recreational fishing activities. Refer **Table 8-2** control measure CM-11; and

Stakeholder	Summary of stakeholder and titleholder correspondence, and any objections and claims made	Assessment of stakeholder objections and claims
	This stakeholder also receives Santos' Quarterly Consultation Update for WA. The January 2020 update provided information on the WA-499-P Exploration Drilling and Site Survey Program.	e. activity notifications. Refer **Table 8-2** control measure CM-10. Santos has assessed the impact to fish in **Section 6**, including interaction with other users in **Section 6.5.** Commitments relating to fisher access, recreational fishing and notifications are addressed in **Table 8-2.** Santos considers the level of consultation to be adequate and will address any additional comments from this stakeholder should they arise in the future. Santos acknowledges WAFICs guidance in the identification of relevant and potentially affected commercial fishers.
Commonwealth Fisheries Association (CFA)	The CFA was provided the *Commercial Fishers WA-499-P Exploration Drilling and Site Survey Program Consultation package* and commonwealth fisheries map via WAFIC email on behalf of Santos on 13 January 2020. This stakeholder also receives Santos' Quarterly Consultation Update for WA. The January 2020 update provided information on the WA-499-P Exploration Drilling and Site Survey Program. No response received to date.	No response has been received by the CFA. Santos has consulted directly with relevant fishers and representative bodies. Santos has assessed the impact fish in **Section 6**, including interaction with other users in **Section 6.5**. Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.
Pearl Producers Association (PPA)	The PPA was provided the *Commercial Fishers WA-499-P Exploration Drilling and Site Survey Program Consultation package* and Pearl Oyster Managed Fishery map via WAFIC email on behalf of Santos on 13 January 2020. This stakeholder also receives Santos' Quarterly Consultation Update for WA. The January 2020 update provided information on the WA-499-P Exploration Drilling and Site Survey Program.	No response has been received by the PPA. Santos has consulted directly with relevant fishers and representative bodies. Santos has assessed the impact to fish in **Section 6**, including interaction with other users in **Section 6.5**.

Stakeholder	Summary of stakeholder and titleholder correspondence, and any objections and claims made	Assessment of stakeholder objections and claims
	No response received to date.	Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.
Australian Southern Bluefin Tuna Industry Association (ASBTIA)	ASBTIA was provided the *Commercial Fishers WA-499-P Exploration Drilling and Site Survey Program Consultation package* and Commonwealth Fisheries map via WAFIC email on behalf of Santos on 13 January 2020. This stakeholder also receives Santos' Quarterly Consultation Update for WA. The January 2020 update provided information on the WA-499-P Exploration Drilling and Site Survey Program. No response received to date.	No response has been received by ASBTIA. Santos has consulted directly with relevant fishers and representative bodies. Santos has assessed the impact to fish in **Section 6**, including interaction with other users in **Section 6.5**. Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.
Recfishwest	Recfishwest was provided the *WA-499-P Exploration Drilling and Site Survey Program Consultation package* via email on 13 January 2020. This stakeholder also receives Santos' Quarterly Consultation Update for WA. The January 2020 update provided information on the WA-499-P Exploration Drilling and Site Survey Program. No response received to date.	No response has been received by Recfishwest. Santos considers the level of consultation to be adequate. Santos will address any comments from this stakeholder should they arise in the future.
Marine Tourism WA (MTWA)	MTWA was provided the *WA-499-P Exploration Drilling and Site Survey Program Consultation package* via email on 13 January 2020. This stakeholder also receives Santos' Quarterly Consultation Update for WA. The January 2020 update provided information on the WA-499-P Exploration Drilling and Site Survey Program. No response received to date.	No response has been received by MTWA. Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.
Community		
Pilbara Ports Authority	The Pilbara Ports Authority was provided the *WA-499-P Exploration Drilling and Site Survey Program Consultation package* via email on 13 January 2020.	No response has been received by the Pilbara Ports Authority.

Stakeholder	Summary of stakeholder and titleholder correspondence, and any objections and claims made	Assessment of stakeholder objections and claims
	This stakeholder also receives Santos' Quarterly Consultation Update for WA. The January 2020 update provided information on the WA-499-P Exploration Drilling and Site Survey Program. No response received to date.	Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.
Commercial Fisheries		
Mackerel Managed Fishery (Area 2) (Ten identified relevant fishers)	These licence holders were provided the *Commercial Fishers WA-499-P Exploration Drilling and Site Survey Program Consultation package* and Mackerel Managed Fishery (Area 2) map via WAFIC email on behalf of Santos on 13 January 2020. Refer to WAFIC comments received. No comments received to date from individual fishers in this fishery.	No response has been received from individual fishers in this fishery. Santos has also consulted with relevant representative bodies. Santos has assessed the impact to fish in **Section 6**, including interaction with other users in **Section 6.5**. Santos considers the level of consultation to be adequate and will address any comments from these stakeholders should they arise in the future.
Pilbara Line Fishery (Nine identified relevant fishers).	These licence holders were provided the *Commercial Fishers WA-499-P Exploration Drilling and Site Survey Program Consultation package* and Pilbara Line Fishery map via WAFIC email on behalf of Santos on 13 January 2020. Refer to WAFIC comments received. No comments received to date from individual fishers in this fishery.	No response has been received from individual fishers in this fishery. Santos has also consulted with relevant representative bodies. Santos has assessed the impact to fish in **Section 6**, including interaction with other users in **Section 6.5**. Santos considers the level of consultation to be adequate and will address any comments from these stakeholders should they arise in the future.
Pilbara Trap Managed Fishery (Three identified relevant fishers).	These licence holders were provided the *Commercial Fishers WA-499-P Exploration Drilling and Site Survey Program Consultation package* and Pilbara Trap Managed Fishery map via WAFIC email on behalf of Santos on 13 January 2020. Refer to WAFIC comments received. No comments received to date from individual fishers in this fishery.	No response has been received from individual fishers in this fishery. Santos has also consulted with relevant representative bodies. Santos has assessed the impact to fish in **Section 6**, including interaction with other users in **Section 6.5**.

Stakeholder	Summary of stakeholder and titleholder correspondence, and any objections and claims made	Assessment of stakeholder objections and claims
		Santos considers the level of consultation to be adequate and will address any comments from these stakeholders should they arise in the future.
Pilbara Crab Managed Fishery (One identified relevant fisher)	These licence holders were provided the *Commercial Fishers WA-499-P Exploration Drilling and Site Survey Program Consultation package* and Pilbara Crab Managed Fishery map via WAFIC email on behalf of Santos on 13 January 2020. Refer to WAFIC comments received. No comments received to date from individual fishers in this fishery.	No response has been received from individual fishers in this fishery. Santos has also consulted with relevant representative bodies. Santos has assessed the impact to fish in **Section 6**, including interaction with other users in **Section 6.5**. Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.
Onslow Prawn Managed Fishery (Ten identified relevant fishers)	These licence holders were provided the *Commercial Fishers WA-499-P Exploration Drilling and Site Survey Program Consultation package* and Onslow Prawn Fishery map via WAFIC email on behalf of Santos on 13 January 2020. Refer to WAFIC comments received. No comments received to date from individual fishers in this fishery.	No response has been received from individual fishers in this fishery. Santos has also consulted with relevant representative bodies. Santos has assessed the impact to fish in **Section 6**, including interaction with other users in **Section 6.5**. Santos considers the level of consultation to be adequate and will address any comments from these stakeholders should they arise in the future.
Development Octopus Fishery (Eight identified relevant fishers)	These licence holders were provided the *Commercial Fishers WA-499-P Exploration Drilling and Site Survey Program Consultation package* via WAFIC email on behalf of Santos on 13 January 2020. Refer to WAFIC comments received. No comments received to date from individual fishers in this fishery.	No response has been received from individual fishers in this fishery. Santos has also consulted directly with relevant representative bodies. Santos has assessed the impact to fish in **Section 6**, including interaction with other users in **Section 6.5**.

Stakeholder	Summary of stakeholder and titleholder correspondence, and any objections and claims made	Assessment of stakeholder objections and claims
		Santos considers the level of consultation to be adequate and will address any comments from these stakeholders should they arise in the future.

4.5 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 (**Section 4.1**), 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 **Table 4-2.**

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

+ Prior to commencement of the activity, Santos will notify all relevant stakeholders listed, or as revised, in **Table 4-2.** The notification will include information on activity timing, vessel movements and vessel details.
+ Upon completion of the activity, Santos will provide a cessation notification to the relevant stakeholders listed, or as revised, in Table 4.2. The final cessation notification will advise stakeholders that the activity has ended.
+ Santos' Quarterly Consultation Update (see **Section 4.6**) will also contain relevant details of this activity until cessation.
+ Up to date knowledge of stakeholders will be managed as described in **Section 4.2.**

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

4.6 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 approximately March, June, September and December annually.

The *WA-499-P Exploration Drilling and Site Survey activities were* included in Santos' Quarterly Consultation Update distributed in January 2020. No comment regarding the proposed activities was received in response to this consultation. This document is provided in **Appendix C - Stakeholder Consultation**.

The Quarterly Consultation Update is circulated to a broad group of Santos stakeholders, including many of the stakeholders identified in **Table 4-2**.

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.

4.7 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.

4.8 Stakeholder-related Control Measures, Performance Outcomes and Standards

Control measures and performance outcomes and standards for stakeholder consultation are included in **Section 8.4.1**.

If, in stakeholder consultation, a change to any control measure or activity outlined in this EP is required, Santos will undertake an internal assessment using the management of change process (**Section 8.10.2**).

5 Environmental impact and risk assessment

OPGGS(E)R 2009 Requirements
Regulation 13(5)
The environment plan must include — (a) details of the environmental impacts and risks of the activity; and (b) an evaluation of those 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.

P(SL)(E)R 2012 Requirements
Regulation 14 (3) & (4)
(3) The environment plan must include — (a) details of all environmental impacts and environmental risks of the petroleum activity; and (b) an evaluation of those impacts and risks; and (c) a description of the environmental risk assessment process used to evaluate those impacts and risks, including the terms used in that process to categorise the levels of seriousness of those impacts and risks. (4) For the avoidance of doubt, the evaluation mentioned in subregulation (3)(b) must evaluate all the environmental impacts and environmental risks arising directly or indirectly from — (a) all aspects of the pipeline activity; and (b) potential emergency conditions, whether resulting from accident or any other cause.

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

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

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

+ Terminology used; and
+ Summary of the approach.

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

5.1 Impact and risk assessment terminology

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

Table 5-1: Impact and risk assessment terms and definitions

Term	Definition
Acceptability	Determined for both impacts and risks. Acceptability of a planned impact is in part determined by the severity (consequence) of the impact after control measures have been implemented. Acceptability of an unplanned impact is in part determined by its risk ranking after control measures have been implemented. For both impacts and risks, acceptability is also determined by a demonstration of the ALARP principle (see next table row), consistency with Santos WA's Environmental Management Policy (QE-91-IQ-00047), consistency with all applicable legislation, and consideration of relevant stakeholder consultation when determining control measures.
ALARP Principle	The ALARP principle is that the residual impacts and risks shall be 'as low as reasonably practicable'. It has particular connotations as a route to reduce risks when considering law, regulation and standards. For an impact or risk to be ALARP, it must be possible to demonstrate that the cost involved in reducing the impact or risk further would be grossly disproportionate to the benefit gained. The ALARP principle arises from the fact that infinite time, effort and money could be spent on the attempt to reduce risk to zero. It should not be understood as simply a quantitative measure of benefit against detriment. It is more a best common practice of judgement of the balance of impact or risk and societal benefit.
EMBA	Environment that may be affected by planned or unplanned events.
Environment	The environment (physical, biological and socio-economic) within the spatial extent over which the planned activity will occur.
Environmental consequence	The severity of an impact in terms of its adverse effects on the environment.
Environmental impact	Any change to the environment, whether adverse or beneficial, wholly or partly resulting from the planned activity.
Environmental risk	Applies to unplanned events. Risk is a function of the likelihood of the unplanned event occurring and the severity (consequence) of the environmental impact that arises from that event.
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.
Likelihood of impact	Probability of an impact occurring (used for risk assessment only).
Non-routine planned event	An attribute of the planned activity that results in some level of environmental impact and may occur or will occur infrequently during the planned activity.
Planned activity	The activity to be undertaken under an environmental plan or oil pollution emergency plan, including the services, equipment, products, assets, personnel, timing, duration and location.
Planned event	An attribute of the planned activity that results in some level of environmental impact and will occur continuously or frequently throughout the duration of the planned activity.
Receptor	A feature of the environment that may have environmental, social and/or economic values.
Unplanned event	An event that results in some level of environmental impact and may occur despite preventative safeguards in place. An unplanned event is not intended to occur during the activity.

5.2 Summary of the environmental impact and risk assessment approach

5.2.1 Overview

Santos WA operates under an overarching Risk Management Policy (QE-91-IF-10050). Santos WA's Risk Management Framework (QE-91-IF-10051) underpins the Risk Management Policy and is consistent with the requirements of Australian Standard/New Zealand Standard International Standards Organization 31000:2019 Risk Management – Guidelines (ISO, 2018).

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

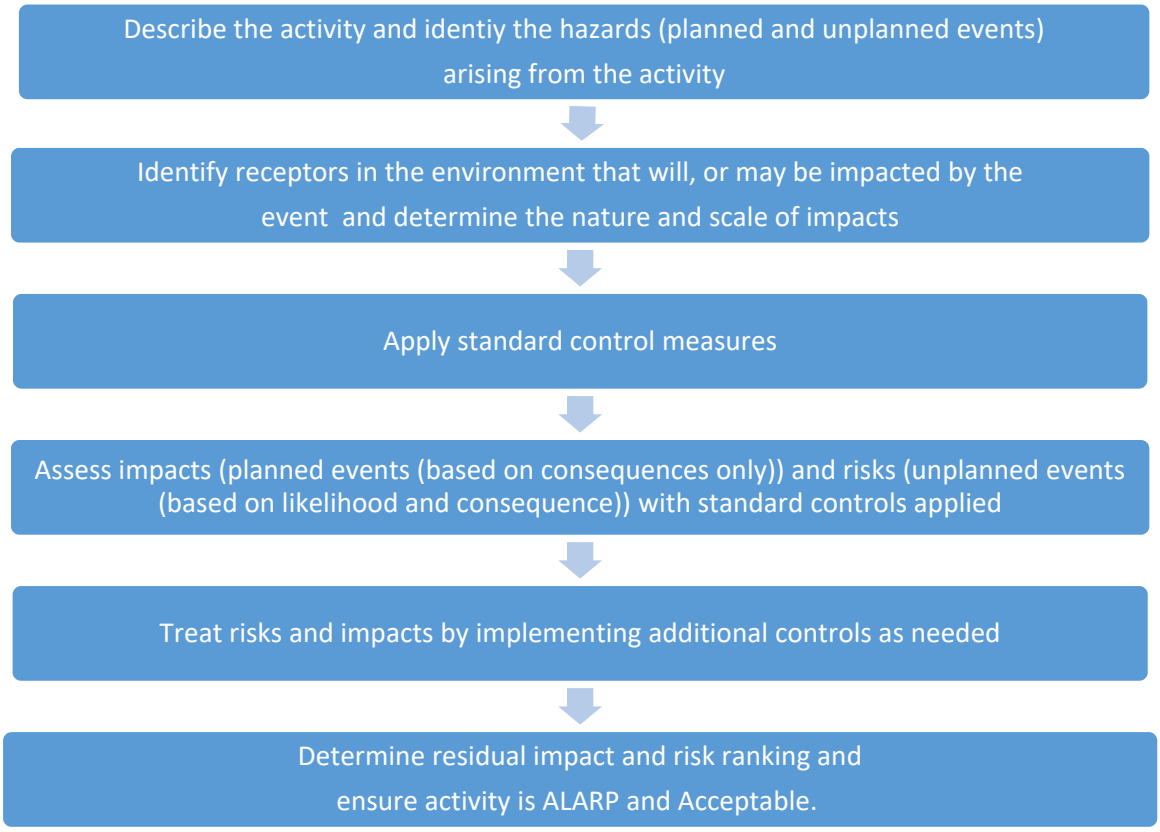


Figure 5-1: Environmental risk and impact assessment process

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

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

These factors were considered in environmental impact and risk assessment workshops. The risk workshops, conducted on 28 November 2019 and 18 December 2019, involved participants from Santos WA as well as specialist environmental consultants with knowledge of the existing environment and the proposed activity along with a potential survey contractor to provide the relevant technical details.

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

5.2.2 Describe the activity and Associated Planned and Unplanned Events

The petroleum activity is described in **Section 2** of this plan. An assessment against the activity was undertaken and the planned and unplanned events were identified. The outcome of this assessment is detailed in the relevant subsections of **Section 6** and **7**.

5.2.3 Determine the nature and scale of impacts and identify receptors that have the potential to be impacted

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

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

For each planned and unplanned event, a set of control measures, environmental performance objectives, environmental performance standards and measurement criteria is identified. The definitions of these terms are consistent with the OPGGS(E)R and P(SL)(E)R. Note that where the P(SL)(E)R uses the term environmental performance objectives, the term environmental performance outcomes is used in this document to address both outcomes and objectives (collectively abbreviated to EPO).

5.2.5 Determine the impact consequence level and risk rankings (on the basis that all control measures have been implemented)

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

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

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

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

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

Table 5-2: Consequence level description

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

Note: Injury or mortality to a protected species is included as a moderate consequence level (**Appendix D - Environment Consequence Descriptors**).

For unplanned events, in addition to the consequence level of the impact, a risk ranking is also determined using an assessment of the likelihood (likelihood ranking) of the impact occurring from an unplanned event. For oil spill events, potential impacts to environmental receptors are assessed where they occur within the EMBA using results from modelling. The risk matrix is provided in **Figure 5-2**.

Table 5-3: Likelihood description

No.	Matrix	Description
5	Probable	1. Event has occurred frequently within the Company. 2. Between 1 and 10 incidents every 10 years (i.e. up to a frequency of 1/year).
4	Likely	1. Event has occurred frequently within the Industry. 2. Between 1 and 10 incidents every 100 years (i.e. up to a frequency of 10^{-1}/year).
3	Unlikely	1. Event has occurred occasionally within the Company. 2. Between 1 and 10 incidents every 1000 years (i.e. up to a frequency of 10^{-2}/year).
2	Very Unlikely	1. Event has occasionally occurred within the Industry. 2. Between 1 and 10 incidents every 10,000 years (i.e. up to a frequency of 10^{-3}/year).
1	Rare	1. Event could happen under exceptional circumstances only. 2. Between 1 and 10 incidents every 100,000 years (i.e. up to a frequency of 10^{-4}/year).

		SEVERITY				
		Negligible	Minor	Moderate	Major	Critical
LIKELIHOOD	5. Probable					
	4. Likely					
	3. Unlikely					
	2. Very Unlikely					
	1. Rare					

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

Figure 5-2: Santos WA risk matrix

5.2.6 Evaluating whether impacts and risks are ALARP

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

5.2.7 Evaluating impact and risk acceptability

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

+ The consequence of a planned event is ranked as A or B; or a risk of impact from an unplanned event is ranked Low to Medium;
+ An assessment has been completed to determine whether further information or studies are required to support or validate the consequence assessment;
+ Assessment and management of risks have addressed the principles of ecologically sustainable development;
+ Demonstration that the acceptable levels of impact and risks have been informed by relevant species recovery plans, threat abatement plans and conservation advice can be demonstrated;
+ Performance standards are consistent with legal and regulatory requirements;
+ Performance standards are consistent with Santos WA's Environmental Management Policy;
+ Performance standards are consistent with industry standards and best practice guidance (e.g., National Biofouling Management Guidelines for the Petroleum Production and Exploration Industry) (Marine Pest Sectoral Committee, 2018);
+ Performance objectives and standards are consistent with stakeholder expectations; and
+ Performance standards have been demonstrated to reduce the impact or risk to ALARP.

6 Planned activities risk and impact assessment

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

P(SL)(E)R 2012 Requirements
Regulation 14(3)
The environment plan must include: (a) details of all environmental impacts and environmental risks of the petroleum activity; and (b) an evaluation of those impacts and risks; and (c) a description of the environmental risk assessment process used to evaluate those impacts and risks, including the terms used in that process to categorise the levels of seriousness of those impacts and risks.
Regulation 14(4)
For the avoidance of doubt, the evaluation mentioned in subregulation (3)(b) must evaluate all the environmental impacts and environmental risks arising directly or indirectly from: (a) all aspects of the petroleum activity; and (b) potential emergency conditions, whether resulting from accident or any other cause

Santos WA's environment assessment identified seven potential sources of environmental impact associated with the planned activities to be undertaken in the operational area. The results of the impact assessments are summarised in **Table 6-1.** Given the risk of a planned event occurring is 100% likelihood (i.e., it will occur), the residual risk ranking is not assessed (as explained in **Section 5.2**). The potential impact assessment for each planned event and the subsequent control and management measures proposed by Santos WA to reduce the extent of the impacts are detailed in the following subsections.

Table 6-1: Summary of the consequence level rankings for hazards associated with planned events

EP Section	Planned event	Residual consequence level
6.1	Acoustic disturbance to marine fauna	A - Negligible
6.2	Light emissions	A - Negligible
6.3	Atmospheric emissions	A - Negligible
6.4	Seabed and benthic habitat disturbance	A - Negligible
6.5	Interaction with other marine users	A - Negligible
6.6	Operational discharges	A - Negligible
6.7	Spill response operations	B - Minor

6.1 Acoustic disturbance to marine fauna

6.1.1 Description of event

Event	Underwater noise emissions will be generated by: + the survey vessel activities (**Section 2.4**); + the geophysical survey equipment, including MBES, SSS, and a boomer SBP (**Section 2.5**); and + underwater acoustical positioning equipment (**Section 2.5**). Noise originating from these sources could potentially have the following effects on marine fauna: + Masking of vocalisations / signals from predators / prey; + Modification of fauna behaviour (avoidance / attraction / disruption of normal behaviour); and + Physical injury to fauna from exposure to excessive noise (barotrauma, hearing loss).
Extent	Localised: A representative survey vessel will have sound levels which do not exceed the marine mammal behavioural disturbance threshold beyond 1200 m. Localised: A conservative estimate for the use of geophysical equipment (MBESs, SSS and boomer SBP) is within a few hundred metres radius depending on the activity characteristics. Localised: A conservative estimate for the use of underwater positioning equipment (USBL) is within hundreds of metres of the source
Duration	Survey vessel noise for the duration of the activity, with intermittent survey equipment noise.

6.1.1.1 Noise generated from survey vessel

Noise associated with vessel activity that could impact marine fauna 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 vessel noise will be from propellers or DP thrusters.

Noise will be generated during transit, towing of geophysical sources and seafloor sampling. The sound levels from the representative vessel are likely to be less than those from *R/V Ocean Pioneer*, a 62-m long 5600 HP (4175 kW) vessel. The *R/V Ocean Pioneer* was measured during transit at 10 knots and found to have a monopole source level of 166.3 dB re 1 µPa @ 1m (Chorney *et al*. 2011). In this study, in the Arctic in 46 m of water, the maximum distance to 120 dB re 1 µPa was found to be 1600 m. A monopole source level is a source level that has been calculated using an acoustic model that accounts for the effect of the sea-surface and seabed on sound propagation, assuming a point-like (monopole) sound source. To place this in context with other studies, McCauley (1998) 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 approximately 1 km.

The 54-m long 3200 HP (2386 kW) *Mermaid Searcher* representative survey vessel is likely over-estimated when considering either the *Ocean Pioneer* or the *Pacific Ariki*, due to the higher speeds and more powerful engines, although the work-rate of the engines, and thus output power and noise, will depend upon speed and sea-state, and the propagation will depend upon the location. Practical spreading loss, $15\log_{10}$(Range) (Urick 1983), is a reasonably conservative approach to take in waters on the continental shelf, representing a balance between spherical and cylindrical spreading. If practical spreading loss is applied with the monopole source level of the *Ocean Pioneer* under transit, 166.3 dB re 1 µPa @ 1m, the distance to 120 dB re 1 µPa (SPL) will be less than 1200 m.

The thrusters on the *Mermaid Searcher* are significantly smaller than the main engines (only 600 kW total installed thruster power, compared to 2386 kW), therefore the use of the monopole source level derived from the main engines to represent the vessel during position holding is conservative. To place this in context with available information, McCauley (1998) calculated the *Pacific Ariki* to have a monopole source level equivalent to approximately 182 dB re 1 µPa @ 1 m while holding position using both main engines and an unspecified bow thruster.

The distance to 120 dB re 1 µPa (SPL) estimated using practical spreading loss for the *Ocean Pioneer* under transit is used as a conservative estimate of the representative survey vessel, the *Mermaid Searcher*, under DP.

Considering the vessel to have a monopole source level of 166.3 dB re 1 µPa, and operating in a single location for 24 hours, allows the accumulated sound levels to be estimated through the addition of $10*\log_{10}$(Time in seconds) to sound levels. This approach can be used to calculate the unweighted Sound Exposure Level (SEL), which can be used in a conservative comparison against relevant SEL impact assessment thresholds.

6.1.1.2 Underwater acoustic positioning

An acoustic pulse is transmitted by the transceiver and detected by the subsea transponder, which replies with its own acoustic pulse. This return pulse is detected by the shipboard transceiver. The time from the transmission of the initial acoustic pulse until the reply is detected is measured by the USBL system and is converted into a range. To calculate a subsea position, the USBL calculates both a range and an angle from the transceiver to the subsea beacon. Angles are measured by the transceiver, which contains an array of transducers. The transducer will then send sound signals, typically at 19 to 33 kHz to a USBL transponder.

The source level and frequency range of the Sonardyne Ranger USBL from previous field measurements (Warner and McCrodan 2011) were found to be 18-36 kHz and 204 dB re 1 µPa @1m (SPL). The per-pulse SEL source level was 173 dB re 1 μPa^2s @ 1 m, and the measured maximum PK was approximately 170 dB re 1 µPa at 30 m. This source can be considered an impulsive sound source for impact assessment purposes for this activity. Austin *et al*. (2012) calculated the distances to SPL isopleths for the Ranger USBL in open water and found the distance to 160 dB re 1 µPa (SPL) to be 36 m. Considering 1000 impulses at 40 m range through summing the received SEL from each impulse results in an unweighted SEL of 144 dB re 1 μPa^2s, which can be used in a conservative comparison against relevant SEL impact assessment thresholds which require the assessment over the length of the activity or 24 hours.

6.1.1.3 Multibeam Echo Sounder

The representative MBES considered for the survey is an R2Sonic 2024, operating at 200-400kHz with a 60° total beam width. The transmit power from this echo sounder is up to 221 dB re 1 µPa @1m (SPL), with a short (15 µs to 1ms) pulse width, however the operational power level and pulse width influence the potential sound fields. This source can be considered an impulsive sound source for impact assessment purposes for this activity. Measurements for the R2Sonic 2024 were reported in Martin *et al*. (2012), who measured a maximum SPL of 162 dB re 1 µPa at 4 m, with the system operating at an average pulse length of 0.11 ms. The accumulated SEL over 363 measured pulses was 121.5 dB re 1 μPa^2s. Measurements of another similar system, operating at 240 kHz were reported in Chorney *et al*. (2011). These measurements show that at 40 m, the PK levels are approximately 170 dB re 1 µPa, and the per-pulse SEL 130 dB re 1 $\mu Pa^2 \cdot s$. Zykov (2013) modelled another similar MBES, and found that the sound levels would not exceed an unweighted 171 dB re 1 $\mu Pa^2 \cdot s$ more than 2 m from the source while conducting a 2.5 h geophysical survey. Additionally, this sonar generates only high frequency signals, and as such will only be relevant for fauna with sensitivity to signals of approximately 200 kHz or higher, which excludes low-frequency cetaceans, fish, and turtles.

6.1.1.4 Side Scan Sonar

The representative SSS considered for this survey is the EdgeTech 4200-FS Digital Towfish which outputs signals at 120 and 410 kHz. Measurements of an EdgeTech 4200 were reported in Crocker and Fratantonio (2016) for 100 and 400 kHz modes, with a maximum per-pulse source level of 176 dB re 1 µPa^{2}s @ 1m (SEL), 205 dB re 1 µPa @ 1m (SPL) and 210 dB re 1 µPa @1m (PK). Austin *et al*. (2013) also measured the system during an operational program, focusing on the 120 kHz impulses. The authors reported a PK of less than 175 dB re 1 µPa and an SPL of less than 170 dB re 1 µPa at 39 m, with the distance from in-beam pulses to an SPL of 160 dB re 1 µPa calculated to be 130 m. The sonar is highly directional, with distances to sound levels outside the beam significantly less than those in the beam. The EdgeTech 4200-FS Digital Towfish in use for this survey will be towed approximately 10 to 20 metres above the seabed, thus the beam will be restricted to a swath close to the seabed. Additionally, this sonar generates only high frequency signals, and as such will only be relevant for fauna with sensitivity to signals of approximately 110 kHz or higher, as shown in Austin *et al*. (2013), which excludes low-frequency cetaceans, fish, and turtles.

6.1.1.5 Boomer Sub Bottom Profiler

The representative boomer SBP considered for this survey is an Applied Acoustics S-Boom Boomer SBP being used with a CSP-D 2400 Joule power source, but only operating at 300 Joules. The output from boomer SBP systems is highly dependent on the model and operational power levels. A measurement of a very similar SBP, also operating at lower power levels, is the Applied Acoustics AP3000 boomer SBP operating at both 750 and 1000 J reported in Martin *et al*. (2012). This boomer had a primary frequency range of 100 to 1000 Hz. During the study, the acoustic data were collected as close as 8 m to the source and directly below it. The data showed that the broadband source level for the system was 203.3 dB 1 µPa @ 1 m SPL over 0.2 ms window length and 172.6 dB re 1 µPa2·s @ 1 m SEL. They found that even with the closest measurement at 8 m, SPL values never exceeded 175 dB re 1 µPa, with the distance to 160 dB re 1 µPa calculated to be 12 m, and the unweighted accumulated SEL over an entire measurement track (525 impulses) in 28 m of water which passed directly over the recorder while operating at 1000 J was 161.5 dB re 1 µPa^{2}s.

6.1.2 Nature and scale of environmental impacts

Potential Receptors: Threatened/migratory fauna (marine mammals (particularly cetaceans), marine turtles (particularly flatback, green and hawksbill turtles), sharks, rays and fish.

The operational area overlaps several internesting buffer BIAs for loggerhead, green, hawksbill and flatback turtles. The operational area also overlaps with a migration BIA for the humpback and blue whales, dugong BIA, foraging BIA for whale sharks, and breeding BIAs for the wedge-tailed shearwater, Australian fairy tern and roseate tern. The only marine protected area that overlaps the operational area is the Montebello Australian Marine Park.

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

- Attraction;
- 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 (used by certain cetaceans for location of prey and other objects);
- Physical injury to hearing or other organs; and
- 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. Coral reefs are one of the noisiest habitats in the ocean, with sources such as breaking swells, snapping shrimp and fish choruses

(Amoser and Ladich, 2005). Broadband levels on reefs are typically 95–110 dB re 1 µPa with a high proportion of low frequency noise (Tolimieri *et al*., 2000). Fish choruses are capable of raising background noise levels to 120–130 dB re 1 µPa (McCauley, 2011). Anthropogenic underwater noise sources in the region comprise shipping and small vessel traffic, petroleum-production and exploration-drilling activities and sporadic petroleum seismic surveys.

The survey will involve the vessel, acoustic positioning through USBL, MBES, SSS and a boomer SBP, as detailed in **Section 2.5**. These sound sources are both non-impulsive (vessel) and impulsive (USBL, MBES, SSS and a boomer SBP), and thus require the consideration of different criteria to assess their potential impact.

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.

6.1.2.1 Marine mammals

No known aggregation, resting, breeding or feeding areas for cetaceans lie in close proximity to the operational area. However, cetaceans may travel through the area, with the operational area being within the migration BIA for the humpback whale,blue whale and dugongs. The relevant species are described in **Section 3.2.3**, and includes both low and mid-frequency cetaceans.

Table 6-2 and **Table 6-3** detail receptor noise impact and behavioural thresholds for continuous noise (vessels) and impulsive noises (survey equipment).

Table 6-2: Continuous Noise: Acoustic effects of continuous noise on marine mammals: Unweighted SPL and SEL_{24h} thresholds

Hearing Group	NMFS (2014)	NMFS (2018)	
	Behaviour	PTS onset thresholds (received level)	TTS onset thresholds (received level)
	SPL (L_p; dB re 1 µPa)	Weighted SEL_{24h} ($L_{E,24h}$; dB re 1 µPa^2·s)	Weighted SEL_{24h} ($L_{E,24h}$; dB re 1 µPa^2·s)

Low-frequency cetaceans	120	199	179
Mid-frequency cetaceans		198	178
Sirenians (dugong)		206	186

Table 6-3: Impulsive Noise: unweighted SPL, SEL_{24h}, and PK thresholds for acoustic effects on marine mammals

Hearing Group	NMFS (2014)	NMFS (2018)			
	Behaviour	PTS onset thresholds (received level)		TTS onset thresholds (received level)	
	SPL (L_p; dB re 1 µPa)	Weighted SEL_{24h} ($L_{E,24h}$; dB re 1 µPa²·s)	PK (L_{pk}; dB re 1 µPa)	Weighted SEL_{24h} ($L_{E,24h}$; dB re 1 µPa²·s)	PK (L_{pk}; dB re 1 µPa)
Low-frequency cetaceans	160	183	219	168	213
Mid-frequency cetaceans		185	230	170	224
Sirenians (dugong)		190	226	175	220

Potential impacts from survey vessel

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 marine mammal 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 marine mammals due to vessel noise however impacts are considered temporary and localised because the marine fauna and the survey vessel will be almost constantly moving and therefore no single area will be impacted for any length of time.

The estimated distances to behavioural and physiological thresholds (as listed in **Table 6-2**) for marine mammals are provided in **Table 6-4**.

Table 6-4: Estimated distances to behavioural and physiological thresholds (as listed in Table 6-2) for marine mammals from vessels

Potential Marine Fauna Receptor	Estimated Distance	Justification
PTS		
Low-Frequency (LF) cetaceans	12 m	Based upon accumulation of unweighted SEL over 24 h for a vessel with a source level of 166.3 dB re 1 µPa

		(SPL), and applying practical spreading loss, see Section 6.1.1.
Mid-Frequency (MF) cetaceans and dugongs	Not predicted to occur	Not predicted to occur for vessels with a significantly greater power output (McPherson *et al*. 2019)
TTS		
Low-Frequency (LF) cetaceans	266 m	Based upon accumulation of unweighted SEL over 24 h for a vessel with a source level of 166.3 dB re 1 µPa (SPL), and applying practical spreading loss, see Section 6.1.1.
Mid-Frequency (MF) cetaceans and dugongs	Not predicted to occur	Not predicted to occur for vessels with a significantly greater power output (McPherson *et al*. 2019)
Behaviour		
Low-Frequency (LF) cetaceans	Within 1200 m	Considering a vessel with a source level of 166.3 dB re 1 µPa (SPL), and applying practical spreading loss, see Section 6.1.1.
Mid-Frequency (MF) cetaceans		

Potential impacts from survey equipment and positioning equipment

The sound levels from positioning equipment are described in **Section 6.1.1**. The proposed equipment has sound levels which could reach the threshold for behavioural disturbance (**Table 6-4**) within 36 m. A nominal accumulation scenario for 1000 impulses (**Section 6.1.3**) results in an unweighted accumulated SEL significantly below thresholds for PTS and TTS in marine mammals. The measured PK at 30 m was 170 dB re 1 µPa, therefore considering both SEL and PK metrics within the criteria (**Table 6-4**), PTS and TTS are not predicted to occur from the positioning equipment.

The sound levels from MBES are described in **Section 6.1.1**. The measurement study from Martin *et al*. (2012) indicates that the threshold for behavioural disturbance (**Table 6-4**) could be exceeded within less than 10 m. PTS and TTS due to SEL is not predicted to occur, considering that a measurement of along a trackline with a closest point of approach of 4 m didn't result in accumulated unweighted levels higher than 121.5 dB re 1 µPa^{2}s. PTS and TTS considering PK is unlikely to occur given the measurement of 170 dB re 1 µPa PK at 40 m. Therefore, considering both SEL and PK metrics within the criteria (**Table 6-4**), PTS and TTS due to the MBES are not predicted to occur.

The sound levels from SSS are described in **Section 6.1.1**. The measurement study Austin *et al*. (2013) indicates that the threshold for behavioural disturbance (**Table 6-4**) could be exceeded within less than 130 m for marine mammals present within the highly directional source output beam pattern. The reported per-pulse sound levels at 40 m are similar to those from the MBES, and as it isn't predicted to exceed either the PTS or TTS criteria considering both SEL and PK metrics (**Table 6-4**), neither is the SSS. Additionally, the per-pulse peak pressure source level of the SSS is below the PK criteria threshold, therefore the criteria cannot be exceeded and PTS and TSS impacts are not predicted to occur.

The sound levels from the boomer SBP are described in **Section 6.1.1**. The modelling results from McPherson and Wood (2017) and Wood and McPherson (2019) indicates that the threshold for behavioural disturbance (**Table 6-4**) could be exceeded within less than 145 m for the boomer, the louder of the two SBP systems. PTS due to SEL is not predicted to occur, although the SEL24h threshold for TTS could be exceeded within 10 m of the source. None of the PK metric criteria (**Table 6-4**) are exceeded.

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. Survey and positioning equipment could cause masking of vocalisations of cetaceans due to the overlap in frequency range between signals and vocalisations. However, due to the limited propagation range of the relevant frequencies (higher frequencies attenuate rapidly), the range at which the impact could occur will be, within hundreds of meters. The masking will apply to MF cetaceans for the positioning equipment, MBES, and SSS, with all signals above 2 kHz. The boomer SBP could potentially mask vocalisations from LF

cetaceans, as it has a primary frequency range from 100 to 1000 Hz, however the low source affected distances are expected to be within hundred to low thousands of meters.

Given the transient and mobile nature of the survey, the operating frequencies and noise maxima of the survey equipment (detailed in **Section 2.5**), effects of noise on marine mammals is expected to be limited to behavioural responses within up to a few kilometres of the survey vessel depending on the heading range of the receptors.

6.1.2.2 Marine reptiles

Turtles utilise shallow waters and beaches of the Montebello Islands, particularly flatback, green and hawksbill turtles for feeding, nesting, breeding and internesting. BIAs within the operational area include the loggerhead turtle (internesting and nesting), green, flatback and hawksbill turtles (internesting and critical nesting habitat). However, internesting activities typically occur within shallower waters.

Marine turtles use sounds for navigation, to avoid predators and to find prey (Dow Piniack 2012). Turtles have been shown to become agitated to impulsive noise sound pressure levels above 175 dB re 1 µPa (McCauley *et al*. 2000). The threshold level of 166 dB re 1 µPa is used as a behavioural disturbance response by turtles to impulsive noise (NSF 2011).

The Recovery Plan for Marine Turtles (Commonwealth of Australia, 2017) notes there is limited information available on the impact of noise on marine turtles and that the impact of noise on turtle stocks may vary depending on whether exposure is short (acute) or long term (chronic). Turtles have been shown to respond to low frequency sound, with indications that they have the highest hearing sensitivity in the frequency range 100–700 Hz (Bartol and Musick, 2003).

Turtles have been recorded successfully breeding on VI over the last 20 years with an estimated survival probability of over 94% (Prince and Chaloupka, 2011). This would indicate that the industrial uses on VI, inclusive of the operational noise emissions, have had little to no measurable impact on adult turtles nesting on VI and, to date, have not shown to have led to a long-term decrease in the size of the adult marine turtle nesting population.

No numerical thresholds have been developed for impacts of continuous sources (e.g. vessel noise) on marine turtles. However, Popper *et al*. (2014) have developed risk-based criteria, and these are presented in Table 6-5. Survey equipment and positioning equipment are considered impulsive sources for this assessment, therefore the criteria from Popper *et al*. (2014) for seismic airguns, an impulsive source, has been adopted (**Table 6-6**).

Table 6-5: Continuous Noise: Criteria for vessel noise exposure for turtles, adapted from Popper *et al*. (2014)

Potential Marine Fauna Receptor	Masking	Behaviour	TTS	Recoverable injury	Mortality and Potential mortal injury
Marine Turtle	(N) High (I) High (F) Moderate	(N) High (I) Moderate (F) Low	(N) Moderate (I) Low (F) Low	(N) Low (I) Low (F) Low	(N) Low (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 meters, intermediate (I) - hundreds of meters, and far (F) – thousands of meters.

Table 6-6: Impulsive noise: Criteria for impulsive noise exposure for turtles, adapted from Popper *et al*. (2014)

Potential Marine Fauna Receptor	Masking	Behaviour	TTS	Recoverable injury	Mortality and Potential mortal injury
Marine Turtle	(N) Low (I) Low (F) Low	(N) High (I) Moderate (F) Low	(N) High (I) Low (F) Low	(N) High (I) Low (F) Low	> 210 dB SEL24h or > 207 dB PK

Potential impacts from survey vessel

Based on the criteria detailed within **Table 6-5** there is a low risk of any injury to marine turtles from vessel noise (**Section 6.1.1**). Behavioural changes, e.g. avoidance and diving, are only predicted for individuals in close proximity to the activity vessels (high risk of behavioural impacts within tens of metres of a vessel and moderate risk of behavioural impacts within hundreds of metres of a vessel). There is a high risk of masking within hundreds of meters of the vessel, and a moderate risk of masking within thousands of metres from the vessel. Turtles have not been shown to have a reliance on sound for finding food or avoiding predators. Sounds potentially could be used by turtles in a social manner to synchronise activities during the nesting season (Ferrara *et al*. 2014), however this has not been demonstrated for sea turtles. The noises are relatively quiet (Ferrara *et al*. 2014), and thus would only have a limited range of detection by turtles even in ideal conditions, with masking from natural sounds likely. The impacts from masking are expected to be low.

Potential impacts from survey equipment and positioning equipment

The sound levels of the survey equipment and positioning equipment (**Section 6.1.1)** are below those associated with the PK criteria for injury (**Table 6-6**) beyond a few metres , and are low enough that SEL criteria will not be reached (McPherson and Wood, 2017). Recoverable injury and TTS could occur within tens of metres applying the relative risk criteria from Popper *et al*, (2014) (**Table 6-6**). Behavioural changes, e.g. avoidance and diving, are only predicted for individuals in close proximity to the survey vessel (high risk of behavioural impacts within tens of metres of source and moderate risk of behavioural impacts within hundreds of metres of the source).

Turtles are unlikely to experience masking even at close range to the source from all sources except the boomer SBP. This is in part because the sounds from most survey and positioning equipment (except the boomer SBP) are all outside of the hearing frequency range for turtles, which for green and loggerhead turtles is approximately 50–2000 Hz, with highest sensitivity to sounds between 200 and 400 Hz (Ridgway *et al*. 1969, Ketten and Bartol 2005, Bartol and Ketten 2006, Bartol 2008, Yudhana *et al*. 2010, Piniak *et al*. 2011, Lavender *et al*. 2012, 2014). The boomer SBP could potentially mask turtle hearing, as it has a primary frequency range from 100 to 1000 Hz, however the low source levels mean the distances within which masking may occur for turtles will be within hundreds to low thousands of meters.

Sea snakes

There is limited information on 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.

6.1.2.3 Sharks, fish and rays

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

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

Thresholds for PTS and recoverable injury are between 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 SEL_{cum} (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.

The criteria defined in Popper *et al*. (2014) for continuous (**Table 6-7**) and impulsive (**Table 6-8**) noise sources has been adopted.

Table 6-7: Continuous 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)	(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 meters, intermediate (I) - hundreds of meters, and far (F) – thousands of meters.

Table 6-8: 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 meters, intermediate (I) - hundreds of meters, and far (F) – thousands of meters.

Potential impacts from survey vessel

Based on criteria developed by Popper *et al*. (2014) for noise impacts on fish, vessel noise has a low risk of resulting in mortality and a moderate risk of TTS impacts when fish are within tens of metres of a vessel. 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.

Potential impacts from survey equipment and positioning equipment

Based on available criteria from Popper *et al* (2014), potential impacts of survey and positioning equipment on fish have been assessed. Impulsive noises from survey equipment could result in physiological impacts to fish located within metres of the sound source considering the results presented in **Section 6.1.1.** The likelihood of fish being close enough to the sound source for physiological impacts to occur is considered remote.

Behavioural impacts to fish from survey equipment noise will be limited to behavioural responses within metres of the noise source. Fish (including sharks and rays) may be temporarily displaced from the vicinity of the noise emissions. The only survey equipment with energy below 1 kHz is the boomer SBP, all other equipment which operates at higher frequencies is unable to be heard by most fish, which further reduces the risk of impact (Ladich and Fay 2013).

The impact of masking is low at all ranges, apart from fish who specialise in pressure detection, which can be impacted in a moderate way at thousands of meters. However, this is only relevant for the boomer SBP, as all other sources have signals outside the hearing range of most fish in the region, which reduces the risk of impact.

6.1.2.4 Invertebrates

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

Potential impacts from survey vessel

Benthic invertebrates are unlikely to be negatively impacted from noise generated from vessel operations due to the fact that the activity is intermittent and of short duration with the vessel not sitting in one location for a period of time. Additionally, 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 close proximity to high-energy noise sources (e.g., 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.

Potential impacts from survey equipment and positioning equipment

For impulsive noise and benthic invertebrates, the source is an important consideration in the assessment. Low frequency sources, such as the boomer SBP, can be considered for the purposes of this assessment in the context of scientific findings relevant to seismic surveys, with no other information available to suggest a more appropriate alternative. Therefore, for the boomer SBP, impulsive noise, the sound levels defined in Day *et al.* 2016 and Payne *et al.* 2008 are considered appropriate to guide an impact assessment (**Table 6-9**).

Table 6-9: Impulsive noise: sound levels relevant to invertebrates

Receptor	Sound levels
Invertebrates: effect at the seafloor (Day *et al.* 2016)	186–190 dB SEL 192–199 dB SEL_{24h} 209–212 dB PK-PK
Invertebrates: no effect at the seafloor (Payne *et al*. 2008)	202 dB PK-PK

Site specific modelling was not conducted against these thresholds for the proposed geophysical activities. However, the Beach Energy Otway Basin Geophysical Survey acoustic modelling, Wood and McPherson (2019), did undertake modelling. This work, as described above, was in similar water depths and geological environment, therefore the results can be used to conduct a high-level comparative assessment. The site-specific study in the Otway found that none of the sound levels listed in **Table 6-9** were exceeded. This result is estimated to be appropriate for geophysical survey activities within the operational area.

The short duration of the survey is expected to reduce the potential for impact on plankton and invertebrates. 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.

There are no thresholds or information available for the assessment of the potential impacts from high-frequency sources such as SSS or MBES on either water column or benthic invertebrates. These sources are often used to assess and quantify plankton densities, including within McCauley et al (2017), who used a Simrad EK60 echosounder operating at 120 kHz.

6.1.2.5 Protected and significant areas

The operational area intersects the Montebello Australian Marine Park (Multiple Use Zone - IUCN Category VI). No recognised breeding or resting area for cetaceans, shark or fish species are known to occur in the operational area, however the operational area does overlap several internesting buffer BIAs for loggerhead, green, hawksbill and flatback turtles. The conservation values of the marine park (as described in **Section 3.2.2**) include foraging areas for marine turtles which are adjacent to important nesting sites. Impacts to turtles from noise are discussed above and due to the short term duration of the activity are not expected to significantly impact the conservation values of the Montebello Australian Marine Park (AMP).

6.1.2.6 Socio-economic

Impacts to fish may result in indirect impacts to fisheries in the operational area, with impacts restricted to moderate within hundreds of meters of the vessel as detailed above. With the majority of the noise emissions being of short duration and of limited extent, any impact on commercial or recreational fishing is expected to be minimal.

6.1.3 Environmental performance outcomes and control measures

EPOs relating to this hazard include:

+ No injury or mortality to EPBC Act and WA Biodiversity Conservation Act 2016 listed fauna during activities (EPO-1).

The control measures considered for this activity are shown in **Table 6-10** with EPSs and measurement criteria for the EPOs described in **Section 8**.

The priority action plan for turtles is set out in the Recovery Plan for Marine Turtles in Australia (Commonwealth of Australia, 2017), which states to manage anthropogenic activities to ensure marine turtles are not displaced from identified Critical Habitat. The recovery plan identifies that a precautionary approach should be applied with surveys that have the potential to cause noise interference when undertaken within internesting habitat.

The conservation advice for humpback whales identifies threats from anthropogenic noise and sets out management actions (controls) to address the threat. The assessment of noise emissions has determined that the activity may have a behavioural impact from anthropogenic noise during the activity. Therefore, the following two relevant controls from the conservation advice for humpback whales have been assessed:

+ Site specific acoustic modelling (as per Approved Conservation Advice for *Megaptera novaeangliae* (humpback whale) (2015)); and
+ Noise management plan (as per Approved Conservation Advice for *Megaptera novaeangliae* (humpback whale) (2015)).

Table 6-10: Control measures – noise emissions

CM Reference	Control measure	Environmental benefit	Potential cost/issues	Evaluation
CM-01	Procedure for interacting with marine fauna incorporating the requirements of EPBC Regulations (Part 8) for interacting with cetaceans	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	Operational costs to adhere to marine fauna interaction restrictions, such as vessel speed and direction, are based on legislated requirements and must be adopted.	**Adopted** – Benefits in reducing impacts to marine fauna outweigh the costs incurred by Santos WA. Control drives compliance with EPBC Regulations (Part 8).
CM-02	Constant bridge watch on survey vessel	Monitoring of surrounding marine environment to identify potential collision risks (and reducing harm) to cetaceans and other marine fauna.	No additional cost – industry practice	**Adopted** – industry practice, benefits outweigh cost. Control drives compliance with the EPBC Regulations.
CM-23	Pre-Start Requirements	Potential reduction in impact of noise to some sensitive receptors based on principles of the EPBC Policy Statement 2.1 – Part A	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	**Adopted –** where practical i.e. where equipment allows) controls
N/A	Undertake site specific acoustic modelling as per Approved	Increase the knowledge of potential impacts.	Additional cost to undertake site	**Rejected** – Cost is disproportionate to increase in

CM Reference	Control measure	Environmental benefit	Potential cost/issues	Evaluation
	Conservation Advice for *Megaptera novaeangliae* (humpback whale) (2015))	However, noise emissions from geophysical surveys are already well documented	specific acoustic modelling.	environmental benefit.
N/A	Develop a noise management plan as per approved Conservation Advice for *Megaptera novaeangliae* (humpback whale) (2015)).	Potential reduction in impacts to marine fauna	Additional cost to develop a noise management plan for a short duration activity (i.e. a few days) that is low risk to marine fauna.	**Rejected** – Cost is disproportionate to increase in environmental benefit.
N/A	Dedicated Marine Mammal Observer (MMO) (as per EPBC Policy Statement 2.1 – Part B.1)	Improved ability to spot and identify marine fauna at risk of impact from vessel and survey noise.	Additional cost of contracting specialist MMO.	**Rejected** – Risk of animals being encountered is too low to justify additional cost of MMO, i.e. cost is disproportionate to environmental benefit.
N/A	Schedule activities to avoid coinciding with sensitive periods for marine fauna present in the operational area	Potential reduction in impact of noise to some sensitive receptors	Impracticable to schedule 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
N/A	Pre-survey research would involve sending a dedicated research vessel to the survey area ahead of time. Allows for survey planning around areas of peak migration and aggregation, therefore reducing risks to marine fauna (EPBC Policy Statement 2.1 – Part B.2)	Increase knowledge of marine fauna activity in the area.	Long lead time as a research vessel sent out to the field would need to go one year ahead of the survey at the planned time to collect relevant data, survey areas often not defined >1 yr. in advance, further risks from vessel collision and	**Rejected** – Cost is disproportionate to increase in environmental benefit

CM Reference	Control measure	Environmental benefit	Potential cost/issues	Evaluation
			emissions; Cost of research vessel.	
N/A	No start up or operations at night-time / low visibility (EPBC Policy Statement 2.1 – Part B.2)	Reduce probability of a cetacean occurring within the low power/shutdown zone and not being detected.	Increases time of survey. Increase cost due to increased survey time. Survey objectives would not be met in available timeframe.	**Rejected** – Cost is disproportionate to increase in environmental benefit
N/A	Spotter planes/ vessels sent to spot fauna ahead of the survey vessel over whole survey area (EPBC Policy Statement 2.1 – Part B.2 & B.3)	Increase detection of individuals or groups of marine fauna which may be displaced or disturbed, during night-time operations when visibility is low.	Marine fauna may have moved away from the area by the time the vessel arrives. Cost of specialist aircraft with good downward visibility, or cost of an additional spotter vessel additional MFOs required on board aircraft. Additional risks to environment through use of vessels/airplanes, increased safety risks to personnel on board additional vessels/airplanes.	**Rejected** – Cost is disproportionate to increase in environmental benefit
N/A	Passive Acoustic Monitoring (PAM) involves the use of hydrophones subsea to detect and monitor the presence of vocalising marine mammals and can assist in the confirmation of the presence of vocalizing cetaceans. Additional detection methods reduce the risks to marine fauna in the vicinity by influencing the survey operations (EPBC Policy Statement 2.1 – Part B.5)	Potential to identify toothed cetaceans which do not breach the sea surface (e.g. on long dives)	Difficult to detect the distance and direction of cetaceans to enable implementation of precaution zones unless confirmed by visual observations, only applicable to vocalizing cetaceans, PAM very dependent on environmental conditions. Minimal costs for basic PAM, however, to enable PAM to be utilized efficiently, more complex PAM systems would be	**Rejected** – Cost is disproportionate to increase in environmental benefit

CM Reference	Control measure	Environmental benefit	Potential cost/issues	Evaluation
			required, with a dedicated vessel thus increasing cost.	
N/A	Adaptive Management: • Terminating the survey for 24 hours is there are 3 or more humpback whale induced shutdowns/ power downs within the previous 24-hour period. • Terminating the survey if there are 3 consecutive days of no collection of survey data due to the presence of migrating humpback whales. (EPBC Policy Statement 2.1 – Part B.6)	Potential reduction in impacts to humpback whales	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

6.1.4 Environmental Impact Assessment

Underwater noise emissions	
Key receptors	**Consequence level**
Noise from operation of equipment and vessels	
Threatened/ migratory fauna	Noise emitted by vessels and the survey activity will be short in duration and is likely to be reduced to background levels within a few kilometres. As such, any potential related marine fauna behavioural impacts are expected to be temporary and short ranged and are not expected to lead to long-term changes in individual behaviour (e.g. migration) or lead to changes at the population level. 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. Potential PTS to low-frequency cetaceans could occur within 12 m of the centre of the vessel (considering a representative vessel that is 54 m long) if the vessel and the cetacean remained in the same place for 24 hours. However, the vessel will never remain in the one position for this long, and as cetaceans are also always moving, the potential for this impact is extremely low. Behavioural impacts may be expected for marine mammals from the survey vessel and equipment. Although the operational area overlaps with the loggerhead, green, hawksbill and flatback turtle internesting BIA, impacts are not expected on a population level or on turtle habitat. Some behavioural response to vessel noise could occur to benthic fish communities within the operational area. The calcareous gravel, sand and silt seabed of the operational area suggests there are unlikely to be any areas of particularly high abundance or diversity of fishes within this area, although it is likely that there will be some attraction of fishes to the subsea infrastructure. It is possible that whale sharks could pass through the operational area, as the BIA overlaps the area. Whale sharks within the operational area would be most likely around the time of the Ningaloo aggregation (March to May). Whale sharks would be expected to show a behavioural response only, as it is unlikely that this species would swim within close range (within metres) of high-energy sound sources (e.g., bow thrusters) or the geophysical survey activities that could result in physiological damage. The slow working speed of vessels within the operational area further reduces the risk of any negative impacts attributable to vessel noise. The Conservation Advice *Rhincodon typus* Whale Shark (Threatened Species Scientific Committee, 2015b) identifies habitat disturbance as a risk. The expected noise levels and behavioural response are not considered to result in habitat disturbance, which is consistent with this advice. Seabirds are also unlikely to be directly affected by underwater noise generated during the operational activities. Due to the distance of the operational area from any seabird nesting colonies, the potential for airborne noise from operational activities to cause disturbance to seabirds is extremely low.
Physical environment/ habitat	Not applicable – noise will not impact the physical environment itself, only the species mentioned above utilising it.
Threatened ecological communities	Not applicable – no threatened ecological communities identified in the area over which noise emissions are expected.
Protected areas	Noise emissions will impact a very small portion of the Montebello Islands Marine Park with any impacts expected be restricted to localised and temporary impacts to marine fauna as they transit through the area.

Underwater noise emissions	
Key receptors	**Consequence level**
Socio-economic	Noise levels are not expected to impact on socio-economic receptors due to their low activity level within the vicinity of the operational area. Impacts to fish may result in indirect impacts to fisheries in the area. However, considering the noise emissions are localised, the available catch area for commercial fishermen and the area over which commercial species spawn, impacts to fisheries are considered acceptable.
Overall worst case consequence	A - Negligible

6.1.5 Demonstration of ALARP

The use of the survey vessel and survey equipment is unavoidable if the planned activity is to proceed. Equipment maintenance will keep the noise levels to within normal operating limits, which will also aid in reducing the likelihood of impacts to sensitive receptors.

The sound levels generated by geophysical surveys are medium to high frequency and decay rapidly with distance travelled from the source, as demonstrated by Zykov (2013), with the furthest distance geophysical noise is expected to travel is less than 1.5 km.

Note that marine fauna affected in varying degrees by acoustic noise (i.e., marine mammals, turtles, sharks and fish) are all expected to avoid the source of noise. This avoidance is likely to be from a small area (due to the small spatial extent of required activities) and to be temporary; i.e., activities are planned for approximately 10 days.

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

Any behavioural impact caused by vessel and survey 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.

The selection of equipment is based on the operational objectives of the activity. The equipment selected is generally tailored to the specific scope and location. Noise from the vessel will be sufficient for sensitive marine fauna to exhibit avoidance behaviour away from the activity to greater than the limited extent that the equipment would cause physiological impacts (within a few meters). The use of equipment is necessary to undertake the survey to inform planned future activities. No viable alternatives exist.

Santos WA have considered the actions prescribed in the Recovery Plan for Marine Turtles in Australia (Commonwealth of Australia, 2017) and Approved Conservation Advice when developing the controls relevant to potential operational activities to minimise noise impacts on marine cetaceans, sharks, fish and marine turtles. Management controls are in place to reduce operating noise including vessel operational protocols, and to adhere to the fauna interaction management stated in Part 8 of the *Environment Protection and Biodiversity Conservation Regulations 2000*. As such, noise emitted during the activities is not expected to significantly impact on marine fauna within the receiving environment.

Additional controls were identified and considered but rejected, as detailed in **Section 6.1.3**. Therefore, the risks to marine fauna from noise associated with the project activities are considered to be ALARP.

6.1.6 Acceptability evaluation

Is the consequence ranked as A or B?	Yes – maximum consequence from underwater noise emissions is A (Negligible).
Is further information required in the consequence assessment?	No – potential impacts and risks are well understood through the information available.
Are risks and impacts consistent with the principles of ESD?	Yes – activity evaluated in accordance with Santos WA's Environmental Hazard Identification and Assessment Procedure which considers principles of ESD.
Are performance standards consistent with industry standards, legal and regulatory requirements, including protected matters?	Yes – strategic objectives of the State Montebello Islands Marine Park met. 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 including but not limited to: Recovery Plan for Marine Turtles in Australia (Commonwealth of Australia 2017), and Approved Conservation Advice for *Megaptera novaeangliae* (humpback whale).
Are risks and impacts consistent with Santos WA Environmental Management Policy?	Yes – aligns with Santos WA Environmental Management Policy.
Are risks and impacts consistent with stakeholder expectations?	Yes – no concerns raised.
Are performance standards such that the impact or risk is considered to be ALARP?	Yes – see ALARP above.

No significant impacts are expected from noise for sensitive receptors in the operational area given the localised and temporary and intermittent nature of the underwater emissions associated with planned activities.

Minimal behavioural changes are expected from all marine fauna in the operational area, and therefore the negligible impacts expected from these noise sources are considered environmentally acceptable. No long-term harm is expected to result to EPBC listed marine fauna during operational activities. Through adherence to Santos WA's *Protected Marine Fauna Interaction and Sighting Procedure* (EA-91-11-00003), which drives compliance with EPBC Policy Statement Part 8, and consideration of EPBC Policy Statement 2.1, the activity is considered acceptable to undertake in the area. In addition, no concerns from stakeholders (including fisheries) have been raised to indicate that the activity will have any unacceptable impacts to socio-economic receptors, nor did DWER highlight any concerns with acoustic disturbance from the activity.

6.2 Light emissions

6.2.1 Description of event

Event	A minimum level of lighting is required for safety and navigational purposes on the survey vessel. Navigational and safety lighting cannot be eliminated.
Extent	Localised, limited light 'spill' or 'glow' onto waters surrounding the survey vessel.
Duration	Navigational and task lighting on vessels will be required on a 24-hour basis.

6.2.2 Nature and scale of environmental impacts

Potential Receptors: Threatened/migratory fauna (marine mammals, marine reptiles - marine turtles (particularly hatchlings), sharks, rays and fish and zooplankton and birds (sea).

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:

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

National Light Pollution Guidelines for Wildlife have also been published in draft (Commonwealth of Australia 2019). According to the draft 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 15-18 km and fledgling seabirds grounded in response to artificial light 15 km away. The effect of light glow may occur at distances greater than 20 km for some species and under certain environmental conditions (Commonwealth of Australia 2019).

Threatened/migratory fauna

Marine mammals

Artificial lighting has the potential to affect marine fauna by altering use of visual cues for orientation, navigation or other purposes, resulting in behavioural responses which can alter foraging and breeding activity, including in dolphins, and create competitive advantage to some species and reduce reproductive success and/or survival in others. Cetaceans and other marine mammals are not known to be significantly attracted to light sources at sea, and therefore disturbances to behaviour are unlikely to occur. There is no evidence to suggest that artificial light sources impact on the migratory, feeding or breeding behaviours of cetaceans. Cetaceans predominantly utilise acoustic senses to survey their environment, rather than vision (WDCS, 2004).

Marine reptiles

The operational area is located within the flatback, loggerhead, hawksbill and green turtle internesting buffer BIA, and therefore individuals are likely to occur in the operational area. All four species nesting on the Montebello and nearby islands are classified as threatened under the EPBC Act 1999 and the WA *Biodiversity Conservation Act 2016.*

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. Specifically, the plan indicates that artificial light may reduce the overall reproductive output of a stock, and therefore recovery of the species, by:

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

The internesting area are defined as a 60 km radius around Barrow Island between October and March for flatback turtles (Oct-Mar), a 20 km radius around Barrow Island between November and March for green turtles (Nov-Mar) and a 20 km radius around Montebello Island for hawksbill turtles (Oct-Feb).

Light pollution reaching marine turtle nesting beaches is widely considered detrimental owing to its ability to alter important nocturnal activities, including choice of nesting sites and orientation/navigation to the sea by post-nesting females and hatchlings (Witherington and Martin, 2003). Light pollution is also highlighted in the Recovery Plan for Marine Turtles in Australia: 2017-2027 as a factor requiring management for successful marine turtle nesting (Commonwealth of Australia, 2017). The most significant risk posed to marine turtles from artificial lighting is the potential disorientation of hatchlings following their emergence from nests, although breeding adult turtles can also be disoriented (Rich and Longcore, 2006 in EPA 2010). Once in the ocean, hatchlings are thought to remain close to the surface, orient by wave fronts and swim into deep offshore waters for several days to escape the more predator-filled shallow inshore waters. During this period, light spill from coastal port infrastructure and ships may `entrap' hatchling swimming behaviour, reducing the success of their seaward dispersion and potentially increasing their exposure to predation via silhouetting (Salmon *et al*., 1992). According to the Recovery Plan for Marine Turtles in Australia: 2017-2027 (Commonwealth of Australia, 2017), the operational area intersects internesting areas identified as habitat critical to the survival of the species for flatback, loggerhead, green and hawksbill turtles.

The North-west Marine Bioregion supports globally significant breeding populations of green (*Chelonia mydas*), hawksbill (*Eretmochelys imbricata*), loggerhead (*Caretta caretta*) and flatback (*Natator depressus*) turtles (DSEWPaC, 2012). The Montebello Islands are the closest significant nesting location to the operational area. The most common species of turtle nesting on the Montebello Islands is the green and flatback turtles. Hawksbill turtles are also seen frequently, whilst Leatherback turtles are the least common. The Recovery Plan for Marine Turtles in Australia: 2017-2027 states that light pollution is of high risk to hawksbill (WA genetic stock) turtles, flatback (Pilbara genetic stock) turtles and green (North West Shelf genetic stock) turtles (Commonwealth of Australia, 2017). Physical habitat modification is of high risk to flatback (Pilbara genetic stock) and green turtles (Scott Reef-Browse Island genetic stock) (Commonwealth of Australia, 2017).

The Montebello Islands are the closest significant nesting location to the operational area.

For marine turtle (and seabird) species, light pollution along, or adjacent to, nesting beaches or rookeries may cause alterations to critical behaviours, such as foraging at sea, the selection of nesting sites and the passage of emerging turtle hatchlings from the beach to the sea (Limpus, 2008). The impacts of these changes include a decrease in nesting success, beach avoidance by nesting females and disorientation, leading to increased mortality through predation, road kill or dehydration (Limpus, 2008; Witherington & Martin, 2000 as cited in DSEWPaC, 2012).

Generally, marine turtles are most sensitive to the shorter wavelengths (< 600 nm), meaning they perceive the violet, blue and green end of the light spectrum more so than the yellow, orange or red end. Typically, the lights used in industrial and offshore applications are fluorescent and halogen lights, falling within the wavelength range that is visible to marine turtles.

Based on published scientific studies and experimental work carried out on turtle hatchling emergence and attraction to lights on Barrow Island, low wattage, low pressure sodium vapour lights are the least "attractive" to turtles, followed by a low wattage light with a yellow filter. High pressure sodium vapour lights and fluorescent white light were the most attractive and therefore the least desirable in terms of reducing impact on turtle behaviour (Pendoley, 2011).

BIAs for marine turtles overlapping the operational area, include the green, flatback and hawksbill turtles (internesting buffer, including for critical habitat).These internesting areas are around Montebello Islands (for all turtles) and Dampier Archipelago (for flatback turtles). 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 (DoEE, 2020). Given the proposed Yoorn-1 well is located approximately 22 km away from the nearest turtle nesting beach (Trimouille Island), light emissions will not be visible from turtle nesting beaches. Experienced nesting females are unlikely to be disturbed by light, and first time nesters are likely to be disturbed by light when they are selecting their first nesting beach (Pendoley, 2014). Given that the closest beach is >20 km from the well location, 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 from land (i.e., >20 km).

Marine turtles have been recorded successfully breeding on VI over the last 20 years with an estimated survival probability of over 94% (Prince and Chaloupka, 2011). This would indicate that the industrial uses on VI, inclusive of the introduction of artificial light sources, have had little to no measurable impact on adult turtles nesting on VI and, to date, have not shown to have led to a long-term decrease in the size of the adult marine turtle nesting population.

The potential impacts of light emissions to flatback, loggerhead, hawksbill and green turtles from the activity are expected to be restricted to localised attraction and temporary disorientation but with no long-term or residual impact due to the short duration of the activity (up to 10 days) . Due to overlap with the BIAs, it is likely that marine turtles will be encountered in the operational area during the nesting and internesting seasons presented. However, it is acknowledged that marine turtles may face multiple threats simultaneously across their lifecycle, including background noise increases and vessel strike. Light emissions may act as a contributor to stock level decline when considering cumulative impacts of threats.

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 the breeding cycle.

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 the survey vessel may result in behavioural impacts to seabirds including terns and shearwaters. However, as they will be for a short duration, the consequence is considered negligible.

Studies conducted between 1992 and 2002 in the North Sea confirmed that artificial light was the reason that birds were attracted to and accumulated around illuminated offshore infrastructure (Marquenie *et al*., 2008) 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 (Surman, 2002). The light from offshore platforms and 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. A study into light impacts upon nocturnally migrating birds on the North Sea found that birds were disoriented and attracted by red and white light (containing visible long-wavelength radiation), whereas they were clearly less disoriented by blue and green light (containing less or no visible long wavelength radiation) (Poot *et al*., 2008). In addition, disoriented adult birds may not be able to return to their burrows 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 overlaps BIAs for the Roseate tern and the Australian fairy tern. The proposed Yoorn-1 well is located ~ 22 km from the nearest land mass (Trimouille Island) that may provide seabird roosting or breeding habitat. As this is greater than the 20 km buffer suggested by the National Light Pollution Guidelines, breeding behaviour should

not be interrupted. The location of the Yoorn-1 well should not significantly impact foraging behaviour, given the large distances typically covered by breeding individuals

6.2.3 Environmental performance outcomes and control measures

EPOs relating to this hazard include:

+ Reduce impacts to marine fauna from lighting on support vessels through limiting lighting to that required by safety and navigational lighting requirements (EPO-2).

The control measures for this activity are shown in **Table 6-11** with EPS and measurement criteria for the EPOs described in **Section 8.**

Table 6-11: Control measures – light emissions

CM Reference	Control measure	Environmental benefit	Potential cost/issues	Evaluation
CM-03	Lighting will be used as required for safe work conditions and navigational purposes	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 including orientation of lighting to reduce light spill on the water wherever feasible without compromising navigation and safety requirements. Reducing the potential for additional light pollution to the environment, thus reducing the potential impacts to fauna.	Additional costs associated with implementing control.	**Accepted** – Cost is considered acceptable for the benefit that may be realised from this control.
N/A	Do not use lighting at night time	Reduce risk of impacts from light emissions during environmentally sensitive periods for listed marine fauna (e.g. turtle nesting/hatching).	Vessel lighting is required for safe operations; therefore this control would restrict activity to daylight hours only, causing delays in scheduled activities, which in turn will have time and cost implications.	**Rejected** – Cost is disproportionate to increase in environmental benefit

CM Reference	Control measure	Environmental benefit	Potential cost/issues	Evaluation
N/A	Exclude offshore lighting during key periods for fauna	Reduce risk of impacts from light emissions during environmentally sensitive periods for fauna	Delays in scheduled activities, including future activities that are relying on this survey information, which in turn will may have time and cost implications.	**Rejected** – Cost is disproportionate to increase in environmental benefit
N/A	Reduce light intensity and/or frequencies which may attract turtles.	Reduce risk of impacts from the intensity of light emissions for fauna (e.g. turtle nesting/hatching, cetacean and bird migration).	Delays in scheduled activities and cost involved with changing lighting may have significant implications on future activities.	**Rejected** – Cost is disproportionate to increase in environmental benefit given the short duration of the activity

6.2.4 Environmental Impact Assessment

Light emissions	
Key receptors	**Consequence level**
Light emissions	
Disturbance to marine fauna from artificial lighting	
Threatened/migratory fauna	Due to management controls and conclusions of ecological studies undertaken on VI, the artificial lighting associated with the vessel survey is considered unlikely to significantly impact on fauna, including the breeding success of seabird and marine turtle populations.
Physical environment/ habitat	Not applicable – light will not impact the physical environment itself, only the species mentioned above utilising it.
Threatened ecological communities	Not applicable – no threatened ecological communities identified in the area over which light emissions are expected.
Protected areas	Light glow may impact sensitive receptors within the Montebello Commonwealth Marine Park, but will be restricted to localised and temporary impacts mentioned to marine fauna above.
Socio-economic receptors	Not applicable – lighting is not expected to cause an impact to socio economic receptors other than as a visual cue for avoidance of the area.
Overall worst-case consequence level	A – Negligible Short-term behavioural impacts only to small proportion of local population and not during critical lifecycle activity. No decrease in local population size or area of occupancy of species, nor loss or disruption of critical habitat, disruption to the breeding cycle or introduction of disease.

6.2.5 Demonstration of ALARP

With the described controls, the consequence of artificial light on marine fauna and seabirds is considered to be negligible with insignificant impacts to ecological function. No population level impacts are expected, and the consequence is considered environmentally acceptable.

There are no safe alternatives to the use of artificial lighting on the survey vessel. Artificial lighting is required on a 24-hour basis for navigational safety in the area, and additional light is required to allow operational activities to proceed safely on a 24-hour basis for occupational health and safety reasons. Therefore, the risks of using 24-hour artificial lighting at an intensity to allow work to proceed are ALARP.

6.2.6 Acceptability evaluation

Is the consequence ranked as A or B?	Yes – maximum consequence from light emissions is A (Negligible).
Is further information required in the consequence assessment?	No – potential impacts and risks are well understood through the information available.
Are risks and impacts consistent with the principles of ESD?	Yes – activity evaluated in accordance with Santos WA's Environmental Hazard Identification and Assessment Procedure which considers principles of ESD.
Are performance standards consistent with industry standards, legal and regulatory requirements, including protected matters?	Yes – management consistent with the intent of the Recovery Plan for Marine Turtles in Australia (Commonwealth of Australia 2017) and EAG (13) Guidelines for Protecting Marine Turtles from Light Impacts.

Are risks and impacts consistent with Santos WA Environmental Management Policy?	Yes – aligns with Santos WA Environmental Management Policy.
Are risks and impacts consistent with stakeholder expectations?	Yes – no stakeholder concerns have been raised.
Are performance standards such that the impact or risk is considered to be ALARP?	Yes – see ALARP above.

The Recovery Plan for Marine Turtles in Australia (Commonwealth of Australia 2017) specifies the following priority actions for the Pilbara genetic stock of flatback turtles and NWS genetic stock of green 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.

Based on the range of controls implemented to manage light emissions associated with operational activities, potential impacts to light-sensitive conservation significant fauna is considered to be minimal and will not cause turtles to be displaced from these habitats. Therefore, the negligible impacts expected from light emissions are considered consistent with the management plan and environmentally acceptable.

6.3 Atmospheric emissions

6.3.1 Description of event

Event	Potential atmospheric emissions include greenhouse gases (GHG), such as carbon dioxide (CO_2) and nitrous oxide (N_2O), non-GHGs such as sulphur oxides (SO_X), oxides of nitrogen (NO_X) and ozone depleting substances (ODS) resulting from: + Use of fuel to power vessel engines, generators and equipment; + Incineration generating point source emissions including CO_2, carbon monoxide (CO), NO_X, sulphur dioxide (SO_2) and particulates; and + ODS should leaks occur from refrigeration and chiller systems on survey vessel.
Extent	Localised within the vicinity of the operational area
Duration	Atmospheric emissions generated during the survey, up to 10 days.

6.3.2 Nature and scale of environmental impacts

Potential Receptors: Physical environment (Air quality).

The potential impacts from the release of air emissions identified above include:

+ Deterioration of local and regional air quality; and
+ Contribution to regional, national and global greenhouse gas emissions.

Physical environment

GHG are a natural part of the atmosphere. The atmosphere allows most sunlight (solar short-wave radiation) to enter and warm the earth. As the surface of the earth cools, it emits infrared radiation (heat), some of which is absorbed by gases in the atmosphere and radiated back to earth. This is called the greenhouse effect. The main gases responsible for this effect are water vapour, CO_2 and N_2O. Other GHG include perfluorocarbons (PFCs), hydrofluorocarbons (HFCs) and sulphur hexafluoride (SF_6). Of these six gases, there would be no emissions of PFCs, HFCs or SF_6 from the activity.

Ozone is a naturally occurring molecule that forms a gaseous layer mostly in the upper atmosphere (the stratosphere) 15-30 km above the surface of the earth and protects life on earth by absorbing ultra-violet radiation from the sun. Scientific evidence indicates that the balance of stratospheric ozone has been upset by the production and release into the atmosphere of ODS, including chlorofluorocarbons, halons, CH_3CCl_3 (Methyl chloroform), carbon tetrachloride, hydrochlorofluorocarbons (a synthetic greenhouse gas) and methyl bromide. ODS and synthetic GHG (HFCs, PFCs and SF_6) are widely used, e.g. in refrigerators, air conditioners and fire extinguishers. These gases deplete the ozone layer by releasing chlorine and bromine atoms into the stratosphere, which destroy ozone molecules. These and other ozone-depleting substances also contribute to varying extents to the enhanced greenhouse effect.

ODS will not be deliberately released during the course the activity. ODS air emissions would only occur in the event of damaged or faulty refrigeration equipment.

Based on the information available, the atmospheric emissions that are a key focus in terms of potential environmental impacts are:

+ GHG (principally CO_2); and
+ Oxides of nitrogen.

6.3.3 Environmental performance outcomes and control measures

EPOs relating to this hazard include:

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

The control measures for this activity are shown in **Table 6-12** with EPS and measurement criteria for the EPOs described in **Section 8**.

Table 6-12: Control measures – atmospheric emissions

CM Reference	Control measure	Environmental benefit	Potential cost/issues	Evaluation
CM-04	Vessel planned maintenance system	Reduces emissions from vessels because equipment operating within its parameters	Operational costs and labour/access requirements of undertaking vessels maintenance	**Adopted** – benefits of operating equipment within operational parameters will help maintain vessel fuel efficiency.
CM-05	Fuel oil management	Reduces emissions through use of low sulphur fuel in accordance with Marine Order 97	Operational costs of refuelling	**Adopted** – environmental benefit outweighs the costs.
CM-06	International Air Pollution Prevention Certificate	Reduces probability of potential impacts to air quality due to ODS emissions, high NOx, SOx and incineration emissions	Vessel has current International Air Pollution Prevention Certificate as per vessel class, during vessel contracting procedure and in pre-mobilisation audits / inspections	**Adopted** – under Marine Orders, the vessel must be compliant to operate in Australian waters.
CM-07	Waste incineration management	Reduce potential impacts to air quality due to waste incineration	Increase in health risk from storage of wastes. Increase in risk due to transfers (increased fuel usage, potential increase in collision risk, disposal on land).	**Adopted** – environmental benefit outweighs the costs associated with transporting waste to shore for landfill.
N/A	No incineration during vessel-based operations activities	Eliminate the potential for emissions due to waste incineration to impact air quality	Increase in health risk from storage of wastes. Increase in risk due to transfers (increased fuel usage, potential increase in collision risk, disposal on land).	**Rejected** – health and safety risks outweigh the benefit given the offshore location. Cost associated with transporting waste to shore for landfill and/or incineration outweighs on-board incineration.
N/A	Removal of all ODS-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. It is noted that ODS is rarely found on vessels.	**Rejected** – based on unacceptable workplace conditions (health and safety)
N/A	Alternative fuel type (non-hydrocarbon	Could reduce level of pollutants released	Practical and reliable alternative fuel types	**Rejected** – not feasible

CM Reference	Control measure	Environmental benefit	Potential cost/issues	Evaluation
	based) selected for the vessel	to the environment during fuel combustion	and power sources for the vessel have not been identified. If an alternative was available, vessels have fuel specification for equipment. Change of fuel may require further modifications to equipment.	
N/A	Use incinerators and engines with higher environmental efficiency	Improves air quality by more efficient burning or fuel combustion	Significant cost in changing unknown vessel equipment	**Rejected** – cost grossly disproportionate to low environmental benefit (impact rated negligible)

6.3.4 Environment Impact Assessment

Atmospheric emissions	
Key receptors	**Consequence level**
Atmospheric emissions	
Threatened/migratory fauna	Emissions are relatively small and will, under normal circumstances, quickly dissipate into the surrounding atmosphere. Therefore, any potential impacts are not expected to result in a decrease in local population size or disruption to the breeding cycle (A - negligible).
Physical environment/ habitat	The activity may result in the deterioration of local and regional air quality. Gaseous and particulate emissions will, under normal circumstances, quickly dissipate into the surrounding atmosphere.
Threatened ecological communities	Not applicable – no threatened ecological communities identified in the area over which air emissions are expected.
Protected areas	The operational area intersects the State Montebello Islands Marine Park. The values of the marine park are not expected to be impacted given the relatively small volume of emissions produced by a vessel.
Socio-economic receptors	As the activity occurs in offshore waters, the combustion of fuels in such remote locations will not impact on air quality in coastal towns or large human settlements. The emissions 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 vessel and therefore will not impact on other marine users in the vicinity.
Overall worst-case consequence level	A - Negligible

6.3.5 Demonstration of ALARP

Power generation through combustion of fossil fuels is essential to undertaking the operational activities either by vessel or power generation. Given the routine maintenance of these systems by suitably qualified personnel, all practicable

management measures are considered to have been implemented, and the likelihood of significant impacts occurring have been reduced to ALARP.

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

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/effort was grossly disproportionate to any benefit. It is considered therefore that the impact of the activities conducted is ALARP.

6.3.6 Acceptability evaluation

Is the consequence ranked as A or B?	Yes – maximum consequence from atmospheric emissions is A (Negligible).
Is further information required in the consequence assessment?	No – potential impacts and risks are well understood through the information available.
Are risks and impacts consistent with the principles of ESD?	Yes – activity evaluated in accordance with Santos WA's Environmental Hazard Identification and Assessment Procedure which considers principles of ESD.
Are performance standards consistent with industry standards, legal and regulatory requirements, including protected matters?	Yes – pursuant to *Protection of the Sea (Prevention of Pollution from Ships) Act* 1983 and Marine Order 97. In line with the Clean Energy Act, Santos WA identifies opportunities to reduce GHG emissions and implements those deemed viable. Examples include the use of waste heat recovery on some power generators and the conversion of power generation on the String of Pearls platforms to instrument air compressor packages.
Are risks and impacts consistent with Santos WA Environmental Management Policy?	Yes – aligns with Santos WA Environmental Management Policy.
Are the activities and their risks and impacts consistent with the principles of ecological sustainable development (ESD)?	Yes – activity evaluated in accordance with Santos WA's Environmental Hazard Identification and Assessment Procedure which considers principles of ESD.
Are risks and impacts consistent with stakeholder expectations?	Yes – no stakeholder concerns have been raised regarding this aspect.
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 reflect Marine Order 97 requirements. The fuel oil utilised during the activity will be compliant with Marine Order 97 in order to control emission quality. As an internationally accepted standard that is utilised industry wide, compliance with MARPOL (Marine Order) standards are considered to be an appropriate control measure.

The overall impacts to the atmosphere and sensitive receptors are expected to be negligible if the emission management is adhered to, and impacts from emissions that are generated by the activity are considered environmentally acceptable.

6.4 Seabed and benthic habitat disturbance (Commonwealth waters only)

6.4.1 Description of event

Event	Disturbance to the seabed and benthic habitats could potentially occur in Commonwealth waters only: + during the collection of sediment samples which is expected to disturb approximately 1.5 m deep and 1m^2 area per sample with a total seabed disturbance of approximately 4 m^2. + From the placement of a single transponder which will be weighted onto the seafloor using sand bags, with a total disturbance of approximately 1 m^2. This may result in minor seabed disturbance, sedimentation or water quality impacts (i.e. increased turbidity).
Extent	**Localised**: within the operational area.
Duration	For operational life of the activity.

6.4.2 Nature and scale of environmental impacts

Potential Receptors: Physical environment (water quality and benthic habitats), threatened/migratory fauna (marine reptiles, sharks, fish and rays), protected and significant areas (marine parks).

Operational activities described above may cause the following impacts:

Direct physical disturbance of benthic and seabed habitat, including benthic fauna by equipment during grab sampling and the temporary placement of the transponder weighted with sandbags for the acoustic positioning system.

Physical environment

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

Temporary or permanent direct loss of benthic habitat and associated biota and degradation of water quality will potentially occur during survey activities.

The benthic biota around the operational area is very similar to that of the wider region, with a low species abundance and high species richness. No significant seabed features or biota have been found in the immediate region surrounding this operational area.

The scale of potential habitat loss and seabed disturbance from localised vessel survey activities is small in comparison to the vast size of soft substrata habitats spanning the NWS and limestone pavement habitats in the region of operations. The relatively small disturbance area (5 m^2) from these planned activities will therefore not have a significant impact on benthic biota or habitat.

Indirect impacts associated with a temporary (several hours) and localised (within tens of metres) decline in water quality due to increased suspended sediments or sedimentation of the seabed are not expected to affect any values and sensitivities of regional importance. It is not considered that localised impacts within the operational area will result in significant indirect impacts (i.e. turbidity) to nearby shoals and banks, offshore reefs or islands given their distance from the activity.

Threatened/migratory fauna

Habitat modification is identified as a potential threat to a number of marine fauna species in relevant Recovery Plans and Conservation Advice (**Table 3-5**). Disturbance of the seabed is not anticipated to significantly affect mobile marine fauna, such as marine mammals, marine reptiles, fish, sharks and rays. The area of seabed to be disturbed within the operational area also represents a negligible portion of the habitat available for these species. 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.

BIAs for marine turtles occur within the operational area, including the loggerhead turtle (internesting and nesting), green, flatback and hawksbill turtles (internesting and critical nesting habitat). However, internesting activities typically occur within shallower waters. The habitat present within the operational area is representative of habitats within the broader BIA and the region. Permanent displacement of habitat from seabed disturbance is not expected due to the small scale of the activity.

Fish, sharks and rays may also forage in the soft sediments for marine invertebrates. However, given the small scale of the activity (5 m^2) and the regional availability of habitat, seabed and benthic habitat disturbance is not expected to affect these species.

Protected and significant areas

The operational area intersects the Montebello Australian Marine Park (Multiple Use Zone - IUCN Category VI). Therefore, seabed and benthic habitat disturbance may occur within the marine park. The conservation values of the marine park (as described in **Section 3.2.2**) that may be directly impacted include:

+ Foraging areas for marine turtles which are adjacent to important nesting sites; and
+ Seafloor habitats and communities of the NWS.

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

6.4.3 Environmental performance outcomes and control measures

EPOs relating to this hazard include:

+ Seabed disturbance is limited to the extent required for sampling (EPO-04).

The control measures considered for this activity are shown in **Table 6-13**. EPSs and measurement criteria for the EPOs are described in **Section 8.**

Table 6-13: Control measures – seabed and benthic habitat disturbance

CM Reference	Control measure	Environmental benefit	Potential cost/issues	Evaluation
CM-08	No anchoring (unless in emergency)	Avoids potential multiple and repeat disturbances to the seabed.	no additional cost due to the nature of the activity	**Adopted** – the environmental benefits outweigh the costs of implementing measure.
N/A	Take fewer samples	Impacts to the seabed are reduced	Substantial cost to the quality of survey data obtained	**Rejected** – cost outweighs the benefit

6.4.4 Environmental Impact Assessment

Seabed and benthic habitat disturbance	
Key receptors	**Consequence level**
Seabed disturbance	
Threatened/migratory fauna	Given the small scale of the activity, minor and short-term nature of indirect impacts and the regional availability of the habitats present, seabed and benthic habitat disturbance is not expected to impact threatened/migratory species. The consequence level is therefore assessed as negligible (A).
Physical environment/ habitat	Impacts from seabed disturbance are expected to be localised, and indirect impacts may result in short-term increases in turbidity to the immediate vicinity of grab samples and placement of the transponder. Given the nature of the habitats within the operational areas that are representative of those within the region, and the localised nature of disturbance, impacts to the physical environment/habitat are assessed as negligible (A).
Threatened ecological communities	Not applicable – no threatened ecological communities are identified in the area where seabed disturbance could occur.
Protected areas	The operational area intersects the Montebello Marine Park (Multiple Use Zone - IUCN Category VI). The relevant values of the marine park are not anticipated to be significantly affected by seabed distance activities, and therefore the consequence has been assessed as negligible (A).
Socio-economic	Not applicable – disturbance of the seabed and benthic habitat within the operational area will not 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. No stakeholder concerns have been raised regarding this aspect.
Worst case consequence level	A - Negligible

6.4.5 Demonstration of ALARP

The vessel survey to be undertaken in State and Commonwealth waters is unavoidable. There are no additional practicable alternatives in order to proceed in a successful and safe manner to reduce seabed disturbance associated with the operational activities. Management controls and installation procedures are designed to further limit the extent of direct seabed disturbance.

The activities within the operational area occur in benthic habitats (i.e. primarily soft sediments with little epifauna) that are widely represented at a regional scale on the NWS (RPS, 2010). Impacts will be localised within the operational area and in the immediate vicinity of the grab samples and transponder. The placement of equipment may leave indentations on the seabed and cause a temporary increase in water column turbidity, but this will be limited to the top layer of sediment.

Given the localised nature of activities which may cause seabed and benthic habitat disturbance, and expected rapid recovery time, environmental impacts are expected to be negligible.

The proposed management controls for seabed disturbance are considered appropriate to manage the risk to ALARP.

6.4.6 Acceptability evaluation

Is the consequence ranked as A or B?	Yes – maximum consequence to seabed and benthic habitats is A (Negligible).
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 WA's Environmental Hazard Identification and Assessment Procedure which considers principles of ESD.
Are performance standards consistent with industry standards, legal and regulatory requirements, including protected matters?	Yes – strategic objectives of the State Montebello Islands Marine Park met. Consistent with Santos procedures and industry standards.
Are risks and impacts consistent with Santos WA Environmental Management Policy?	Yes – aligns with Santos WA Environmental Management Policy.
Are performance standards consistent with stakeholder expectations?	Yes – no concerns raised.
Are performance standards such that the impact or risk is considered to be ALARP?	Yes – see ALARP above.

The potential consequence of seabed disturbance on receptors is discussed above. With the control measures in place, including compliance with industry standards and legislation, no significant impacts are expected. As such, the risk is considered acceptable.

6.5 Interaction with other marine users

6.5.1 Description of event

Event	Sources of impact to other marine users may occur as a result of, but not limited to: + The survey vessel moving through the operational area posing collision risk and potential inconvenience; and + Towed equipment. The presence of the activity could potentially inhibit marine user groups, tourism, commercial shipping, fishing and other oil and gas activities.
Extent	Operational area
Duration	Temporary and intermittent interaction with vessels when transiting the operational area

6.5.2 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 survey vessel is in the operational area.

Socio-economic

There are three Commonwealth and eleven State fisheries that overlap the operational area and are actively fished (**Section 3.2.4**).

An analysis of the current fishery closures, depth range of activity, historical fishing effort data, fishing methods and consultation feedback (refer to **Section 4**) has revealed that there is a low potential for interaction with commercial fisheries. None of the Commonwealth fisheries identified in **Section 3.2.4** are likely to be active in the operational area. For state-managed fisheries, the Pilbara Trap Managed Fishery and the Pilbara Line Fishery of the Pilbara Demersal Scalefish Fishery may access the operational area. The Pilbara Trap Managed Fishery is seaward of the 30 m isobath and landward of the 200 m isobaths; there are six licenses with the allocation consolidated onto three vessels (DoF, 2012). The Pilbara Line Fishery licensees are permitted to operate anywhere in Pilbara waters over a restricted season; there are nine licences in this fishery.

To avoid impacts to commercial fisheries, the activity will avoid commercial fishing vessels and schooling fish in the vicinity of commercial fishing activities. Therefore, there are no impacts expected to commercial fisheries.

The nearest recognised shipping route is approximately 10 km outside of the operational area (**Figure 3-16**). Analysis of historical AUSREP shipping data indicates that commercial vessels do use the general area, however this is most likely vessels in the oil and gas industry as activity is mostly located around oil and gas fields with transit to and from ports. Should commercial vessels need to deviate from planned routes to avoid the activity vessel, this may slightly increase transit times and fuel consumption. No concerns have been raised by the shipping industry through consultation or in the past five years relating to disturbance to shipping routes as a result of activities within the region.

Tourism activities are expected to occur infrequently in the operational area. Activities such as snorkelling, diving, surfing and fishing activities are most likely to occur around the Islands, banks and shoals, as is traditional or subsistence fishing. Interaction with tourism and the survey vessel are unlikely to occur, potentially resulting in minor deviations from their planned route, which may slightly increase transit times and fuel consumption.

AMSA requires a high level of communication during the activity, and inclusion of the activity on a notice to mariners, therefore reducing the likelihood of interaction with other sea users.

6.5.3 Environmental performance outcomes and control measures

EPOs relating to this hazard 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 (EPO-05).

The control measures for this activity are shown in **Table 6-14**. EPSs and measurement criteria for the EPOs are described in **Section 8.**

Table 6-14: Control measures – interaction with other marine users

Reference No	Control measure	Environmental benefit	Potential cost/issues	Evaluation
CM-03	Lighting will be used as required for safe work conditions and navigational purposes.	Reduces risk of environmental impact from vessel collisions due to ensuring safety requirements are fulfilled. 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.	Negligible costs of operating navigational equipment. Costs associated with vessel fit-out with navigational equipment.	**Adopted** – The safety benefits (and thus environmental benefits) outweigh the cost. Compliance with Marine Orders are a legislated requirement.
CM-09	Seafarer competency and 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-02	Constant bridge watch on survey vessel	Minimises risk of collision through visual identification and avoidance of other vessels and Reduce impacts to commercial fisheries by actively avoiding their activities and schooling fish in their vicinity	Negligible costs	**Adopted** - - Benefits considered to outweigh costs
CM-10	Stakeholder consultation	Santos WA will update relevant stakeholders on a quarterly basis and prior to the activity commencing	Costs associated with personnel time in preparing and distributing information and collating/addressing any feedback provided	**Adopted** – Benefits considered to outweigh negligible costs to Santos WA
CM-11	No fishing from vessel	Reduce potential impacts to fisheries in the vicinity of the activity	Negligible costs.	**Adopted** – Benefits considered to outweigh negligible costs to Santos WA

Reference No	Control measure	Environmental benefit	Potential cost/issues	Evaluation
N/A	Eliminate the use of the survey vessel	Would eliminate potential impacts to other marine users	Not considered feasible as a vessel is the only form of transport that can undertake the survey activity	**Rejected** – Not feasible
N/A	Manage the timing of the survey to avoid peak marine user periods (e.g. tourism and recreational fishing)	Would eliminate potential impacts to other marine users	Not considered feasible as marine users could potentially be in the area all year round when operational activities are required all year round. The area that stakeholders are excluded from is small when compared to the area available to other marine users, and there is low fishing activity in the area as evidenced through consultation.	**Rejected** – Stakeholders in the area all year round

6.5.4 Environmental Impact Assessment

Interaction with other marine users	
Key receptors	**Consequence Level**
Interaction with other marine users	
Threatened/migratory fauna	Not applicable – related to socio-economic receptors only.
Physical environment/ habitat	
Threatened ecological communities	
Protected areas	
Socio-economic receptors	Commercial fishing, shipping and tourism in the area is expected to be low. Santos WA has committed to avoiding active commercial fishing and schooling fish in the vicinity of commercial fishing activities to negate any impacts to commercial fisheries. Other marine users currently plan their activities in consideration of other petroleum activities and other marine users (shipping) in the region. AMSA requires a high level of communication during the activity, therefore reducing the likelihood of interaction with other sea users.
Overall worst case consequence	A - Negligible

6.5.5 Demonstration of ALARP

No alternative options to the use of vessels are possible in order to undertake marine based operational activities. If the management controls are adhered to, then the risk of interfering with other users of the sea will have been reduced to ALARP.

Stakeholders have been informed of the proposed installation activity as detailed in **Section 4**. Throughout the duration of EP preparation, details of the activity have been communicated to relevant stakeholders as appropriate. In consultation, stakeholders are made aware of the proposed area from which other marine users may be excluded for the duration of the activity and the potential schedule.

No concerns have been raised by stakeholders regarding the potential exclusion from the proposed operational area.

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

6.5.6 Acceptability evaluation

Is the consequence ranked as A or B?	Yes – maximum interaction with other marine users consequence is A (Negligible).
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 WA's Environmental Hazard Identification and Assessment Procedure which considers principles of ESD.
Are performance standards consistent with industry standards, legal and regulatory requirements, including protected matters?	Yes – management consistent with Safety of Life at Sea (SOLAS) 1974 and *Navigation Act 2012* and Marine Orders.
Are risks and impacts consistent with Santos WA Environmental Management Policy?	Yes – aligns with Santos WA Environmental Management Policy.
Are risks and impacts consistent with stakeholder expectations?	Yes – no concerns raised.
Are performance standards such that the impact or risk is considered to be ALARP?	Yes – see ALARP above.

The presence of the survey vessels is not expected to significantly affect tourism, commercial fishing operations or shipping traffic given the amount of similar habitat available in the surrounding areas and the various routes that can be taken. If third party operations avoid the operational area, there should be no additional risk of collision, and this risk is therefore acceptable.

The risk level of inhibiting tourism, commercial fishing or shipping operations is therefore considered acceptable in this case, as the vessel will have a collision radar to allow communication between vessels and notifications are issued through Australia Hydrographic Office (AHO) and AMSA. In addition, no concerns have been raised by other sea users regarding the proposed activity (**Section 4**).

6.6 Vessel discharges

6.6.1 Description of event

Event	Planned discharges from the survey vessel to the marine environment include: + Deck drainage/run off; + Sewage and grey water; + Food wastes; + Cooling water; + Bilge water; and + Brine (if a reverse osmosis unit is used for water treatment). **Deck drainage/run off** Deck drainage from rainfall or wash-down operations would discharge to the marine environment. The deck drainage would contain particulate matter and residual chemicals such as cleaning chemicals, oil and grease. **Sewage and greywater** The volume of sewage and food waste is directly proportional to the number of persons on-board the vessels. Depending on waste production rates and the specifications of sewage systems available, the total volume of this waste stream generated typically ranges between 0.04 and 0.45 m^3 per day per person. Treated sewage/greywater will be disposed in accordance with Marine Order 96. **Food waste** Putrescible waste is estimated to consist of approximately 1 L of food waste per person per day. The vessel will dispose food waste in accordance with AMSA and Marine Order 95, and MARPOL Annex V. **Cooling water** Seawater is used as a heat exchange medium for the cooling of machinery engines. Cooling water temperatures vary dependent upon the vessel's engines' work load and activity. **Bilge water** While in the operational area, the vessel may discharge oily water after treatment at a concentration of up to 15 ppm through an approved oily water filter system required by Marine Order 91. **Brine** If a reverse osmosis unit is used for water treatment, waste brine generated will be discharged to the ocean at a salinity of approximately 10% higher than seawater. The volume of the discharge is dependent on the requirement for fresh (or potable) water and demand based on the number of people on-board.
Extent	Localised: within the area around the discharge points and in the direction of the prevailing current in surface waters. 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 not expected to occur.
Duration	During the period of the activity, localised impacts to water quality will occur.

6.6.2 Nature and scale of environmental impacts

Potential Receptors: Physical environment (water quality, benthic habitats), threatened/migratory fauna (marine mammals, marine turtles, sharks, rays and fish (pelagic) and seabirds).

Physical environment

Specifics of potential impacts to water quality from vessel discharges are as follows.

Eutrophication impacts from sewage, greywater and putrescible food wastes

Sewage liquids and grey water discharges to the ocean from the vessel can cause water discolouration, localised nutrient enrichment, increase in water column productivity of phytoplankton and bacteria, or oxygen depletion from increased biological oxygen demand around the discharge. Liquid sewage generally contains more than 99% fresh water with trace contaminants and nutrients such as organic carbon, nitrogen and phosphorus, which could cause toxicity impacts to the marine environment, as well as suspended solids and bacterial organisms which could transmit disease to marine fauna and humans.

Dispersion and dilution of discharges is expected to be rapid in the open ocean environment as the discharges are of low volume and short duration, from a vessel that will be moving for the majority of the activity. The discharges will be subject to biodegradation of organics through bacterial action, oxidation and evaporation.

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, will sink and disperse in the currents. On average, seawater has a salt concentration of 35,000 ppm. The volume of the discharge is dependent on the requirement for fresh (or potable) water and the number of people on board.

Changes to seawater salinity can play a significant role in the growth and size of aquatic life and the marine species disturbance, either in a beneficial way (e.g. shellfish) or in an adverse way.

According to some studies about the effects of changes in the salinity of sea water on marine organisms, the primary and apparent changes might occur firstly in mobile species such as plankton and fish; the reaction will be highest in those organisms with a plankton stage in their life history (Hiscock *et al*, 2004 cited in Danoun, 2007). However, impacts differ between different sorts of organism. In some fish, juvenile stages are more vulnerable to salinity changes than the adult generation.

Most marine species are able to tolerate short-term fluctuations in salinity in the order of 20–30% (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, temporary and intermittent nature of brine discharges from the survey vessel, the impact on water quality in the operational area is expected to be low. There is no relationship between the level of salinity and biological or chemical oxygen demand of the discharged concentrate – over 80% of the minerals that encompass concentrate salinity are sodium and chloride, and they are not food sources or nutrients for aquatic organisms.

Changes in water 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 it mixes with the receiving waters, with discharge waters being less than 1°C above background levels within less than 100 m (horizontally) of the discharge point. Vertically, the discharge will be within background levels within 10 m (Woodside, 2008).

Several studies have been carried out in order to determine how the distribution and abundance of marine flora and fauna species react to a change in temperature. Temperature can have an influence on the growth and reproduction of marine species. Mobile species such as plankton and fish are the first and most likely sort of marine life to be influenced due to changes in the seawater temperature (Hiscock *et al*, 2004 cited in Danoun, 2007). Temperature increase can have a positive effect on reproduction and growth rate but also lead to a shorter lifespan depending on the species affected and the extent of temperature change.

Cooling water discharge points vary between vessels. However, they all adopt the same discharge design that permits cooling water to be discharged above the water line, in order to facilitate cooling and oxygenation of this wastewater stream before mixing with the surrounding marine environment. Given the relatively low volume of cooling water, the

temperature differential and the open ocean water surrounding the vessel, the impact on water quality is expected to be low and short-term.

Contamination from releases of bilge water and deck drainage

Discharges of oily bilge water could result in a localised reduction in water quality with impacts on protected marine fauna and plankton. However, oily water discharged from vessels will be treated to a concentration (<15 ppm) in accordance with Marine Order 91: Marine Pollution Prevention - Oil requirements that will unlikely lead to any impacts to the receiving environment. Given the concentration and dosage of exposed receptors within surface waters (e.g. plankton, fish) is expected to be very low and toxic, impacts to organisms would be on a negligible scale.

Given that oil and grease residues in oily water drainage will be in low concentrations, the potential for impact is low and would be further reduced due to the strong tidal movements experienced in the region and the naturally turbid environment. Dispersion and biodegradation of potentially contaminated oily water drainage is expected to be rapid and highly localised resulting in no long-term or adverse effects on water quality or marine ecology. An initial dilution of 100:1 is expected to occur from within metres to 10s of metres from the discharge location.

Threatened/migratory fauna

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

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

Protected and significant areas

The operational area intersects the Montebello Australian Marine Park (Multiple Use Zone - IUCN Category VI). All conservation values of the marine park (as outlined in **Section 3.2.2**) have the potential to be impacted by planned operational discharges through impacts to the physical environment and marine fauna as discussed in the sections above. Therefore, planned operational discharges are not expected to significantly impact the conservation values of the Montebello AMP.

6.6.3 Environmental performance outcomes and control measures

EPOs relating to this hazard include:

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

The control measures considered for this activity are shown in **Table 6-15**. EPSs and measurement criteria for the EPOs are described in **Section 8**.

Table 6-15: Control measures evaluation for operational discharges

CM Reference	Control measure	Environmental benefit	Potential cost/issues	Evaluation
CM-12	Vessel sewage system	Reduces potential impacts of inappropriate discharge of sewage. Drives compliance with MARPOL requirements.	Personnel cost in ensuring vessel certificates are in place during vessel contracting and in pre-mobilisation audits and inspections, and in reporting discharge levels.	**Adopted** – Benefits of ensuring vessel is compliant outweigh the minimal costs of personnel time.
CM-13	Vessel oily mixtures system	Reduces potential impacts of planned discharge of oily water to the environment Provides compliance with Marine Order 91 Marine Pollution Prevention – Oil.	Additional time and personnel costs in maintaining oil record book.	**Adopted** – Benefits of ensuring vessel is compliant outweigh the minimal costs of personnel time and is a legislated requirement.
CM-14	Waste (garbage) management plan	Reduces probability of garbage being discharged to sea, reducing potential impacts to marine fauna. Stipulates putrescible waste disposal conditions and limitations. Drives compliance with MARPOL requirements and prohibits the discharge of food within 3nm of land (i.e. within State waters).	Personnel cost of pre-mobilisation audits and inspections, and in reporting discharge levels	**Adopted** – Benefits of ensuring vessel is compliant outweigh the minimal costs of personnel time
CM-15	Deck cleaning product selection procedure	Deck cleaning materials are selected based on MARPOL requirements - Marine Order 95	Costs minimal	**Adopted** – Benefits outweigh costs
N/A	Scupper plugs on survey vessel are continuously in place to prevent deck drainage.	Would eliminate potential impacts of contaminants being discharged to sea in rain water.	Increased health and safety risks from wet deck not draining. Large amounts of water on a vessel's deck can also cause stability issues (free-surface effect)	**Rejected** – Safety considerations outweigh the benefit given small volumes of contaminants
N/A	Mandatory closed drain system on survey vessel to prevent deck drainage discharged overboard.		Increased cost due to treatment system required, modifications to vessels, storage space required for containment of drained liquids,	**Rejected** – Cost outweighs the benefit given the low impact expected from planned discharges and high potential impacts from risk transfer.

CM Reference	Control measure	Environmental benefit	Potential cost/issues	Evaluation
			increase in transfers to vessels resulting in increased potential impacts and risks. Increased transfers result in increased fuel usage, increased safety risks to personnel during transfer (e.g. crushing between skips), increase in crane movements.	
N/A	Storage of some wastes on-board survey vessel (e.g. oily water, food waste and sewage) for disposal onshore.	Would eliminate discharge to sea, reducing potential impacts to the marine environment	Storage space required for containment of waste, increase in transfers to vessels resulting in increased potential impacts and risks. Increased transfers results in increased fuel usage, increased safety risks to personnel during transfer (e.g. crushing between skips), increase in crane movements.	**Rejected** – Cost outweighs the benefit given the low impact expected from planned discharges and high potential impacts from risk transfer. Noting that vessels will adhere to Marine Order 95 to ensure waste disposal is undertaken correctly in State/Commonwealth waters.

6.6.4 Environmental Impact Assessment

Planned operational discharges	
Key receptors	**Consequence level**
Operational discharges	
Physical environment/ habitat	As the activity is located in an open oceanic environment where tides and currents would quickly dilute and disperse the planned discharges, and the activity is short-term (days) and transient, it is not expected that impacts to the physical environment or fauna will occur. 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. As such, only short-term behavioural impacts are expected with no decrease in local population size or area of occupancy of species, nor loss or disruption of critical habitat, disruption to the breeding cycle or introduction of disease.
Threatened/migratory fauna	
Threatened ecological communities	Not applicable – no threatened ecological communities are identified in the area where operational discharges are expected to disperse.
Protected areas	The operational area intersects the Montebello Marine Park (Multiple Use Zone - IUCN Category VI). The relevant values of the marine park are not anticipated to be

Planned operational discharges	
Key receptors	**Consequence level**
	significantly affected by vessel discharges, and therefore the consequence has been assessed as negligible (A).
Socio-economic	Not applicable – no planned operational discharges will occur within areas known to be utilised by third party operators or for tourism and recreation. No impacts to fish stocks are expected to occur. Therefore, there is no conceivable impact to commercial, traditional or recreational fisheries.
Overall worst case consequence	A - Negligible

6.6.5 Demonstration of ALARP

Vessels are required to undertake operational activities. 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 controls considered but rejected are in **Section 6.6.3**.

6.6.6 Acceptability evaluation

Is the consequence ranked as A or B?	Yes – maximum planned operational discharge consequence is rated A (negligible).
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 WA's Environmental Hazard Identification and Assessment Procedure which considers principles of ESD.
Are performance standards consistent with industry standards, legal and regulatory requirements, including protected matters?	Yes - management consistent with Marine Orders, and Santos WA procedures. Strategic objectives of the North-West Marine Parks Network met.
Are risks and impacts consistent with Santos WA Environmental Management Policy?	Yes – aligns with Santos WA Environmental Management Policy.
Are risks and impacts consistent with stakeholder expectations?	Yes – no concerns raised.
Are performance standards such that the impact or risk is considered to be ALARP?	Yes – see ALARP above.

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

+ Marine Order 91: Marine Pollution Prevention – Oil;
+ Marine Order 96: Marine Pollution Prevention – Sewage; and
+ Marine Order 95: Marine Pollution Prevention – Garbage.

The operational discharges are not expected to significantly impact the receiving environment 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.

Deteriorating water quality is identified as a potential threat to turtles in the marine turtle recovery plan and some bird and shark species. However, the operational discharges are not expected to significantly impact the receiving environment with management controls proposed. Therefore, the activities will be conducted in a manner that is considered acceptable.

6.7 Spill response operations

The spill response strategies that may be adopted in the event of a hydrocarbon spill have been identified in **Section 7.4**. Potential impacts arising from the implementation of the following spill response operations/actions have been assessed as planned events in this section.

6.7.1 Description of event

Event	In the event of a hydrocarbon spill, response strategies will be implemented where possible to reduce environmental impacts to ALARP. The selection of strategies will be undertaken through the Net Environmental Benefit Analysis (NEBA) process, outlined in the OPEP. Spill response will be under the direction of the relevant Controlling Agency, as defined within the OPEP (Section 2.2), which may be Santos WA and/or another agency. In all instances, Santos WA will undertake a 'first-strike' spill response and will act as the Controlling Agency until the designated Controlling Agency assumes control. The response strategies deemed appropriate for the worst case oil spill scenarios identified for the activity are detailed in **Section 7.4.3** and comprise: + Source control; + Monitoring and evaluate; + Mechanical dispersion; + Shoreline protection and deflection; + Shoreline clean-up; + Waste management; + Oiled wildlife response; and + Scientific monitoring. 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 oiled wildlife response operations where disturbance and handling of wildlife may be undertaken intentionally.
Extent	Extent of spill.
Duration	As required.

6.7.2 Nature and Scale of environmental impacts

Potential Receptors: Physical environment, Threatened/migratory fauna, Protected areas (Marine Parks, KEFs, Commonwealth Heritage Place) and Socio-economic receptors.

Given spill response operations will be within offshore waters, and shorelines, primarily using vessels, the types of impact are consistent with operations described elsewhere within this EP for routine operations. Details of these environmental impacts and risks for spill response operations are outlined in **Table 6-16**.

Table 6-16: Nature and scale of environmental impacts and risks for activities – spill response operations

Light emissions:	
Spill response activities will involve the use of vessels which are required at a minimum, to display navigational lighting. Vessels may operate in close proximity to shoreline areas during spill response activities. Spill response activities will also involve onshore operations including the use of vehicles and temporary camps which may require lighting.	
Potential receptors:	Threatened/ Migratory Fauna Protected Areas Socio-Economic
Lighting may cause behavioural changes to fish, birds and marine turtles which can have a heightened consequence during key life-cycle activities, for example turtle nesting and hatching. Turtles and birds, which includes threatened and migratory fauna, have been identified as key fauna susceptible to lighting impacts; **Section 6.2** provides further detail on the nature of impacts to fish, birds and marine turtles. Spill response activities which require lighting may take place in protected areas important to turtles and birds, for example, shoreline locations of Barrow Island and the Montebello Islands are seasonally important for turtles, including BIAs and critical habitats. This could result in, indirect impacts on the values of the protected areas. As a consequence of impacts to fauna, lighting has the potential to impact supported industries such as tourism.	
Noise:	
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:	Threatened/ Migratory Fauna Protected Areas Socio-Economic
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 life-cycle process (e.g. spawning, breeding, calving). Underwater noise can also mask communication or echolocation used by cetaceans. **Section 6** provides further detail on these impacts from vessels. Cetaceans have been identified as the key concern for vessel noise within the EMBA. The humpback migration BIA is within the EMBA. Spill response activities using vessels have the potential to impact fauna in protected areas, this includes the Ningaloo World Heritage Area/Commonwealth Heritage Place. 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/or roosting/feeding areas for shorebirds. As a consequence of impacts to fauna (including shorebirds, marine mammals and fish), noise has the potential to impact supported industries such as tourism and commercial fishing. Noise from aircraft used for surveillance purposes is not expected to cause disturbance to fauna as the aircraft will remain airborne, however, there may be a resulting loss of amenity value through the presence of and noise from aircraft.	
Atmospheric emissions:	

The use of fuels to power vessel and aircraft engines, generators and mobile equipment used during spill response activities will result in emissions of greenhouse gases (GHG) such as carbon dioxide (CO_2) and nitrous oxide (N_2O), along with non-GHG such as sulphur oxides (SOx) and nitrous oxides (NOx). Emissions will result in localised decrease in air quality.

Potential receptors:	Physical Environment/habitat Threatened/Migratory Fauna Protected Areas

Atmospheric emissions from spill response equipment will be localised (apart from aircraft emissions which will rapidly dissipate) and while there is potential for fauna and flora impacts, the use of mobile equipment, vessels and vehicles is not considered to create emissions on a scale where noticeable impacts would be predicted. Emissions may occur in protected areas, 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:

+ Bilge water;
+ Deck drainage;
+ Putrescible waste and sewage;
+ Cooling water from operation of engines; and
+ Brine.

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;
+ Decanting and disposal of oily water from storage tanks during offshore containment and recovery;
+ Sewage/putrescible and municipal waste at camp areas; and
+ Creation, storage and transport of oily waste and contaminated organics.

Potential receptors:	Threatened/Migratory Fauna Physical Environment/habitat Protected Areas Socio-Economic

Operational discharges from vessels, including decanting and disposal of oily water to free storage during offshore containment and recovery operations, may create a localised and temporary reduction in marine water quality. Effects include nutrient enrichment, toxicity, turbidity, temperature and salinity increases, as detailed in **Section 6.6**. These may impact a different set of receptors than previously described in that section given vessel use may occur in shallower coastal waters during spill response activities. Discharge could potentially occur adjacent to marine habitats such as corals, seagrass, macroalgae, and in protected areas (i.e. receptors anywhere within the EMBA), which support a more diverse faunal community, however, discharges will be very localised and temporary.

Cleaning of oil contaminated equipment, vehicles and vessels, has the potential to spread oil from contaminated areas to those 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 back into the marine environment and result in further dispersion of the oil. The process of flushing has the potential to physically damage shoreline receptors such as mangroves and rocky shoreline communities, increase levels of erosion, and create an additional, and potentially higher, level of impact than if the habitat was left to bio-remediate.

Sewage, putrescible and municipal waste will be generated from onshore activities at temporary camps which may include toilet and washing facilities. These wastes have the potential to attract fauna, impact habitats, flora and fauna and reduce the aesthetic value of the environment, which may be within protected areas. The creation,

storage and transport of oily waste and contaminated organics has the potential to spread impacts of oil to areas, habitats and fauna not previously contaminated.

Physical presence and disturbance:

The movement and operation of vessels, aircraft, vehicles, personnel and equipment, undertaking of clean-up activities and the set-up of temporary camp areas during spill response activities has the potential to disturb the physical environment and marine/coastal habitats and fauna, which may include those habitats and fauna within protected areas. Disturbance may also impact cultural and amenity values of an area. The movement of vessels could potentially introduce invasive marine species attached as biofouling to nearshore areas, while vehicle and equipment movement could spread non-indigenous flora and fauna.

Oiled wildlife response activities may involve deliberate disturbance (hazing), capture, handling, cleaning, rehabilitation and release of wildlife which could lead to additional impacts to wildlife.

Potential receptors:	Threatened/Migratory Fauna Physical Environment/habitat Protected Areas Socio-Economic

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 anchor/chain, nearshore booms and grounding. Vessel use in shallow coastal waters also increases the chance of contact or physical disturbance with marine megafauna such as turtles and dugongs. Booms create a physical barrier on the surface waters that has the potential to injure or entangle passing marine fauna that are either surface breathing or feeding.

The presence of and noise from surveillance aircraft may result in a temporary loss of amenity value.

Vehicles, equipment, personnel presence 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/feeding areas. Shoreline clean-up may involve the physical removal of substrates that could cause impact to habitats and coastal hydrodynamics and alter erosion/accretion rates. 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/vehicles use will limit sensitive habitat damage and damage to important fauna areas.

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. The establishment of temporary camp areas will be carried out under direction of DoT and DBCA with suitable advice sought if access is needed to culturally significant areas.

Oiled wildlife response may include the hazing, capture, handling, transportation, cleaning and release of wildlife susceptible to oiling such as birds and marine turtles. While oiled wildlife response is aimed at having a net benefit, poor responses can potentially create additional stress and exacerbate impacts from oiling, interfering with life-cycle processes, hampering recovery and in the worst instance increasing levels of mortality.

Impacts from invasive marine species released from vessel biofouling include out-competition, predation and interference with other ecosystem processes. The ability for a non-native species to establish is generally mitigated in deeper offshore waters where the depth, temperature, light availability and habitat diversity is not generally conducive to supporting reproduction and persistence of the invasive species. However, in shallow coastal areas, such as areas where vessel-based spill response activities may take place, conditions are likely to be more favourable.

Impacts from invasive terrestrial species are similar in that the invasive species can out-compete local species (e.g. weeds) and interfere with ecosystem processes. Non-native species may be transported attached to equipment, vehicles and clothing. Such an introduction would be especially detrimental to wilderness areas or protected terrestrial reserves which may have a relatively undisturbed flora and fauna community.

The disturbance to marine and coastal natural habitat, as well as the potential for disruption to culturally sensitive areas, which may occur in specially protected areas, may have flow on impacts to socio-economic values and industry (e.g. tourism, fisheries).

Disruption to other users of marine and coastal areas and townships:

Spill response activities may involve the use of vessels, aircraft, 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 (commercial, recreational and traditional fishing, tourism and recreation, other oil and gas operators)
The use of vessels in the nearshore and offshore environment and the undertaking of spill response activities at shoreline locations may exclude the general public and industry use of the affected environment. As well as impacting leisure activities of the general public, this may impact on revenue with respect to industries such as tourism and commercial fishing. The mobilisation of personnel to small communities has the potential to affect the local community through demands on local accommodation and business, reducing the availability of services to members of the public.	

6.7.3 Environmental performance outcomes and control measures – spill response operations

EPOs, control measures, EPSs and measurement criteria for oil spill preparedness and response activities are outlined in the relevant strategy sections of the OPEP. Control Measures relevant to reducing the potential impacts from spill response operations are shown in **Table 6-17**.

Table 6-17: Control measures for reducing potential impacts from spill response operations

Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
Competent Incident Management Team (IMT) and oil spill responder personnel.	Ensures that spill response strategy selection and operational activities consider the potential for additional environmental impacts.	Personnel and operational costs associated with maintaining competent IMT team and responder personnel.	**Adopted –** Considered a standard spill response control.
Use of competent vessel crew and personnel.	Reduces potential for environmental impacts from vessel usage.	Personnel and operational costs associated with maintaining contracts with competent vessel crew and personnel.	**Adopted –** Considered a standard spill response control.
Acoustic Disturbance			
Vessels and aircraft compliant with Santos WA's Protected Marine Fauna Interaction and Sighting Procedure (EA-91-11-00003).	Reduces potential for behavioural disturbance to cetaceans.	No cost/issue associated with this control measure	**Adopted –**Ensures compliance with Part 8 of the EPBC Regulations 2000, which is considered a standard spill response control (regulatory requirement).
Light Emissions			
Select temporary base camps in consultation with DoT and DBCA.	Reduce coastal habitat and fauna disturbance.	No cost/issue associated with this control measure.	**Adopted –** Considered a standard control to be adopted by the relevant Control Agency.
Atmospheric Emissions			
Where required under MARPOL, vessels will maintain a current	Reduces level of air quality impacts.	Personnel and operational costs associated with	**Adopted –** Considered a standard spill response control

Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
International Air Pollution Prevention (IAPP) Certificate		maintaining Air Pollution Certificate.	(regulatory requirement).
Disruption to Other Marine Users			
Stakeholder consultation	Promotes awareness and reduces potential impacts from response to socio-economic activities	Minimal cost in relation to overall effort/costs in managing incident	**Adopted –** Considered a standard control for incident management
Operational Discharges and waste			
Vessel sewage system	Reduces potential for water quality impacts.	No cost/issue associated with this control measure.	**Adopted –** Considered a standard spill response control (regulatory requirement).
Oily mixtures system	Reduces potential for water quality impacts.	No cost/issue associated with this control measure.	**Adopted –** Considered a standard spill response control (regulatory requirement).
Approved oily water decanting	Reduces impact from discharge of oily water from storage. Frees up space in liquid waste containers to allow further waste collection.	No cost/issue associated with this control measure.	**Adopted –** Considered a standard spill response control (regulatory requirement).
Compliance with controlled waste, unauthorised discharge and landfill regulations.	Ensures correct handling and disposal of oily wastes.	No cost/issue associated with this control measure.	**Adopted –** Considered a standard spill response control (regulatory requirement).
Physical presence and disturbance			
Spill response activities selected on basis of a net environmental benefit analysis.	Provides a systematic and repeatable process for evaluating strategies with net least environmental impact.	No cost/issue associated with this control measure	**Adopted –** Considered a standard spill response control.
Vessels and aircraft compliant with Santos WA's Protected Marine Fauna Interaction and Sighting Procedure (EA-91-11-00003).	Reduces potential for behavioural disturbance to cetaceans.	No cost/issue associated with this control measure	**Adopted –**Ensures compliance with Part 8 of the EPBC Regulations 2000, which is considered a standard spill response control (regulatory requirement).
Use of shallow draft vessels for shoreline and nearshore operations.	Reduce seabed and shoreline disturbance.	Operational costs associated with operating shallow draft vessels for shoreline and nearshore operations.	**Adopted –** Considered a standard control.
OSR Team Leader assesses and selects	Reduce coastal habitat and fauna disturbance.	No cost/issue associated with this control measure.	**Adopted –** Considered a standard control.

Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
vehicles appropriate to shoreline conditions.			
Conduct shoreline, nearshore habitat, bathymetry assessment.	Reduce shoreline habitat disturbance.	Operational costs associated with conducting shoreline nearshore habitat assessment.	**Adopted –** Considered a standard control.
Establish demarcation zones for vehicle and personnel movement considering sensitive vegetation, bird nesting and roosting areas and turtle nesting habitat.	Reduce coastal habitat and fauna disturbance.	No cost/issue associated with this control measure.	**Adopted –** Considered a standard control.
Operational restriction of vehicle and personnel movement to limit erosion and compaction.	Reduce coastal habitat erosion and compaction.	No cost/issue associated with this control measure.	**Adopted –** Considered a standard control.
Prioritise use of existing roads and tracks.	Reduce coastal habitat and fauna disturbance.	No cost/issue associated with this control measure.	**Adopted –** Considered a standard control.
Soil profile assessment prior to earthworks.	Reduce habitat disruption and erosion.	Operational costs associated with soil profile assessment.	**Adopted –** Considered a standard control.
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.
Pre-cleaning and inspection of equipment (quarantine)	Reduces potential for invasive species to offshore islands	Cost/effort in inspecting equipment	**Adopted –** Considered a standard control.

6.7.4 Environmental Impact Assessment

Spill Response Operations	
Key Receptor	**Consequence Level**
Spill Response Operations – Light Emissions	
Threatened, migratory, or local fauna Physical environment or habitat Threatened ecological communities Protected areas Socio-economic receptors	The receptors considered most sensitive to lighting from vessel and shoreline operations are seabirds, shorebirds and marine turtles, particularly over summer months with respect to marine turtles where emerging hatchlings are sensitive to light spill onto beaches. Temporary camps will be positioned at the direction of DoT or DBCA; therefore, the consequence of shoreline lighting is considered *Negligible*. These species are likely to be values of the protected area they occur in (e.g., Montebello Islands, Ningaloo), and the impact to the protected area from light is also considered *Negligible*. As a consequence of impacts to fauna, lighting has the potential to impact supported industries, such as tourism; however, as impacts to fauna are considered negligible, any indirect impacts on tourism will also be *Negligible*.
Overall worst-case consequence level	A – *Negligible*
Spill Response Operations – Acoustic Disturbance	
Threatened, migratory, or local fauna Physical environment or habitat Threatened ecological communities Protected areas Socio-economic receptors	The receptor considered most sensitive to vessel noise disturbance is the humpback whale during migration season, when these whales come close to the Montebello Islands and Barrow Island during their peak migration (July to October), as well as populations of marine turtles, whale sharks and pygmy blue whales. However, following the adoption of control measures to limit close interaction with protected fauna (i.e., Protected Marine Fauna Interaction and Sighting Procedure (EA-91-II-00003)), a temporary behavioural disturbance is expected only with a consequence of *Negligible*. With respect to noise from onshore operations (mobile equipment and vehicles), nesting, roosting or feeding birds are considered to be the most sensitive to noise, in particular shorebirds that may be aggregating at Montebello Islands, Barrow Island and the Ningaloo coast. The equipment used is not considered to have excessive sound levels and, following direction by DoT and DBCA on the location of temporary camp areas, the consequence to birds from noise is expected to be *Negligible*. Shorebirds may be official values of the protected area they occur in, and the impact to the protected area from noise is also considered *Negligible*.
Overall worst-case consequence level	A – *Negligible*
Spill Response Operations – Atmospheric Emissions	
Threatened, migratory, or local fauna Physical environment or habitat Threatened ecological communities Protected areas Socio-economic receptors	Atmospheric emissions from spill response equipment will be localised; and impacts to even the most sensitive fauna, such as birds, are expected to be *Negligible*. Because of the emissions will be localised and low level, impacts to protected area values, physical environment and socio-economic receptors are predicted to be *Negligible*.

Spill Response Operations	
Key Receptor	**Consequence Level**
Overall worst-case consequence level	A – *Negligible*
Spill Response Operations – Operational Discharges and Waste	
Threatened, migratory, or local fauna Physical environment or habitat Threatened ecological communities 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 has the potential to impact supported industries, such as tourism and commercial fishing; however, as impacts to fauna are considered *Negligible*, any indirect impacts on socio-economic receptors will also be *Negligible*. Onshore, the use of flushing water has the potential to damage sensitive shoreline and intertidal habitats, e.g., mangroves; however, low-pressure flushing only will be used, preventing further damage to habitats or erosion of sediments. For sensitive habitats, the deployment of booms will be considered to retain flushed hydrocarbons, if this presents a net benefit. Following these control measures, the use of flushing to clean shorelines and intertidal habitats is seen to have a *Negligible* additional impact to habitats, fauna or protected area values. The cleaning of contaminated vehicles and equipment onshore has the potential to spread oily waste and damage habitats if not contained. Decontamination units will be in used during the spill response, thus containing waste and preventing any secondary contamination. The consequence of cleaning discharges is therefore ranked as *Negligible* in terms of impacts to habitats, fauna or protected area values. Sewage, putrescible waste and municipal waste generated onshore will be stored and disposed of at approved locations. The storage, transport and disposal of hydrocarbon-contaminated waste arising from spill response operation actions, such as containment and recovery and shoreline clean up, will be managed by Santos WA's appointed waste management contractor; and dedicated waste containment areas will prevent the spreading or leaching of hydrocarbon contamination. The consequence of sewerage discharges is therefore ranked as *Negligible* in terms of impacts to habitats, fauna or protected area values.
Overall worst-case consequence level	A – *Negligible*
Spill Response Operations – Physical Presence and Disturbance	
Threatened, migratory, or local fauna Physical environment or habitat Threatened ecological communities	The use of vessels and nearshore booms has the potential to disturb benthic habitats, including sensitive habitats in coastal waters, such as corals, seagrass, macroalgae and mangroves. A review of shoreline and shallow water habitats and of bathymetry and the establishment of demarcated areas for access and anchoring will reduce the level of impact to *Negligible*. The use and movement of vehicles, equipment and personnel during shoreline response activities has the potential to disturb coastal habitats, such as dune

Spill Response Operations	
Key Receptor	**Consequence Level**
Protected areas	vegetation, samphire and mangroves, and important habitats of threatened and migratory fauna, including nests of turtles and birds and bird roosting areas. Furthermore, clean-up can involve physical removal of substrates that could impact habitats and fauna and alter coastal hydrodynamics. As with vessel use, an assessment of appropriate vehicles and equipment to reduce habitat damage, along with the establishment of access routes, demarcation zones, and operational restrictions on equipment and vehicle use, will limit sensitive habitat damage and damage to important fauna areas. The establishment of temporary camp areas will be done under direction of DoT and DBCA with suitable advice sought if access is needed to culturally significant areas. Following these and other control measures, the resultant consequence to the physical environment and habitat is assessed as *Minor*, indicating that there may be a detectable reduction in habitat area from response activities (as separate from spill impacts), but recovery will be relatively rapid once spill response activities cease. As with all spill response activities, this disturbance will only occur if there is a net benefit to accessing and cleaning shoreline areas. The main direct disturbance to fauna would be the hazing, capture, handling, transportation, cleaning and release of wildlife susceptible to oiling impacts, such as birds and marine turtles. This would only be done if this intervention were to deliver a net benefit to the species, but it may result in a *Minor* consequence. These habitats or environments are likely to be values of the protected area they occur in, and the impact to the protected areas from physical disturbance is therefore also considered *Minor*. The disturbance to marine and coastal natural habitat, as well as the potential for disruption to culturally sensitive areas, which may occur in specially protected areas, may have flow-on impacts to socio-economic values and industry (e.g., tourism, fisheries). This impact is considered *Minor.*
Socio-economic receptors	
Overall worst-case consequence level	B – *Minor*
Spill Response Operations – Disruption to Other Users of Marine and Coastal Areas and Townships	
Threatened, migratory, or local fauna	The use of vessels in the nearshore and offshore environment and spill response activities at shoreline locations and within townships may exclude general public and industry use. Note that this is distinct from the socio-economic impact of a spill itself, which would have a far greater detrimental impact to industry and recreation. Following the application of control measures, it is considered that the additional impact of spill response activities on affected industries would be *Minor*.
Physical environment or habitat	
Threatened ecological communities	
Protected areas	
Socio-economic receptors	
Overall worst-case consequence level	B – *Minor*

6.7.5 Demonstration of ALARP

A Net Environmental Benefit Analysis (NEBA) is the primary tool used during spill response to evaluate response strategies with the goal of selecting strategies that results 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

compared to undertaking no response. NEBA will be undertaken by the relevant Controlling Agency for the activity. For those activities under the control of Santos WA, the Incident Management Team (IMT) Environmental Team Leader will be responsible for reviewing the priority receptors and selected response strategies identified within the OPEP and coordinating the NEBA for each operational period. This will mean that at the strategy level, the response operations reduce additional environmental impacts to ALARP.

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

Given the types of activities considered appropriate to responding to a worse-case spill and the scale of operations, standard control measures adopted by Santos WA for spill response to reduce the level of additional impacts are considered to reduce these impacts to ALARP. This includes working with the relevant Controlling Agency for spill response and applying the process 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 WA considers the actions prescribed in the Recovery Plan for Marine Turtles in Australia (Commonwealth of Australia 2017) and Approved Conservation Advice for other threatened fauna (**Table 3-5**) relevant to spill responses for the activities to minimise noise and light impacts on marine cetaceans, fish and marine turtles. The proposed activity will not result in significant impacts on these species and implementation of identified control measures is in line with the relevant Conservation Advice and Recovery Plans. Pollution events (such as hydrocarbon spills) could impact on fauna (as described in **Section 7.4**), and the use of vessels and equipment during the spill response could result in potential impacts as described within this EP. Control measures in place for vessel and helicopter use as provided in **Section 6.7.3** will reduce potential impacts to marine fauna and these are consistent with current conservation advice. The assessed residual consequence for this impact is minor and cannot be reduced further without disproportionate costs. It is considered therefore that the impact of the activities conducted are acceptable and ALARP.

6.7.6 Acceptability evaluation

Is the consequence ranked as A or B? Is the risk ranked between Low to Medium?	Yes – maximum consequence is a B (Minor) from planned events and maximum risk is Medium.
Is further information required in the consequence assessment?	No – potential impacts and risks well understood through the information available.
Are risks and impacts consistent with the principles of ESD?	Yes – activity evaluated in accordance with Santos WA's Environmental Hazard Identification and Assessment Procedure which considers principles of ESD.
Are performance standards consistent with industry standards, legal and regulatory requirements, including protected matters?	Yes – management consistent with EPBC Act Regulations (Part 8), Marine Orders (91, 96 and 97) and Australian Ballast Water Requirements.
Are risks and impacts consistent with Santos WA Environmental Management Policy?	Yes – aligns with Santos WA Environmental Management Policy.
Are risks and impacts consistent with stakeholder expectations?	Yes – no concerns raised. During any spill response, a close working relationship with relevant regulatory bodies (e.g. DoT, DBCA, AMSA) will occur and thus there will be ongoing consultation with relevant stakeholders on the acceptability of response operations. Wildlife response will be conducted in accordance with the WA Oiled Wildlife Response Plan (WA OWRP) and Pilbara Regional Oiled Wildlife Response Plan.
Are performance standards such that the impact or risk is considered to be ALARP?	Yes – see ALARP above.

7 Unplanned activities risk assessment

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

P(SL)(E)R 2012 Requirements
Regulation 14(3)
The environment plan must include: (a) details of all environmental impacts and environmental risks of the petroleum activity; and (b) an evaluation of those impacts and risks; and (c) a description of the environmental risk assessment process used to evaluate those impacts and risks, including the terms used in that process to categorise the levels of seriousness of those impacts and risks.
Regulation 14(4)
For the avoidance of doubt, the evaluation mentioned in subregulation (3)(b) must evaluate all the environmental impacts and environmental risks arising directly or indirectly from: (a) all aspects of the petroleum activity; and (b) potential emergency conditions, whether resulting from accident or any other cause

Santos WA's environmental assessment identified four potential sources of environmental risks associated with the unplanned events for this activity. The results of the environmental assessment are summarised in **Table 7-1**. A comprehensive risk and impact assessment for each of the unplanned events, and subsequent control measures proposed by Santos WA to reduce the risk and impacts to ALARP, are detailed in the following sub-sections.

Table 7-1: Summary of the environmental risks associated with unplanned events

EP Section	Unplanned event	Likelihood	Consequence	Residual consequence level
7.1	Dropped objects	2 – Very Unlikely	A – Negligible	Low
7.2	Introduction of invasive marine species	1 – Rare	D – Major	Medium
7.3	Marine fauna Interaction	2 – Very unlikely	B – Minor	Medium
7.4	Accidental release of hydrocarbons	2 – Very unlikely	D – Major	Medium

Unplanned releases of hazardous materials to the marine environment such as lubricating and hydraulic oils were considered not a credible event during the risk assessment. Such materials would only be found below deck (e.g. in engine room) during the activity and in small quantities (e.g. from 5 litre containers), with no feasible release pathway to the environment.

7.1 Dropped objects

7.1.1 Description of event

Event	Solid wastes such as containers, cardboard, plastic and polythene packaging may be blown or dropped accidentally in to the sea, potentially impacting sensitive receptors. Release of these waste items may occur as a result of overfull and/or uncovered bins or the loss of survey or personal protective equipment overboard which could result in seabed disturbance or floating debris.
Extent	Localised (seabed and water column within the operational area) to widespread if successfully translocated to new areas via ocean currents or project equipment transit.
Duration	Temporary (or until solid waste degrades or is retrieved).

7.1.2 Nature and scale of environmental impacts

Potential Receptors: Physical environment (water quality and benthic habitats), threatened/migratory fauna (marine reptiles, sharks, fish and rays), socio-economic receptors (fisheries, tourism and recreation).

Non-hazardous solids such as sampling survey equipment and plastics have the potential to smother benthic environments and harm marine fauna through compression, entanglement or ingestion. Marine turtles and seabirds are particularly at risk from entanglement. Marine turtles may mistake plastics for food; once ingested, plastics can damage internal tissues and inhibit physiological processes, which can both potentially result in fatality. Marine debris has been highlighted as a threat to marine turtles, humpback whales and whale sharks in the Recovery Plan for Marine Turtles in Australia (Commonwealth of Australia, 2017), Conservation Management Plan for the Blue Whale (Recovery Plan) (DoEE, 2015), Approved Conservation Advice for *Megaptera novaeangliae* (humpback whale) and Approved Conservation Advice for *Rhincodon typus* (whale shark). The Recovery Plans and Approved Conservation Advices 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.

Release of any hazardous components such as oily residues may result in the pollution of the immediate receiving environment, which may lead to impacts to marine flora and fauna. Physiological damage, through ingestion or absorption may occur to individual fish, sharks, cetaceans, marine reptiles or seabirds.

Impacts to socioeconomic receptors could occur should debris interfere with other marine users or their equipment (e.g. fishing nets).

The area of potential disturbance due to a non-buoyant dropped object would be restricted to the operational area. The seabed within the operational area is made up of calcareous gravel, sand and silt. The operational area does not overlap any KEFs. Damage to hard substrates, and associated fauna, may occur, however such impact is expected to be restricted to the size of the dropped object, and since the survey vessel will operate over a very short period of time, overall impacts will be negligible.

7.1.3 Environmental performance outcomes and control measures

EPOs relating to this hazard include:

+ No unplanned objects, emissions or discharges to sea or air (EPO-6).

The Control Measures for this activity are shown in **Table 7-3**. EPSs and measurement criteria for the EPOs are described in **Section 8**.

Table 7-2: Dropped objects – Control Measures Evaluation

CM Reference	Control measure	Environmental benefit	Potential cost/issues	Evaluation
CM-14	Waste (garbage) management plan.	Reduces probability of waste being discharged to sea, reducing potential impacts to marine fauna. Ensures food waste is discharged in manner that does not pose risk to the environment. Ensures compliance with Marine Orders (94 and 95) and MARPOL (Annex III and V) requirements as appropriate for vessel class.	Personnel cost of vessel audits and inspections, and in recording and reporting waste management.	**Adopted -** benefits of ensuring vessel is compliant outweighs the costs.
CM-16	Dropped object recovery	Avoids leaving debris on seabed	May delay survey	**Adopted –** where feasible
CM-17	Dropped object prevention procedure.	Impacts to environment are reduced by preventing dropped objects and by retrieving dropped objects where possible.	Personnel costs involved in implementing procedures and in incident reporting.	**Adopted -** benefits of ensuring procedures are followed and measures implemented outweighs the costs of personnel time.

7.1.4 Environmental Impact Assessment

Hazardous and Non-Hazardous Unplanned Discharges – Solid	
Key Receptors	Physical environment (benthic habitats), threatened/migratory fauna (marine mammals, marine reptiles, sharks, fish and rays), socio-economic receptors (fisheries, tourism and recreation)
Consequence	A – Negligible
	Lost equipment, dropped objects, and hazardous/non-hazardous waste could result in localised damage to the seabed, impacts to water quality and the benthic environment. The overall consequence level was assessed as **negligible**.
Likelihood	2 – Very Unlikely
	A set of control measures and checks have been proposed to ensure that the risks of dropped objects, lost equipment or release of hazardous/ non-hazardous solid waste to the environment has been minimised. The likelihood of dropped objects in the operational area is limited and given the controls in place, the likelihood of releasing hazardous and non-hazardous solids to the environment resulting in a negligible consequence is considered very unlikely (assumes potential for a single loss dropped object incident during the activity).

Hazardous and Non-Hazardous Unplanned Discharges – Solid	
Residual Risk	The residual risk associated with this hazard is Low.

7.1.5 Demonstration of ALARP

Wastes generated and equipment used during the activity and managed through the proposed control measures. The control measures proposed are considered sufficient to reduce the risk of dropped objects to a level that is ALARP. No further feasible control measures were identified.

7.1.6 Acceptability evaluation

Is the risk ranked between Low to Medium?	Yes –residual risk is ranked 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 WA's Environmental Hazard Identification and Assessment Procedure which considers principles of ESD.
Are performance standards consistent with industry standards, legal and regulatory requirements, including protected matters?	Yes – Management consistent with MARPOL Annex V. Controls implemented will minimise the potential impacts from the Activity to species identified in relevant Recovery Plans and Approved Conservation Advice (**Table 3-5**) as having the potential to be impacted by marine debris (solid hazardous/ non-hazardous releases).
Are risks and impacts consistent with Santos WA Environmental Management Policy?	Yes – aligns with Santos WA Environmental Management Policy.
Are risks and impacts consistent with stakeholder expectations?	Yes – No concerns raised.
Are performance standards such that the impact or risk is considered to be ALARP?	Yes (see ALARP above).

With the controls in place to prevent accidental release of hazardous/ non-hazardous solid waste or a dropped object, and the negligible impacts predicted, the risk to the marine environment is considered low and reduced to a level that is considered acceptable. The aActivity undertaken with the controls, will be conducted in a manner that is acceptable under the relevant Recovery Plans and Approved Conservation Advice to prevent accidental release of hazardous/ non-hazardous solid (marine debris) (**Table 3-5**).

7.2 Introduction of invasive marine species

7.2.1 Description of event

Event	Introduction of invasive marine species (IMS) may occur due to: + Biofouling on vessels and external/internal niches (e.g. sea chests, seawater systems, etc); + Biofouling on equipment that is routinely submerged in water (e.g. survey equipment); Once established, IMS have the potential to out-compete indigenous species and affect overall native ecosystem function.
Extent	Localised (seabed and water column 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).

7.2.2 Nature and scale of environmental impacts

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

IMS are marine flora and fauna that have been introduced into a region that is beyond their natural range but have the ability to survive, and possibly thrive (DAFF, 2011). The majority of climatically compatible IMS to the NWS are found in south-east Asian countries.

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

+ over-predation of native flora and fauna;
+ out-competing of native flora and fauna for food;
+ human illness through released toxins;
+ depletion of viable fishing areas and aquaculture stock;
+ reduction of coastal aesthetics; and
+ damage to marine and industrial equipment and infrastructure.

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

IMS species of concern are those that are not native to the region; are likely to survive and establish in the region; and are able to spread by human mediated or natural means. Species of concern vary from one region to another depending on various environmental factors such as water temperature, salinity, nutrient levels and habitat type. These factors dictate their survival and invasive capabilities. IMS, if they successfully establish, can out-compete native species for food or space, preying on native species or changing the nature of the environment and can subsequently impact on fisheries (commercial and recreational) or aquaculture. This is primarily through altering benthic habitats which in turn may result in changes to biological assemblages and a reduction in biodiversity.

It is recognised that artificial, disturbed and/or polluted habitats in tropical regions are susceptible to 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. For this reason, increased management requirements have been implemented in recent years by Commonwealth and State regulatory agencies.

Biofouling on vessel hulls and other external niche areas, biofouling on internal niches and biofouling on equipment routinely immersed in water all pose a potential risk of introducing IMS into Australia. The potential biofouling risk

presented by the survey vessel will relate to the length of time that the vessel has already been operating in Australian waters or, if it has been operating outside Australian waters, the location/s of the operations it has been undertaking, the length of time spent at these location/s, and whether the vessel has undergone hull inspections, cleaning and application of new anti-foulant coating prior to returning to operate in Australia.

7.2.3 Environmental performance outcomes and control measures

EPOs relating to this hazard include:

+ No introduction of marine pest species (EPO-7).

The Control Measures for this activity are shown in **Table 7-3**. EPSs and measurement criteria for the EPOs are described in **Section 8**.

Table 7-3: Introduction of IMS – Control Measures Evaluation

CM Reference	Control measure	Environmental benefit	Potential cost/issues	Evaluation
CM-18	Invasive marine species management plan	The risk of introducing IMS is reduced due to assessment procedure	Personnel costs involved in risk assessing vessels and immersible equipment in accordance with the IMSMP. Costs associating with reducing the IMS risk to 'low' e.g. dry docking, cleaning or additional costs due to inspections. Could lead to potential delays and therefore costs, in vessel and equipment contracting process due to availability of vessels.	**Adopted** – minimal personnel costs and potential delays or costs to project are considered outweighed by the benefits of reducing the risk of IMS.
CM-19	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.
N/A	Restrict vessel operations to using vessels and equipment that have operated in local, State or National 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/National waters therefore work could not be completed.	**Rejected** – not feasible without significant impact on survey objectives / schedule.
N/A	Mandatory dry docking of vessels prior to entering field to clean vessel and/or equipment and remove biofouling.	Demonstrates that no IMS were 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.

CM Reference	Control measure	Environmental benefit	Potential cost/issues	Evaluation
				Given other controls in place already reducing the risk, cost outweighs benefit.

7.2.4 Environmental Impact Assessment

Invasive Marine Species	
Key Receptors	Physical environment (shoals and banks, benthic habitats, offshore reefs and islands), threatened/migratory fauna (marine mammals, marine reptiles, sharks, fish and rays), protected and significant areas (marine parks), socio-economic receptors (fisheries, tourism and recreation)
Consequence	D – Major
	IMS could result in reduction in diversity or health of the ecosystem, which may result in economic losses with long-term effects on industry. The overall consequence level was assessed as **major**.
Likelihood	1 – Rare
	The pathways for IMS introduction are well known, and subsequently standard preventative measures are proposed. It is unlikely that an IMS would be able to successfully translocate from the operational area to surrounding shallower habitats. With controls in place to reduce the risk, introduction of IMS is considered unlikely.
Residual Risk	The residual risk associated with this hazard is Medium.

7.2.5 Demonstration of ALARP

The proposed management controls for IMS are considered appropriate to manage the risk of pest introduction in this case and bring the chance of pest introduction to ALARP.

Ballast water exchange will be managed in accordance with the IMSMP and legislative requirements, to demonstrate vessels are low risk so that marine pest species are not introduced.

Santos WA has adopted a risk-based approach to managing biofouling given it is not practicable or reasonable to inspect and/or clean every vessel before each voyage. Such an approach is consistent with other petroleum operators on the 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 marine pest species 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. Through the biofouling risk assessment approach, Santos WA is confident that the *Fish Resources Management Act 1994* and associated regulations prohibiting the introduction of non-endemic fish species will be met.

The Santos WA IMSMP uses a semi-quantitative approach to assess IMS risk for each individual vessel and immersible equipment. This approach takes into account Vessel History (port of call log and maintenance history), status of antifoul coating, any recently completed IMS inspections (from an independent biofouling inspector), home port location and other factors which contribute to IMS risk (i.e. transport methods).

To achieve a low risk status, a vessel operator is required to demonstrate that

- a vessel's seawater systems are being maintained/protected from marine growth;
- it has not recently operated at any locations (as per port of call log) where there are known IMS of concern;

- the antifoul coating system is certified and within stated efficacy period; and
- if entering state waters from an international location there is a completed IMS Inspection within 7 days prior to departure of the overseas location which returns a result of low risk.

This approach is consistent with DPIRD requirements. However, it also applies to locally sourced vessels, which are vessels whose home port is located within the Santos IMS Management Zone (also defined in the IMSMP). Where a vessel operator cannot provide all of the above information, the vessel is deemed an uncertain risk or high risk.

Management options for high or uncertain risk vessels or immersible equipment include:

- IMS inspection (by a 3rd party inspector);
- treatment and/or cleaning; or
- Outright rejection of the vessel or equipment and an alternative vessel contracted.

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

7.2.6 Acceptability evaluation

Is the risk ranked between Low to Medium?	Yes – introduction of invasive marine species residual risk ranking is Medium.
Is further information required in the consequence assessment?	No – potential impacts and risks well understood through the information available.
Are risks and impacts consistent with the principles of ESD?	Yes – activity evaluated in accordance with Santos WA's Environmental Hazard Identification and Assessment Procedure which considers principles of ESD.
Are performance standards consistent with industry standards, legal and regulatory requirements, including protected matters?	Yes – management consistent with *Biosecurity Act* (2015) and National Biofouling Guidance for the Petroleum Industry.
Are risks and impacts consistent with Santos WA Environmental Management Policy?	Yes – aligns with Santos WA Environmental Management Policy.
Are risks and impacts consistent with stakeholder expectations?	Yes – No concerns raised.
Are performance standards such that the impact or risk is considered to be ALARP?	Yes (see ALARP above).

All vessels and in-sea equipment will meet the requirements of the Santos IMSMP which addresses all applicable State and Commonwealth regulatory requirements. Application of the proposed management and adherence to regulations reduces the likelihood of introducing IMS into the operational area. While the potential exists for IMS to be translocated to the area, with the application of rigorous preventative measures and controls, the risk is deemed acceptable in this case.

7.3 Marine fauna interaction

7.3.1 Description of event

Event	There is the potential for vessels or equipment involved in operational activities to interact with marine fauna, including potential strike or collision, potentially resulting in severe injury or mortality.
Extent	Within the operational area, in the immediate vicinity of the survey vessel.
Duration	During the Activity.

7.3.2 Nature and scale of environmental impacts

Potential receptors: Threatened/migratory fauna (marine mammals, marine turtles, whale sharks, seabirds).

Cetaceans are naturally inquisitive marine mammals that are often attracted to vessels underway; for example, dolphins commonly 'bow ride' with vessels.

Marine fauna in surface waters that would be most at risk from vessel collision include marine mammals, marine turtles and whale sharks. As summarised in **Figure 3-6** to **Figure 3-12**, the operational area overlaps with a number of BIA's including breeding BIA's for five seabird species, internesting BIAs for four turtle species, a migration BIA for the humpback whale and a distribution BIA for the pygmy blue whale. Approved Conservation Advice for *Megaptera novaeangliae* (humpback whale) indicates that humpback whales are one of the most frequently reported whale species involved in vessel strikes worldwide (Laist *et al*., 2001; Jensen & Silber, 2003). The increase in vessel numbers (Silber & Bettridge, 2012) is not only a threat to humpback whales in relation to vessel strikes but also in disturbance and displacement from key habitats. Similarly, boat strike is also recognised by the Approved Conservation Advice for *Rhincodon typus* (whale shark) as one of the threats to the recovery of whale sharks.

The worst potential impact from vessel collision would be mortality or serious injury of an individual. Collisions between vessels and cetaceans are most frequent on continental shelf areas where high vessel traffic and cetacean habitat occur simultaneously (WDCS, 2004). There have been recorded instances of cetacean deaths as a result of vessel collisions in Australian waters (e.g. a Bryde's whale in Bass Strait in 1992) (WDCS, 2004), though the data indicate this is likely to be associated with container ships and fast ferries. Whale and Dolphin Conservation Society (WDCS) (2004) also indicates that some cetacean species, such as humpback whales, can detect and change course in order to avoid a vessel.

The most commonly sighted whale in continental shelf waters of the region is the humpback whale. The humpback whale migrates between calving grounds in the Kimberley region of WA to feeding grounds in Antarctica; with the northbound migration from early June to early August (BHPB, 2005), and the peak of the northbound migration between Exmouth Gulf and the Dampier Archipelago occurring around July, concentrated inshore of the 200 m depth contour (Jenner *et al.*, 2001). The southern migration, which peaks around early September, with pods travelling in shallower waters, typically at 30 - 100 m and passing to the west of Barrow Island and north of the Montebello islands. Higher numbers may be encountered in the operational area during humpback whale southern migration, however significant numbers are not expected given the direction (east of the Montebello islands) of the operational area. Migrating individuals may traverse the operational area, however, the timing will avoid humpback whale migration season, as described in **Table 3-8**.

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).

It is likely that individual loggerhead, green, hawksbill and flatback turtles may be encountered in the operational area, particularly due to overlap with BIAs and proximity to known nesting beaches.

Marine turtle mortality due to boat strike has been identified as an issue in Queensland waters in the Marine Turtle Recovery Plan (Commonwealth of Australia, 2017). However, turtles appear to be more vulnerable to boat strike in areas of high urban population where incidents of pleasure crafts are higher. WA turtle populations have not been

highlighted as those most affected by boat strike, possibly due to the relatively low human population density of the NWS coast line.

7.3.3 Environmental performance outcomes and control measures

EPOs relating to this hazard include:

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

The Control Measures for this activity are shown in **Table 7-4**. EPSs and measurement criteria for the EPOs are described in **Section 8.**

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

CM Reference	Control measure	Environmental benefit	Potential cost/issues	Evaluation
CM-01	Procedure for interacting with marine fauna	Reduces risk of physical and behavioural impacts to marine fauna from vessels because if they are sighted, then vessels can slow down, or move away.	Operational costs to adhere to marine fauna interaction restrictions, such as vessel speed and direction are based on legislated requirements and must be accepted.	**Adopted** – Benefits in reducing impacts to marine fauna outweigh the costs incurred by Santos WA. Control drives compliance with EPBC Regulations (Part 8).
CM-02	Constant bridge watch on survey vessel	Monitoring of surrounding marine environment to identify potential collision risks (and reducing harm) to cetaceans and other marine fauna.	No additional cost – industry practice	**Adopted** – industry practice, benefits outweigh cost. Implementing EPBC Policy Statement 2.1 Part B for whales ensures compliance with the EPBC Regulations.
N/A	Restrict the timing of activities to operate outside of sensitive periods only.	Reduce risk of collisions (causing harm) during environmentally sensitive periods for listed marine fauna.	Protected Marine Fauna species are present year-round meaning there are no non-sensitive periods to operate in.	**Rejected** – Grossly disproportionate to the environmental benefit and would severely limit operations which are required to occur 24 hours a day, 7 days a week.
N/A	Dedicated MMO on survey vessel (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** – Risk of animals being encountered is too low to justify additional cost of MMO, i.e. cost is disproportionate to

CM Reference	Control measure	Environmental benefit	Potential cost/issues	Evaluation
				environmental benefit.
N/A	Activities will only occur during daylight hours.	Potential for a vessel-fauna collision occurring is decreased due to vessel being stationary when visibility is lower at night.	Lengthens time of the activity – approximately double. Increased cost due to increased operation time (more than double the cost and therefore grossly disproportionate).	**Rejected** – Substantial additional cost due to doubling of operation duration.
N/A	Spotter planes / vessels sent ahead to planned night-time operational area.	Eliminate / reduce likelihood and consequence of impact to marina fauna.	Marine fauna may have moved away from the area by the time the vessel arrives. Cost of specialist aircraft with good downward visibility, or cost of an additional spotter vessel additional MFOs required on board aircraft. Additional risks to environment through use of vessels/airplanes, increased safety risks to personnel on board additional vessels/airplanes.	**Rejected** – Cost is disproportionate to increase in environmental benefit

7.3.4 Environmental Impact Assessment

Marine Fauna Interaction	
Key Receptors	Threatened/migratory fauna (marine mammals, marine reptiles, sharks and seabirds).
Consequence	B - Minor
	In the event of a collision with marine fauna, there is the potential for injury or death to an individual. The number of receptors present at the operational area is expected to be limited to a small number of transient individuals. There are multiple BIAs that occur in the operational area; such as internesting areas for marine turtles, migration paths for the humpback whale and breeding locations for a number of seabirds. As such there is the potential for death or injury of EPBC 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	2 – Very unlikely

Marine Fauna Interaction	
	Marine fauna interaction is considered very unlikely given the small operational area and short timeframe, slow moving vessels (typically <5 knots), open ocean environment and the ability for fauna to move away. The Australian National Marine Safety Committee (NMSC) reports that during 2009, there was one report of a vessel collision with a marine animal (species not defined) (NMSC, 2010). No known aggregation areas occur within the operational area and therefore concentrations of milling individuals are unlikely. The noise generated from vessel operations will deter marine fauna from coming in close proximity to vessels. Consequently the likelihood of a collision with marine fauna resulting in a minor consequence is considered to be very unlikely.
Residual Risk	The residual risk associated with this hazard is Medium

7.3.5 Demonstration of ALARP

No alternative options to the use of a vessel are possible in order to undertake the activity. If the management controls are adhered to then the risk of marine fauna collisions will have been reduced to ALARP.

The proposed management controls for marine fauna collision are considered appropriate to manage the risk to ALARP. Additional controls considered but rejected are detailed below.

7.3.6 Acceptability evaluation

Is the risk ranked between Low to Medium?	Yes – maximum marine fauna collisions 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 WA's Environmental Hazard Identification and Assessment Procedure which considers principles of ESD.
Are performance standards consistent with industry standards, legal and regulatory requirements, including protected matters?	Yes – management consistent with Part 8 of the EPBC Regulations. Controls implemented will minimise the potential impacts from the activity to species identified in Recovery Plans and conservation advice as having the potential to be impacted by boat strike.
Are risks and impacts consistent with Santos WA Environmental Management Policy?	Yes – aligns with Santos WA Environmental Management Policy.
Are risks and impacts consistent with stakeholder expectations?	Yes – No concerns raised.
Are performance standards such that the impact or risk is considered to be ALARP?	Yes (see ALARP above).

Application of the proposed management and adherence to applicable regulations in line with relevant actions prescribed in the Recovery Plans and Approved Conservation Advices, reduces the likelihood of vessel interactions with marine fauna. While the potential exists for a collision to occur, it is considered a rare scenario. Vessels will be travelling at low speeds within the operational area, also reducing the likelihood of fauna strike. In the unlikely event that an impact did occur, it would be highly probable that only a single individual would be contacted. It is thought that owing to the rare likelihood of a collision occurring, coupled with the potential impact being limited to a single individual, the risk is deemed acceptable in this case.

7.4 Accidental release of hydrocarbons

7.4.1 Description of event

There is the potential for loss of containment of marine diesel as a result of a vessel collision event occurring during the activity, as discussed below. Diesel spill trajectory modelling was utilised to predict the potential extent of a spill event.

Event	It is considered credible that a release of diesel to the marine environment could occur from a collision between the survey vessel and a third party vessel. Such events could have sufficient impact to result in the rupture of a diesel tank (loss of integrity). This is considered credible given the diesel tanks may not be protected or double-hulledm], and fuel tank ruptures resulting in a hydrocarbon release have occurred before. 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 vessel to undertake the survey is yet to be confirmed; a review of available survey vessels indicated that the largest single fuel tank is likely to be up to 250 m^3 in capacity. Although the likely survey vessel's largest fuel tank will be smaller, a conservative modelled spill volume of 329 m^3 has been used for this EP.
Extent	Diesel spill trajectory modelling (GHD 2019) indicated that there was some probability of a 329 m^3 diesel spill extending as follows: + Shoreline loading at low exposure (10 g/m^2) may occur between Ningaloo Coast North, approximately 300 km to the southwest of the release location, and Dampier Archipelago, approximately 150 km to the east. The potential for shoreline contact at the medium (100 g/m^2) and high (1,000 g/m^2) exposure values was confined to the proximal locations of Montebello Islands, Lowendal Islands and Barrow Island. + The maximum potential accumulated oil ashore across all shorelines was modelled as ~222 tonnes, occurring entirely at the Montebello Islands. + Other shoreline receptors that were predicted to receive shoreline oiling during other stochastic realisations included Barrow Island (maximum of ~130 tonnes), Lowendal Islands (maximum of ~11 tonnes) and Dampier Archipelago, Muiron Islands and Ningaloo Coast North (each receiving <0.3 tonnes). + The surface slick exceeding the low exposure value of 1 g/m^2 (visible sheen) was modelled to extend a maximum distance of ~350 km to the southwest and ~200 km to the northeast of the spill location, with a similar predicted spatial extent for the low total entrained oil exposure value (10 ppb). + The low dissolved hydrocarbon exposure value (10 ppb) was predicted to extend a maximum distance of ~220 km to the southwest and ~160 km to the northeast.
Duration	329 m^3 release of diesel was modelled for a release over 0.5 hour, replicating the potential duration of a spill arising from a significant collision. Effects of a worst case spill may involve 10-20 year recovery period.

7.4.1.1 Spill modelling information

Diesel

A surface release of 329 m^3 of diesel was modelled from the survey 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 approximately 50% of the released volume within several days of release. The diesel will also become increasingly subject to entrainment into the water column as the density increases after losing the lighter components through evaporation (APASA 2013).

7.4.1.2 Diesel characteristics

A summary of the representative characteristics of diesel, as assessed in this EP, is provided in **Table 7-5**.

Table 7-5: Summary of diesel characteristics

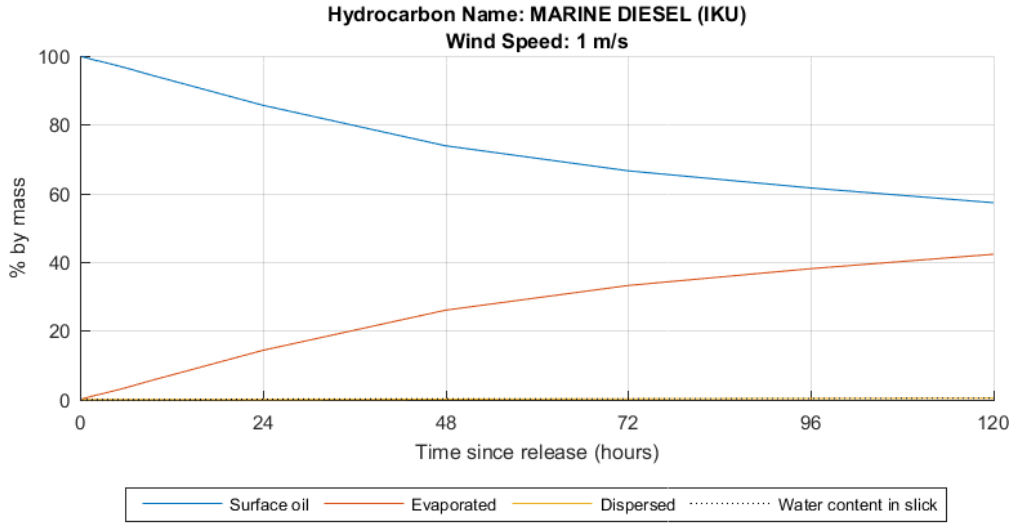
Oil Name	Initial density (g/cm^3) (25°C)	Viscosity (cP) (25 °C)	Component	Volatiles (%)	Semi-volatiles (%)	Low Volatility (%)	Residual (%)	Aromatics (%)
			Boiling Points (°C)	<180 C4 to C10	180-265 C11 to C15	265 – 380 C16 to C20	>380 > C20	Of whole oil < 380 °C BP
				NON-PERSISTENT			PERSISTENT	
Diesel	0.8368 @15°C	3.9 @20°C	% of total	6	34.6	54.4	<5	3.0

Source: APASA (2014a)

7.4.1.3 Marine Diesel Weathering

A preliminary analysis of hydrocarbon weathering for Marine Diesel was undertaken with the SINTEF Oil Weathering Model (OWM) (GHD, 2019). 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 7-1**. 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 (5 days). Under moderate winds (5 m/s), 40% of the initial surface slick is predicted to remain after 24 hours, decreasing further to ~10% after 48 hours and ~1% after 72 hours. With high winds (10 m/s), the surface slick is predicted to be almost entirely evaporated and dispersed after 12 hours. Marine diesel has a very low tendency for emulsion formation with only ~1% water content entrained into the surface slick after 120 hours across the three constant wind assessment conditions.



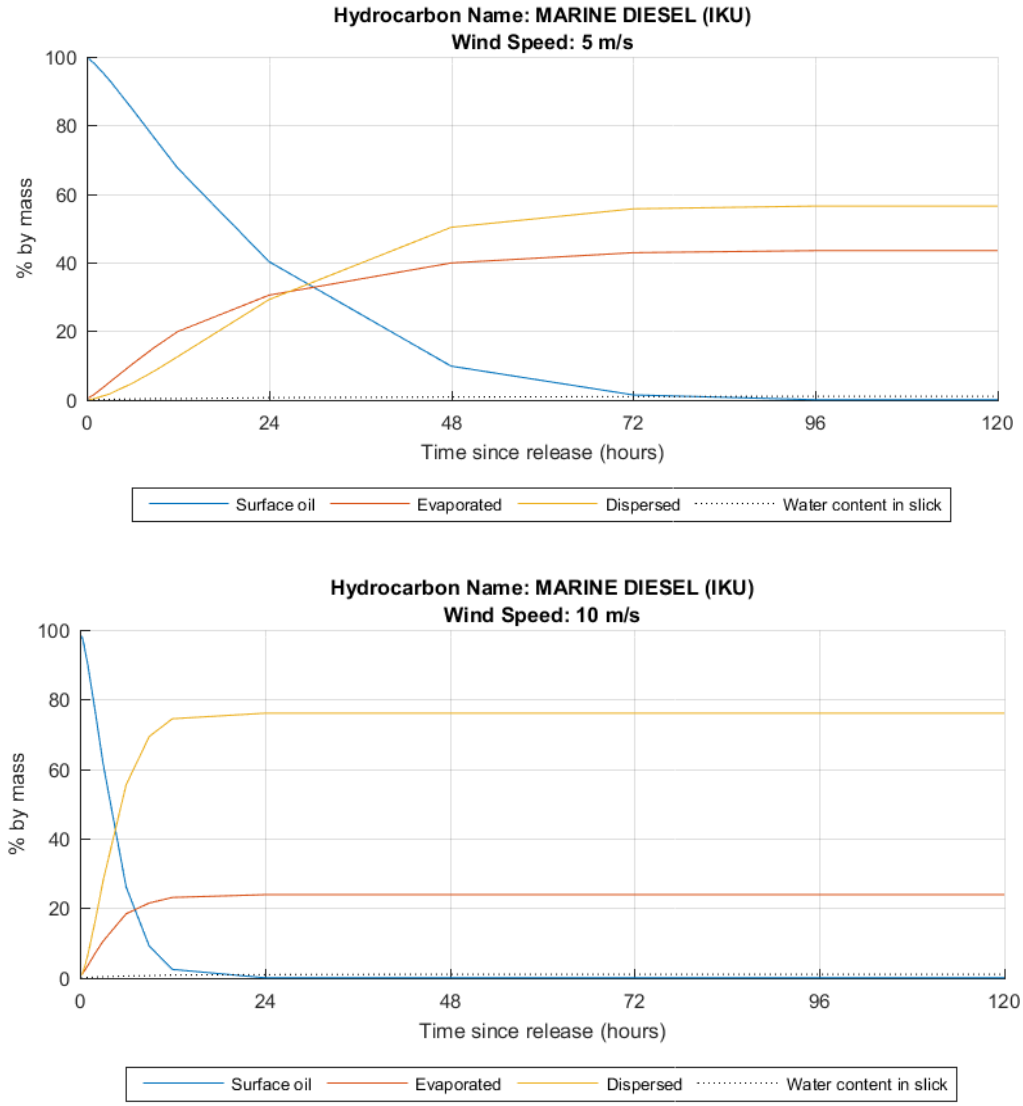


Figure 7-1: Simulated weathering of the SINTEF Marine Diesel (IKU) hydrocarbon for constant wind speeds of 1 m/s (top), 5 m/s (middle) and 10 m/s (bottom)

7.4.1.4 Exposure Values

The outputs of the quantitative hydrocarbon spill modelling are used to assess the environmental risk, if a credible hydrocarbon spill scenario occurred, by defining which areas of the marine environment could be exposed to hydrocarbon levels exceeding exposure values that may result in impact to sensitive receptors. The degree of impact will depend on the sensitivity of the biota contacted, the duration of the contact (exposure) and the toxicity of the hydrocarbon mixture making the contact. The toxicity of a hydrocarbon will change over time, due to weathering processes altering the composition of the hydrocarbon.

The modelling considered four key physical or chemical phases of hydrocarbons that pose differing environmental and socioeconomic risks: surface hydrocarbons, total water accommodated fraction (WAF; or entrained hydrocarbons), dissolved water-accommodated fraction and shoreline accumulated hydrocarbons. The modelling used defined hydrocarbon exposure values, as relevant for risk assessment and oil spill planning, for the various hydrocarbon phases. To ensure conservatism in the environmental assessment process, the exposure values applied to the model are selected to adopt the most sensitive receptors that may be exposed, the longest likely exposure times and the more toxic hydrocarbons.

Exposure values applied for surface hydrocarbons, total water accommodated fraction (WAF) hydrocarbons (entrained), dissolved WAF and accumulated hydrocarbons ashore used in the modelling study are summarised in **Table 7-6**. The adopted exposure values are based primarily on the exposure values defined in NOPSEMA Bulletin #1 Oil Spill Modelling (April 2019).

Table 7-6: Summary of the exposure values applied in the GHD (2019) modelling

Exposure Values			Description
Surface hydrocarbons (floating) (g/m^2)	Low	1	**Risk Evaluation (EMBA)** It is recognised that a lower floating oil concentration of 1 g/m^2 (equivalent to a thickness of 0.001 mm or 1 ml of oil per m^2) is visible as a rainbow sheen on the sea surface. Although this is lower than the threshold for ecological impacts, it may be relevant to socio-economic receptors and has been used as the exposure value to define the spatial extent of the environment that might be contacted (EMBA) from floating oil. **Response Planning** Contact at 1 g/m^2 (as predicted by oil spill trajectory modelling) is used as a conservative trigger for activating scientific monitoring plans as detailed in the OPEP.
	Moderate	10	**Risk Evaluation** There is a paucity of data on floating oil concentrations with respect to impacts to marine organisms. Hydrocarbon concentrations for registering biological impacts resulting from contact of surface slicks have been estimated by different researchers at about 10–25 g/m^2 (French et al., 1999; Koops et al., 2004; NOAA, 1996). The impact of floating oil on birds is better understood than on other receptors. A conservative threshold of 10 g/m^2 has been applied for when ecological impacts would commence from surface hydrocarbons (floating oil) in this EP. Although based on birds, this hydrocarbon threshold is also considered appropriate for turtles, sea snakes and marine mammals (NRDAMCME, 1997). **Response Planning** Contact at 10 g/m^2 is estimated minimum threshold for commencing operational and/or scientific monitoring components.
	High	50	**Risk Evaluation** At greater thicknesses the potential for impact of floating oil to wildlife increases. Studies have indicated that a concentration of surface oil 25 g/m^2 or greater would be harmful for all birds that contacted the hydrocarbon slick (Scholten et al. 1996; Koops et al. 2004). This was chosen as a conservative threshold for high impacts due to the foraging (sooty tern), breeding and foraging (lesser frigatebird); and breeding (wedge-tailed shearwater, Australian fairy tern, lesser crested tern, white-tailed tropicbird and roseate tern) that overlap the operational area. **Response Planning** Contact at 25 g/m^2 is not specifically used for spill response planning.
	Low	10	**Risk Evaluation (EMBA)**

Shoreline Hydrocarbons (g/m^2)			An accumulated concentration of oil above 10 g/m^2 on shorelines is considered to represent a level of socio-economic effect (NOPSEMA, 2019), e.g. reduction in visual amentity of shorelines. This value has been used in previous studies to represent a low contact value for interpreting shoreline accumulation modelling results (French-McCay, 2005, 2006). **Response Planning** Not specifically used for response planning because accumulations at this concentration cannot be effectively cleaned.
	Moderate	100	**Risk Evaluation** The impact threshold concentration for exposure to hydrocarbons stranded on shorelines is derived from levels likely to cause adverse impacts to marine or coastal fauna and habitats. These habitats and marine fauna known to use shorelines are most at risk of exposure to shoreline accumulations of oil, due to smothering of intertidal habitats (such as mangroves and emergent coral reefs) and coating of marine fauna. Environmental risk assessment studies (French-McCay, 2009) report that an oil thickness of 0.1 mm (100 g/m^2) on shorelines is assumed as the lethal threshold for invertebrates on hard substrates (rocky, artificial or man-made) and sediments (mud, silt, sand or gravel) in intertidal habitats. Therefore, a conservative exposure value for impacts of 100 g/m^2 has been applied to impacts from shoreline accumulation of hydrocarbons. **Response Planning** A shoreline concentration of 100 g/m^2, or above, is likely to be representative of the minimum limit that the oil can be effectively cleaned according (AMSA, 2015; NOPSEMA, 2019) and is therefore used as a guide for shoreline clean-up planning. This threshold equates to approximately ½ a cup of oil per square metre of shoreline contacted.
	High	1000	**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/m^2 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.
Total water accommodated fraction (entrained) (ppb)	Low	10	**Risk Evaluation (EMBA)** Entrained hydrocarbons, as opposed to DAHs, are oil droplets suspended in the water column and insoluble. Entrained hydrocarbons are not as bioavailable to marine organisms compared to DAHs and on that basis are considered to be a less toxic, especially over shorter exposure time frames. Entrained hydrocarbons still have potential effects on marine organisms through direct contact with exposed tissues and ingestion (NRC, 2005) however the level of exposure causing effects is considered to be considerably higher than for DAHs.

			Much of the published scientific literature does not provide sufficient information to determine if toxicity is caused by entrained hydrocarbons, but rather the toxicity of total oils which includes both dissolved and entrained components. Variations in the methodology of the total water accommodated fraction (TWAF (entrained and dissolved)) may account for much of the observed wide variation in reported threshold values, which also depend on the test organism types, duration of exposure, oil type and the initial oil concentration. Total oil toxicity acute effects of total oil as LC50 for molluscs range from 500 to 2,000 ppb (Clark et al., 2001; Long and Holdway, 2002). A wider range of LC50 values have been reported for species of crustacea and fish from 100 to 258,000,000 ppb (Gulec et al., 1997; Gulec and Holdway, 2000; Clark et al., 2001) and 45 to 465,000,000 ppb (Gulec and Holdway, 2000; Barron et al., 2004), respectively. The 10 ppb threshold represents the very lowest concentration and corresponds generally with the lowest trigger levels for chronic exposure for entrained hydrocarbons in the ANZECC (2019) water quality guidelines. This is consistent with NOPSEMA (2019) guidance. **Response Planning** Contact at 10 ppb (as predicted by oil spill trajectory modelling) is used as a trigger for activating scientific monitoring plans as detailed in the OPEP. Establishes planning area for scientific monitoring based on potential for exceedance of water quality triggers (NOPSEMA, 2019).
	Moderate[1]	100	**Risk Evaluation** The 100 ppb exposure value is considered to be more representative of sub-lethal impacts to most species and lethal impacts to sensitive species based on toxicity testing as described above. This is considered conservative as toxicity to marine organisms from oil is likely to be driven by the more bioavailable dissolved aromatic fraction, which is typically not differentiated from entrained oil in toxicity tests using water accommodated fractions (WAFs). Given entrained oil is expected to have lower toxicity than dissolved aromatics, especially over time periods where these soluble fractions have dissoluted from entrained oil, the higher Moderate exposure value for entrained oil over dissolved aromatic hydrocarbons (100 vs 50 ppb) is considered appropriate. **Response Planning**

[1] The NOPSEMA Bulletin (April 2019) lists 'High' exposure values for entrained and dissolved aromatic hydrocarbons of, 100 ppb and 400 ppb, respectively. Santos considers it inconsistent with the mechanisms of oil toxicity to have a High exposure for DAHs greater than that for entrained oil. For that reason, Santos has used 100 ppb as the 'Moderate' exposure value for entrained oil. This is more aligned with the Moderate exposure value for DAHs of 50 ppb – i.e. it is consistent with the mechanism of toxic effect that a Moderate exposure value for entrained oil would be greater than a Moderate exposure value for DAHs.

			Encompassed by response to 10 ppb. There is nothing different for higher exposure values
	High	-	No high exposure value for entrained.
Dissolved water accommodated fraction (ppb) [1]	Low	10	**Risk Evaluation (EMBA)** Dissolved Aromatic Hydrocarbons include the monoaromatic hydrocarbons (MAHs) (compounds with a single benzene ring such as BTEX [benzene, toluene, ethyl benzene, and xylenes]) and polycyclic aromatic hydrocarbons (PAHs) (compounds with multiple benzene rings such as naphthalenes and phenanthrenes). These compounds have a greater bioavailability that other components of oil and are considered to be main contributors to oil toxicity. The toxicity of DAHs is a function of the concentration and the duration of exposure by sensitive receptors with greater concentration and exposure time causing more sever impacts. Typically tests of toxicity done under laboratory conditions measure toxicity as proportion of test organisms affected (e.g. 50% mortality or LC50) at the end of a set time period, often 48 or 96 hours. French-McCay (2002) in a review of literature, reported LC50 for dissolved PAHs with 96 h exposure, range between 30 ppb for sensitive species (2.5th-percentile species) and 2,260 ppb for insensitive species (97.5th-percentile species), with an average of about 250 ppb. The range of LC50s for PAHs obtained under turbulent conditions (this includes fine oil droplets) was 6 ppb to 410 ppb with an average of 50 ppb (French-McCay, 2002). Further research by Woodside (Woodside 2019) for Balnaves-3 crude undertook laboratory-based ecotoxicology tests across a range of water accommodated fraction to determine the point of "No observed effect Concentrations (NOECs). The lowest NOEC reported is 123 ppb, from the amphipod acute toxicity tests. All other toxicity tests indicated NOECs ranging from 610 to 6640 ppb, with a median value of 2695 ppb. Based on these ecotoxicology tests, the selected dissolved aromatic hydrocarbon threshold of 6 ppb is considered highly conservative. The DAH modelling results used to inform the EMBA and risk assessment outlined within this EP considers instantaneous exposure and therefore applying the literature concentration data for PAH exposure over 96 hours is considered highly conservative. Nevertheless, a threshold of 10 ppb to inform the EMBA as the lowest concentration documented in research that could have some potential negative effect on marine organisms. This is considered to be sub lethal, with most marine organisms a concentration of between 50 and 400 ppb is considered to be more appropriate for risk assessment. **Response Planning** Contact at 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).
	Moderate	50	**Risk Evaluation** Approximates potential toxic effects, particularly sublethal effects to sensitive species (refer to above text). Consistent with NOPSEMA (2019).

			Response Planning Encompassed by response to 6ppb. There is nothing different for higher exposure values.
	High	400	**Risk Evaluation** Approximates toxic effects including lethal effects to sensitive species (NOPSEMA, 2019). **Response Planning** Encompassed by response to 6 ppb. There is nothing different for higher exposure values.

7.4.1.5 Exposure values in relation to EMBA

Hydrocarbon exposure values for surface oil, entrained oil, dissolved aromatic hydrocarbons and hydrocarbons ashore have been used to define the spatial extent of the Environment that May Be Affected (EMBA) (see also **Section 3.1**), as shown in **Table 7-7**.

Table 7-7: Summary of EMBA contact thresholds

Hydrocarbon component	Surface oil concentration (g/m^2)	Entrained oil concentration (ppb)	Dissolved aromatic hydrocarbon concentration (ppb)	Hydrocarbons ashore (g/m^2)
Exposure value	Low	Low	Low	Low
EMBA	1	10	10	10

7.4.1.6 Spill modelling results discussion

Floating oil

A surface slick (> $1g/m^2$) was predicted to extend up to approximately 350 km from the release location. Contact by the surface slick at the > $1g/m^2$ exposure value was predicted at the Montebello Australian Marine Park (99% probability with a minimum arrival time of 0.1 days), Barrow-Montebello Surrounds (21% probability and minimum arrival time of 0.3 days) and Montebello Islands (14% probability and minimum arrival time 0.3 days).

Entrained oil (total water-accommodated fraction (total WAF))

Entrained diesel above 10 ppb was primarily confined within 200 km of the release site with some isolated exceedances up to ~350 km to the southwest. Exceedances of the high exposure value (100 ppb) were predicted up to a maximum of ~160 km to the southwest of the spill location and ~140 km to the northeast.

Exposure to entrained oil above the 100 ppb exposure value was forecasted at a number of receptors including the Montebello AMP (95% probability). Lower contacted probabilities were predicted at Montebello Islands (16% probability) and Barrow-Montebello Surrounds (20% probability).

Dissolved oil (dissolved WAF)

Dissolved diesel above 10 ppb was predicted to occur a maximum distance of ~220 km to the southwest and ~160 km to the northeast. Exceedances at the medium exposure (50 ppb) were predicted up to ~150 km to the southwest and ~110 km to the northeast. Concentrations above the high exposure (400 ppb) value were only predicted in sparse patches within ~50 km of the release location.

Contact above the 50ppb exposure value was predicted at a number of receptors, including Montebello AMP (98% probability), Montebello Islands (16% probability) and Barrow-Montebello Surrounds (22% probability).

Shoreline accumulated oil

Oil accumulation on shorelines above the 10 g/m^2 exposure value was predicted to occur at Montebello Islands at a 24% probability. Lower contact probabilities of 1-6 % were predicted for Dampier Archipelago, Lowendal Islands, Barrow Island, Murion Islands and Ningaloo Coast. Minimum times to shoreline accumulation at these receptors ranged from 0.5 days (Montebello Islands) to 6.1 days (Dampier Archipelago). The average maximum volumes of oil accumulated ashore (exceeding the exposure value) were predicted to be 222 tonnes at the Montebello Islands, 130 tonnes at Barrow Island, 11 tonnes for Lowendal Islands and <0.3 tonnes at Dampier Archipelago, Murion Islands and Ningaloo Coast North.

7.4.1.7 Spill risk assessment approach

The spill risk assessment approach adopted is based on Santos WA's Oil Spill Risk Assessment and Response Planning Procedure (QE-91-II-20003). The procedure describes the spill risk assessment process for marine oil spills as follows:

+ Identify the spatial extent of the environment that may be affected (the EMBA);
+ Identify areas of high environmental value (HEV) within the EMBA;
+ Risk assess areas of HEV with a high probability and level of oil contact (Hotspots); and
+ Identifies priorities for protection.

7.4.1.8 Areas of high environmental value (HEV)

Santos WA has predetermined areas of HEV (**Figure 7-2**) along the Western Australian coastline by ranking these areas based on:

+ Protected area status – This is used as an indicator of the biodiversity values contained within that area, where a World Heritage Area, Ramsar Wetland and Marine Protected Area will score higher than areas with no protection assigned; and
+ BIAs of LTS – These are spatially defined areas where aggregations of individuals of a species are known to display biologically important behaviour, such as breeding, feeding, resting or migration. Each one of these within the predefined areas contributes to the score.

Further input to determine areas of HEV included:

+ Sensitivity of habitats to impact from hydrocarbons in accordance with the guidance document Sensitivity Mapping for Oil Spill Response produced by IPIECA, the International Maritime Organisation and International Association of Oil and Gas Producers;
+ Sensitivities of receptors with respect to hydrocarbon-impact pathways;
+ Status of zones within protected areas (i.e., IUCN (1a) and sanctuary zones compared to IUCN (VI) and multiple use zones);
+ Listed species status and predominant habitat (surface versus subsurface); and
+ Social values, i.e., socio-economic and heritage features (e.g., commercial fishing, recreational fishing, amenities, aquaculture).

Tallied scores for each predefined area along the Western Australian coastline were then ranked from 1 to 5, with an assignment of 1 representing areas of the highest environmental value and those with 5 representing the areas of the lowest environmental value.

7.4.1.9 Hotspots

While the entire EMBA will be considered during risk assessment and spill response planning, it is best practice to concentrate greatest effort and level of detail on those parts of the EMBA that have:

+ The greatest intrinsic environmental value – i.e., HEV areas ranked 1-3;
+ The highest probability of contact by oil (either floating, entrained or dissolved aromatic); and
+ The greatest potential concentration or volume of oil arriving at the area.

These areas are termed 'Hotspots'. Defining Hotspots is typically the first step in undertaking detailed spill risk assessment and spill response planning. Hotspots are a subset of HEV areas that:

+ Have the highest probability of contact (at least higher than 5%) above the impact assessment exposure values for surface hydrocarbons and shoreline accumulation based on modelling results; and
+ Receive the greatest concentration or volume of oil, either floating or stranded oil, entrained oil or dissolved aromatic hydrocarbons above exposure values described in **Section 7.4.1**

7.4.1.10 Priorities for protection

For the purposes of a spill response preparedness strategy, it is not necessary for all Hotspots to have detailed planning. For example, wholly submerged Hotspots may only be contacted by entrained oil, and the response would be largely to implement scientific monitoring to determine impact and recovery. Hotspots with features that are not wholly submerged (i.e. emergent features) should have specific spill response planning conducted. This final determination of 'Priority for Protection' sites, to inform 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. An assessment of each protection priority will be undertaken to determine the most appropriate spill response strategies based on the type of oil and the values of the protection priority area. This is done through a strategic NEBA approach outlined in the OPEP.

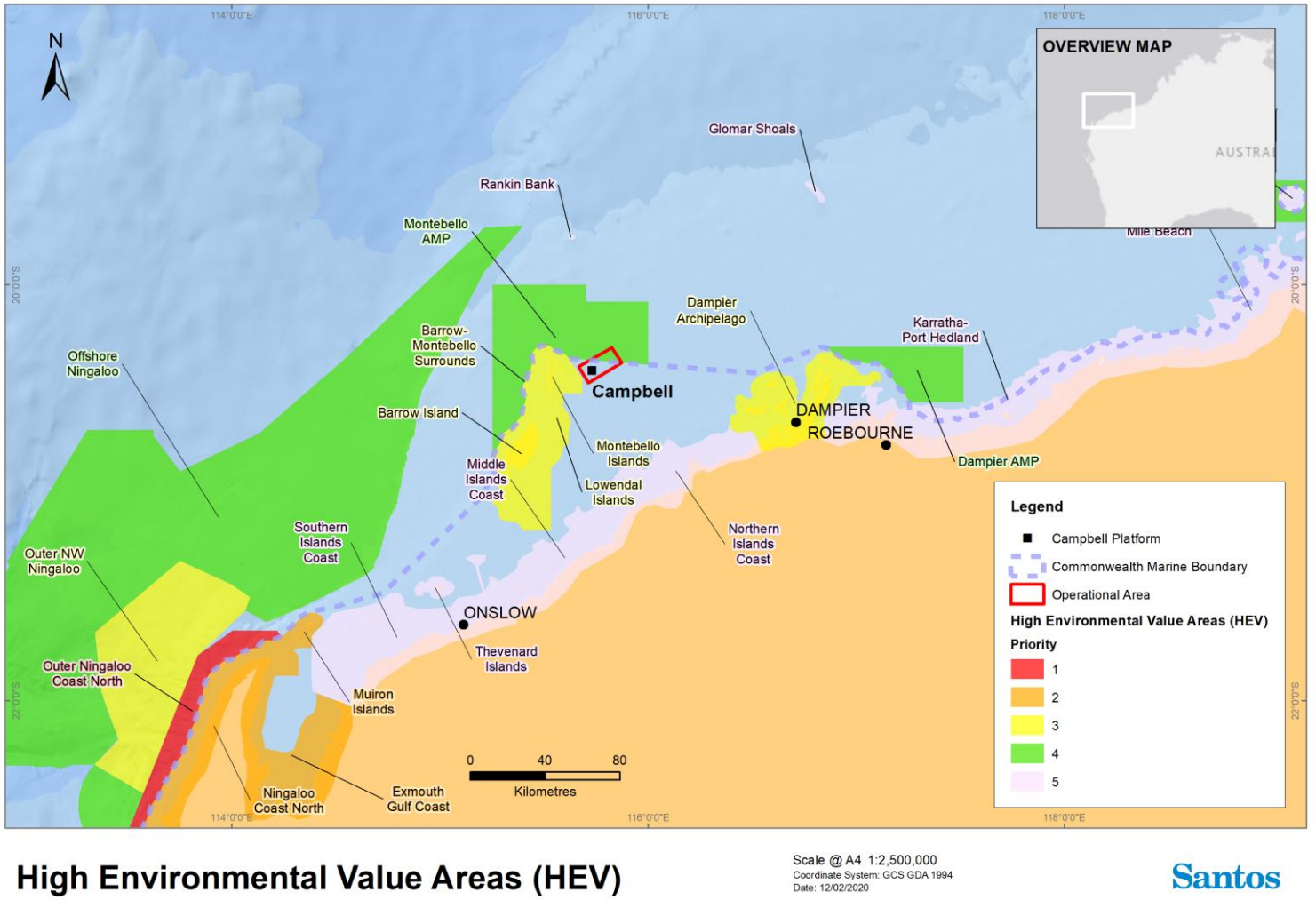


Figure 7-2: HEVs within the EMBA

7.4.2 Nature and scale of environmental impacts

Potential 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, Marine Parks and Commonwealth Heritage Areas) and Socio-economic (commercial, recreational and traditional fisheries, recreation and tourism, oil and gas industry).

Hydrocarbon spills will cause a decline in water quality and may cause chemical (e.g. toxic) and physical impacts to marine species (e.g. coating of emergent habitats, oiling of wildlife at sea surface). 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.

Unplanned hydrocarbon releases to the marine environment, as a result of a vessel collision (diesel) would result in a localised reduction in water quality in the upper surface waters of the water column near the location of the spill. A worst-case surface release from a vessel collision (diesel) would result in a surface slick, above the exposure value of 1 g/m^2 thickness, potentially extending up to 350 km from the release location. Shorelines in which oil accumulation was predicted (above the 10 g/m^2 exposure value) included the Montebello Islands, Lowendal Islands and Barrow Island, with the average maximum volumes ashore ranging from 220 to <0.3 tonnes. The greatest predicted exposure to entrained oil concentrations (> 10 ppb exposure value) and Dissolved WAF (> 10 ppb) resulted from the release of diesel with exposure forecast at the Montebello AMP, Montebello Islands, and Barrow-Montebello Surrounds at worst-case concentrations ranging from 344 ppb to 1,154 ppb for entrained oils, and 290 ppb to 545 ppb for Dissolved WAF.

The potential impact pathways (physical and chemical) of hydrocarbon exposure for receptors and habitats are summarised in **Table 7-8**. Potential impacts to receptors found within the EMBA are further described in **Table 7-9** with respect to an unplanned spill of all hydrocarbons associated with this EP (diesel). A summary is provided below.

Table 7-8: 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, 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.
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	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.

Receptor	Physical pathway	Potential impacts	Chemical pathway	Potential impacts
	the substrate and continual weathering of the oil.			
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 is dependent 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.
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.

Receptor	Physical pathway	Potential impacts	Chemical pathway	Potential impacts
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 dissolved aromatic hydrocarbons across cellular membranes. Reduced mobility and capacity for oxygen exchange.	Mortality. Cell damage. Reduced metabolic capacity. Reduced immune response. Disease. Reduced growth. Reduced reproductive output. Reduced egg/larval success. Growth abnormalities. Behavioural disruption.
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 dissolved aromatic hydrocarbons across cellular membranes (e.g. gills).	Mortality. Cell damage. Flesh taint. Reduced metabolic capacity. Reduced immune response. Disease. Reduced growth. Reduced reproductive output. Reduced egg/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.	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.

Receptor	Physical pathway	Potential impacts	Chemical pathway	Potential impacts
				Reduced growth. Reduced reproductive output. Growth abnormalities. Behavioural disruption.
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.	Behavioural disruption particularly during turtle nesting periods.	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 (i.e. baleen whales).	Behavioural disruption such as deviation from migration pathways and commonly frequented feeding grounds. For smooth skinned marine mammals more susceptible to chemical pathways than physical pathways.	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.
Plankton	Coating of feeding apparatus.	Mortality.	Inhalation. Ingestion.	Mortality.

Receptor	Physical pathway	Potential impacts	Chemical pathway	Potential impacts
	Reduced mobility and capacity for oxygen exchange.	Behavioural disruption (e.g. reduced mobility).	External contact.	Impairment of biological activities (e.g. 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.
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 7-9: Impacts of a diesel spill on receptors found within the EMBA

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 and 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 Montebello Islands. 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 i.e. baleen whales.
	Nine migratory marine mammal species were identified by the PMST. 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 and humpback whale BIAs (**Figure 3-6**). For further information on environmental impacts to marine mammals from hydrocarbon exposure and increased toxicity, refer to **Table 7-8**. 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 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	

Receptor	Impacts of hydrocarbon spills	
	Entrained and dissolved aromatic hydrocarbons in the water column	**Surface hydrocarbons**
	over the Lowendal Shelf. The closest BIA (foraging and nursing) is at Exmouth Gulf and the Ningaloo Coast located approximately 182 km from the operational area. 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 (Commonwealth of Australia, 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.
	Six species of threatened marine reptile were identified as possibly being impacted by a spill. Short-nosed seasnake, flatback, hawksbill, leatherback, green and loggerhead 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 3-7** to **Figure 3-10.** Significant green turtle and flatback turtle rookeries are located on the western side of Barrow Island and on the Montebello Islands respectively. Nesting green turtles have also been observed on Varanus Island. Hawksbill turtles are known to nest in greater numbers of the eastern beaches of Varanus Island. Critical habitat including important nesting beaches for other turtle species are present within the EMBA, including locations where spill modelling indicated the accumulation of hydrocarbons on shorelines. The highest average shoreline accumulations, above the 100 g/m^2 exposure value, were predicted at the Montebello Islands, Lowendal Islands, Barrow Island, Barrow-Montebello Surrounds and the Montebello Australian Marine Park. 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 7-8**.	
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

Receptor	Impacts of hydrocarbon spills	
	Entrained and dissolved aromatic hydrocarbons in the water column	Surface hydrocarbons
		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.
	Five threatened species of seabirds and six threatened species of shorebirds were identified within the EMBA by the PMST (**Table 3-4**). Of these, only 4 species of seabird and 3 species of shorebird were identified within the operational area. The Australian fairy tern (vulnerable status) has foraging habitat intersecting the operational area and a BIA for breeding within the EMBA. Therefore, the species may be impacted by surface and entrained hydrocarbons while foraging (dive and skim feeding) with higher numbers expected during the breeding period of August to February. Other migratory seabird BIAs for breeding and foraging include lesser crested tern, roseate tern and wedge-tailed shearwater, and white-tailed tropicbird (**Figure 3-12**). 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 worst-case slick (diesel spill) could extend up to 350 km from the release location at the 1 g/m^2 exposure value, 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 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 on environmental impacts to seabirds/shorebirds through hydrocarbon exposure and toxicity effects, refer to **Table 7-8.**	

Receptor	Impacts of hydrocarbon spills	
	Entrained and dissolved aromatic hydrocarbons in the water column	**Surface hydrocarbons**
Sharks, Rays and Fish	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 and therefore demersal fish communities (including those associated with the Continental Slope Demersal Fish Communities KEF located approximately 69 km from the operational area) may be exposed. For further information on environmental impacts to fish/sharks/rays from hydrocarbon exposure and toxicity effects, refer to **Table 7-8**.	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. However, for diesel the surface slick may extend up to 350 km from the release location at the 1 g/m^2 exposure value and will weather at the sea surface over time with little entrainment into the water column. 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.
	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, narrow), giant manta ray and reef manta ray which may be present in the EMBA. However, given the absence of critical habitat for most of these species, significant numbers are not expected to be exposed to hydrocarbons in the event of a spill. Grey nurse sharks, white sharks, sawfishes and manta rays 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 3-11** and the main whale shark aggregation location (Ningaloo Marine Park) is 4 km northwest of the operational area. The EPBC Act-listed whale shark may occur in 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 on environmental impacts to fish/sharks/rays from hydrocarbon exposure and toxicity effects, refer to **Table 7-8**.	

Receptor	Impacts of hydrocarbon spills	
	Entrained and dissolved aromatic hydrocarbons in the water column	Surface hydrocarbons
Socio-economic		
Commercial, Recreational and Traditional Fisheries	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.	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 infrastructure.
	A number of commercial fisheries operate within the EMBA (**Section 3.2.4**). 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 (e.g. seagrass meadows, mangrove communities, intertidal mudflats) which may provide nursery habitat for fishery species (e.g. 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 that tainting of fish occurs when fish are exposed to ambient concentrations of 4–300 ppm (4,000-300,000 ppb) of hydrocarbons in the water, for durations of 24 hours or more, with response to phenols and naphthenic acids being the strongest. Given that entrained hydrocarbons are predicted to exceed >1,338 ppb in the scenario of a surface release of marine diesel oil as a result of a vessel collision; **Section7.4.1**), 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. Given the large volume of oil that could potentially be released, it is possible that 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 (e.g. 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. Entrained oil >100 ppb could reach pearl farming activities at the Montebello Islands. Pearl oysters are filter feeders, therefore entrained oil droplets could create negative impacts through ingestion and accumulation of hydrocarbon compounds in oyster tissues or interference with respiratory structures. Ecotox (2009) reported NOEC levels of a comparable oyster species from weathered condensates ranged from approximately 9,000 to 28,000 ppm. Such impacts could lead to sub-lethal (e.g. reduced oyster growth rates, reduced reproductive success) or at worst lethal impacts. Given that dissolved hydrocarbons could reach acutely toxic levels, mortality could occur. Significant impacts on aquaculture would be unlikely as predictive modelling reported that the maximum entrained hydrocarbon concentration for the worst replicate as 864 ppb at Barrow-Montebello Surrounds. Additionally, pearling leases identified in the region are currently inactive and no stakeholder concerns have been raised. However, if these leases were to become active within the life of this EP, then some loss of value to the local industry could occur in the event of a loss of well control/vessel collision resulting in a spill.	

Receptor	Impacts of hydrocarbon spills	
	Entrained and dissolved aromatic hydrocarbons in the water column	Surface hydrocarbons
Recreation and Tourism	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. 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 surface slick 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.	
Shipping	Multiple shipping fairways intersect the EMBA (**Table 3-6**). 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 carried out in the vicinity of operational area is low, and therefore interference of defence activities due to a hydrocarbon spill is expected to be minimal.	
Shipwrecks	As described in **Section 3.2.4**, a number of shipwreck sites have been recorded in the EMBA with the closest located approximately 10 km west of the operational area and on the north-eastern side of the Montebello Islands (*Plym HMS*). 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 hundreds of kilometres from the release location. The potential for in-water hydrocarbons to impact on shipwrecks is poorly documented however it has been proposed that exposure to oil and/or dispersant may alter bacterial community composition (biofilms) inhabiting shipwrecks possibly altering corrosion potential (Salerno *et al* 2016).	
Indigenous users	Marine resource use by Indigenous people is generally restricted to coastal waters. Fishing, hunting and the maintenance of maritime 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 given that no native title claims, ethnographic or archaeological sites or records of aboriginal occupation are listed for the Montebello Islands or the surrounding marine waters of the nearby islands (**Section 3**). Therefore, interference due to a hydrocarbon spill are expected to be minimal.	
Existing oil and gas activity	A number of oil and gas operators operate within the EMBA with existing projects and infrastructure in place as well as continuing drilling and exploration programs. A 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. Chevron's Gorgon and WA Oil operations on Barrow Island, and Santos' other activities may be impacted in the event of an unplanned spill event through exclusion or access restrictions in the event of spill response/clean-up activities (if applicable).	

Receptor	Impacts of hydrocarbon spills	
	Entrained and dissolved aromatic hydrocarbons in the water column	Surface hydrocarbons
Protected Areas		
Marine Parks and Commonwealth Heritage Areas	Protected areas are described in **Section 3.1**, and are summarised below. These areas provide key habitats that support an array of marine flora and fauna along with unique natural phenomena. Ningaloo Coast World Heritage Area and National Heritage Place Includes important and significant natural habitats for in situ conservation of biological diversity including threatened species. Significant geomorphic features, natural phenomena and areas of exceptional natural beauty. Dampier Archipelago (including the Burrup Peninsula) Commonwealth Heritage Area Contains a diverse array of Aboriginal heritage including dreaming sites, ceremonial sites, rock engravings and archaeological sites. It is of exceptional heritage interest for its diverse array of rock engravings and stone arrangements and the importance of these within the Aboriginal traditions of Ngarda-Ngarli peoples. Australian Marine Parks (AMPs): Montebello, Ningaloo, Gascoyne, Argo-Rowley Terrace, Dampier, Carnarvon Canyon, Shark Bay, Eighty Mile Beach AMPs Includes habitat for foraging and migratory seabirds, foraging/breeding area for marine turtles, migrating humpback whales and blue whales, foraging sharks, sea floor habitats. State Marine Parks and Marine Management Areas: Barrow Island Marine Park, Barrow Island Marine Management Area, Montebello Islands Marine Park and Muiron Islands Marine Management Area Includes foraging and nesting areas for marine turtles, and feeding/resting/breeding areas for seabirds and migratory shorebirds. Includes shallow water and shoreline habitats that support a range of marine fauna and flora species, including those of conservation significance.	
	These parks 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 listed above may also support nursery/feeding/aggregation areas for fisheries species and therefore may assist in maintaining healthy fish stocks and commercial/recreational fisheries.	
KEFs	KEFs overlapping the EMBA are described in **Section 3**, and are summarised below: Ancient Coastline at 125m Depth Contour Contributes to higher diversity and enhanced species richness relative to soft sediment habitat. Attracts opportunistic feeding by larger marine life including humpback whales, whale sharks and large pelagic fish. Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula	

Receptor	Impacts of hydrocarbon spills	
	Entrained and dissolved aromatic hydrocarbons in the water column	Surface hydrocarbons
	Supports the productivity and species richness of Ningaloo Reef. Continental Slope Demersal Fish Communities Provides important habitat for demersal fish communities, characterised by high endemism and species diversity. Glomar Shoal Provides important habitats for a number of commercial and recreational fish species.	
	While the features associated with the KEFs are subtidal and will 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. In the case of Continental Slope Demersal Fish Communities, the planktonic eggs and larvae of these demersal fish communities may be impacted by a spill.	

7.4.3 Environmental performance outcomes and control measures

EPOs relating to this hazard include:

+ No loss of containment of hydrocarbon to the marine environment (EPO-8).

Control measures applied to prevent an oil spill are shown in **Table 7-10** and corresponding EPSs and measurement criteria are described in **Section 8.4**.

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 7-10: Accidental release of hydrocarbons – Control Measure Evaluation

CM reference	Control measure	Environmental benefit	Potential cost/issues	Evaluation
CM-02	Constant bridge watch on survey vessel	Minimises risk of collision through visual identification and avoidance of other vessels	Negligible costs	**Adopted -** - Benefits considered to outweigh costs
CM-03	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.
CM-09	Seafarer Competency and 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.

CM reference	Control measure	Environmental benefit	Potential cost/issues	Evaluation
CM-20	Vessel spill response plans (SOPEP)	Implements response plans on board vessels to deal with unplanned hydrocarbon releases and spills quickly and efficiently in order to reduce impacts to the marine environment.	Administrative costs of preparing documents. Generally undertaken by vessel contractor so time for Santos WA personal to confirm and check SOPEP in place.	**Adopted** – Benefits considered to outweigh costs.
CM-21	Accepted Oil pollution emergency plan (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** – Benefits of ensuring procedures are followed and measures implemented and that the vessels are compliant, outweighs the costs. Regulatory requirement must be adopted.
CM-22	Marine assurance standard	Ensures vessels meet Marine assurance standards to reduce the likelihood of unplanned discharges	Costs associated with personnel time in checking vessel.	**Adopted** – Benefits of ensuring procedures are followed and measures implemented and that the vessels are compliant, outweighs the costs. Regulatory requirement must be adopted.
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

7.4.4 Environmental Impact Assessment

Description	
Key Receptors	Physical environment - water quality, Shallow benthic, intertidal and shoreline habitats

Description	
	Threatened/migratory fauna - plankton, invertebrates, marine mammals, marine reptiles, sharks, rays and fish, birds (seabirds and shorebirds) Protected Areas - KEFs, Marine Parks and Commonwealth Heritage Areas Socio-economic - commercial, recreational and traditional fisheries, recreation and tourism, oil and gas industry).
Consequence	D - Major

A summary of the consequence assessment for each receptor category is presented below.

Physical environment and habitats

Exposure of nearshore environments to entrained oils and DAHs has the potential to impact intertidal habitats including benthic coral reefs and mangrove areas which may result in a long-term decrease in ecological values given toxicity impacts associated with hydrocarbon exposure (**Table 7-8** and **Table 7-9**). Additionally, emergent features may also be impacted by the presence of floating oil at the sea surface resulting in impacts due to coating or smothering.

The consequence assessment undertaken at selected Hotspot areas (refer **Section 7.4.4**) revealed that the worst-case consequence to the physical environment and habitats from a vessel collision resulting in a worst-case accidental hydrocarbon release was ranked as a D – Major.

Threatened/migratory fauna

Habitat modification/degradation/disruption/loss, deteriorating water quality and marine pollution are identified as potential threats to a number of marine fauna species in relevant Recovery Plans and Conservation Advice (**Table 3-5**). Potential impact pathways (physical and chemical) of hydrocarbon exposure for receptors are summarised in **Table 7-8**, and potential impacts to receptors found within the EMBA are further described in **Table 7-9**.

The potential pathways and impacts to marine fauna through hydrocarbon exposure and potential toxicity effects are summarised in **Table 7-8**. Transient fauna traversing the area may also be potentially impacted by a spill through exposure to floating oil, entrained or DAHs. The potential impacts to transient receptors due to the presence of surface and water column hydrocarbons are summarised in **Table 7-9**.

The potential impacts of a hydrocarbon release on seabird breeding and feeding areas are discussed in **Table 7-9**.

The consequence assessment undertaken at selected Hotspot areas (refer **Section 7.4.4**) revealed that the worst-case consequence to threatened/migratory fauna from a vessel collision was ranked as a D – Major.

Protected areas

The EMBA intersects several Marine Parks, AMPs, Commonwealth Heritage Areas and marine management areas (**Section 3.1**). 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.

The consequence assessment undertaken at selected Hotspot areas (refer **Section 7.4.4**) revealed that the worst-case consequence to protected areas from a vessel collision resulting in a worst-case accidental hydrocarbon release was ranked as a D – Major.

Socio-economic receptors

There is the potential temporary disruption to fishing activities if the surface slick or entrained oil and DAH plume moves through fishing areas (**Table 3-7**).

It is possible that 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 that tainting of fish occurs when fish are exposed to ambient concentrations of 4–300 ppm (4,000-300,000 ppb) of hydrocarbons in the water, for durations of 24 hours or more, with response to phenols and naphthenic acids being the strongest.

Description	
Given the large volume of oil that could potentially be released, it is possible that 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 Lowendal, Barrow and Montebello Islands and could occur through direct impacts to fish or to fish habitats (e.g. seagrass, coral reef, mangrove habitats). Entrained and surface oil could impact pearl farming activities at the Montebello Islands. Given that pearl oysters are filter feeders, entrained oil droplets could create negative impacts through ingestion and accumulation of hydrocarbon compounds in oyster tissues or interference with respiratory structures. Such impacts could lead to sub-lethal (e.g. reduced oyster growth rates, reduced reproductive success) or at worst lethal impacts. Given that dissolved hydrocarbons could reach acutely toxic levels, mortality could occur. A number of oil and gas operators operate within the EMBA with existing projects and infrastructure in place as well as continuing drilling and exploration programs (**Table 3-7**). 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 7-8** and **Table 7-9**. The consequence assessment undertaken at selected Hotspot areas (refer **Section 7.4.4**) revealed that the worst-case consequence to socio-economic receptors from a vessel collision resulting in a worst-case accidental hydrocarbon release, was ranked as a D – Major.	
Likelihood	2 – Very 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 10 to 20 years. With the proposed control measures in place to prevent releases, any decline in local populations or degradation of habitats is considered very likely 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 Very Unlikely.	
Residual Risk	The residual risk associated with this hazard is Medium.

7.4.4.1 Hotspot Consequence Assessment

Using the process described in **Section 7.4.1**, areas of High Environmental Value within the EMBA were identified, as listed below.

- Barrow Island
- Barrow-Montebello Surrounds
- Dampier AMP
- Dampier Archipelago
- Glomar Shoals
- Lowendal Islands
- Montebello AMP
- Montebello Islands
- Muiron Islands
- Ningaloo Coast North
- Offshore Ningaloo
- Outer Ningaloo Coast North
- Outer NW Ningaloo

The values and sensitivities associated with these HEVs have been described in **Appendix B - Description of the Existing Environment.**

The process (from **Section 7.4.1**) identified the following Hotspots:

- Montebello Islands;
- Barrow Island;
- Lowendal Islands
- Barrow-Montebello Surrounds

Table 7-11 provides a summary of the consequence assessment results for each of the Hotspot areas. The consequence assessment was based on predicted contact and concentration of floating oil, accumulated oil, entrained oil and dissolved aromatic hydrocarbons (DAHs). For each Hotspot area the consequence to the key values were assessed using the methodology described in **Section 7.4.4**.

Table 7-11: Hotspot consequence assessment results from worst case vessel collision spills

Receptor (Hotspot) Name	HEV Ranking	Values	Oil Spill Modelling Parameter		Diesel 359 m^3	Consequence Category	Consequence Ranking	Total
Montebello Islands	3	<u>Habitats</u> Reefs - coral spawning: Mar & Oct Algae (40%) Mangroves (globally unique as offshore) Fish habitat Intertidal sand flat communities Mangroves are considered globally unique <u>Turtles</u> Loggerhead and green (significant rookery), hawksbill, flatback turtles - Loggerhead turtle nesting: Dec-Jan, Green turtle nesting: Nov- to Apr. Peak period from Jan-Feb, Flatback turtle nesting: Dec-Jan, Hawksbill turtle nesting: Oct-Jan Northwest and Eastern Trimouille Islands (hawksbill) Western Reef and Southern Bay at Northwest Island (green) <u>Seabirds</u> Migratory and threatened seabirds – 14 species Significant nesting (Sept-Feb), foraging and resting areas <u>Whales</u> Humpback (Jun-Jul) / Pygmy blue (Apr-Aug) whale migration <u>Socio-Economic</u> Pearling (inactive/pearling zones)	*Probability of contact by floating oil at 10 g/m^2*	*(%)*	14.2	+ Threatened / Migratory Fauna + Physical Environment/ Habitat + Protected Areas + Socio-Economic Receptors	D D D D	D
			Minimum time to contact by floating oil 10 g/m^2	*Time (days)*	0.3			
			Maximum oil loading on shorelines >10g/m^2	*tonnes*	221.7			
			Maximum accumulated concentration >100g/m^2	*g/m^2*	18,935.2			
			Maximum length of shoreline oiled (>100 g/m^2)	*(km)*	14.1			
			Maximum concentration of entrained oil >100 ppb	*(ppb)*	344.2			
			Maximum concentration of dissolved	*(ppb)*	260.2			

Receptor (Hotspot) Name	HEV Ranking	Values	Oil Spill Modelling Parameter		Diesel 359 m^3	Consequence Category	Consequence Ranking	Total
		Very significant for recreational fishing and charter boat tourism Social amenities and other tourism Nominated place (National heritage)	*hydrocarbon >10 ppb*					
Barrow Island	3	<u>Habitats</u> Bandicoot Bay - conservation area Fisheries Act (benthic fauna/seabird protection), mudflats, rock platforms, mangroves, clay pans Mangroves are in Bandicoot Bay (considered globally unique) Coral reefs (eastern side) - Biggada Reef (Coral spawning: Mar & Oct) Biggada Creek <u>Turtles</u> Regionally and nationally significant green turtle (western side) and flatback turtle (eastern side) nesting beaches Turtle Bay north beach North and west coasts - John Wayne Beach also loggerhead and hawksbill turtles. Peak turtle nesting periods - Loggerhead turtle nesting: Dec-Jan, Green turtle nesting: Nov- to Apr. Peak period from Jan-Feb, Flatback turtle nesting: Dec-Jan, Hawksbill turtle nesting: Oct-Jan <u>Seabirds</u> Migratory birds (important habitat) (important bird area) 10th of top 147 bird sites.	*Probability of contact by floating oil at 10 g/m^2*	*(%)*	3.3	+ Threatened / Migratory Fauna + Physical Environment/ Habitat + Protected Areas + Socio-Economic Receptors	D D D C	D
			Minimum time to contact by floating oil 10 g/m^2	*Time (days)*	2.4			
			Maximum oil loading on shorelines >10 g/m^2	*tonnes*	130.8			
			Maximum accumulated concentration >100g/m^2	*m^2*	18,890.3			
			Maximum length of shoreline oiled <u>(>100 g/m^2)</u>	*(km)*	11			

Receptor (Hotspot) Name	HEV Ranking	Values	Oil Spill Modelling Parameter		Diesel 359 m^3	Consequence Category	Consequence Ranking	Total
		Highest population of migratory birds in BI Nature reserve (south-south east island). Double island important bird nesting (shearwaters, sea eagles). <u>Whales</u> Pygmy blue whale northern migration (Apr -Aug) <u>Cultural Heritage</u> Important Aboriginal cultural 13 listed sites incl. (pearling camps) <u>Socio-Economic</u> Significant for recreational fishing and charter boat tourism Nominated place (National heritage)	*Maximum concentration of entrained oil >100 ppb*	*(ppb)*	340.7			
			Maximum concentration of dissolved hydrocarbon >10 ppb	*(ppb)*	86.8			
Lowendal Islands	3	<u>Habitats</u> Important shallow lagoons with seagrass for dugongs Deep water benthic (soft sediment) habitats Dugong and batman reef Mangroves are considered globally unique as they are offshore Macro algal reefs (40%) <u>Turtles</u> Important hawksbill (Beacon, Parakeelya, Kaia and Pipeline), Loggerhead and green turtle nesting (minor) Nesting is reported to occur throughout the year in WA, peaking between October and January	*Probability of contact by floating oil at 10 g/m^2*	*(%)*	2.5	+ Threatened / Migratory Fauna + Physical Environment/ Habitat + Protected Areas + Socio-Economic Receptors	D D D C	
			Minimum time to contact by floating oil 10 g/m^2	*Time (days)*	1.3			
			Maximum oil loading on shorelines >10 g/m^2	*tonnes*	10.6			
			Maximum accumulated concentration >100g/m^2	*m^2*	3,743.8			

Receptor (Hotspot) Name	HEV Ranking	Values	Oil Spill Modelling Parameter		Diesel 359 m^3	Consequence Category	Consequence Ranking	Total
		Significant Flatback rookery , nesting season for Flatback turtles peaks in December and January with subsequent peak hatchling emergence in February and March Seabirds Approximately 89 species of avifauna, 12 -14 species of migratory and seabirds Marine mammals Seagrass beds around the Lowendal islands thought to provide valuable food source for dugongs Protected Areas The Barrow Island Marine Management Area most of the waters around Barrow Island, the Lowendal Islands and the Barrow Island Marine Park. Socio-economic and Heritage values Social amenities and other tourism, Very significant for recreational fishing and charter boat tourism	*Maximum length of shoreline oiled (>100 g/m^2)*	*(km)*	2.8			
			Maximum concentration of entrained oil >100 ppb	*(ppb)*	293.2			
			Maximum concentration of dissolved aromatic hydrocarbon >10 ppb	*(ppb)*	176.8			
	3	Habitats Coral reefs habitat Seabirds Migratory birds Whales Humpback/ pygmy blue whale migration Socio-economic Significant for recreational fishing and charter boat tourism	*Probability of contact by floating oil at 10 g/m^2*	*(%)*	20.8	+ Threatened / Migratory Fauna + Physical Habitat + Protected Areas + Socio-economic Receptors	C D D	D
			Minimum time to contact by floating oil 10 g/m^2	*Time (days)*	0.3			
			Maximum oil loading on	*tonnes*	N/A			

Receptor (Hotspot) Name	HEV Ranking	Values	Oil Spill Modelling Parameter		Diesel 359 m^3	Consequence Category	Consequence Ranking	Total
Barrow – Montebello Surrounds[2]			*shorelines >10g/m^2*				B	
			Maximum accumulated concentration >100g/m^2	*g/m^2*	NA			
			Maximum length of shoreline oiled (>100 g/m^2)	*(km)*	NA			
			Maximum concentration of entrained oil >100 ppb	*(ppb)*	864.3			
			Maximum concentration of dissolved hydrocarbon >10 ppb	*(ppb)*	354.4			

[2] Barrow Island Shoals, within the Barrow-Montebello Surrounds is only emergent at lowest astronomical tide. Therefore, this receptor is considered a submerged feature.

7.4.5 Demonstration of ALARP

The use of the survey vessel is integral to activity and therefore vessels and associated risks of unplanned hydrocarbon releases, cannot be completely eliminated.

Given the short duration of the survey, offshore refuelling will not be undertaken.

The combination of the standard prevention control measures (**Section 7.4.3**) (which reduce the likelihood of the event happening), and the spill response strategies (which may reduce the consequence) together reduce the overall hydrocarbon spill risk.

No additional controls have been identified and given the controls in place detailed above, the assessed residual risk for this impact is medium 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 WA 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 control measures is presented in the OPEP (SO-91-RI-20058.02).

7.4.6 Acceptability evaluation

Is the risk ranked between Low to Medium?	Yes – residual risk is ranked as Medium.
Is further information required in the consequence assessment?	No – potential impacts and risks are well understood through the information available.
Are the activities and their risks and impacts consistent with the principles of ESD?	Yes – aligns with the principles of ecologically sustainable development where these natural resources are used in a sustainable manner with environmental and economic considerations factored into decision making.
Are performance standards consistent with industry standards, legal and regulatory requirements, including protected matters?	Yes – management consistent with the OPGGS(E)R and the P(SL)(E)R. Santos WA has considered the values and sensitivities of the receiving environment including, but not limited to: + Conservation values of the Montebello Australian Marine Park, the Barrow Island Marine Park and Management Area and Montebello Marine Park; + Relevant species Recovery Plans, Conservation Management Plans and management actions including but not limited to: Recovery Plan for Marine Turtles in Australia (Commonwealth of Australia 2017), Approved Conservation Advice for *Megaptera novaeangliae* (humpback whale) and Approved Conservation Advice for *Rhincodon typus* (whale shark).
Are risks and impacts consistent with Santos WA Environmental Management Policy?	Yes – aligns with Santos WA Environmental Management Policy
Are risks and impacts consistent with stakeholder expectations?	Yes – no concerns raised.
Are performance standards such that the impact or risk is considered to be ALARP?	Yes – see ALARP assessment above.

8 Implementation strategy

OPGGS(E)R 2009 Requirements
Regulation 14(1)
The environment plan must contain an implementation strategy for the activity in accordance with this regulation.

P(SL) (E) Regs 2012 Requirements
Regulation 15(1)
The environment plan must contain an implementation strategy for the activity in accordance with this regulation.

The specific measures and arrangements that will be implemented in the event of an oil pollution emergency are detailed within the oil pollution emergency plan (OPEP).

Stakeholder engagement is assessed separately for the requirements of the Reindeer activities. Ongoing stakeholder management strategies are discussed in **Section 4**.

8.1 Environmental management system

OPGGS(E)R 2009 Requirements
Regulation 14(3)
The implementation strategy must contain a description of the environmental management system for the activity, including specific measures to be used to ensure that, for the duration of the activity: (a) the environmental impacts and risks of the activity continue to be identified and reduced to a level that is as low as reasonably practicable; and (b) control measures detailed in the environment plan are effective in reducing the environmental impacts and risks of the activity to as low as reasonably practicable and an acceptable level; and (c) environmental performance outcomes and standards set out in the environment plan are being met.

P(SL)(E)R 2012 Requirements
Regulation 15(3)
The implementation strategy must identify the specific systems, practices and procedures to be used to ensure that: (a) The environmental impacts and environmental risks of the petroleum activity are continuously reduced to as low as is reasonably practicable; and (b) The environmental performance objectives and environmental performance standards in the environment plan are met.

The Santos WA management system exists to support its ethical, professional and legal obligations to undertake work in a manner that does not cause harm to people or the environment. The management system is a framework of policies, standards, processes, procedures, tools and control measures that, when used together by a properly resourced and competent organisation, result in these outcomes:

A common HSE approach is followed across the organisation;

+ HSE is proactively managed and maintained;
+ The mandatory requirements of HSE management are implemented and are auditable;
+ HSE management performance is measured and corrective actions are taken;
+ Opportunities for improvement are recognised and implemented; and
+ Workforce commitments are understood and demonstrated.

This implementation strategy is designed to meet the requirements of the EP to ensure that:

+ Environmental impacts and risks continue to be identified for the duration of the activity and reduced to ALARP;
+ Control measures are effective in reducing environmental impacts and risks to ALARP and acceptable levels;
+ Environmental performance outcomes and standards set out in this EP are met; and
+ Stakeholder consultation is maintained throughout the activity as appropriate.

8.2 Environmental Management Policy

Santos WA's Environmental Management Policy (**Appendix A1**) clearly sets out Santos WA's strategic environmental objectives and the commitment of the management team to continuous environmental performance improvement. This EP has been prepared in accordance with the fundamentals of this policy. By accepting employment with Santos WA, each employee and contractor is made aware during the recruitment process that he or she is responsible for the application of this policy.

8.3 Hazard identification, risk and impact assessment and controls

Hazards and associated environmental risks and impacts for the proposed activities have been systematically identified and assessed in this EP (refer to **Sections 6** and **7**). The control measures and EPSs that will be implemented to manage the identified risks and impacts, and the EPOs that will be achieved, are detailed in **Section 8.4**.

To ensure that environmental risks and impacts remain acceptable and ALARP during the activity and for the duration of this EP, hazards will continue to be identified, assessed and controlled as described in Document Management (**Section 8.10**) and Audits and Inspections (**Section 8.11**).

Any new, or proposed amendment to a control measure, EPS or EPO will be managed in accordance with the MoC procedure (**Section 8.10.2**).

Oil spill response control measures and EPSs and EPOs are listed in the OPEP.

8.4 Environmental performance

To ensure environmental risks and impacts will be of an acceptable level, EPOs have been defined and are listed in **Table 8-1** for planned activities, those relating to oil spill response are listed in the OPEP.

Table 8-1: Environmental Performance Outcomes

Reference	Environmental Performance Outcomes
EPO-1	No injury or mortality to EPBC Act and WA Biodiversity Conservation Act 2016 listed fauna during activities
EPO-2	Reduce impacts to marine fauna from lighting on vessels through limiting lighting to that required by safety and navigational lighting requirements
EPO-3	Reduce impacts to air and water quality from planned discharges and emissions from the activities
EPO-4	Seabed disturbance is limited to the extent required for sampling
EPO-5	Reduce impacts on other marine users through the provision of information to relevant stakeholders such that they are able to plan for their activities and avoid unexpected interference
EPO-6	No unplanned objects, emissions or discharges to sea or air
EPO-7	No introduction of marine pest species
EPO-8	No loss of containment of hydrocarbon to the marine environment

8.4.1 Control measures and environmental performance

OPGGS(E)R 2009 Requirements
Regulation 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.

P(SL)(E)R 2012 Requirements
Regulation 14(5)
The environment plan must include – (a) environmental performance standards — (i) that state the performance required of persons, equipment and procedures for the purposes of managing the environmental impacts and environmental risks of the petroleum activity; and (ii) against which the performance of the operator in meeting the environmental performance objectives in the environment plan, can be measured; (b) measurement criteria for the purposes of determining whether — (i) the environmental performance objectives and environmental performance standards in the environment plan have been met; and (ii) the implementation strategy in the environment plan has been complied with.

The control measures that will be used to manage identified environmental impacts and risks and the associated statements of performance required of the control measure (i.e., EPSs) are listed in **Table 8-2.** Measurement criteria outlining how compliance with the control measure and the expected environmental performance could be evidenced are also listed.

All control measures and EPS and associated measurement criteria relating to preparedness and response operations are contained within the Yoorn-1 Geophysical Survey Oil Pollution Emergency Plan (SO-91-RI-20058.02).

Table 8-2: Control measures and environmental performance standards for the proposed activity

Control Measures	CM Reference No.	Environmental Performance Standard	EPS Reference No.	Measurement Criteria	Performance Objective Reference	Section
Procedure for interacting with marine fauna	CM-01	Survey vessel complies with Santos WA's Protected Marine Fauna Interaction and Sighting Procedure (EA-91-II-00003) which ensures compliance with Part 8 of the Environment Protection and Biodiversity Conservation Regulations 2000 which include controls for minimising the risk of collision with marine fauna such as: - The application of cautionary zones and no approach zones for marine mammals, whale sharks and turtles; - Directives on vessel speeds within cautionary zones; - Helicopter and aircraft requirements such as approach distances and direction and no hovering zones; and - Guidance for sighting, recording and reporting of marine fauna.	CM-01-EPS-01	Statement of conformance, which demonstrates that the contractor is aware of the requirements of the Protected Marine Fauna Interaction and Sighting Procedure (EA-91-11-00003) and commits to meeting them during the activity. Marine fauna observation records are maintained.	EPO-1	Section 6.1 Section 7.3
Constant bridge watch on survey vessel	CM-02	Monitoring of surrounding marine environment is undertaken from vessel bridge.	CM-02-EPS-01	Records show that 24 hour bridge watch was maintained	EPO-1 EPO-5	Section 6.1 Section 6.5 Section 7.3
		Avoid active commercial fishing vessels and schooling fish in the vicinity of commercial fishing activities	CM-02-EPS-02	Vessel log documents changes to vessel survey as applicable	EPO-5	Section 6.5
Lighting will be used as required for safe work conditions and navigational purposes.	CM-03	Survey vessel navigation lighting and equipment is compliant with COLREGS / Marine Orders Part 30: Prevention of Collisions, and with Marine Orders Part 21: Safety of Navigation and Emergency Procedures to minimise collision risk.	CM-03-EPS-01	Vessel certification confirms compliance with applicable regulations	EPO-2	Section 6.2 Section 6.3 Section 6.5 Section 7.4
		Premobilisation review of lighting on vessel is undertaken prior to activities commencing to confirm only necessary lighting for safety and navigation, including, where feasible, orientation to reduce light spill on the water	CM-03-EPS-02	Documented premobilisation review confirms lighting restricted to that necessary for safety and navigation.	EPO-2	Section 6.2
Vessel planned maintenance system	CM-04	Documented maintenance program is in place for equipment that provides a status on the maintenance of equipment to ensure equipment is working efficiently and operating within its parameters.	CM-04-EPS-01	Vessels have records that demonstrate maintenance is performed as per the vessel's planned maintenance system requirements.	EPO-3	Section 6.3
Fuel oil management	CM-05	MARPOL-compliant (Marine Order 97) fuel oil (diesel) will be used during the activity	CM-05-EPS-01	Fuel bunkering records and/or relevant purchase records show that compliant fuel oil was used	EPO-3	Section 6.3
		IFO or HFO will not be used during the activity	CM-05-EPS-02	Fuel bunkering records and/or relevant purchase records show that compliant fuel oil was used	EPO-3	
		No vessel-to-vessel refuelling within the operational area.	CM-05-EPS-03	Fuel bunkering records confirms no vessel to vessel refuelling undertaken during the activity	EPO-3	
International Air Pollution Prevention Certificate	CM-06	Pursuant to Marine Order 97, the vessel will maintain a current International Air Pollution Prevention Certificate, which certifies that measures to prevent ozone-depleting substance (ODS) emissions, and reduce NOx, SOx, and incineration emissions during the activity are in place.	CM-06-EPS-01	Current International Air Pollution Prevention Certificate (if required for the vessel class under Marine Order 97)	EPO-3	Section 6.3
Waste incineration management	CM-07	Waste incineration on the vessel is managed in accordance with Marine Order 97.	CM-07-EPS-01	Completed waste record book or recording system confirms compliance with requirements during the activity	EPO-3	Section 6.3 Section 7.4

Control Measures	CM Reference No.	Environmental Performance Standard	EPS Reference No.	Measurement Criteria	Performance Objective Reference	Section
No anchoring, unless in an emergency	CM-08	No anchoring, unless in an emergency.	CM-08-EPS-01	Vessel log and incident reports confirm no anchoring, or detail the emergency situation that lead to the requirement for anchoring (where relevant).	EPO-4	Section 6.4 Section 7.3
Seafarer competency and certification	CM-09	Vessel crew are trained and competent, in accordance with Flag State regulations, to navigate vessels and reduce interaction with other marine users.	CM-09-EPS-01	Training records confirm vessel crew with responsibilities for navigation hold current seafarer competency and certification.	EPO-5	Section 6.5
Stakeholder consultation	CM-10	Santos WA provided a *Quarterly Consultation Update* to relevant stakeholders and all stakeholder correspondence recorded in stakeholder database.	CM-10-EPS-01	Records of transmittal for quarterly consultation update to relevant stakeholders. Stakeholder communications database is maintained	EPO-5	Section 6.5
		Santos WA notifies AHO and AMSA's JRCC prior to commencement of the activity.	CM-10-EPS-02	Transmittal records demonstrate notification of activity prior to the activity commencing.	EPO-5	
		Santos will notify all relevant stakeholders listed, or as revised, in Table 4 2 of relevant activity details prior to commencement, including activity timing, vessel movements, proposed cessation date and vessel details.	CM-10-EPS-03	Transmittal records demonstrate notification of activity prior to the activity commencing.	EPO-5	
No fishing from vessel	CM-11	Personnel are prohibited from recreational fishing activities on the vessel.	CM-11-EPS-01	Induction records confirm no fishing prohibition is communicated to all personnel	EPO-5	Section 6.5
Vessel sewage system	CM-12	Pursuant to Marine Order 96, the survey vessel will have a current International Sewage Pollution Prevention (ISPP) Certificate which certifies that required measures to reduce impacts from sewage disposal are in place.	CM-12-EPS-01	Current International Sewage Pollution Prevention Certificate	EPO-3	Section 6.6
		Preventive maintenance on sewage treatment equipment is completed as scheduled.	CM-12-EPS-02	Vessels have records that demonstrate that maintenance is performed as per the vessel's planned maintenance system requirements.		
		Sewage from vessels is discharged or retained, in accordance with Marine Order 96 noting no discharge within State Waters.	CM-12-EPS-03	Records demonstrate that sewage was appropriately discharged or retained.		
Vessel oily mixtures system	CM-13	Oily mixtures (bilge water) only discharged to sea in accordance with Marine Order 91, noting no discharge within State Waters.	CM-13-EPS-01	Oil record book is maintained.	EPO-3	Section 6.6
		Preventive maintenance on oil filtering equipment completed as scheduled.	CM-13-EPS-02	Vessels have records that demonstrate that maintenance is performed as per the vessel's planned maintenance system requirements.		
		Pursuant to Marine Order 91, (support vessels larger than 400 t) will have an International Oil Pollution Prevention Certificate, which certifies that required measures to reduce impacts of planned oil discharges are in place.	CM-13-EPS-03	Current International Oil Pollution Prevention Certificate		
Waste (garbage) management plan.	CM-14	Garbage management plan implemented to reduce the risk of waste released to sea, in accordance with Marine Order 95. The plan includes detail for: + Bin types to allow for waste segregation; + Lids and covers to prevent windblown waste; + Waste segregation to allow for separation of recyclables; + Bin storage to maintain good hygiene practices and prevent loss of waste overboard; and + Food waste to ensure correct storage and disposal, noting no discharge within State Waters.	CM-14-EPS-01	Records show that garbage management plan is implemented Inspection records show that garbage management plan is implemented Vessel's garbage record book maintained to record quantities and types of waste in accordance with Marine Order 95	EPO-6	Section 6.6 Section 7.1

Control Measures	CM Reference No.	Environmental Performance Standard	EPS Reference No.	Measurement Criteria	Performance Objective Reference	Section
Deck cleaning product selection procedure	CM-15	Deck cleaning products planned to be released to sea meet the criteria for not being harmful to the marine environment according to Marine Order 94 to minimise potential impacts to water quality.	CM-15-EPS-01	Safety Data Sheet (SDS) and product supplier supplementary data for any deck cleaning products are retained as required.	EPO-3	Section 6.6
Dropped object recovery	CM-16	Objects dropped overboard are recovered to mitigate the environmental consequences from objects remaining in the marine environment, unless the environmental consequences are negligible, or safety risks are disproportionate to the environmental consequences.	CM-16-EPS-01	Incident records shows the fate of dropped objects and the associated risk assessment is approved by the EP owner.	EPO-6	Section 7.1
Dropped object prevention procedures.	CM-17	Vessel lifting procedures include the following control measures to reduce the risk of objects entering the marine environment: + Lifting equipment certification and inspection. + Lifting crew competencies. + Heavy lift procedures. + Preventative maintenance on cranes.	CM-17-EPS-01	Records demonstrate implementation of lifting procedures.	EPO-6	
Invasive marine species management	CM-18	Vessels are managed to low risk in accordance with the Santos WA Invasive Marine Species Management Plan (EA-00-RI-10172) prior to movement or transit into or within the invasive marine species management zone, which requires: + Assessment of applicable vessels using the IMSMP risk assessment; and + The management of immersible equipment to low risk.	CM-18-EPS-01	Completed risk assessment demonstrating vessel and equipment is low risk of translocating IMS	EPO-7	Section 7.2
		Pursuant to the Biosecurity Act 2015 and Australian Ballast Water Management Requirements 2017, support vessels carrying ballast water and engaged in international voyages shall manage ballast water so that marine pest species are not introduced.	CM-18-EPS-02	Records show Ballast Water Management is implemented. Completed ballast water record book or log is maintained.	EPO-7	Section 7.2
Anti-foulant system	CM-19	Vessel anti-foulant system maintained in compliance with *International Convention on the Control of Harmful Anti-fouling Systems on Ships*	CM-19-EPS-01	Current International Anti-Fouling System Certificate.	EPO-7	Section 7.2
Vessel spill response plans (SOPEP)	CM-20	Survey vessel has a shipboard oil pollution emergency plan (SOPEP) which outlines steps taken to combat spills.	CM-20-EPS-01	Records demonstrate compliance with the SOPEP Inspection records demonstrate implementation of the SOPEP	EPO-8	Section 7.4
Accepted Oil pollution emergency plan (OPEP)	CM-21	In the event of a hydrocarbon spill to sea, the Santos WA OPEP requirements are implemented to mitigate environmental impacts.	CM-21-EPS-01	Incident database records show that oil spill to see are responded to in accordance with the OPEP.	EPO-8	Section 7.4
Marine assurance standard	CM-22	Vessels selected and on-boarded in accordance with the *Marine Assurance Standard* (QE-91-ZH-10001) to ensure contracted vessels are operated, maintained and manned in accordance with industry standards (e.g. Marine Orders) and regulatory requirements (this EP) and the relevant Santos procedures mentioned in this EP	CM-22-EPS-01	Completed inspection checklist and premobilisation documentation demonstrates that requirements have been met.	EPO 8	Section 7.4
Pre-start Requirements	CM-23	Prior to commencing start-up of geophysical survey equipment in-water, the following will be completed: - A trained crew member (refer **Section 8.6.2**) observing for marine mammals, whale sharks or turtles within 500 m of the vessel during daylight for 15 minutes prior to start-up (if no sightings, survey can commence); - If marine mammals, whale sharks or turtles are sighted within 500 m of the geophysical equipment prior to commencement of survey equipment, the operation will be delayed until the animal has moved at least 500m away or 10 minutes has passed since the last sighting;	CM-23-EPS-01	Geophysical survey checklist completed prior to survey equipment commencement to provide evidence that pre-start requirements were followed.	EPO-1	Section 6.1

Control Measures	CM Reference No.	Environmental Performance Standard	EPS Reference No.	Measurement Criteria	Performance Objective Reference	Section
		- Soft-start procedures enacted over 30 minutes (if equipment allows) - Night operations can commence if there were no more than 3 delays due to marine fauna in the preceding 24 hour period.				
Pre-Activity commencement assurance check	CM-24	Prior to activity commencement, an assurance check will be undertaken in accordance with Santos WA Environment Management of Change Procedure (EA-91-IQ-10001). This involves a documented review of the EP to ensure: - The activity details are current; - Changes in legislation are identified; - Stakeholder consultation has been completed and stakeholder concerns addressed; - Potential impacts and risks are still relevant; - Oil spill scenario is appropriate ; - EPO and EPS are appropriate; and - Activity is acceptable and ALARP in accordance with the EP.	CM-24-EPS-01	Completed Assurance Check form	EPO-1 EPO-2 EPO-3 EPO-4 EPO-5 EPO-6 EPO-7 EPO-8	Section 6 and 7

8.5 Leadership, accountability and responsibility

OPGGS(E)R 2009 Requirements
Regulations 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.

P(SL) (E) Regs 2012 Requirements
Regulations 15(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.

While Santos WA's Chief Executive Officer has the overall accountability for the implementation of the Santos WA Management System and Environmental Management Policy, Santos WA's Manager – Offshore Drilling and Completions, is accountable for ensuring implementation, management and review of this EP.

The effective implementation of this EP requires collaboration and cooperation amongst Santos WA and its contractors. The chain of command and accountabilities of personnel in relation to the implementation, management and review of the EP is outlined in **Table 8-3**. It is also outlined in the OPEP for oil spill response.

Table 8-3: Chain of command, key leadership roles and responsibilities

Role	Responsibilities
Perth office based roles	
Manager – Offshore D&C	+ Ensures Santos' policies and standards are adhered to and communicated to all employees and contractors; + Promotes HSE as a core value integral with how Santos does its business; + Empowers personnel to 'stop-the-job' due to HSE concerns; + Provides resources for HSE management; + Ensures a high level of HSE performance and drives improvement opportunities; + Ensures emergency response plans are in place; + Maintains communication with company personnel, government agencies and the media; + Approves Management of Change (MoC) documents, if acceptable and ALARP; and + Ensures annual HSE improvement plan is completed.
Company Site Representative	Has responsibility for: + Implementation of EP commitments; + Ensuring personnel competency; + Ensuring compliance with procedures and work instructions; + Site focal point for onshore/offshore communications; + Reporting of all incidents and potential hazards; + Leading site-based incident response; and + Implementation of corrective actions from environmental incidents and audits.

Role	Responsibilities
Survey Vessel Master	Has overall responsibility for: + Implementation and compliance with relevant environmental legislative requirements, EP commitments and operational procedures on the vessel; + Maintaining clear communication with personnel on board; + Communicating hazards and risks to the workforce; + Monitoring daily activities on the vessel to ensure that the relevant environmental legislative requirements, EP commitments and operational procedures are being followed; + Maintaining vessels to all regulatory and class requirements; + Maintaining their vessel in a state of preparedness for emergency response; and + Reporting environmental incidents to PIC and ensuring follow-up actions are carried out.
Santos HSE Manager	Has overall responsibility for: + Ensuring incident preparedness and response arrangements meet Santos WA and regulatory requirements; + Approving the OPEP; and + Providing ongoing resources to maintain compliance with the OPEP and other Santos WA incident response requirements.
Santos HSE Coordinator(s)	+ Ensures the EP is managed and reviewed: monitors conformance with EPOs and EPSs, and the implementation strategy in the EP; + Prepares, maintains and distributes the environmental compliance register; + Completes regular HSE reports, inspections and audits; + Completes HSE inductions and promotes general awareness; + Collates HSE data and records; + Contributes to HSE incident management and investigations; + Provides operational HSE oversight and advice; + Facilitates the development and implementation of MoC documents; + Provides incident reports, compliance reports and notifications to NOPSEMA; + Ensures stakeholder consultation and communication requirements have been fulfilled; and + Ensures subcontractors are communicated the EP requirements.
HSE Team Lead – Security Emergency Response	Has overall responsibility for: + Overarching incident and crisis management responsibility; + Managing the CMT and IMT personnel training program; + Reviewing and assessing competencies for CMT, IMT, and field-based IRT members; + Managing the Duty roster system for CMT and IMT personnel; and + Managing the maintenance and readiness of incident response resources and equipment.

Role	Responsibilities
Senior Oil Spill Response Advisor	Has 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 3rd-parties; + Developing and defining objectives, strategies and tactical plans for response preparedness defined in this OPEP and IRP; and + Undertaking assurance activities on arrangements outlined within the OPEP.
All personnel	+ Adhere to HSE obligations; + Carry out duties in accordance with defined work systems and procedures; + Report sightings of marine fauna and marine pollution; + Identify HSE improvement opportunities wherever possible; + Report HSE incidents, hazards or non-conformances to supervisors in a timely manner; and + Understand their obligation to 'stop-the-job' due to HSE concerns.

8.6 Workforce training and competency

OPGGS(E)R 2009 Requirements
Regulations 15(5)
The implementation strategy must include measures to ensure that each employee or contractor working on, or in connection with, the activity is aware of his or her responsibilities in relation to the environment plan including during emergencies or potential emergencies, and has the appropriate competencies and training.

P(SL) (E) Regs 2012 Requirements
Regulations 15(5)
The implementation strategy must include measures to ensure that each employee or contractor working on, or in connection with, the petroleum activity is aware of his or her responsibilities in relation to the environment plan and has appropriate competencies and training.

8.6.1 Inductions

All personnel on the vessel will complete an induction which will include a component addressing their EP responsibilities. Induction attendance records for all personnel will be maintained. Inductions will include information on:

+ Environmental Management Policy;
+ Regulatory regime (State and Commonwealth);
+ EPBC Act Policy Statement 2,1;
+ Operating environment (e.g. nearby protected marine areas);
+ Activities with highest risk;
+ EP commitments (e.g. **Table 8-2**);
+ Incident reporting and notifications
+ Regulatory compliance reporting;

+ Management of change process for changes to EP activities; and
+ Oil pollution emergency response (e.g. OPEP requirements).

8.6.2 Training and competency

All members of the workforce on the survey vessel will complete relevant training and/or hold relevant qualifications and certificates for their roles.

Trained Crew undertaking marine fauna observations prior to survey commencement must have proven experience in whale observation, distance estimation and reporting (as per Part A2 of the EPBC Act Policy Statement 2.1, noting that the policy statement allows for a trained crew member to undertake this role, as opposed to a marine mammal observer).

Santos WA and its contractors are individually responsible for ensuring that their personnel are qualified and trained. The systems, procedures and responsible persons will vary and will be managed through the use of online databases, staff on boarding process and training departments.

Personnel qualification and training records will be sampled at various times such as during the procurement process, inductions, crew change, and operational inspections and audits.

8.6.3 Workforce involvement and communication

Daily operational meetings will be held at which HSE will be a standing agenda item. It is a requirement that supervisors attend daily operational meetings and that all personnel attend daily toolbox or pre-shift meetings. Toolbox or pre-shift meetings will be held to plan jobs and discuss work tasks, including HSE risks and their 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).

8.7 Emergency preparedness and response

OPGGS(E)R 2009 Requirements
Regulation 14(8)
The implementation strategy must contain an oil pollution emergency plan and provide for the updating of the plan.

P(SL) (E)R 2012 Requirements
Regulation 15(10) P(SL)(E)R 2012
The implementation strategy must include an oil spill contingency plan that — (a) sets out details of the following — (i) preparations to be made for the possibility of an oil spill; (ii) emergency response arrangements to be implemented if an oil spill occurs; (iii) recovery arrangements to be implemented if an oil spill occurs; and (iv) current oil spill trajectory modelling that applies to the petroleum activity; (b) requires the operator to conduct tests of the emergency response arrangements set out in the oil spill contingency plan at specified intervals; and (c) describes the tests mentioned in paragraph (b).

Vessels are required to have and implement incident response plans, such as an emergency response plan and SOPEP. Regular incident response drills and exercises (e.g., as defined in an emergency response plan or SOPEP) are carried out to refresh the crew in using equipment and implementing incident response procedures.

Santos WA will implement the activity OPEP (SO-91-RI-20058.02) in the event of a hydrocarbon spill. The OPEP details how Santos WA will prepare and respond to a spill event and meets the requirement of the OPGGS(E)R 2009 and P(SL)(E)R 2012.

8.8 Incident reporting, investigation and follow-up

OPGGSR 2009 Requirements
Regulation 14(2)
The implementation strategy must: (a) state when the titleholder will report to the Regulator in relation to the titleholder's environmental performance for the activity; and (b) provide that the interval between reports will not be more than 1 year. Note: Regulation 26C requires a titleholder to report on environmental performance in accordance with the timetable set out in the environment plan.
Regulation 14(7)
The implementation strategy must provide for sufficient monitoring of, and maintaining a quantitative record of, emissions and discharges (whether occurring during normal operations or otherwise), such that the record can be used to assess whether the environmental performance outcomes and standards in the environment plan are being met.

P(SL)(E)R 2012 Requirements
Regulation 17(1)
The environment plan must include the following: (c) A list of all incidents that are classified as reportable incidents in relation to the petroleum activity.
Regulation 17(2)
The environment plan must classify an incident as a reportable incident if: (a) It could arise from the petroleum activity; and (b) It has the potential to cause an environmental impact that is classified, under the environmental risk assessment process described in the environment plan, as moderate or more serious than moderate.

All personnel will be informed through inductions and daily operational meetings of their duty to report HSE incidents and hazards. Reported HSE incidents and hazards will be shared during daily operational meetings and will be documented in the incident management systems as appropriate. HSE incidents will be investigated in accordance with the Santos WA Incident Reporting and Investigation Procedure (QE-91-IF-00002) or vessel contractor procedures.

Environmental recordable and reportable incidents will be reported to NOPSEMA and DMIRS as required, in accordance with **Section 8.9**. The incident reporting requirements will be provided to all crew on board the facilities and support vessels with special attention to the reporting time frames to provide for accurate and timely reporting

For the purposes of this activity, in accordance with OPGGS(E) and P(SL)(E) Regulations:

- A recordable incident, for an operator of a petroleum activity, means an incident arising from the petroleum activity that –
  - breaches an EPO or EPS in the EP for the petroleum activity; and
  - is not a reportable incident.
- A reportable incident, for an operator of a petroleum activity, means —
  - an incident that is classified as a reportable incident under the environment plan for the petroleum activity; or
  - an incident arising from the petroleum activity if —
  - the incident has caused, or has the potential to cause, an adverse environmental impact; and
  - under the environmental risk assessment process described in the environment plan for the petroleum activity, that environmental impact is categorised as moderate or more serious than moderate. in accordance with **Table 5-2**.

Reportable incidents under this EP are those unplanned events that have been assessed to have a moderate or greater consequence level (i.e. C, D or E). These incidents are:

- Introduction of invasive marine species; and
- Accidental release of hydrocarbons.

In the event that an environmental incident arises that is not previously evaluated by this EP; which has the potential to cause an adverse impact that is categorised as moderate, or more serious than moderate; the incident will be considered a reportable incident and reported as such.

8.9 Reporting and notifications

OPGGSR 2009 Requirements
Regulation 14(2)
The implementation strategy must: (a) state when the titleholder will report to the Regulator in relation to the titleholder's environmental performance for the activity; and (b) provide that the interval between reports will not be more than 1 year. 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.

P(SL) (E)R 2012 Requirements
Regulation 16
The environment plan must include arrangements for — (a) monitoring, and recording information about, the petroleum activity that are sufficient to enable the Minister to determine whether — (i) the environmental performance objectives and environmental performance standards in the environment plan have been met; and (ii) the implementation strategy in the environment plan has been complied with; and

(b) reporting to the Minister on the information recorded under paragraph (a) at intervals agreed with the Minister, but not less often than annually.

8.9.1 Notifications and Compliance Reporting

Regulatory, other notification and compliance reporting requirements are summarised in **Table 8-4**

All reporting to DMIRS will be undertaken via the incident line or in writing to petroleum.environment@dmirs.wa.gov.au

Table 8-4: Activity notification and reporting requirements

Initiation	Required Information	Timing	Type	Recipient
Before the activity				
Consultation with AMSA (Refer **Table 4-2**)	Notification of proposed start and end dates and any other relevant information for the NTM to be issued	At least 24–48 hours before operations commence	Written	AMSA's JRCC
		No less than four working weeks before operations	Written	AHO
Consultation	Prior to commencement of the activity, Santos will notify all relevant stakeholders of information on activity timing, vessel movements and vessel details.	At least one week prior	Written	All relevant stakeholders listed, or as revised, in Table 4 2
Consultation with Department of Agriculture and Water Resources (DAWR) – Biosecurity (vessels, aircraft and personnel) (Refer **Table 4-2**)	Prior to commencement of the activity application to the department for assessment of biosecurity risk of vessel as applicable.	At least 1 month prior to activity commencement	Written	DAWR Biosecurity (vessels, aircraft and personnel)
<u>OPGGS(E) Regulation 29 & 30 – Notifications</u> NOPSEMA and DMIRS must be notified that the activity is to commence.	Complete NOPSEMA's Regulation 29 Start or End of Activity Notification form for both notifications. DMIRS can also be notified using NOPSEMA's notification form. Details of the survey vessel, and associated contactor will be provided in the pre-start notification.	At least 10 days before the activity commences.	Written	NOPSEMA DMIRS
During the activity				

Initiation	Required Information	Timing	Type	Recipient
OPGGS(E) Regulation 26B and P(SL)(E) Regulation 30 - Recordable Incident NOPSEMA and DMIRS must be notified of a breach of an EPO or EPS, in the environment plan that applies to the activity that is not a reportable incident.	Complete Recordable Environmental Incident Monthly Report form.	The report must be submitted as soon as practicable after the end of the calendar month, and in any case, not later than 15 days after the end of the calendar month.	Written	NOPSEMA DMIRS
OPGGS(E) Regulation 26 & 26A and P(SL)(E) Regulation 28 & 29 - Reportable Incident NOPSEMA and DMIRS must be notified of any reportable incidents. A reportable incident is defined as: An incident relating to the activity that has caused, or has the potential to cause,	The oral notification must contain: + All material facts and circumstances concerning the reportable incident known, or that by reasonable search or enquiry could be found out; and + Any action taken to avoid or mitigate any adverse environmental impacts of the reportable incident; and + The corrective action that has been taken, or is proposed to be taken, to stop, control or remedy the reportable incident.	As soon as practicable, and in any case not later than 2 hours after the first occurrence of a reportable incident; or if the incident was not detected at the time of the first occurrence, at the time of becoming aware of the reportable incident.	Oral	NOPSEMA (Commonwealth) DMIRS (State)
	A written record of the oral notification must be submitted. The written record is not required to include anything that was not included in the oral notification.	As soon as practicable after the oral notification.	Written	NOPSEMA NOPTA DMIRS

Initiation	Required Information	Timing	Type	Recipient
moderate to significant environmental damage.	A written report must contain: + All material facts and circumstances concerning the reportable incident known, or that 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; and + The action that has been taken, or is proposed to be taken, to prevent a similar incident occurring in the future. Consider reporting using NOPSEMA's Report of an Accident, Dangerous Occurrence or Environmental Incident form for incidents in Commonwealth jurisdiction. Consider reporting using DMIRS's Environmental & Reportable Incident/Non-compliance Reporting Form for incidents in State jurisdiction.	Must be submitted as soon as practicable, and in any case not later than 3 days after the first occurrence of the reportable incident. For incidents in Commonwealth jurisdiction, the same report to be submitted to NOPTA within 7 days after giving the written report to NOPSEMA.	Written	NOPSEMA NOPTA DMIRS
AMSA Reporting	Titleholder agrees to notify AMSA of any marine pollution incident[3].	Within 2 hours of incident.	Oral	AMSA

[3] For clarity and consistency across Santos WA regulatory reporting requirements Santos WA 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 WA's environmental impact and risk assessment process outlined in **Section 5**.

Initiation	Required Information	Timing	Type	Recipient
Under the MoU between Santos WA and AMSA	POLREP and SITREP available online (refer OPEP).	POLREP as requested by AMSA following verbal notification. SITREP as requested by AMSA within 24 hours of request.	Written	AMSA
Director of National Parks Reporting Notification of the event of oil pollution within a marine park or where an oil spill response action must be taken within a marine park.	Not specified, however should include details of event and response actions being undertaken with the marine park.	So far as reasonably practicable prior to response action being written.	Not defined	Director of National Parks
DPIRD Reporting If marine pests or disease are suspected this must be reported to DPIRD.	Notification of any suspected marine pests or diseases including any organism listed in the Western Australian Prevention List for Introduced Marine Pests and any other non-endemic organism that demonstrates invasive characteristics.	Within 24 hours.	Oral	DPIRD FishWatch
DAWE 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 7 days to EPBC.permits@environment.gov.au	Written	DAWE
	Marine fauna sighting data recorded in the marine fauna sighting database.	As soon as practicable, in any case no later than 3 months after the end of the activity.	Written	DAWE
Any harm or mortality to fauna listed as threatened under the WA Biodiversity Conservation Act 2016	Notification of any harm or mortality to fauna listed as a threatened species under the WA Biodiversity Conservation Act 2016 as a result of Santos activities.	A fauna report will be submitted to DBCA Within 7 days to fauna@dbca.wa.gov.au	Written	DBCA DMIRS

Initiation	Required Information	Timing	Type	Recipient
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	DAWE
Department of Biodiversity, Conservation and Attractions Reporting Impacts to marine mammals or turtles in reserves.	Notification of any incidence of entanglement, boat collisions and stranding of marine mammals in the reserves and any incident of turtle mortality and incidents of entanglement in the reserves as detailed in the Management Plan for the Montebello/Barrow Islands Marine Conservation Reserves.	Within 48 hours.	Written	DBCA
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 2 hours.	Oral	DoT
	WA DoT POLREP and SITREP available online (refer OPEP).	As requested by DoT following verbal notification.	Written	DoT
End of activity				
OPGGS(E) Regulation 14 (2) & 26C and P(SL)(E) Regulation 16 & 34 - Reporting Environmental Performance Performance should be recorded and reported to the regulators.	Report will address all the requirements of the DMIRS "Guideline for Preparing Annual Reports" and must contain sufficient information to determine whether or not EPOs and EPSs in the EP have been met. In accordance with P(SL)(E) Regulation 34 and the above guidelines, the report will also include volumes and details of all emissions and discharges to any land, air, marine, seabed, sub-seabed, groundwater, sub-surface or inland waters environment as provided in **Table 8-5**.	An environmental performance report will be submitted within three months of completion of the activity.	Written	NOPSEMA DMIRS

Initiation	Required Information	Timing	Type	Recipient
OPGGS(E) Regulation 29 – Notifications NOPSEMA and DMIRS must be notified that the activity is completed.	Complete NOPSEMA's Regulation 29 Start or End of Activity Notification form for both notifications. DMIRS can also be notified using NOPSEMA's notification form.	Within 10 days after finishing.	Written	NOPSEMA DMIRS
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 6 months of the final Regulation 29 (2) notification.	Written	NOPSEMA
Consultation requirement	Upon completion of the activity, Santos will provide a cessation notification to the relevant stakeholders listed, or as revised, in **Table 4-1**. The final cessation notification will advise stakeholders that the activity has ended	Within 10 days after finishing.	Written	relevant stakeholders listed, or as revised, in **Table 4-1**

8.9.2 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.

P(SL) (E)R 2012 Requirements
Regulations 15(7) (and 34)
The implementation strategy must provide for — (a) specified emissions and discharges (whether occurring during normal operations or otherwise) to any air, marine, seabed and sub-seabed environment to be monitored and recorded in a way that — (i) is accurate; and (ii) can be audited against the environmental performance standards and measurement criteria in the environment plan; and (b) the monitoring mentioned in paragraph (a) to be done either continuously or at specified intervals; and (c) tests to assess the performance of the monitoring equipment used for the purposes of paragraph (a) to be conducted at specified intervals.

Vessel-based discharges to the marine environment, associated with this activity will be recorded and controlled in accordance with requirements under relevant marine orders.

In addition to the reporting requirements of **Table 8-4**, Regulation 14(7) of the OPGGS(E) Regulations and 34 of the Petroleum (Submerged Lands) (Environment) Regulations 2012 has specific monitoring and reporting requirements to NOPSEMA and DMIRS which will include those outlined in **Table 8-5**. Given the short-term nature of the activity, the recordings will be taken once on completion of the activity and a single report of emissions and discharges will be provided in the end of activity report discussed in **Table 8-4**. No specific calibration or testing is undertaken for any of the monitoring equipment in relation to this short term activity.

Table 8-5: Monitoring methods for emissions and discharges

Emission/discharge	Method of monitoring
Air emissions (N_2O, NOx, SOx, CO_2, ODS) from vessel	Based on NPI calculations / estimates based on vessel fuel use
Oily water discharges	Oily water discharges are monitored by a vessel's oily discharge monitor and analyses the discharge flowrate and oil content. This is then recorded in the vessel's oil record book on an ad hoc basis if/when discharge occurs. Maintenance of the system is performed as per the vessel's planned maintenance system requirements which would include testing of the monitor, however this is not expected to be undertaken during this activity.

Emission/discharge	Method of monitoring
Sewage discharges	Estimated from personnel on board numbers
Food waste	Estimated from personnel on board numbers
ODS	Leakage reports (if any)
Discharges to seabed	Dropped object reports (if any)

8.10 Document management

8.10.1 Information Management and Document Control

This EP and the associated OPEP, as well as any approved MoC documents, are controlled documents and current versions will be available on the Santos WA intranet. Vessel contractors are also required to maintain current versions of these documents.

EPOs and EPSs will be measured based on the measurement criteria listed in **Table 8-3.** Such records will be maintained for a period of five years. Contractors are required to make these records available upon request.

8.10.2 Management of change

Proposed changes to this EP and OPEP will be managed in accordance with the Santos WA Environment Management of Change Procedure (EA-91-IQ-10001). The MoC process provides a systematic approach to initiate, assess, document, approve, communicate and implement changes to EPs and OPEPs.

The MoC process considers Regulations 7, 8 and 18 of P(SL)(E)R 2012 and determines whether and in what manner a proposed change can proceed. The MoC procedure will determine whether a revision of the EP is required and whether that revision is to be submitted to DMIRS. If a revision of the EP is not required, the MoC form will detail the basis for the decision and if a bridging document or written notification is required for submission and acceptance to DMIRS prior to the activity commencing. For a change to proceed, the associated environmental impacts and risks must be demonstrated to be ALARP and acceptable. Additional stakeholder consultation may be required depending on the nature and scale of the change. Additional information on the MoC process is provided in **Figure 8-1** and **Figure 8-2**.

The MoC procedure also allows the assessment of new information that may become available post EP acceptance. For example, new management plans for marine reserves, recovery plans or conservation advice for species and changes to the EPBC Act Protected Matters Search results. If review identifies new information, this is treated as 'Change that has an impact on Environment Plan' in **Figure 8-1** and **Figure 8-2**, and the MoC procedure is followed accordingly.

The MoC procedure also includes an assurance check process which applies the MoC process to long term (usually five year drilling EPs) EPs that may have lengthy periods of time between use or acceptance and activity commencement. Applying this Assurance Check to this EP (refer to Control Measure CM-24) helps Santos WA determine whether the activity will still comply with the EP and is still acceptable, or, if there are any changes to what is covered by the relevant EP. Where there is an identified change from the accepted EP content, a check is done to test the "significance" of the change, to determine whether it can be accommodated which may then result in an MoC as described above.

Accepted MoCs become part of the in force EP or OPEP, are tracked on a register and are made available on Santos WA's intranet. Where appropriate, the EP compliance register will be updated so that control measure or environmental performance standard changes are communicated to the workforce and implemented. Any MoC will be distributed to the management people identified in **Table 8-3**; and the most relevant management position will ensure the MoC is communicated and implemented, which may include crew meetings, briefings or communications as appropriate for the change.

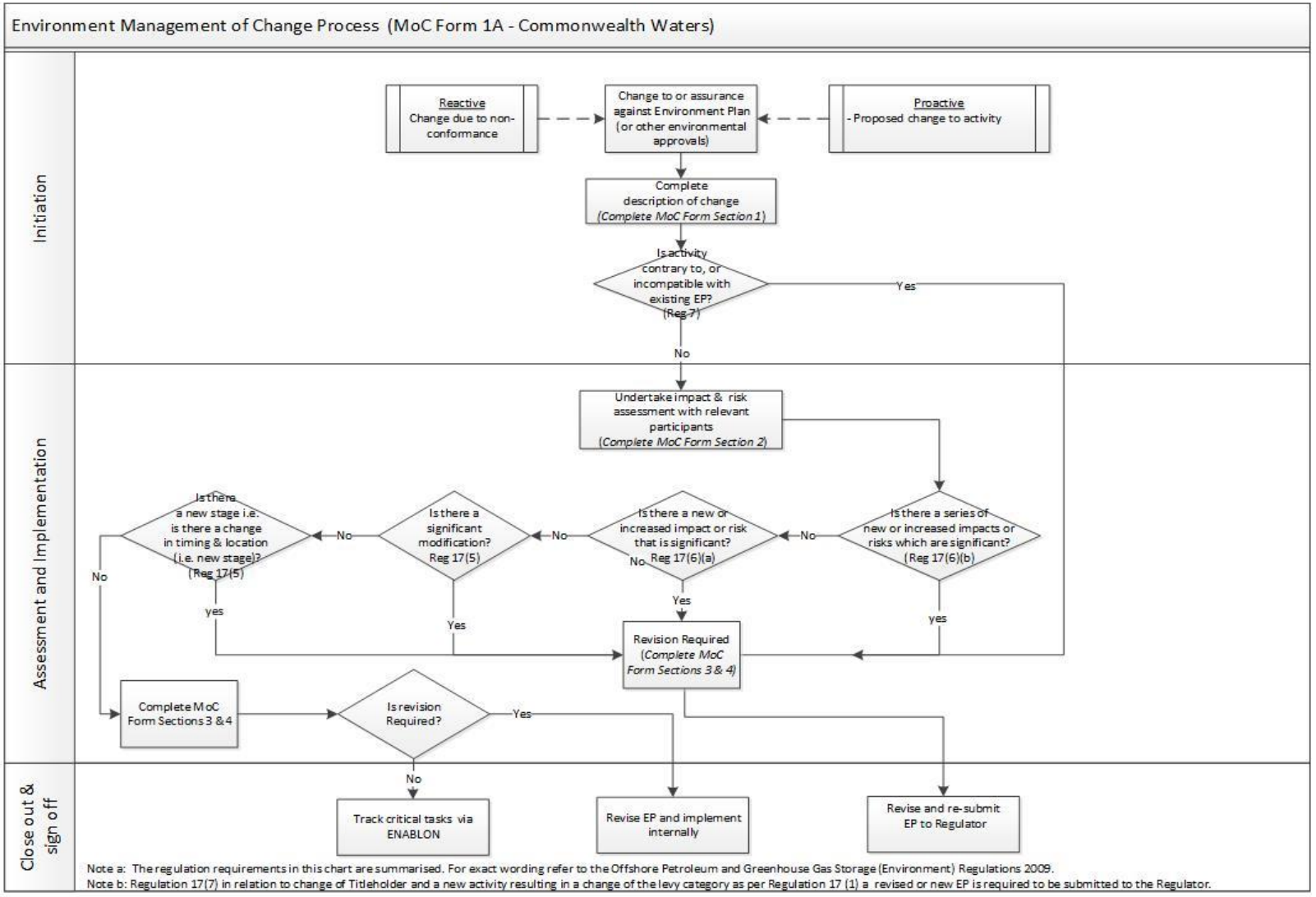


Figure 8-1: Environment management of change process (Commonwealth Waters)

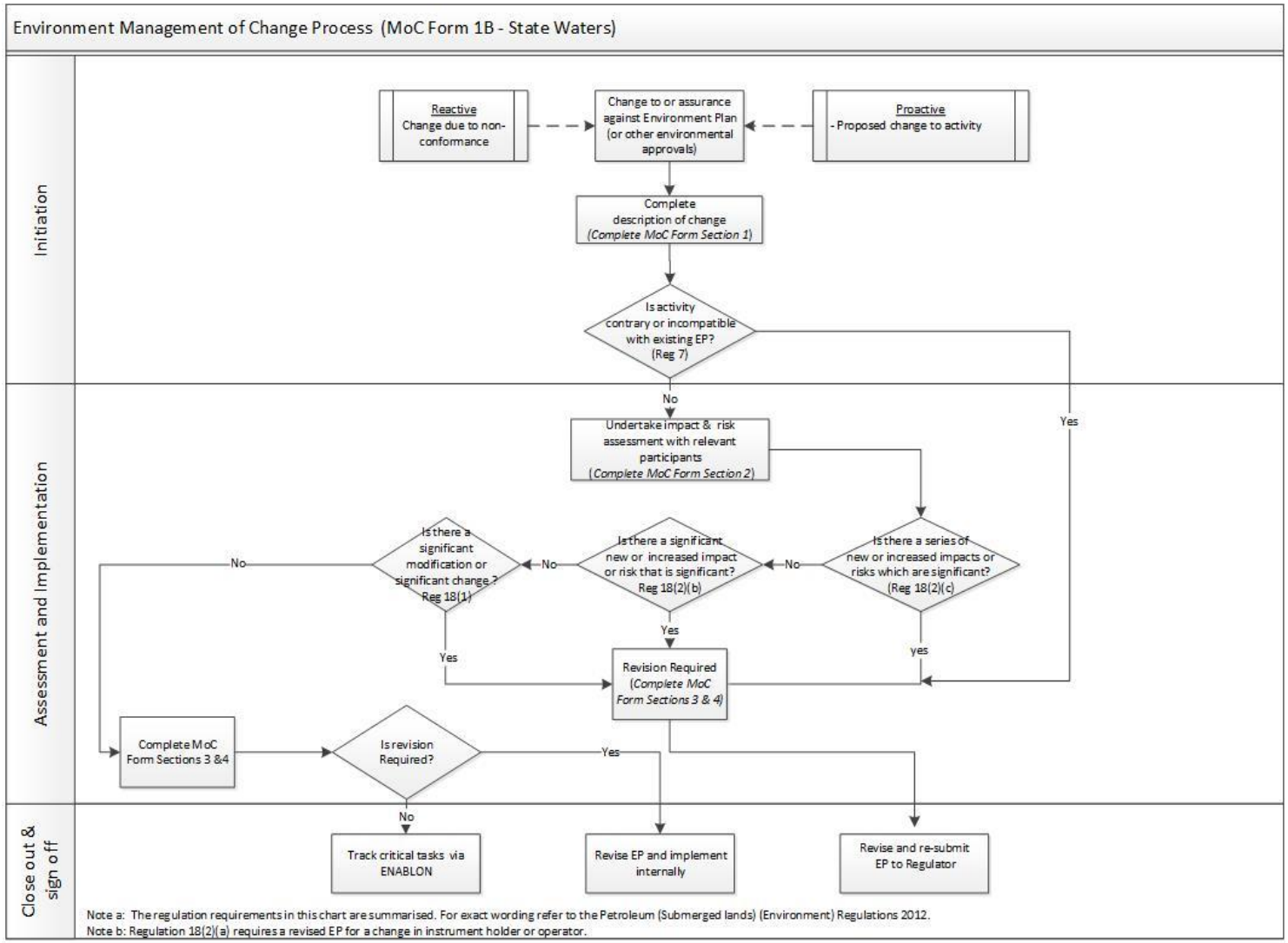


Figure 8-2: Environment management of change process (State Waters)

8.10.3 Reviews

This EP includes an assessment of impacts and risks across the entire operational area, during any time of the year for planned and unplanned events given the nature of the 24/7 operations.

It is recognised that the following may change over the validity of the EP:

- Legislation;
- Businesses conditions, activities, systems, processes and people;
- Industry practices;
- Science and technology; and
- Societal and stakeholder expectations.

To ensure that Santos WA maintains up to date knowledge of the industry, legislation and conservation advice the following tasks are undertaken:

- Maintaining membership of APPEA, which provides a mechanism for communicating potential changes in legislation, industry practice and other issues that may affect EP implementation to relevant personnel in Santos WA;
- Undertaking annual spill response exercises to check spill response arrangements and capability are adequate;
- Identifying stakeholders prior to the activity commencing under this EP via the mechanisms outlined in **Section 4**.
- Undertaking annual review of Values and Sensitivities of the Western Australian Marine Environment (EA-00-RI-10062) which includes completing a new EPBC PMST, review of **Appendix A2 - Regulatory Framework of Relevant Legislation** against relevant legislation to capture and review any relevant updates, and incorporate as required, as well as a review of any recently known published relevant scientific papers;
- Subscriptions to various regulator updates; and
- Regular liaison meetings with Regulators.

Through maintenance of up to date knowledge, these changes are identified. If the changes have an impact on the activity or risks described and assessed in this EP, the EP will be reviewed and any changes required documented in accordance with Santos WA's MoC procedure (**Section 8.10.2**).

8.11 Audits and inspections

P(SL)(E)R 2012 Requirements
Regulation 15(6)
The implementation strategy must provide for the monitoring of, audit of, management of non-compliance with, and review of, the operator's environmental performance and the implementation strategy.

OPGGS(E)R 2009 Requirements
Regulation 14(6)
The implementation strategy must provide for sufficient monitoring, recording, audit, management of nonconformance and review of the titleholder's environmental performance and the implementation strategy to ensure that the environmental performance outcomes and standards in the environment plan are being met.

Santos WA audit plans and schedules are reviewed and updated at the beginning of each calendar year and cover all Santos WA facilities and activities. Santos WA's audit schedule may be amended to accommodate operational priorities, activity risk, personnel availability or high audit demand during certain periods (e.g., regulatory audits, contractor audits). Santos WA will determine if a survey vessel audit is required following contract award and vessel confirmation.

Audits will be undertaken in a manner consistent with Santos WA's Assurance Standard (QE-91-ZF-100073).

Audit scope typically includes a selection of control measures and EPSs and EPOs. However, audits may also include other parts of the EP.

Audits findings may include opportunities for improvement and non-conformances. Audit non-conformances are managed as described in **Section 8.11.2**.

8.11.1 Inspections

During an activity, HSE inspections (desktop or vessel based) will be conducted at least once during the activity to identify hazards, incidents and EP non-conformances. These inspections will also ~~to~~ check compliance against all the environmental performance objectives and standards of this EP (**Table 8-3**) and inform end of activity reporting (**Table 8-4).** Any in-field opportunities for improvement or corrective actions will be discussed during the inspection with the Vessel Master.

8.11.2 Non-conformance management

EP non-conformances will be addressed and resolved by a systematic corrective action process as outlined in Santos WA's Assurance Standard (QE-91-ZF-10007). Non-conformances arising from audits and inspections will be entered into Santos WA's incident and action tracking management system (i.e., 'Enablon'). Once entered, corrective actions, time frames and responsible persons will be assigned. Corrective action 'close out' will be monitored using a management escalation process.

8.11.3 Continuous improvement

For this EP, continuous improvement will be driven by the list below and may result in a review of the EP, with changes applied in accordance with **Section 8.10.2**.

- Improvements identified from the review of business-level HSE key performance indicators;
- Actions arising from Santos WA and departmental HSE improvement plans;
- Corrective actions and feedback from HSE audits and inspections, incident investigations and after action reviews;
- Opportunities for improvement and changes identified during pre-activity reviews and MoC documents;
- Stakeholder engagement that may be undertaken during the course of the EP; and
- Actions taken to address concerns and issues raised during the ongoing stakeholder management process (**Section 4**).

Identified continuous improvement opportunities will be assessed in accordance with the MoC process (**Section 8.10.2**) to ensure any potential changes to this EP or the OPEP are managed in accordance with the Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009 and in a controlled manner

9 References

ABARES (Australian Bureau of Agricultural and Resource Economics and Sciences) (2010). Fisheries Status Reports 2010. Australian Government.

ABARES (2018). Fisheries Status Reports 2018. Australian Government. Available from: [http://www.agriculture.gov.au/SiteCollectionDocuments/abares/publications/fsr2018.pdf].

Amoser, S. and Ladich, F. (2005). Are hearing sensitivities of freshwater fish adapted to the ambient noise in their habitats? Journal of Experimental Biology 208, 3533-3542.

AMSA (2019). Shipping fairways network. Data provided through consultation.

AMSA (2015). Technical guidelines for preparing contingency plans for Marine and Coastal Facilities. Available from: https://www.amsa.gov.au/sites/default/files/2015-04-np-gui012-contingency-planning.pdf.

APASA (2013). Oil Spill Risk Assessment for VI Hub. Prepared for Apache Energy Ltd by Asia-Pacific Applied Science Associates, Perth, Western Australia, August 2013.

Astron (2012). Varanus and Bridled Islands Mangrove Monitoring Annual Report 2011. Prepared for Apache Energy Limited. Astron Environmental Services, Perth.

Austin, M., A. McCrodan, and J. Wladichuk. 2013. Underwater Sound Measurements. *In* Reider, H.J., L.N. Bisson, M. Austin, A. McCrodan, J. Wladichuk, C.M. Reiser, K.B. Matthews, J.R. Brandon, K. Leonard*, et al.* (eds.). *Marine mammal monitoring and mitigation during Shell's activities in the Chukchi Sea, July–September 2013: 90-Day Report*. Report Number P1272D–2. Technical report by LGL Alaska Research Associates Inc., Anchorage, AK, USA and JASCO Applied Sciences, Victoria, BC, Canada for Shell Gulf of Mexico, Houston, TX, USA, National Marine Fisheries Service, and US Fish and Wildlife Services. 198 pp, plus appendices. http://www.nmfs.noaa.gov/pr/pdfs/permits/shell_chukchi_openwater_90dayreport.pdf

Austin, M.E., G.A. Warner, and A. McCrodan. 2012. *Underwater Sound Propagation Acoustics Technical Report: Maersk Oil Kalaallit Nunaat A/S 2012 3D Seismic Program Block 9 (Tooq)*. Version 2.0. Technical report by JASCO Applied Sciences for Golder Associates A/S and Golder Associates Ltd. http://naalakkersuisut.gl/~/media/Nanoq/Files/Hearings/2012/Offentliggorelse%202011%2015/Answers/Bilag/M%C3%A6rsk%20EIA%20ENG%20Appendix%20D%201.pdf.

Baldridge, H.D.Jr. (1970). Sinking Factors and Average Densities of Florida Sharks as Functions of Liver Buoyancy. Copeia 4: 744—754.

Bartol, M.S. and Musick, J.A. (2003). Sensory biology of sea turtles. In: Lutz, P.L., Musick, J.A., Wyneken, J. (eds) Biology of sea turtles, Vol II. CRC Press, Boca Raton, FL, p. 79-102.

Bartol, S.M. and D.R. Ketten. 2006. *Turtle and tuna hearing*. *In*: Swimmer, Y. and R. Brill. Volume December 2006. NOAA Technical Memorandum NMFS-PIFSC-7. 98-103 p. http://www.sefsc.noaa.gov/turtles/TM_NMFS_PIFSC_7_Swimmer_Brill.pdf#page=108.

Bartol, S.M. 2008. A review of auditory funcion of sea turtles. *Bioacoustics* 17: 57-59. https://doi.org/10.1080/09524622.2008.9753763.

Bergert, B.A. and Wainwright, P.C. (1997). Morphology and Kinematics of Prey Capture in the Syngnathid Fishes Hippocampus erectus and Syngnathus floridae. Marine Biology 127: 563–570.

BHPB (2005). Pyrenees Development: Draft EIS. BHP Billiton, Perth, Western Australia.

CALM, MPRA (2005). Management Plan for the Ningaloo Marine Park and Muiron Islands Marine Management Area 2005–2015. Management Plan No. 52. Department of Conservation and Land Management and Marine Parks and Reserves Authority, Perth, Western Australia

Cardno (2011). Airlie Island and Taunton Reef Habitat Survey. Report prepared for Apache Energy Ltd by Cardno Ecology Lab, Perth, Western Australia, October 2011.

Chevron (2005). Gorgon Development on Barrow Island Technical Report Intertidal Habitats. Technical Appendix C9 prepared by RPS Bowman Bishaw Gorham April 2005 for Chevron Texaco Australia, Perth, Western Australia.

Chorney, N.E., G.A. Warner, J.T. MacDonnell, A. McCrodan, T.J. Deveau, C.R. McPherson, C. O'Neill, D.E. Hannay, and B. Rideout. 2011. *Underwater Sound Measurements*. *In*: Reiser, C.M., D.W. Funk, R. Rodrigues, and D.E. Hannay (eds.). Marine mammal monitoring and mitigation during marine geophysical surveys by Shell Offshore Inc. in the Alaskan Chukchi and Beaufort Seas, July-October 2010: 90-day report. LGL Report P1171E–1. Report from LGL Alaska Research Associates Inc. and JASCO Applied Sciences for Shell Offshore Inc., National Marine Fisheries Service (US), and US Fish and Wildlife Service. 240 pp plus appendices. http://www.nmfs.noaa.gov/pr/pdfs/permits/shell_90day_report2010.pdf.

Clark, C.W., W.T. Ellison, B.L. Southall, L.T. Hatch, S.M. Van Parijs, A.S. Frankel, and D.W. Ponirakis. 2009. Acoustic masking in marine ecosystems: Intuitions, analysis, and implication. *Marine Ecology Progress Series* 395: 201-222. https://doi.org/10.3354/meps08402.

Colson, D.J. (1998). Sound Production During Feeding in Hippocampus seahorses (Syngnathidae). Environmental Biology of Fishes 51: 221–229.

Commonwealth of Australia. 2019. Draft National Light Pollution Guidelines for Wildlife Including Marine Turtles, Seabirds and Migratory Shorebirds, Commonwealth of Australia 2019.

Connell, D.W. and Miller, G.J. (1981). Petroleum hydrocarbons in aquatic ecosystems – behaviour and effects of sub lethal concentrations. CRC report Critical reviews in environmental controls.

Crocker, SE and Fratantonio FD (2016). Characteristics of Sounds Emitted During High-Resolution Marine Geophysical Surveys. -NPT Technical Report 12,203. Available online:

https://pdfs.semanticscholar.org/ae89/c4d56f2484a0f107af7119ed0c12c350bd70.pdf?_ga=2.226163610.1037607845.1588735571-1802879418.1588735571

DAFF (2011). Australian Ballast Water Management Requirements – Version 5. Viewed 26 March 2012, <http://www.daff.gov.au/aqis/avm/vessels/quarantine_concerns/ballast/australian-ballast-water-management-requirements.l>.

Danoun, R. (2007). Desalination Plants: Potential impacts of brine discharge on marine life. The Ocean technology Group, The University of Sydney, Australia. Final Project 05/06/2007.

Day, RD, McCauley, RD, Fitzgibbon, QP, Hartmann, K and Semmens, JM. (2016). Assessing the Impact of Marine Seismic Surveys on Southeast Australian Scallop and Lobster Fisheries. Impacts of Marine Seismic Surveys on Scallop and Lobster Fisheries. University of Tasmania, Hobart, Fisheries Research & Development Corporation. FRDC Project No 2012/008: 159.

DEC (2007). Management Plan for the Montebello/Barrow Islands Marine Conservation Reserves 2007–2017: Management Plan No. 55. Department of Environment and Conservation, Perth, Western Australia.

DEC, MPRA 2007 Management Plan for the Montebello/Barrow Islands Marine Conservation Reserves 2007–2017. Management Plan No. 55. Department of Environment and Conservation and Marine Parks and Reserves Authority, Perth, Western Australia.

DEWHA (2008d). Approved Conservation Advice for Green Sawfish. Canberra: Department of the Environment, Water, Heritage and the Arts. Available from: http://www.environment.gov.au/biodiversity/threatened/species/pubs/68442-conservation-advice.pdf. In effect under the EPBC Act from 07-Mar-2008.

DoE (2012), Conservation Management Plan for the Southern Right Whale - A Recovery Plan under the Environment Protection and Biodiversity Conservation Act 1999 2011 - 2021, Commonwealth of Australia, 2012.

DoE (2013a), Recovery Plan for the White Shark (Carcharodon carcharias) 2013. Commonwealth of Australia.

DoE (2014b), Recovery Plan for the Grey Nurse Shark (Carcharias taurus) 2014. Commonwealth of Australia.

DoE (2015a) Sawfish and River Sharks Multispecies Recovery Plan. DoEE, Canberra.

DoE (2015b) Conservation Management Plan for the Blue Whale—A Recovery Plan under the Environment Protection and Biodiversity Conservation Act 1999. Commonwealth of Australia.

DoE (2015c). Conservation Advice Calidris ferruginea curlew sandpiper. Canberra: Department of the Environment. Available from: [http://www.environment.gov.au/biodiversity/threatened/species/pubs/856-conservation-advice.pdf]. In effect under the EPBC Act from 26-May-2015.

DoE (2015d). Conservation Advice Numenius madagascariensis eastern curlew. Canberra: Department of the Environment. Available from: [http://www.environment.gov.au/biodiversity/threatened/species/pubs/847-conservation-advice.pdf]. In effect under the EPBC Act from 26-May-2015.

Commonwealth of Australia (2017). Recovery Plan for Marine Turtles in Australia 2017 – 2027.

DoF (Department of Fisheries) (2012). Advice to Mr Coutts of Biofouling Solutions on "Marine Pest Didemnum perlucidum in Western Australian Waters". Unpublished letter dated 23 July 2012.

Dow Piniak W.E. 2012. Acoustic Ecology of Sea Turtles: Implications for Conservation. PhD thesis, Marine Science and Conservation Duke University. pp 136. Accessed online on 07/06/2019 at: https://dukespace.lib.duke.edu/dspace/bitstream/handle/10161/6159/Piniak_duke_0066D_11691.pdf?sequence=1

DSEWPaC (Department of Sustainability, Environment, Water, Population and Communities) (2011a) National recovery plan for threatened albatrosses and giant petrels 2011-2016. Commonwealth of Australia, Hobart.

DSEWPaC (2011b). Approved Conservation Advice for Sternula nereis nereis (Fairy Tern). Canberra, ACT: Department of Sustainability, Environment, Water, Population and Communities. Available from: [http://www.environment.gov.au/biodiversity/threatened/species/pubs/82950-conservation-advice.pdf]. In effect under the EPBC Act from 03-Mar-2011.

DSEWPaC (2012). Marine bioregional plan for the North-west Marine Region, Prepared under the Environment Protection and Biodiversity Conservation Act 1999.

DSEWPaC (2013). Approved Conservation Advice for Rostratula australis (Australian painted snipe). Canberra: Department of Sustainability, Environment, Water, Population and Communities. Available from: http://www.environment.gov.au/biodiversity/threatened/species/pubs/77037-conservation-advice.pdf. In effect under the EPBC Act from 15-May-2013.

Ecotox Services Australia (2009). Toxicity Assessment of Weathered and Un-Weathered Breaknock-2, Calliance-1 and Torosa-4 Condensate Samples. Test Report for Woodside Energy Ltd. June 2009.

EPA (2010). Environmental Assessment Guideline for Protecting Marine Turtles from Light Impacts. Environmental Assessment Guideline No. 5. Environmental Protection Authority Western Australia. November 2010.

Falkner, I., Whiteway, T., Prezeslawski, R. and Heap, A.D. (2009). Review of ten key ecological features (KEFs) in the Northwest Marine Region. A report to the Department of the Environment, Water, Heritage and the Arts by Geoscience Australia, Record 2009/13.

Ferrara, C.R., R.C. Vogt, R.S. Sousa-Lima, B.M.R. Tardio, and V.C.D. Bernardes. 2014. Sound communication and social behavior in an Amazonian river turtle (*Podocnemis expansa*). *Herpetologica* 70(2): 149-156. https://doi.org/10.1655/HERPETOLOGICA-D-13-00050R2.

French-McCay, D.P. (2002). Development and Application of an Oil Spill Toxicity and Exposure Model, OilToxEx. Environmental Toxicology and Chemistry 21(10): 2080-2094.

French-McCay, D. (2009). *State-of-the-art and research needs for oil spill impact assessment modeling*, in: Proceedings of the 32nd AMOP Technical Seminar on Environmental Contamination and Response. Presented at the 32nd AMOP Technical Seminar on Environmental Contamination and Response, Environment Canada, Ottawa, pp. 601–653.

Garnett, ST & Crowley, GM (2000). The action plan for Australian birds 2000, recovery outline, lesser noddy (Australian), Environment Australia, Canberra.

GHD (2019). WA-499-P Geophysical and Geotechnical Survey Environment Plan Diesel Spill Modelling Report. Report prepared for Santos WA Energy Limited. December 2019.

Gordon, J., Gillespie, D., Potter, J., Frantzis, A., Simmonds, M.P., Swift, R. and Thomson, D. (2004). A Review of the Effects of Seismic Surveys on Marine Mammals. Marine Technology Society Journal 37: 16–34.

Jenner, K.C.S., Jenner, M-N.M. and McCabe, K.A. (2001). Geographical and temporal movements of humpback whales in Western Australian waters. APPEA Journal 41: 749-765.

Jensen, A.S. and Silber, G.K. 2003. Large whale ship strike database. U.S. Department of Commerce. National Oceanic and Atmospheric Administration. Technical Memorandum NMFS-OPR-25. pp.37.

Ketten, D.R. and S.M. Bartol. 2005. *Functional measures of sea turtle hearing*. ONR project final report. Document Number ONR Award Number N00014-02-1-0510. Office of Naval Research (US).

Koops, W., Jak, R.G. and van der Veen, D.P.,2004. Use of dispersants in oil spill response to minimise environmental damage to birds and aquatic organisms. Trondheim, Norway: Interspill 2004.

Ladich, F. and R.R. Fay. 2013. Auditory evoked potential audiometry in fish. *Reviews in Fish Biology and Fisheries* 23(3): 317-364. https://doi.org/10.1007/s11160-012-9297-z.

Laist, D.W., Knowlton, A.R., Mead, J.G., Collet, A.S. and Podesta, M. (2001). Collisions between ships and whales. Marine Mammal Science 17(1): 35–75.Last, P.R. and Stevens, J.D. (2009). Sharks and Rays of Australia (Second Edition). Collingwood, Victoria: CSIRO Publishing.

Lavender, A.L., S.M. Bartol, and I.K. Bartol. 2012. Hearing capabilities of loggerhead sea turtles (*Caretta caretta*) throughout ontogeny. *In* Popper, A.N. and A.D. Hawkins (eds.). *The Effects of Noise on Aquatic Life*. Volume 730. Springer. pp. 89-92. https://doi.org/10.1007/978-1-4419-7311-5_19.

Lavender, A.L., S.M. Bartol, and I.K. Bartol. 2014. Ontogenetic investigation of underwater hearing capabilities in loggerhead sea turtles (*Caretta caretta*) using a dual testing approach. *Journal of Experimental Biology* 217(14): 2580-2589. https://jeb.biologists.org/content/217/14/2580.

LEC (1990). Seafloor and Habitat Description Proposed Gas Pipeline Routes. Unpublished report to Hadson Energy by Le Provost Environmental Consultants, October 1990.

Limpus, C.J. (2008). A biological review of Australian marine Turtles 2. Green turtle, Chelonia mydas (Linnaeus). The State of Queensland, Environmental Protection Agency, Brisbane, Queensland.

Lindquist, D.C., Shaw, R.F. and Hernandez Jr, F.J. (2005). Distribution patterns of larval and juvenile fishes at off shore petroleum platforms in the north central Gulf of Mexico. Estuarine, Coastal and Shelf Science 62: 655-665.

Martin, B., J.T. MacDonnell, N.E. Chorney, and D.G. Zeddies. 2012. Appendix A: Sound Source Verification of Fugro Geotechnical Sources. *In ESS Group, Inc. Renewal Application for Incidental Harassment Authorization for the Non-Lethal Taking of Marine Mammals Resulting from Pre-Construction High Resolution Geophysical Survey*. For Cape Wind Associates, LLC. http://www.nmfs.noaa.gov/pr/pdfs/permits/capewind_iha_application_renewal.pdf.

Marquenie, J., Donners, M., Poot, H., Steckel, W. and de Wit, B. (2008). Adapting the spectral composition of artificial lighting to safeguard the environment. pp 1-6

McCauley, R. (1998). Radiated underwater noise measured from the drilling rig Ocean General, rig tenders Pacific Ariki and Pacific Frontier, fishing vessel Reef Venture and natural sources in the Timor Sea, Northern Australia. (Report No. C98-20). Centre for Marine Science and Technology, Curtin University of Technology, Perth, Western Australia.

McCauley, R.D, Fewtrell, J., Duncan, A.J., Jenner, C., Jenner, M-N., Penrose, J.D., Prince, R.I.T., Adhitya, A., Murdoch, J., and McCabe, K. (2000). Marine Seismic Surveys- A Study of Environmental Implications, APPEA Journal, pp. 692-708.

McCauley, R.D. and Salgado-Kent, C. (2008). Sea Noise Logger Deployment 2006–2008 Scott Reef – Whales, Fish and Seismic Surveys. Report for URS/Woodside Energy by Centre for Marine Science and Technology (CMST). Project CMST 639–2 and 688. Report No. R2008-36. Unpublished report for Woodside.

McCauley, R.D. (2011). Woodside Kimberley sea noise logger program, Sept-2006 to June-2009: Whales, fish and man-made noise. Report produced for Woodside Energy Ltd, 86 pp.

McCauley, R.D., R.D. Day, K.M. Swadling, Q.P. Fitzgibbon, R.A. Watson, and J.M. Semmens. 2017. Widely used marine seismic survey air gun operations negatively impact zooplankton. Nature Ecology & Evolution 1(7): 1-8. https://doi.org/10.1038/s41559-017-0195.

McPherson, C.R., J.E. Quijano, M.J. Weirathmueller, K.R. Hiltz, and K. Lucke. 2019. *Browse to North-West-Shelf Noise Modelling Study: Assessing Marine Fauna Sound Exposures*. Document Number 01824, Version 2.0. Technical report by JASCO Applied Sciences for Jacobs. https://www.epa.wa.gov.au/sites/default/files/PER_documentation2/Appendix%20D%203.pdf.

McPherson, C. R. and M. A. Wood (2017). Otway Basin Geophysical Operations Acoustic Modelling: Acoustic Modelling for Assessing Marine Fauna Sound Exposures, Technical report by JASCO Applied Sciences for Lattice Energy. Appendix C of Beach Energy Environment Plan, Otway Geophysical and Geotechnical Seabed Assessment.

Meekan, M.G., Wilson, S.G., Halford, A. and Retzel, A. (2001). A comparison of catches of fishes and invertebrates by two light trap designs, in tropical NW Australia. Marine Biology 139: 373–381.

Milicich, M.J., Meekan, M.G. and Doherty, P.J. (1992). Larval supply: a good predictor of recruitment in three species of reef fish (Pomacentridae). Mar Ecol Prog Ser. 86: 153-166.

Myrberg, A.A.Jr. (1978). Underwater Sound: Its Effects on the Behaviour of Sharks pp. 392–417. In E.S. Hodgson and R.F. Mathewson (eds.). Sensory Biology of Sharks, Skates and Rays. Office of Naval Research, Arlington.

Neil, KM, Hilliard, RW, Clark, P, Russell, B, Clark, R and Polglaze, J (2005) Situation and Gaps Analysis of Introduced Marine Species, Vectors, Nodes and Management Arrangements for the Northern Planning Area, Report published by the National Oceans Office (Marine Division, Department of Environment and Heritage), Canberra.

NMFS (National Marine Fisheries Service) (2014). *Marine Mammals: Interim Sound Threshold Guidance* (webpage). National Marine Fisheries Service, National Oceanic and Atmospheric Administration, U.S. Department of Commerce. http://www.westcoast.fisheries.noaa.gov/protected_species/marine_mammals/threshold_guidance.html.

NMFS (National Marine Fisheries Service) (2018). 2018 Revision to: Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing (Version 2.0): Underwater Thresholds for Onset of Permanent and Temporary Threshold Shifts. U.S. Department of Commerce, NOAA. NOAA Technical Memorandum NMFS-OPR-59.

NRC (2003). Ocean Noise and Marine Mammals. Summary Review for the National Academies National Research Council by the National Research Council. The National Academies Press, Washington D.C, United States.

NSF (National Science Foundation) U.S. Geological Survey, and National Oceanic and Atmospheric Administration (U.S.) (2011). *Final Programmatic Environmental Impact Statement/Overseas.* Environmental Impact Statement for Marine Seismic Research Funded by the National Science Foundation or Conducted by the U.S. Geological Survey. National Science Foundation, Arlington, VA.

Payne, JF., Andrews, CD., Fancey, LL., Guiney, J., Cook, A and Christian, JR. (2008). "Are seismic surveys an important risk factor for fish and shellfish?" Bioacoustics 17(1-3): 262-265.

Pendoley Environmental (2011). Varanus Island Marine Turtle Tagging Programme 2010 – 2011 Nesting Season. Report to Apache Energy by Pendoley Environmental Pty Ltd.

Piniak, W.E., D.A. Mann, S.A. Eckert, and C.A. Harms. 2011. Amphibious hearing in sea turtles. *In*: Hawkins, T. and A.N. Popper (eds.). *2nd International Conference on the Effects of Noise on Aquatic Life*. 15-20 Aug 2010. Springer-Verlag, Cork, Ireland.

Poot, H., Ens, B. J., de Vries, H., Donners, M. A. H., Wernand, M. R. and Marquenie, J. M. (2008). Green light for nocturnally migrating birds. Ecology and Society 13(2): 47.

Prince, R.I.T. (2001). Aerial survey of the distribution and abundance of dugongs and associated macroinvertebrate fauna- Pilbara Coastal and Offshore Region, W.A. Report to Environment Australia.

Prince, R.I.T. and Chaloupka, M. (2011). Estimating demographic parameters for a critically endangered marine species with frequent reproductive omission: hawksbill turtles nesting at Varanus Island, Western Australia. Marine Biology 159(2): 355-363.

Richardson, W.J., Greene, C.R., Malme, C.I. and Thomson, D.H. (1995). Marine Mammals and Noise Academic Press, San Diego, California.

Ridgway, S.H., E.G. Wever, J.G. McCormick, J. Palin, and J.H. Anderson. 1969. Hearing in the giant sea turtle, *Chelonia mydas*. *Proceedings of the National Academy of Sciences* 64(3): 884-890. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC223317/pdf/pnas00113-0080.pdf.

Ripley, J.L. (2006). Effects of Environmental Factors on the Paternal Brood Pouch and Sound Production in Two Sympatric Pipefish Species from the Chincoteague Bay, Virginia. Dissertation submitted to the Eberly College of Arts and Sciences at West Virginia University. Department of Biology, Morgantown, West Virginia.

RPS (2010). Technical Appendix – Marine Mammals. Wheatstone Project EIS/ERMP. Unpublished report for Chevron Australia Pty Ltd, March 2010.

Salerno, J., Little, B., Lee, J., Ray, R., and Hamdan, L.J. (2016) Conserving archaeological sites as biological and historical resources in the Gulf of Mexico: the effects of crude oil and dispersant on the biodiversity and corrosion potential of shipwreck bacterial biofilms. American Geophysical Union's Ocean Sciences Meeting. New Orleans, February 22, 2016.

Salmon, M., Wyneken, J., Fritz, E. and Lucas, M. (1992). Sea finding by hatchling sea turtles: role of brightness, silhouette and beach slope orientation cues. Behaviour, 122.

Shaw, R.F., Lindquist, D.C., Benfield, M.C., Farooqi, T. and Plunket, J.T. (2002). Offshore petroleum platforms: functional significance for larval fish across longitudinal and latitudinal gradients. Prepared by the Coastal Fisheries Institute, Louisiana State University. U.S. Department of the Interior, Minerals Management Service, Gulf of Mexico OCS Region, New Orleans, LA. OCS Study MMS 2002-077, p. 107.

Scholten, M.C.Th., Kaag, N.H.B.M., Dokkum, H.P. van, Jak, R.G., Schobben, H.P.M. and Slob, W. 1996. Toxische effecten van olie in het aquatische milieu, TNO report TNO-MEP – R96/230. Den Helder, the Netherlands.

Silber, K,G., & S. Bettridge (2012). An assessment of the final rule to implement vessel speed restrictions to reduce the threat of vessel collisions with North Atlantic Right Whales. NOAA Technical Memorandum NMFS-OPR-48. February 2012.

Simmonds, M.P., Dolman, S.J. and Weilgart, L. (eds). (2004). Oceans of Noise [Online]. http://www.wdcs.org/submissions_bin/OceansofNoise.pdf. AWDCS Science Report Published by the Whale and Dolphin Conservation Society.

Southall, B.L., Bowles, A.E., Ellison, W.T., Finneran, J.J., Gentry, R.L., Greene Jr., C.R., Kastak, D., Ketten, D.R., Miller, J.H., Nachtigall, P.E., Richardson, W.J., Thomas, J.A. and Tyack, P.L. (2007). Marine mammal noise exposure criteria: Initial scientific recommendations. *Aquatic Mammals* 33(4):1–121.

Surman, C. (2002). Survey of the marine avifauna at the Laverda-2 appraisal well (WA-271-P) Enfield Area Development and surrounding waters. Report prepared for Woodside Energy Ltd., Perth.

SVT. (2010). Underwater Noise Assessment Halyard-1. Unpublished report prepared for Apache Energy Ltd by SVT Engineering Consultants.

Threatened Species Scientific Committee (2015a). Conservation Advice Megaptera novaeangliae humpback whale. Canberra: Department of the Environment. Available from: [http://www.environment.gov.au/biodiversity/threatened/species/pubs/38-conservation-advice-10102015.pdf]. In effect under the EPBC Act from 01-Oct-2015.

Threatened Species Scientific Committee (2015b). Conservation Advice Rhincodon typus whale shark. Canberra: Department of the Environment. Available from: http://www.environment.gov.au/biodiversity/threatened/species/pubs/66680-conservation-advice-01102015.pdf. In effect under the EPBC Act from 01-Oct-2015.

Threatened Species Scientific Committee (2015b). Conservation Advice Balaenoptera physalus fin whale. Canberra: Department of the Environment. Available from: [http://www.environment.gov.au/biodiversity/threatened/species/pubs/37-conservation-advice-01102015.pdf]. In effect under the EPBC Act from 01-Oct-2015.

Threatened Species Scientific Committee (2015c). Conservation Advice Balaenoptera borealis sei whale. Canberra: Department of the Environment. Available from:[http://www.environment.gov.au/biodiversity/threatened/species/pubs/34-conservation-advice-01102015.pdf]. In effect under the EPBC Act from 01-Oct-2015.

Threatened Species Scientific Committee (2015d). Conservation Advice Pterodroma Mollis soft-plumaged petrel. Canberra: Department of the Environment. Available from: http://www.environment.gov.au/biodiversity/threatened/species/pubs/1036-conservation-advice-01102015.pdf. In effect under the EPBC Act from 01-Oct-2015.

Threatened Species Scientific Committee (2016f). Conservation Advice Calidris canutus Red knot. Canberra: Department of the Environment. Available from:[http://www.environment.gov.au/biodiversity/threatened/species/pubs/855-conservation-advice-05052016.pdf]. In effect under the EPBC Act from 05-May-2016.

Threatened Species Scientific Committee (2016g). Conservation Advice Limosa lapponica menzbieri Bar-tailed godwit (northern Siberian). Canberra: Department of the Environment. Available from: [http://www.environment.gov.au/biodiversity/threatened/species/pubs/86432-conservation-advice-05052016.pdf]. In effect under the EPBC Act from 05-May-2016.

Tolimieri, N., Jeffs, A. and Montgomery, J.C. (2000). Ambient sound as a cue for navigation by the pelagic larvae of reef fishes. Marine Ecology Progress Series. Vol 207: 219 – 244.

Urick, R.J. 1983. *Principles of Underwater Sound*. 3rd edition. McGraw-Hill, New York, London. 423 p.

Walker, D.I and McComb, A.J. (1990). Salinity response of the seagrass Amphibolus antarctica: an experimental validation of field results. Aquatic Botany 36: 359-366.

Warner, G.A. and A. McCrodan. 2011. Underwater Sound Measurements. (Chapter 3) *In* Hartin, K.G., L.N. Bisson, S.A. Case, D.S. Ireland, and D.E. Hannay (eds.). *Marine mammal monitoring and mitigation during site clearance and geotechnical surveys by Statoil USA E&P Inc. in the Chukchi Sea, August-October 2011: 90-day report. LGL Rep. P1193*. Report by LGL Alaska Research Associates, Inc. and JASCO Research Ltd. for Statoil USA E&P Inc., NMFS, and USFWS. p. 202 + appendices. ftp://wkst189.oar.noaa.gov/noaa_documents.lib/NMFS/Auke%20Bay/AukeBayScans/Removable%20Disk/p1192.pdf.

WDCS (2004). Oceans of Noise. Whale and Dolphin Conservation Society (Online). Available from: [http:www.wdcs.org/stop/pollution/index.php].

Wells, F.E., McDonald, J.I. and Huisman, J.M. (2009). Introduced marine species in Western Australia. Published by the Department of Fisheries, Perth, WA.

Wiese, F.K., Montevecchi, W.A., Davoren G.K., Huettmann F., Diamond A.W. and Linke, J. (2001). Seabirds at Risk around Offshore Oil Platforms in the North-west Atlantic. Marine Pollution Bulletin Vol. 42, No. 12, pp. 1285-1290.

Witherington, B.E. and Martin, R.E. (2003). Understanding, assessing and resolving light-pollution problems on sea turtle nesting beaches. Florida Marine Research Institute Technical Report TR-2 3rd Edition Revised, Florida Department of Environmental Protection, Tequesta, Florida, United States of America.

Wood, M. A. and C. R. McPherson (2019). Supplemental modelling results for Otway Basin Geophysical Operations Acoustic Modelling: Acoustic Modelling for Assessing Marine Fauna Sound Exposures, Technical note by JASCO Applied Sciences for Lattice Energy. Appendix D of Beach Energy Environment Plan, Otway Geophysical and Geotechnical Seabed Assessment

Woodside (2008). Torosa South-1 Pilot Appraisal Well Environment Plan. Woodside Energy, Perth.

Yudhana, A., J.D. Sunardi, S. Abdullah, and R.B.R. Hassan. 2010. Turtle hearing capability based on ABR signal assessment. *Telkomnika* 8: 187-194.

Zykov, M.M. 2013. *Underwater Sound Modeling of Low Energy Geophysical Equipment Operations*. Document Number 00600, Version 2.0. Technical report by JASCO Applied Sciences for CSA Ocean Sciences. https://www.slc.ca.gov/wp-content/uploads/2018/09/AppG.pdf.

Appendix A1 - Santos WA Environment Management 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.

Kevin Gallagher
Managing Director & CEO

APPROVED 28 November 2018

QE-91-IQ-00047_REV 5

Appendix A2 - Regulatory Framework of Relevant 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.	No	Commonwealth – Department of Agriculture, Water and the Environment	There are no known sites of Aboriginal Heritage Significance within the operational area or EMBA.	N/A
Australian Ballast Water Requirements, Version 7	Australian Ballast Water Management Requirements outline the mandatory ballast water management requirements to reduce the risk of introducing harmful aquatic organisms into Australia's marine environment through ballast water from international vessels. These requirements are enforceable under the *Biosecurity Act 2015*.	Yes	Commonwealth – Department of Agriculture and Water Resources	Potential internationally sourced vessel operating in Australian Waters which could have the potential for introduction of Invasive Marine Species and potential ballast water exchange.	**Section 7.1** – Introduction of IMS
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 is one national heritage places found on the National Heritage List, within the EMBA, as identified by the Act.	**Section 7.4 -** hydrocarbon release
Australian Maritime Safety Authority Act 1990 (AMSA Act)	This Act specifies that the Australian Maritime Safety Authority's (AMSA) role includes protection of the marine environment from pollution from ships and other environmental damage caused by shipping. AMSA is responsible for administering the Marine Orders in Commonwealth waters. AMSA is the spill	Yes	AMSA	This Act applies to the use of any vessel associated with operations and is relevant to the activity in regards to the unplanned pollution from vessels.	**Section 7.4 -** hydrocarbon release

Commonwealth Legislation	Summary	Relevant to activity?	Administering Authority	Relevant aspects of the activity	EP Section
	control agency for shipping sourced spill in Commonwealth waters. Facilitates international cooperation and mutual assistance in preparing and responding to a major oil spill incident and encourages countries to develop and maintain an adequate capability to deal with oil pollution emergencies. Requirements are given effect through AMSA. AMSA is the lead agency for responding to oil spills in the marine environment and is responsible for the Australian National Plan for Maritime Environmental Emergencies.				
Marine Orders	Marine Orders (MO) are subordinate rules made pursuant to the Navigation Act 2012 and Protection of the Sea (Prevention of Pollution from Ships) Act 1983 affecting the maritime industry. They are a means of implementing Australia's international maritime obligations by giving effect to international conventions in Australian law.	Yes	AMSA	Vessel movements, safety, discharges and emissions	**Section 6 –** Planned activities **Section 7 –** Unplanned activities
Aquatic Resources Management Act 2016	This Act will be the primary legislation used to manage fishing, aquaculture, pearling and aquatic resources in Western Australia. The Act was scheduled for commencement on 1 January 2019,	Yes	Department of Primary Industries and Regional Development	Vessel movements have the potential to introduce IMS	**Section 7.1**

Commonwealth Legislation	Summary	Relevant to activity?	Administering Authority	Relevant aspects of the activity	EP Section
	however, this has been deferred while an amendment to the Act is progressed.				
Maritime Powers Act 2013	Protects the heritage values of shipwrecks and relics for shipwrecks over 75 years. It is an offence to interfere with a shipwreck covered by this Act. Available historic shipwreck locations covered by international conventions enacted by this legislation have been identified and assessed (as applicable) within this EP.	No	The Department of Immigration and Border Protection	This Act applies to the shipwrecks (over 75 years old) within the EMBA. There is no planned interaction or interference with shipwrecks, and any unplanned impacts is only expected to affect the surface waters.	N/A
Biosecurity Act 2015 *Biosecurity Regulations 2016*	This Act provides the Commonwealth with powers to take measures of quarantine, and implement related programs as are necessary, to prevent the introduction of any plant, animal, organism or matter that could contain anything that could threaten 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 Agriculture and Water Resources	Potential internationally-sourced vessel operating in Australian Waters which could have the potential for introduction of Invasive Marine Species and potential ballast water exchange	**Section 7.1** – Introduction of IMS
Environment Protection and	The Act aims to: + Protect MNES;	Yes	Commonwealth – Department of	The activity involves potential impacts to MNES	**Section 6.2** – Light emissions

Commonwealth Legislation	Summary	Relevant to activity?	Administering Authority	Relevant aspects of the activity	EP Section
Biodiversity Conservation Act 1999 *Environment Protection and Biodiversity Conservation Amendment Regulations 2006*	+ Provide for Commonwealth environmental assessment and approval processes; and + Provide an integrated system for biodiversity conservation and management of protected areas.		Agriculture, Water and the Environment	which are threatened and migratory species;	**Section 6** – Underwater Noise emissions **Section 6.6** – Planned operational discharges **Section 7.4 -** hydrocarbon release
Environment Protection and Biodiversity Conservation Act 1999 - Proclamation – Ningaloo Marine Park (Commonwealth Waters)	The Declaration of Ningaloo Marine Park in Commonwealth Waters.	Yes	Commonwealth – Department of Agriculture, Water and the Environment	Unplanned hydrocarbon/chemical release	**Section 7.4 -** hydrocarbon release
Historic Shipwrecks Act 1976 *Historic Shipwrecks Regulations 2018*	This Act protects shipwrecks that have lain in territorial waters for 75 years or more. It is an offence to interfere with any shipwreck covered by the Act. *Note Act and Regulations planned to be repealed on commencement of Underwater Cultural Heritage Act 2018*	No	Commonwealth – Department of Agriculture, Water and the Environment	This Act applies to the shipwrecks (over 75 years old) within the EMBA. There is no planned interaction or interference with shipwrecks, and any unplanned impacts is only expected to affect the surface waters.	N/A
Underwater Cultural Heritage Act 2018	This Act extends protection provided under the *Historic Shipwrecks Act 1976* to other wrecks such as submerged aircraft and human remains. It also increases penalties applicable to damaged sites.	No	Commonwealth – Department of Agriculture, Water	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
	Commencement date of Act to be proclaimed, but will commence at latest on 24 August 2019.		and the Environment	There is no planned interaction or interference with shipwrecks, and any unplanned impacts is only expected to affect the surface waters.	
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 Agriculture, Water and the Environment; and Climate Change Authority	This Act applies to the atmospheric emissions through combustion engine use to operate the vessels associated with the activity. Implementation of the Act will reduce the impact of GHG emissions associated with vessel use for the installation and commissioning activity, through compliance with MARPOL Annex VI (Marine Order Part 97: Marine Pollution Prevention – Air Pollution), and require the use of low sulphur fuel.	**Section 6.3** – Atmospheric emissions
Maritime Legislation Amendment (Prevention of Air Pollution from Ships) Act 2007	This Act implements the requirements of MARPOL 73/78 Annex VI for shipping in Commonwealth waters.	Yes	Commonwealth, Department of Infrastructure, Regional Development and Cities	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	**Section 6.3** – Atmospheric emissions

Commonwealth Legislation	Summary	Relevant to activity?	Administering Authority	Relevant aspects of the activity	EP Section
				Order Part 97: Marine Pollution Prevention – Air Pollution), and require the use of low sulphur fuel.	
Navigation Act 2012	An act regulating navigation and shipping including Safety of Life at Sea (SOLAS). A number of Marine Orders enacted under this Act apply directly to offshore petroleum exploration and production activities: + Marine Orders - Part 17: Liquefied gas carriers and chemical tankers + Marine Orders - Part 21: Safety of navigation and emergency procedures + Marine Orders - Part 30: Prevention of collisions + Marine Orders - Part 47: Mobile Offshore Drilling Units + Marine Orders - Part 50: Special purpose ships + Marine Orders - Part 57: Helicopter Operations + Marine Order - Part 59: Off-shore industry vessel operations + Marine Orders - Part 60: Floating Offshore facilities	Yes	Commonwealth, Department of Infrastructure, Regional Development and Cities	All vessel movements associated with the activity will be governed by marine safety regulations and marine orders under the Act.	**Section 7.4 -** hydrocarbon release

Commonwealth Legislation	Summary	Relevant to activity?	Administering Authority	Relevant aspects of the activity	EP Section
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". 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.	~~No~~ Yes	NOPSEMA	Environmental impacts and environmental risks of the activity due to: + Noise emissions; + Artificial light; + Atmospheric emissions; + Seabed and benthic habitat disturbance; + Interaction with other marine users; + Vessel discharges; + Spill response operations + Dropped objects; + Introduction of invasive marine species; + Marine fauna interaction; + Accidental release of hydrocarbons.	N/A
Ozone Protection and Synthetic Greenhouse Gas Management Act 1989	Regulates the manufacture, importation and use of ozone depleting substances (typically used in fire-fighting equipment	Yes	Commonwealth - Department of Agriculture, Water	The activity does not include import, export or manufacture activities of ODS.	**Section 6.3** – Atmospheric emissions

Commonwealth Legislation	Summary	Relevant to activity?	Administering Authority	Relevant aspects of the activity	EP Section
	and refrigerants). Applicable to the handling of any ODS.		and the Environment	This Act applies where ODS is found on vessel refrigeration systems, however, this is a rare occurrence.	
Protection of the Sea (Powers of Intervention) Act 1981 *Protection of the Sea (Powers of Intervention) Regulations 1983*	The Act authorises the Commonwealth to take measures for the purpose of protecting the sea from pollution by oil and other noxious substances discharged from ships and provides legal immunity for persons acting under an AMSA direction.	Yes	Commonwealth, Department of Infrastructure, Regional Development and Cities	Potential impacts to commonwealth waters in the event of an unplanned hydrocarbon spill.	**Section 7.6- 7.8 –** Unplanned hydrocarbon spills
Protection of the Sea (Prevention of Pollution from Ships) Act 1983 *Protection of the Sea (Prevention of Pollution from Ships) (Orders) Regulations 1994* *Protection of the Sea (Prevention of Pollution from Ships) Act 1983*	This Act relates to the protection of the sea from pollution by oil and other harmful substances discharged from ships. This Act disallows any harmful discharge of sewage, oil and noxious substances into the sea and sets the requirements for a shipboard waste management plan. The following Marine Orders relating to marine pollution prevention have been put in place to give effect to relevant regulations of Annexes I, II, III, IV, V and VI of MARPOL 73/78: + Marine Orders - Part 91: Marine Pollution Prevention - Oil + Marine Orders - Part 93: Marine Pollution Prevention - Noxious Liquid Substances	Yes	Commonwealth, Department of Infrastructure, Regional Development and Cities	The Act is relevant to the extent that Santos WA will comply with MARPOL through the following relevant Marine Orders relating to marine pollution prevention have been put in place to give effect to relevant regulations of Annexes I, II, III, IV, V and VI of MARPOL 73/78:	**Section 6.6** – Planned operational discharges **Section 7 –** Unplanned activities risk assessment

Commonwealth Legislation	Summary	Relevant to activity?	Administering Authority	Relevant aspects of the activity	EP Section
	+ Marine Orders - Part 94: Marine Pollution Prevention - Harmful Substances in Packaged Forms + Marine Orders - Part 95: Marine Pollution Prevention – Garbage + Marine Orders - Part 96: Marine Pollution Prevention – Sewage + Marine Orders - Part 97: Marine Pollution Prevention - Air Pollution + Marine Orders - Part 98: Marine Pollution - Anti-fouling Systems				
Protection of the Sea (Civil Liability of Bunker Oil Pollution Damage) Act 2008	This Act implements the requirements for the International Convention on Civil Liability for Bunker Oil Pollution Damage.	Yes	Commonwealth, Department of Infrastructure, Regional Development and Cities	This Act applies to diesel refueling which will be undertaken at sea as part of the activity. Compliance with the Act reduces the risk of bunker oil pollution.	**Section 7.4 -** hydrocarbon release
Protection of the Sea (Harmful Antifouling Systems) Act 2006	This Act relates to the protection of the sea from the effects of harmful anti-fouling systems. It prohibits the use of harmful organotins in ant-fouling paints used on ships.	Yes	Commonwealth, Department of Infrastructure, Regional Development and Cities	This Act applies to vessel movements in Australian Waters associated with the activity. Vessels are required to have biofouling systems in place to prevent introduction of IMS / harmful impact on Australian biodiversity.	**Section 7.1** – Introduction of IMS

State legislation

State legislation	Summary	Relevant to activity?	Administering authority	Relevant aspects of the activity	EP section
Conservation and Land Management Act 1984	DBCA is responsible for the day to day management of marine parks vested with Marine Parks and Reserves Authority (MPRA) and provide administrative support to the MPRA. Marine nature reserves, marine parks and marine management areas are the three reserve categories vested in the MPRA. Offshore operations must comply with specific marine park conditions when navigating or conducting activities in or near areas designated as marine sanctuaries for conservation, recreational, ecological, historical, research, educational, or aesthetic qualities.	Yes	Department of Biodiversity, Conservation and Attractions (DBCA)	Unplanned hydrocarbon/chemical release	**Section 6 –** Planned activities risk assessment **Section 7 –** Unplanned activities risk assessment
Environmental Protection Act 1986 *Environmental Protection Regulations 1987*	The Environment Protection Act 1986 (EP Act) requires all petroleum activities with the potential to cause significant environment harm to be referred to OEPA	Yes	The Environment Protection Agency	Santos have not referred this activity to the OEPA, as the activity was not determined to cause significant environment harm	**Section 6 –** Planned activities risk assessment **Section 7 –** Unplanned activities risk assessment
Environmental Protection (Unauthorised Discharges) Regulations 2004	The purpose of the Regulations is to cover discharges into the environment from business or commercial activity which are not serious enough to cause pollution or environmental harm and breach the provisions of the Environmental Protection Act 1986 (EP Act).	Yes	Department of Water and Environment Regulation	Unplanned hydrocarbon/chemical release (Response Actions – OPEP)	**Section 7 –** Unplanned activities risk assessment

State legislation	Summary	Relevant to activity?	Administering authority	Relevant aspects of the activity	EP section
Environment Protection (Controlled Waste) Regulations 2004	Regulates the transportation of controlled waste on roads in Western Australia (storage, handling, labelling, transport, tracking etc)	Yes	Department of Water and Environment Regulation (DWER)	Unplanned hydrocarbon/chemical release (Response Actions – OPEP)	**Section 7 –** Unplanned activities risk assessment
Fish Resources Management Act 1994 *Fish Resources Management Regulations 1995*	This Act establishes a framework for management of fishery resources and is the nominated lead agency responsible for implementing Western Australian marine biosecurity management requirements through implementation of the *Fish Resources Management Act 1994* (FRMA 1994) and associated regulations.	Yes	Department of Primary Industries and Regional Development (DPIRD)	Introduction of IMS.	**Section 7.1**– Introduction of invasive species
Petroleum (Submerged Lands) Act 1982 *Petroleum (Submerged Lands) (Environment) Regulations 2012*	The environment plan must include: (a) details of all environmental impacts and environmental risks of the activity; and (b) an evaluation of those impacts and risks; and (c) a description of the environmental risk assessment process used to evaluate those impacts and risks, including the terms used in that process to categorise the levels of seriousness of those impacts and risks.	Yes	Department of Mines, Industry Regulation and Safety	Environmental impacts and environmental risks of the activity due to: + Noise emissions; + Artificial light; + Atmospheric emissions; + Seabed and benthic habitat disturbance; + Interaction with other marine users; + Vessel discharges; + Spill response operations + Dropped objects; + Introduction of invasive marine species;	**Section 5** – Environmental impact and risk assessment **Section 6** – Planned events **Section 7** – Unplanned events

State legislation	Summary	Relevant to activity?	Administering authority	Relevant aspects of the activity	EP section
				+ Marine fauna interaction; + Accidental release of hydrocarbons.	
West Australian Maritime Archaeology Act 1973	Protects maritime archaeological sites on state land and in State waters, such as bays, harbours and rivers. Other than shipwrecks, it includes single relics, such as an anchor, and land sites associated with exploration, early settlements, whaling and pearling camps and shipwreck survivor camps	No	West Australian Museum	No archaeological relics identified within operational area or EMBA.	N/A

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*.	No	Planned operational discharges occur as parted of operations.	**Section 6.6** – Planned operational discharges
Agreement Between the Government of Australia and the Government of Japan for the Protection of Migratory Birds in Danger of Extinction and Their Environment 1974 (commonly referred to as the Japan Australia Migratory Bird Agreement or JAMBA)	This agreement recognises the special international concern for the protection of migratory birds and birds in danger of extinction that migrate between Australia and Japan. Implemented in EPBC Act 1999.	Yes	Only relevant in so far as the credible spill scenario may result in impact to migratory seabirds foraging or nesting in area.	**Section 7.4 -**hydrocarbon release
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 1999.	Yes	Only relevant in so far as the credible spill scenario may result in impact to migratory seabirds foraging or nesting in area.	**Section 7.4 -**hydrocarbon release
Convention for the Control of Transboundary Movements of Hazardous Wastes and Their Disposal 1989 (Basel Convention)	This convention deals with the transboundary movement of hazardous wastes, particularly by sea. Implemented in *Hazardous Waste (Regulation of Exports and Imports) Act 1989*.	No	Activity does not involve transboundary movement of hazardous wastes.	N/A
United Nations Convention on Biological Diversity -1992	An international treaty to sustain life on earth.	Yes	Relevant only insofar as the activity may interact with MNES (threatened and	**Section 6** – Underwater noise emissions

International agreements and conventions	Summary	Relevant to activity?	Relevant aspects	EP section
			migratory species) protected under the EPBC Act.	**Section 7.1**- Introduction of IMS **Section 7.4** -hydrocarbon release
Convention on Oil Pollution Preparedness, Response and Co-operation 1990 (OPRC 90)	This convention comprises national arrangements for responding to oil pollution incidents from ships, offshore oil facilities, sea ports and oil handling. The convention recognises that in the event of pollution incident, prompt and effective action is essential.	Yes	In the event that worse-case credible spill scenarios may enact a national arrangement for response.	**Section 7.4** -hydrocarbon release
Convention on the Conservation of Migratory Species of Wild Animals 1979 (Bonn Convention)	The Bonn Convention aims to improve the status of all threatened migratory species through national action and international agreements between range states of particular groups of species.	Yes	Only relevant in so far as the credible spill scenario may result in impact to MNES protected migratory species.	**Section 7.4** -hydrocarbon release
International Convention for the Establishment of an International Fund for Compensation for Oil Pollution Damage (Fund 92)	This convention ensures compensation is provided for damage caused by oil pollution.	No	Relevant to oil tankers, not supply or support vessels.	N/A
International Convention for the Prevention of Pollution from Ships 1973/1978 (MARPOL 73/78)	This Convention and Protocol (together known as MARPOL 73/78) build on earlier conventions in the same area. MARPOL is concerned with operational discharges of pollutants from ships. It contains five Annexes, dealing respectively with oil, noxious liquid substances, harmful packaged substances, sewage and garbage.	Yes	Already dealt with through the *Protection of the Sea (Prevention of Pollution from Ships) Act 1983* – refer to legislation table above	N/A

International agreements and conventions	Summary	Relevant to activity?	Relevant aspects	EP section
	Detailed rules are laid out as to the extent to which (if at all) such substances can be released in different sea areas. The legislation giving effect to MARPOL in Australia is the Protection of the Sea (Prevention of Pollution from Ships) Act 1983, the Navigation Act 1912 and several Parts of Marine Orders made under this legislation.			
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 7.4** -hydrocarbon release
International Convention on Civil Liability for oil pollution damage (1969)	This convention provides a mechanism for ensuring the payment of compensation for oil pollution damage.	No	Relevant to oil tankers	N/A
International Convention for the Control and Management of Ships' Ballast Water and Sediments (Ballast Water Convention) 2004	The IMO has been addressing the problem of IMS in ships' ballast water since the 1980s. Ballast water and sediments guidelines were adopted in 1991 and the ballast water convention was adopted in 2004. Recent accession by Finland has triggered the final entry into force of these international requirements. As a result, the International Convention for the Control and Management of Ships' Ballast Water and Sediment will enter into force on 8th September 2017 (IMO Briefing 22 2016). It aims to prevent the spread of	Yes	Potential internationally sourced vessel operating in Australian Waters which could have the potential for introduction of Invasive Marine Species and potential ballast water exchange	Section 7.1 – Introduction of IMS

International agreements and conventions	Summary	Relevant to activity?	Relevant aspects	EP section
	harmful aquatic organisms from one region to another, by establishing standards and procedures for the management and control of ships' ballast water and sediments. Ballast Water Management systems must be approved by the Administration in accordance with this IMO Guidelines.			
United Nations Convention on the Law of the Sea (UNCLOS) (1982)	Part XII of the convention sets up a general legal framework for marine environment protection. The convention imposes obligations on State Parties to prevent, reduce and control marine pollution from the various major pollution sources, including pollution from land, from the atmosphere, from vessels and from dumping (Articles 207 to 212). Subsequent articles provide a regime for the enforcement of national marine pollution laws in the many different situations that can arise. Australia signed the agreement relating to the implementation of Part XI of the Convention in 1982, and UNCLOS in 1994.	Yes	Only relevant to the extent that Santos WA will comply with MARPOL through the following relevant Marine Orders relating to marine pollution prevention have been put in place to give effect to relevant regulations of Annexes I, II, III, IV, V and VI of MARPOL 73/78: + Marine Orders - Part 91: Marine Pollution Prevention - Oil + Marine Orders - Part 93: Marine Pollution Prevention - Noxious Liquid Substances + Marine Orders - Part 95: Marine Pollution Prevention – Garbage + Marine Orders - Part 96: Marine Pollution Prevention – Sewage + Marine Orders - Part 97: Marine Pollution Prevention - Air Pollution + Marine Orders - Part 98: Marine Pollution - Anti-fouling Systems	**Section 6.6** – Planned operational discharges **Section 7.1**- Introduction of IMS **Section 7.4** -hydrocarbon release

International agreements and conventions	Summary	Relevant to activity?	Relevant aspects	EP section
United Nations Framework Convention on Climate Change (1992)	The objective of the convention is to stabilise greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous interference with the climate system. Australia ratified the convention in December 1992 and it came into force on 21 December 1993.	Yes	Only relevant in to the extent that to reduce impact of GHG emissions associated with vessel use, Santos WA will comply with MARPOL Annex VI (Marine Orders Part 97: Marine Pollution Prevention – Air Pollution) And require the use of low sulphur fuel.	**Section 6.3** – Atmospheric emissions

Standards and Codes of Practice

Standards and Codes of Practice	Summary	Relevant to activity?	Relevant aspects	EP section
Australian Standard/New Zealand Standard International Standards Organization 31000:2019 Risk Management – Guidelines (ISO, 2018)	Provides guidelines on managing risk in a way that can be customised to any organisation and context.	Yes	Santos WA's Risk Management Framework (QE-91-IF-10051) underpins the Risk Management Policy and is consistent with the requirements of Australian Standard/New Zealand Standard International Standards Organization 31000:2019 Risk Management – Guidelines (ISO, 2018).	Summary of the environmental impact and risk assessment approach

Appendix B - Description of the Existing Environment

Appendix B1 Description of the Existing Environment

Appendix B2 PMST Searches

Appendix C - Stakeholder Consultation

Appendix D - Environment Consequence Descriptors

	Consequence level	A – Negligible	B – Minor	C – Moderate	D – Major	E – Critical
	Acceptability	Acceptable	Acceptable	Unacceptable	Unacceptable	Unacceptable
	Severity	*No impact or negligible impact.* *Environmental impact lasting days up to 1 week*	*Detectable but insignificant change to local population, industry or ecosystem factors. Localised effect* *Environmental impact lasting weeks up to 12 months*	*Significant impact to local population, industry or ecosystem factors.* *Environmental impact lasting 1 to 10 years*	*Major long-term effect on local population, industry or ecosystem factors.* *Environmental impact lasting 10 to 20 years*	*Complete loss of local population, industry or ecosystem factors AND/ OR major wide-spread regional impacts with slow to no full recovery.* *Environmental impact lasting more than 20 years to no recovery*
Environmental Receptors	**Fauna** In particular, EPBC Act listed threatened/migratory fauna or WA Wildlife Conservation Act 1950 specially protected fauna	Short term behavioural impacts only to small proportion of local population and not during critical lifecycle activity; No decrease in local population size; No reduction in area of occupancy of species; No loss/disruption of habitat critical to survival of a species; No disruption to the breeding cycle of any individual; No introduction of disease likely to cause a detectable population decline.	Detectable but insignificant decrease in local population size (excluding protected species); Insignificant reduction in area of occupancy of species; Insignificant loss/disruption of habitat critical to survival of a species; Insignificant disruption to the breeding cycle of local population.	Significant decrease in local population size but no threat to overall population viability; Significant behavioural disruption to local population; Significant disruption to the breeding cycle of a local population; Significant reduction in area of occupancy of species; Significant loss of habitat critical to survival of a species; Modify, destroy, remove, isolate or decrease availability of quality of habitat to the extent that a significant decline in local population is likely; Introduce disease likely to cause a significant population decline.	Long term decrease in local population size and threat to local population viability; Major disruption to the breeding cycle of local population; Major reduction in area of occupancy of species; Fragmentation of existing population; Major loss of habitat critical to survival of a species; Modify, destroy, remove, isolate or decrease availability of quality of habitat to the extent that a long term decline in local population is likely; Introduce disease likely to cause a long term population decline	Complete loss of local population; Complete loss of habitat critical to survival of local population; Wide spread (regional) decline in population size or habitat critical to regional population.
	Physical Environment / Habitat Includes: air quality; water quality; benthic habitat (biotic/abiotic), particularly habitats that are rare or unique; habitat that represents a Key Ecological Feature[4]; habitat within a protected area; habitats that include benthic primary producers[5] and/ or epi-fauna[6]	No or negligible reduction in physical environment / habitat area/function.	Detectable but localised and insignificant loss of area/function of physical environment / habitat. Rapid recovery evident within ~ 1 year (seasonal recovery)	Significant loss of area and/or function of local physical environment / habitat. Recovery over medium term (2–10 years)	Major, large-scale loss of area and/or function of physical environment / local habitat. Slow recovery over decades.	Complete destruction of local physical environment / habitat with no recovery; Long term (decades) and wide spread loss of area or function primary producers on a regional scale
	Threatened ecological communities (EPBC Act listed ecological communities)	No decline in threatened ecological community population size, diversity or function; No reduction in area of threatened ecological community; No introduction of disease likely to cause decline in threatened ecological community population size, diversity or function.	Detectable but insignificant decline in threatened ecological community population size, diversity or function; Insignificant reduction in area of threatened ecological community.	Significant decline in threatened ecological community population size, diversity or function; Significant reduction in area of threatened ecological community; Introduction of disease likely to cause significant decline in threatened ecological community population size, diversity or function.	Major long term decline in threatened ecological community population size, diversity or function Major reduction in area of threatened ecological community Fragmentation of threatened ecological community Introduce disease likely to cause long term decline in threatened ecological community population size, diversity or function	Complete loss of threatened ecological community
	Protected Areas Includes: World Heritage Properties; Ramsar wetlands; Commonwealth/ National Heritage Areas; Land/ Marine Conservation Reserves.	No or negligible impact on protected area values; No decline in species population within protected area; No or negligible alteration, modification, obscuring or diminishing of protected area values.*	Detectable but insignificant impact on one of more of protected area's values. Detectable but insignificant decline in species population within protected area. Detectable but insignificant alteration, modification, obscuring or diminishing of protected area values*	Significant impact on one of more of protected area's values; Significant decrease in population within protected area; Significant alteration, modification, obscuring or diminishing of protected area values.	Major long term effect on one of more of protected area's values Long term decrease in species population contained within protected area and threat to that population's viability Major alteration, modification, obscuring or diminishing of protected area values	Complete loss of one of more of protected area's values; Complete loss of species population contained within protected area.
	Socio-economic receptors Includes: fisheries (commercial and recreational); tourism; oil and gas; defence; commercial shipping.	No or negligible loss of value of the local industry; No or negligible reduction in key natural features or populations supporting the activity.	Detectable but insignificant short-term loss of value of the local industry. Detectable but insignificant reduction in key natural features or population supporting the local activity.	Significant loss of value of the local industry; Significant medium term reduction of key natural features or populations supporting the local activity.	Major long-term loss of value of the local industry and threat to viability. Major reduction of key natural features or populations supporting the local activity.	Shutdown of local industry or widespread major damage to regional industry; Permanent loss of key natural features or populations supporting the local industry.

* Excluding World Heritage Areas

[4] As defined by the Department of Environment (DoE)
[5] Benthic photosynthetic organisms such as seagrass, algae, hard corals and mangroves
[6] Fauna attached to the substrate including sponges, soft corals and crinoids.