Santos

Barossa Development Drilling and Completions Environment Plan

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

Rev	Owner	Reviewer	Approver
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Revision history

Rev	Rev Date	Author / Editor	Amendment
1	05/10/21	Santos	Issued to NOPSEMA
2	24/12/2021	Santos	Issued to NOPSEMA in response to RFFWI 1
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Abbreviations

Abbreviation	Description
µ	Micron
°C	Degrees Celsius / Centigrade (Degrees)
AFMA	Australian Fisheries Management Authority
AFZ	Australian Fishing Zone
AHO	Australian Hydrographic Office
AIS	Automatic Identification System
ALARP	as low as reasonably practicable
AMOSC	Australian Marine Oil Spill Centre
AMP	Australian Marine Park (Commonwealth)
AMSA	Australian Maritime Safety Authority
APPEA	Australian Petroleum Production and Exploration Association
ASBTIA	Australian Southern Bluefin Tuna Industry Association
BIA	biologically important area
BOP	blowout preventer
Cefas	Centre for Environment, Fisheries and Aquaculture (United Kingdom)
CFA	Commonwealth Fisheries Association
CHARM	chemical hazard and risk management
CM	control measure
CoA	Commonwealth of Australia
DAFF	Department of Agriculture, Fisheries and Forestry (Commonwealth)
DAH	dissolved aromatic hydrocarbon
dB	decibels
DAWE	Department of Agriculture, Water and the Environment
DEWHA	Department of the Environment, Water, Heritage and the Arts
DITT	Department of Industry, Tourism and Trade – Northern Territory Government
DNP	Director of National Parks
DoE	Department of Environment
DoE	Department of the Environment
DoEE	Department of the Environment and Energy
DP	dynamic positioning
DSEWPaC	Department of Sustainability, Environment, Water, Population and Communities
EEZ	Exclusive Economic Zone
EMBA	environment that may be affected
ENVID	environmental hazard identification workshop

Abbreviation	Description
EP	Environment Plan
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
EPO	environmental performance objective
EPS	environmental performance standard
ESD	ecologically sustainable development
FPSO	floating production, storage and offloading
GHG	greenhouse gas
GHS	globally harmonized system of classification and labelling of chemicals
HSE	health, safety and environment
Hz	hertz
IMS	invasive marine species
IMT	Incident Management Team
ISO	International Organization for Standardization
JRCC	Joint Rescue Coordination Centre
KEF	key ecological feature
kHz	kilohertz
km	kilometre
km/hr	kilometres per hour
km^2	square kilometres
LCM	lost circulation material
LNG	liquid natural gas
LOWC	loss of well control
LWIV	light well intervention vessel
MARPOL	International Convention for the Prevention of Pollution from Ships
m	metres
m/s	metres per second
m^2	square metres
m^3	cubic metres
MC	measurement criteria
MDO	marine diesel oil
MEVA	moderate exposure value area
MNES	matters of national environmental significance
MODU	mobile offshore drilling unit
MoU	Memorandum of Understanding
MPNMP	Marine Park Network Management Plan

Abbreviation	Description
NAF	non-aqueous fluids
NAXA	North Australian Exercise Area
NEBA	net environmental benefit analysis
NHMRC	National Health and Medical Research Council
nm	nautical mile
NMR	North Marine Region
NOAA	National Oceanic and Atmospheric Administration
NOPSEMA	National Offshore Petroleum Safety and Environmental Management Authority
NOPTA	National Offshore Petroleum Titles Administrator
NWS	North West Shelf
ODS	ozone-depleting substances
OCNS	Offshore Chemical Notification Scheme
OPEP	Oil Pollution Emergency Plan
OPP	Offshore Project Proposal
OPGGS	offshore petroleum and greenhouse gas storage
PAH	polycyclic aromatic hydrocarbons
PK	peak sound level
PMST	Protected Matters Search Tool
PSZ	petroleum safety zone
PTS	permanent threshold shift
Ramsar	Convention on Wetlands of International Importance
ROV	remotely operated vehicles
RMR	riserless mud recovery
SCE	solids control equipment
SDS	Safety Data Sheet
SEL	sound exposure level
SMPEP	Shipboard Marine Pollution Emergency Plan
SOLAS	safety of life at sea
SOPEP	Shipboard Oil Pollution and Emergency Plan
SPL	sound pressure level
TRF	Timor Reef Fishery
TTS	temporary threshold shift
WBM	water-based mud

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1. Introduction

1.1 Environment plan summary

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

The following *Barossa Development Drilling and Completions EP* summary has been prepared as required by Regulation 11(4).

EP summary material requirement	Relevant section of EP containing EP summary material
The location of the activity	**Section 2**
A description of the receiving environment	**Section 3** and **Appendix C**
A description of the activity	**Section 2**
Details of the environmental impacts and risks	**Sections 6** and **7**
The control measures (CM) for the activity	**Sections 6** and **7**
The arrangements for ongoing monitoring of the titleholder's environmental performance	**Section 8**
Response arrangements in the Oil Pollution Emergency Plan	*Barossa Development Oil Pollution Emergency Plan* (OPEP)
Consultation already undertaken and plans for ongoing consultation	**Section 4**
Details of the titleholders nominated liaison person for the activity	**Section 1.5**

1.2 Activity overview

Santos Ltd (Santos) proposes to conduct a Barossa Development drilling and completions campaign (herein referred to as the Barossa Development Drilling Campaign) within Commonwealth petroleum production licence NT/L1, approximately 263 km north-northwest of Darwin, Northern Territory (**Figure 1-1**).

The petroleum activity (herein referred to as the activity) covered in this EP is part of the Barossa Development, comprising an offshore gas-condensate field produced using a floating production, storage and offloading (FPSO) facility, subsea production wells, supporting subsea infrastructure and a gas export pipeline. The Barossa Development is described in the Barossa Development Offshore Project Proposal (OPP) (ConocoPhillips, 2018), which was accepted by the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) in March 2018.

This EP identifies and evaluates credible environmental impacts and risks associated with the drilling and completions campaign and ongoing management of the completed wells.

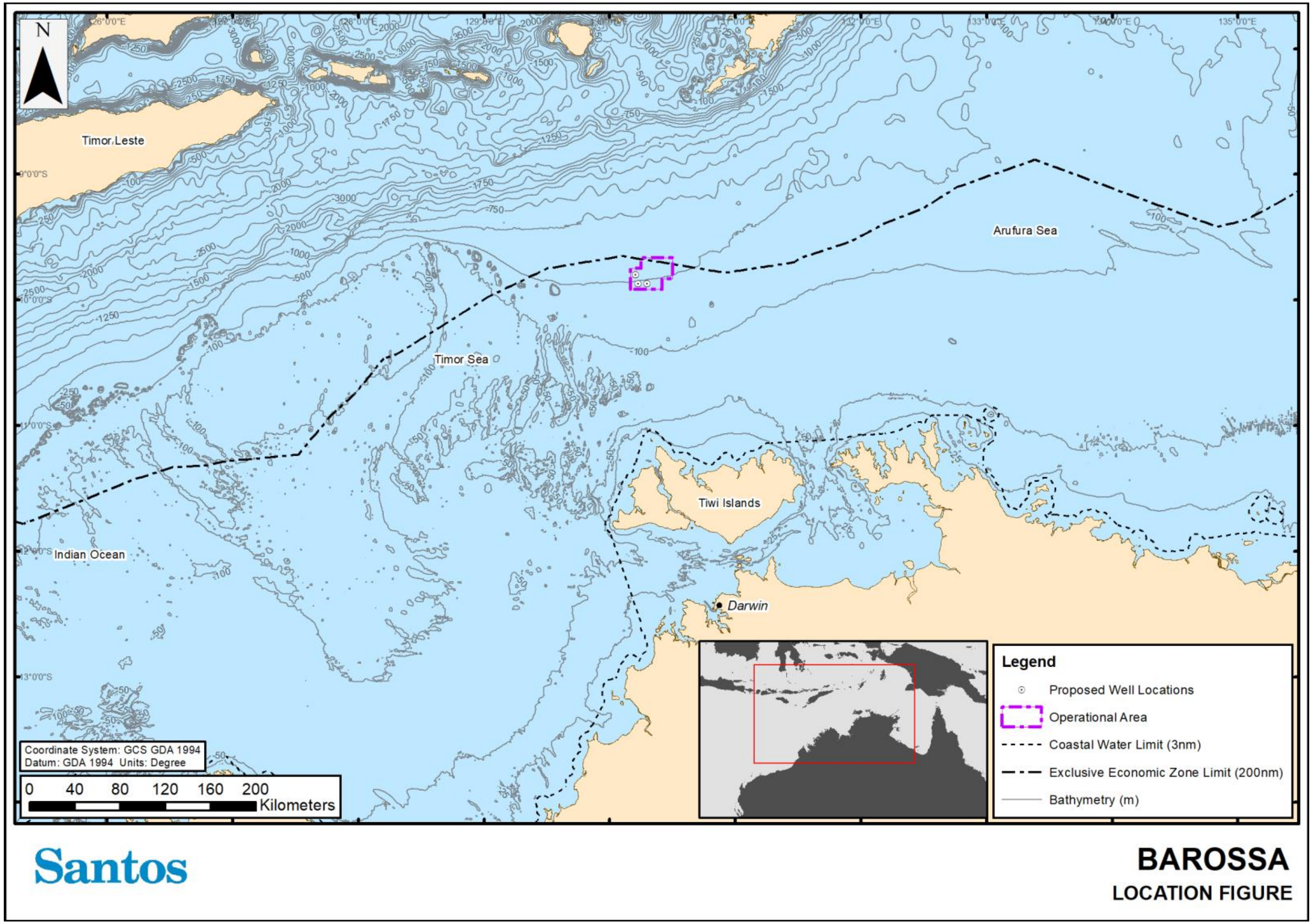

Figure 1-1: Location of proposed activity

1.3 Purpose of this Environment Plan

OPGGS(E)R 2009 requirements
Regulation 10A
For Regulation 10, the criteria for acceptance of an environment plan are that the plan: (a) is appropriate for the nature and scale of the activity; and (b) demonstrates that the environmental impacts and risks of the activity will be reduced to as low as reasonably practicable; and (c) demonstrates that the environmental impacts and risks of the activity will be of an acceptable level; and (d) provides for appropriate environmental performance outcomes, environmental performance standards and measurement criteria; and (e) includes an appropriate implementation strategy and monitoring, recording and reporting arrangements; and (f) does not involve the activity or part of the activity, other than arrangements for environmental monitoring or for responding to an emergency, being undertaken in any part of a declared World Heritage property within the meaning of the *Environment Protection and Biodiversity Conservation Act* (EPBC Act); and (g) demonstrates that: (i) the titleholder has carried out the consultations required by Division 2.2A; and (ii) the measures (if any) that the titleholder has adopted, or proposes to adopt, because of the consultations are appropriate. (h) complies with the Act and the regulations.

This EP has been prepared in accordance with the Commonwealth Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009 (OPGGS(E)R), as acceptance by NOPSEMA.

In accordance with the OPGGS(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 to demonstrate that impacts and risks are being continuously reduced to ALARP and are at an acceptable level. The environmental management of the activity described in the EP complies with the Santos Environment, Health and Safety Policy (**Appendix A**) and with all relevant legislation (**Appendix B**). This EP documents and considers all relevant stakeholder consultation performed during the development of the EP.

1.4 Environment plan validity

This EP is valid from the date that it is accepted by NOPSEMA, until 31 December 2025 or submission and acceptance of Regulation 25A end-of-operation of EP notification (whichever comes first). The activity will not commence until 2022 (**Section 2.1**).

Santos may revise the EP, using the Management of Change (MoC) process described in **Section 8.10.2**. Any changes made under this process will not affect the validity of this EP.

1.5 Operator and titleholder details

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

The titleholder details are provided in **Table 1-1**, with the nominated operator shown in bold.

Table 1-1: Titleholder details for drilling activities

Title	Titleholder (nominated operator in bold)	ABN	Interest (%)	Contact details
NT/L1	**Santos NA Barossa Pty Ltd**	**109 974 932**	**37.5%**	Business Address: Level 7, 100 St Georges Terrace, Perth, Western Australia, 6000 Telephone number: (08) 6218 7100 Fax number: (08) 6218 7200 Email address: barossa.regulatory@santos.com
	Santos Offshore Pty Ltd	158 702 071	25.0%	
	SK E&S Australia Pty Ltd	005 475 589	37.5%	Business Address: Level 6, 60 Martin Place, Sydney NSW 2000, Australia Telephone number: (02) 2121 3304 Fax number: None Email address: geonwoo.kim@sk.com

1.5.1 Details for nominated liaison person

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

Name: Nick Phillips

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

Telephone number: 6218 7100

Email address: barossa.regulatory@santos.com

1.5.2 Notification procedure in the event of changed details

In the event 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 will notify NOPSEMA and provide the updated details.

1.6 Environmental management framework

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

1.6.1 Santos Environment, Health and Safety Policy

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

Sections 4, **6** and **7** reflect this policy, detailing and evaluating environmental impacts and risks and providing control measures with set environmental performance outcomes and standards.

1.6.2 Relevant environmental legislation

Relevant legislative requirements are presented in **Appendix B**, inclusive of the relevant EP sections where the legislation may prescribe or control how an activity is undertaken. Australia is a signatory to numerous international conventions and agreements that oblige the Commonwealth government to prevent pollution and protect specified habitats, flora and fauna. Relevant government departments have been consulted during the development of this EP to ensure compliance with all relevant legislation, conventions and agreements. Those that are relevant to the activities are detailed in **Appendix B**.

1.6.3 Oil Pollution Emergency Plan

The *Barossa Development Oil Pollution Emergency Plan* (OPEP) (BAA-200-0314) details spill management arrangements, including the Santos incident management structure.

Each activity conducted under the Barossa Development OPEP has an activity-specific OPEP addendum. The *Barossa Development OPEP Addendum – Drilling and Completions* (BAA-200-0316) provides activity information comprising:

+ a description of the spill profile
+ applicable response strategies
+ net environmental benefit analysis (NEBA)
+ spill response ALARP assessment.

2. Activity description

OPGGS(E)R 2009 Requirements
Regulation 13. Environmental assessment
Description of the activity 13(1) The environment plan must contain a comprehensive description of the activity including the following: (a) the location or locations of the activity; (b) general details of the construction and layout of any facility; (c) an outline of the operational details of the activity (for example, seismic surveys, exploration drilling or production) and proposed timetables; and (d) any additional information relevant to consideration of environmental impacts and risks of the activity.

2.1 Activity overview

This EP provides for drilling and completing up to eight production wells using a semi-submersible mobile offshore drilling unit (MODU), light well intervention vessel (LWIV) and the ongoing management of the complete wells until future commissioning and production phases. Activities included in this EP are:

+ movement of the MODU within the operational area (including the entry and exit of the area)
+ MODU and vessel commissioning and demobilising activities (e.g., equipment testing, tank flushing and cleaning, inventory management, etc.)
+ deployment and recovery of the MODU anchors and mooring lines (including potential for pre-lay anchors)
+ riserless drilling
+ drilling with a conventional closed-circulating fluid system and riserless mud recovery
+ installation of casing strings
+ drilling using water-based and non-aqueous drilling fluid systems
+ installation and operation of a blow-out preventer (BOP)
+ cementing
+ well completions, including perforating and well flowback (i.e., sampling, clean up, and flaring)
+ installation of Christmas trees
+ contingency activities such as side-track drilling, re-drilling sections, re-spud and abandonment
+ well intervention
+ ongoing well inspection, maintenance and management
+ general operations associated with the use of a MODU, vessels, helicopters and remotely operated vehicles (ROVs) within the operational area.

A summary of the activity is provided in **Table 2-1**.

Table 2-1: Summary of key activity

GENERAL DETAILS	
Activity window	2022 – 2025
Drilling and completions activities	Yes
Well intervention activities	Yes
Ongoing well management activities	Yes
OPERATIONAL ACTIVITIES	
MODU type	Semi-submersible MODU
In-field MODU no.	One MODU drilling production wells
Vessel type	Light well intervention Offshore multi-purpose Anchor handling
In-field vessel no.	Approximately one to four at any time
Remotely operated vehicles	Yes
Helicopters	Yes
DRILLING & COMPLETIONS ACTIVITIES	
No. of completed wells	Six are planned, with provision for an additional two contingency wells
Estimated drilling activity duration	Approximately 90 days per well
Estimated light well intervention activity duration	Approximately seven days per well
Drilling fluid type	Water-based and non-aqueous drilling fluids
Well flowback	Yes
Well re-spud/sidetrack	Contingency
Well abandonment	Contingency
ONGOING WELL MANAGEMENT	
Vessel-based activities	Could occur anytime following well completion Short-term duration (days) per well

2.1.1 Location

The activity will occur within Commonwealth Petroleum Production Licence NT/L1.

Six subsea production wells are planned to be drilled and completed around the future locations of three subsea production manifolds, with two wellheads adjacent to each manifold. If required, up to two contingency production wells could be drilled and completed at any manifold (eight wells in total). Proposed well locations are provided in **Table 2-2** and shown in **Figure 1-1**. The final well locations are subject to change by up to 1 km but will remain within the defined operational area (**Section 2.1.2**).

Table 2-2: Provisional names and locations for the six planned wells

Well Name	Latitude	Longitude
BS-03	09° 47' 50.973"S	130° 12' 26.482"E
BS-09	09° 47' 52.010"S	130° 12' 26.748"E
BS-16	09° 52' 07.785"S	130° 13' 42.843"E
BS-17	09° 52' 08.214"S	130° 13' 43.832"E
BS-19	09° 52' 07.107"S	130° 18' 06.710"E
BS-25	09° 52' 06.232"S	130° 18' 07.330"E

2.1.2 Operational area and petroleum safety zone

The permit area NT/L1 has been defined as the operational area within which all petroleum activities will occur (**Figure 2-1**).

Water depths over the operational area range from approximately 204 m to 376 m.

A petroleum safety zone (PSZ) (communicated via Notice to Mariners) will be in place around the MODU (temporary during the activity) and completed wells (ongoing). The PSZ is defined as a circular zone with a 500 m radius around the MODU surface location and completed subsea well location.

During drilling activities, a cautionary zone (communicated via Notice to Mariners) will be in place around the MODU and anchors which may extend up to 2.5 km from the MODU. Vessels not involved with the operations of the offshore facility are advised to avoid navigating, anchoring, stopping or fishing within the limits of any charted cautionary area.

All MODU, vessel and helicopter activities within the operational area are considered part of the petroleum activity. Activities outside of the operational area are not part of the petroleum activity. These activities will be managed in accordance with applicable jurisdictional legislation.

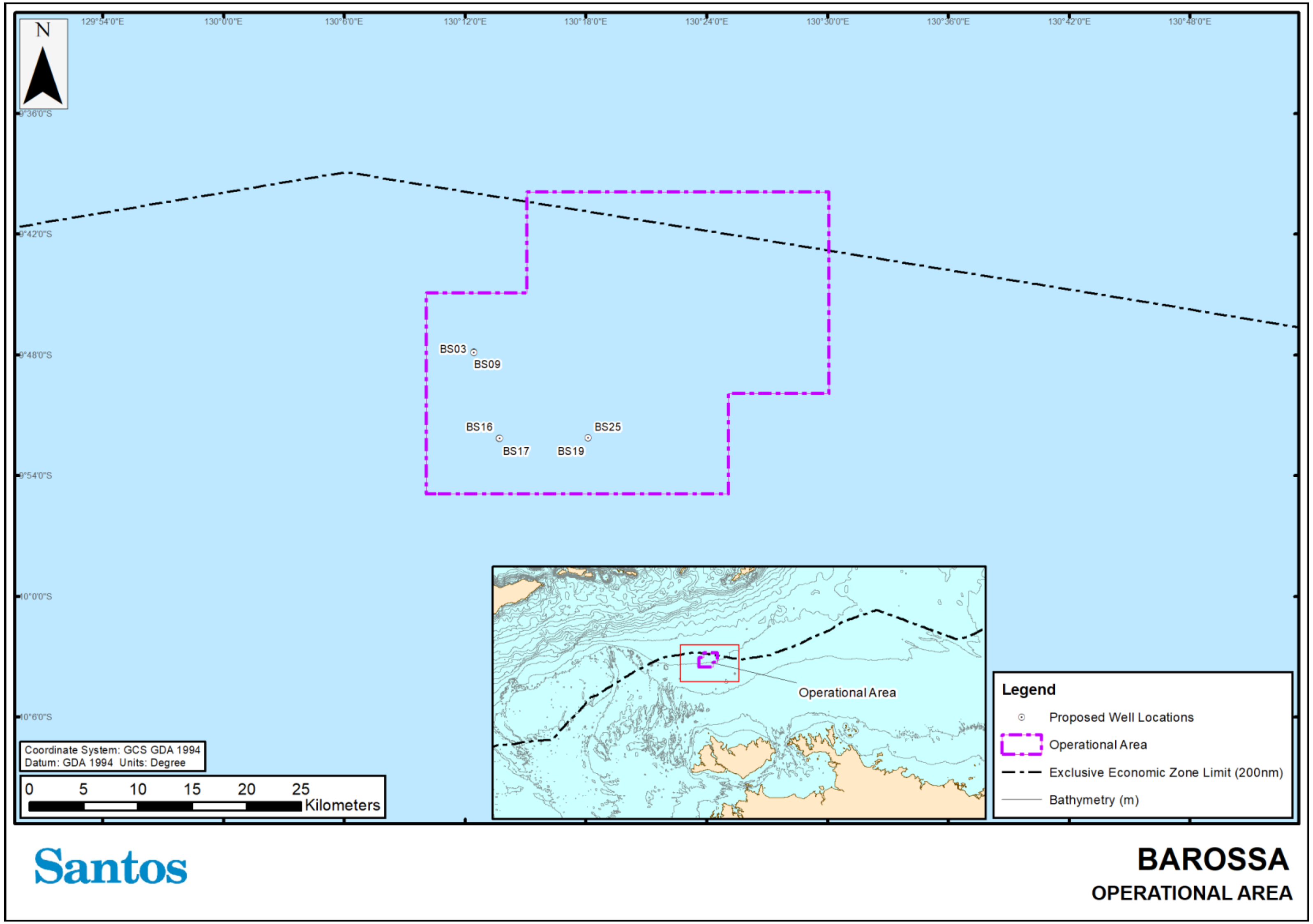

Figure 2-1: Barossa development drilling and completions operational area

2.1.3 Timing and duration

The activity is scheduled to begin in Q2 2022 subject to obtaining all regulatory and business approvals. The drilling and completions activities may take multiple calendar years to complete.

This EP assumes the activities may be undertaken at any time of year. The drilling and completion of each well is estimated to take approximately 90 days of continuous well operations (24 hours per day, seven days per week). This activity duration includes positioning (towing) and anchoring of the MODU, drilling, completion and well flowback and testing activities.

Additionally, each LWIV activity is estimated to take approximately seven days of continuous operations (24 hours per day, seven days per week).

It is possible that the activity durations may increase if technical difficulties or interruptions are encountered (e.g., equipment failures, weather, etc.). The MODU may also leave the operational area and return to finish the activity, although this is not planned.

Drilling, completion, well cleanup and light well intervention activities may occur concurrently in the operational area but not on the same well.

All stages of the well lifecycle are managed in accordance with a NOPSEMA-accepted *Well Operations Management Plan* (WOMP) and under this EP until the acceptance of a future commissioning and production/operations EP. Vessel-based activities (e.g., ROV operations) may occur at the wellhead locations following completion of drilling for short durations (days) as required.

2.2 Equipment spread

2.2.1 Mobile offshore drilling unit

All wells will be drilled with a semi-submersible MODU. The MODU will be towed into position by up to three support vessels.

Up to 12 anchors, within a radius of up to 2.5 km, may be deployed via support vessels from the MODU to maintain position. MODU anchors (and associated components such as chains, wires, marker buoys) are typically deployed on arrival at location but may be pre-laid before the MODU arrives. Anchors may be reset at any time (e.g., if ‘dragging’). Excess anchors and associated components may be laid on the seabed for temporary storage.

Upon MODU departure, anchors will be retrieved to the MODU and/or vessels.

2.2.2 Light well intervention vessel

A LWIV will be used for riserless well intervention and for installing the Christmas trees. LWIVs are typically subsea support vessels approximately 120 m long and equipped with ROVs and intervention equipment.

2.2.3 Vessels

Typically, up to three support vessels will be required to assist the MODU. These vessels will likely consist of a combination of anchor handling support vessels and offshore multi-purpose vessels. The support vessels will remain outside of the PSZ, unless undertaking operational activities.

Anchor handling support vessels will be used to position the MODU in the operational area, move the MODU between well locations and to deploy and retrieve anchors for the MODU.

Offshore multi-purpose vessels will also supply equipment and materials to the MODU and undertake vessel-based activities such as ROV surveys in the operational area.

Equipment and material transfers may include, but are not limited to, crew supplies, hydrocarbons (diesel, engine oil, hydraulic fluids, base oil, grease, etc.), bulk drilling products, MODU and drilling equipment, and waste.

MODU cranes will be used for equipment and material transfers between the MODU and vessels. Bulk products will also be transferred via hoses.

At least one support vessel will remain on standby to the MODU within the distance defined in the Safety Case (nominally three nautical miles) for MODU support and emergency response.

2.2.4 Remotely operated vehicle

ROVs may be used for a variety of activities, including:

+ seabed and hazard surveys
+ monitoring of subsea operations (e.g., cementing operations)
+ installation, functioning, monitoring and retrieval of subsea infrastructure and equipment (e.g., BOP)
+ ongoing well-management activities
+ recovery of objects.

ROVs will be deployed from the MODU and/or vessels. Each ROV requires an umbilical to provide electrical power and data and operational transmissions. The ROV will be fitted with various tools and camera systems (still/video).

2.2.5 Helicopters

Helicopters will be used primarily for crew change, and occasionally for medevac and equipment and material transfers. Helicopter flights are likely to occur several times a week.

2.3 Well construction

2.3.1 Design and method

The geology and geological risks are well understood as there have been eight previous well penetrations nearby.

Well sequencing may involve drilling and completing each individual well or batch drilling. Batch drilling involves drilling the same section (or sections) of multiple wells sequentially before going back and drilling the next section of each well until the target depth is reached at each well.

Each proposed subsea well is similar in design.

The conductor (42-inch), structural hole (30-inch) and initial sections of the surface hole (20") will be drilled riserless using seawater and pre-hydrated bentonite sweeps to clean the hole and casings will be run in hole and cemented in place. The fluids and drilled cuttings will exit the well at seabed while drilling these holes.

The lower sections of the surface hole (20inch) section will be displaced to a water-based mud (WBM) circulating system with well returns to the rig, using a riserless mud recovery (RMR) system. It is planned that the RMR system will be used for the 20inch section of all wells, however if the RMR system does not demonstrate reasonable reliability (i.e. subsea pumps and control systems) or fails to meet the technical objective (to maintain an inhibited mud system in the lower part of the 20 inch interval) it will be removed or not used for some wells. If RMR is not used, this section will be drilled riserless and the WBM and drilled cuttings will be discharged near the seabed.

The plan is to drill the intermediate hole (14¾-inch) sections with WBM. The BOP is run using the marine riser system and drilling fluid and cuttings will be returned to the MODU using a conventional riser system.

Prior to drilling the production hole section (8½-inch), the well will be suspended with two barriers to install a Tubing Head Spool required for well completions. The production hole section will then be drilled using WBM with the BOP installed. Drilling and completions fluid and cuttings will be returned to the MODU using a conventional riser system.

As a contingency, non-aqueous fluids (NAF) may also be used for intermediate and/or production hole sections should technical issues be encountered.

All wells have been designed to enable future removal of property in accordance with Section 573(3) of the Offshore Petroleum and Greenhouse Gas Storage Act 2006.

2.3.2 Drilling and completions fluids

Drilling fluids are required to maintain pressure overbalance, lubricate and cool the drill bit, prevent formation damage, maintain shale stability and remove drilled cuttings from the wellbore.

WBM typically consists of 80 to 90% by volume of fresh or saline water, with the balance made up of water-soluble and insoluble additives. Additives typically used include acids, weighting materials, water-soluble polymers, pH controllers, alkalinity controllers, defoamers, detergents and contingency lost circulation materials.

Completion fluids comprised of concentrated solutions of inorganic salts, such as chlorides and bromides, will be displaced downhole once the drilling phase has been completed. These completion fluids are solids-free and used to 'complete' the wells while minimising reservoir formation damage and control reservoir formation pressures.

The estimated volume of water-based drilling fluids and completion fluids released to sea is approximately 7,700 m^3 per well[1].

NAF consists of a base of non-aqueous fluid to which other ingredients such as emulsifiers, wetting agents, rheology modifiers, clay, lime and barite are added. The base non-aqueous fluid typically represents about 50 to 65% of the total volume of the complete mud. Bulk NAF systems will not be released to sea.

2.3.3 Solids management

Drilled cuttings for the riserless conductor, structural hole and initial sections of the surface hole (and potentially the lower section of the surface hole as explained in **Section 2.3.1**) will exit the wellbore at the seabed.

Fluids and cuttings for the remaining hole sections to target depth will be returned to the MODU and treated through a solids control system.

Cuttings will typically be removed via shale shakers and centrifuges (as required) and discharged to sea surface. Drilling fluids will be re-circulated downhole, stored for future use or disposal, or discharged to sea surface if no longer required.

Shale shakers are comprised of a series of vibrating shaker screens. The screens are sized so that valuable drilling fluid (i.e., liquid and fine solids) passes through ('underflow') and drilled cuttings do not ('overflow'). Centrifuges may be used to remove ultra-fine solids in the recovered drilling fluid (i.e., once surface hole section casing installed). The ultra-fine solids are detrimental to the drilling fluid properties due to increased surface area and reactivity. Centrifuges do not process all the well returns. Given the large volume, it is not practicable to centrifuge the entire drilling fluids system. Hence, a portion of the drilling fluid recovered from the shakers may be sent to the centrifuges for the removal of finer particles.

Solids control equipment will be used to reduce the amount of residual NAF on drilled cuttings before discharge. The reclaimed NAF will be retained onboard and recycled into the mud system or sent onshore for disposal. Bulk NAF systems will not be released to sea.

[1] Volumes are best-available estimates based on data acquired from previous Barossa drilling activities and include contingencies such as those detailed in Section 2.3.6.

The estimated volume of drilled WBM based cuttings released to sea is approximately 1,300 m^3 per well[1], and approximately 440m^3 of NAF based cuttings (if NAF is used)

2.3.4 Cementing

The conductor surface casing and intermediate casing strings will be cemented in place. This will provide a structural base for the well and is critical to well integrity. The majority of cement pumped remains downhole, but some volume may be discharged at the seabed (when cementing the conductor).

Some cement may be mixed and discharged at surface as part of cement unit commissioning before the start of drilling.

Cement in excess to demand will be discharged to sea as a slurry during the activity.

During cementing operations, surface cementing equipment and lines will need to be flushed, washed and cleaned with water to prevent hard setting. The residual cement and wash water will be discharged to sea after each cement job.

Cement spacer in well returns and residual surface tank volumes will also be discharged to sea during cementing operations.

Tracer dyes may be used during cementing operations for the purpose of detecting leaks.

2.3.5 Blow-out preventer

A BOP/Lower Marine Riser Package will be installed on the wellhead as a barrier to manage well integrity by providing a means to seal, control and monitor the well during drilling operations. The BOP is suitable for all expected conditions in the Barossa gas field and is capable of isolating the well in an emergency. It will be installed once the surface hole section has been drilled and cased.

Function and pressure tests of the BOP are regularly conducted as part of routine operations. The operation of the BOP (valves) uses open hydraulic systems and each time the BOP is operated (including testing), small volumes of BOP control fluid will be discharged to the ocean. The BOP control fluids generally consist of water mixed with a water-based corrosion inhibitor and lubricity additive. Each function or pressure test of the BOP will result in approximately 600 L of BOP control fluid being discharged to the ocean.

2.3.6 Well construction contingencies

If operational or technical issues are encountered during drilling, the following contingency activities may be required:

- Well plugging and abandonment: Abandonment of a well will involve installation of permanent barriers (e.g., cement plugs) and recovery of well casings and conductor above the seabed. Well abandonment would result in the use of additional cement which may result in the release of cement to the seabed.
- Re-spudding: The location of the re-spud would typically be within the immediate area of the original well location, as it will need to be connected to the intended manifold. If a re-spud of a well is required, the well operations would be similar to the original well. This would result in an additional volume of cuttings and slightly increased physical footprint on the seabed.
- Sidetrack drilling: In some operational circumstances, the option of a sidetrack instead of a re-spud may be considered when operational issues are encountered. If a sidetrack is undertaken, a portion of the original well would be appropriately abandoned by installing permanent barriers. The hole size and drilling fluids used for a sidetrack would be similar to those used in the original well, depending on the exact nature of the reason for the sidetrack.

- Additional casing installation in intermediate hole section: If significant downhole losses or hole instability are experienced during drilling of the 14¾-inch hole, the 11⅞-inch casing string may be set and cemented shallower, a 10⅝-inch × 12¼-inch hole drilled to the original planned casing point and a 9⅝" liner set and cemented. There will be a slight decrease in drill cuttings generated due to smaller hole size but a small increase in cement discharged to the seabed.
- Perforating may be required if the reservoir section of casing is permeability impaired during drilling operations or the completed well does not flow as expected. Perforating operations will involve the deployment and subsequent detonation of perforating charges down hole to increase the potential flow from the reservoir to the well once producing.

2.3.7 Well completions

Following drilling operations, the well will be completed in preparation for production. Well completion operations include activities such as installation of a pre-perforated liner, wellbore clean-up and displacement to completion fluid, installation of upper completion production tubing, well flowback, and well suspension.

Water-based well completion fluids will be circulated through the well to confirm the well is clear of solids laden drilling fluids. Water-based completion fluids will be circulated back to the MODU and a volume of well completion fluid, in the order of 100 m^3 per well, will be released to the marine environment. There will be no NAF released to sea during the well completions.

Each well will be flowed back to the MODU to remove drilling fluids and impurities/debris from the wellbore. The wells will be flowed up to a maximum rate of 120 MMscf/d until pre-defined clean-up criteria have been met and the necessary production data and samples have been collected – this will notionally take 24 to 36 hours pending well and surface process conditions. Base oil will be used in the flow back, to create the under-balance so the well will flow.

During well flowback, the completions fluids, produced water and hydrocarbons (reservoir fluids) will be analysed and separated on the MODU by the well flowback separator. Flammable hydrocarbons will be flared via an air-atomized burner. The non-flammable completion fluids and produced water will be treated via a water treatment package to reduce the oil-in-water content before operational discharge.

During well flowback, water that has been condensed from the steam used to heat the fluids via a steam exchanger in the well flowback package will also be discharged to sea.

To mitigate the risk of hydrate formation, methanol may be injected into the process stream during the well flowback at rates of approximately 1 to 5 L/min. The methanol will either be flared or passed through the oil-in-water treatment package if dissolved in the water phase. A mixture of monoethylene glycol (MEG) and water may also be used for hydrate prevention during well intervention operations – if this mixture is recovered it will be passed through the oil-in-water treatment package.

Following well flowback, the well will be suspended with wireline plugs in the completion.

2.3.8 Subsea tree installation

Once wells are completed by the MODU, vertical subsea Christmas trees will be installed using a LWIV.

The subsea Christmas tree and well intervention package will be function and pressure tested as part of routine installation activities. The operation of the tree valves uses open hydraulic systems, and each time the valves are operated (including testing), small volumes of water-based control fluid will be discharged to the ocean. The control fluids generally consist of water mixed with a water-based corrosion inhibitor and lubricity additive. Each function or pressure test of the subsea Christmas tree will result in approximately 60 L of control fluid being discharged to the ocean.

During the vertical Christmas tree installation there will be multiple connections/disconnections of the subsea intervention package. During this process, discrete volumes of well-suspension fluid, including MEG, sea water and potentially dry gas, will be discharged to the ocean.

Once the LWIV activity is complete, the well will remain shut-in for a period until future development commissioning and production phases.

In all stages of this activity, there will be two verified barriers in place.

2.3.9 Ongoing well management

Once the MODU finishes work on each well, the completed wells (before and after Christmas tree installation) will be managed in accordance with the NOPSEMA-accepted WOMP. This may require short-term vessel-based activities such as ROV operations. The wells will have two barriers to the environment at all stages prior to commissioning for production.

2.3.10 Emergency response and well suspension procedures

Standard well-suspension equipment will be available offshore to safely install temporary barriers should the MODU require emergency evacuation for any reason (e.g., cyclone). In the event the MODU is down-manned for a cyclone, the well will be suspended with two verified independent barriers to flow. The integrity of these barriers will be independent of any cyclonic metocean conditions and is verified within the NOPSEMA-accepted WOMP for the activity where the plan for well suspension in the event of a cyclone is assessed.

Routine and contingency testing of the MODU and vessel safety critical systems may be undertaken during the activity to comply with offshore regulatory requirements (e.g., safety cases).

3. Description of the environment

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

3.1 Introduction

This section describes the key physical, biological, socio-economic and cultural characteristics of the existing environment that may be affected by the activity. The description of the environment applies to two areas: the operational area (**Section 2.1.2**), and the environment that may be affected (EMBA; **Section 3.1.1**). These are shown in **Figure 3-1**.

3.1.1 Determining the environment that may be affected

Stochastic hydrocarbon dispersion and fate modelling, applied to the worst-case spill scenario for the operational area identified as relevant to the activity (**Section 7.5**), was undertaken to inform the EMBA. Stochastic modelling is created by overlaying hundreds of individual hypothetical oil spill simulations from an oil spill into a single map, with each simulation subject to a different set of metocean conditions drawn from historical records. Stochastic modelling is completed to reduce uncertainty in risk assessment and spill response planning.

The modelling considered key physical and 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 to determine the area that might be contacted by hydrocarbons for the various hydrocarbon phases. The EMBA boundary was identified using low exposure values which are not considered to be representative of a biological impact, but they are adequate for identifying the full range of environmental receptors that might be contacted by surface and/or subsurface hydrocarbons (NOPSEMA, 2019a) and a visible sheen. This also approximates the range of socio-economic effects and establishes a planning area for scientific monitoring. Refer to **Table 7-10** for the exposure values used and **Section 7.5** for further information about the reasons why these exposure values have been selected and how they relate to the risk assessment.

While the EMBA represents the largest possible spatial extent that could be contacted by any of the worst-case spill events modelled, an actual spill event is more accurately represented by only one of the simulations from the stochastic modelling, resulting in a much smaller spatial footprint in the event of an actual spill. Modelling of a single simulation, representative of a single spill event, is termed deterministic modelling. This is discussed further in **Section 7.6.2.2**.

The EMBA based on hydrocarbon spill modelling did not result in contact at the Scott Reef and Surrounding Waters Commonwealth Heritage Place but came very close to the feature. Due to its protected status, the EMBA was extended to include this feature. As a result, the feature has been considered in the risk assessment for unplanned events.

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. The information contained herein draws upon Santos' *Barossa Development Values and Sensitivities of the Marine and Coastal Environment* document (**Appendix C**) and Protected Matters Search Tool (PMST) searches[2] (**Appendix D**).

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

The operational area is located within Commonwealth waters in the Timor Sea, approximately 138 km north of the Tiwi Islands and 263 km north-northwest of Darwin, NT. The operational area is located within the North Marine Region (NMR), which encompasses approximately 625,689 km^2 of Commonwealth waters from west Cape York Peninsula to the NT/WA border (CoA, 2008, 2012a) (**Figure 3-1**).

The EMBA intersects with both the NMR and the North-west Marine Region (NWMR), as well as international waters. The key physical characteristics of the NMR and NWMR relevant to the EMBA include (CoA, 2012a):

+ a wide continental shelf, with water depths averaging less than 70 m
+ Van Diemen Rise, which forms part of a key ecological feature (KEF) (**Section 3.2.4.2**). This feature includes a range of geomorphic features, such as shelves, shoals, banks, terraces and valleys
+ a series of shallow calcium carbonate-based canyons (approximately 80 to 100 m deep and 20 km wide) in the northern section of the region
+ the Arafura Shelf, which forms part of a KEF (**Section 3.2.4.2**) and is up to 350 km wide and has an average water depth of 50 to 80 m, and is characterised by features such as canyons and terraces
+ currents driven predominantly by strong winds and tides and a monsoonal climate and complex weather patterns
+ significant sea country for Traditional Owners.

The EMBA lies within Australian Commonwealth and international waters of south-west Indonesia and Timor-Leste. These international waters (belonging to Indonesia and Timor-Leste) are comparable to the Australian oceanic waters within the EMBA, with no remarkable variation in water quality parameters or significant variation in sea state conditions expected. Areas of the Lesser Sunda Ecoregion found within the EMBA encompass the chain of islands and surrounding waters from Bali, Indonesia to Timor-Leste. This ecoregion contains suitable habitat for corals on shallow water substrates formed by limestone and lava flows and is thought to contain more than 500 species of scleractinian reef-building corals (DeVantier *et al*., 2008).

The ecoregion is considered important for coral endemism, particularly the areas of Bali-Lombok, Komodo and East Flores. Fringing coral reefs tend to be less developed on the southern, more exposed shorelines (Wilson *et al*., 2011).

[2] Note the coarse granularity of the PMST reports can make the output look different to the spatial area represented on figures within the EP.

3.2.1.1 Bioregions

Based on the Integrated Marine and Coastal Regionalisation of Australia, version 4.0 (CoA, 2006), the regional descriptions relevant to the operational area and the EMBA are provided in **Table 3-1** and **Figure 3-1**. Bioregions within international waters of the EMBA have not been formally classified, although the habitats within these waters have been described by published scientific literature and studies.

The operational area is situated within the Timor Transition Bioregion of the NMR (Department of the Environment and Heritage, 2006) bioregion that primarily features shelf slope and plateau to the west, and canyon and ridge to the east. It includes the Arafura Shelf, mentioned previously, which is recognised as a KEF (**Section 3.2.4.2**).

Table 3-1: Integrated Marine and Coastal Regionalisation of Australia provincial bioregions relevant to the activity

Bioregion	Operational area	EMBA
Northern Shelf Province	✗	✓
Northwest Shelf Transition	✗	✓
Timor Province	✗	✓
Timor Transition	✓	✓

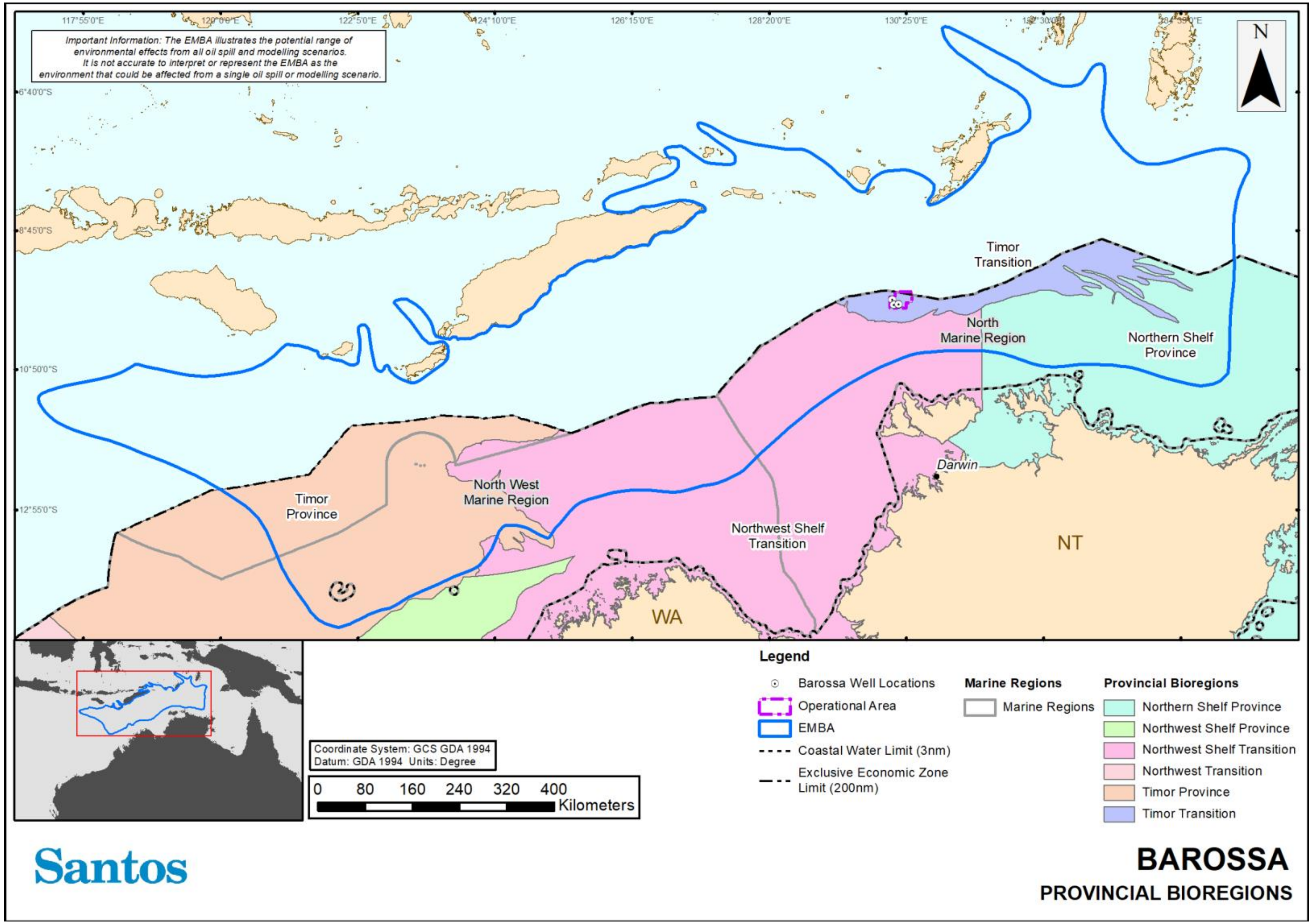

Figure 3-1: Integrated Marine and Coastal Regionalisation of Australia provincial bioregions in relation to the environment that may be affected

3.2.2 Summary of Barossa Studies

A number of environmental baseline studies have been undertaken for the project to characterise the existing marine environment within and surrounding NT/L1, within which the activity is located. The studies have involved the collection of detailed baseline data over 12 months (July 2014 to July 2015) to capture seasonal variability in the area. In addition to providing specific data and information across the area, the studies collected data that have been used to validate the hydrodynamic model developed by RPS, which underpins the credible hydrocarbon spill modelling.

Figure 5-2 in the accepted OPP shows the locations of the sampling sites and includes benthic towed video transects, benthic habitat, sediment, infauna and water quality sampling in the immediate vicinity of the proposed well locations.

The baseline studies undertaken were preceded by early engagement with key agencies (e.g. the Australian Institute of Marine Science (AIMS)) and were informed by a comprehensive literature review and gap analysis. A summary of the studies considered in the development of this EP is provided in **Table 3-2** below. Further detail and copies of the studies are provided in Section 5, Appendix C and Appendix D of the OPP.

Table 3-2: Summary of Barossa environmental studies

Study type	Description of study	Reference
Field-based studies		
Metocean data collection	Collection of metocean data on the surface and through the water column from July 2014 to March 2015, within and in the vicinity of the Barossa field, e.g. current, conductivity, wave and wind data.	Fugro, 2015
Water quality survey	Collection of baseline data on physical and chemical components of water quality in the vicinity of the Barossa field. The surveys were completed in June 2014, January 2015 and April 2015.	Jacobs, 2015a, 2015b, 2014
Sediment quality and infauna survey	Collection of baseline data on sediment quality and infauna communities in the vicinity of the Barossa field.	Jacobs, 2015c
Benthic habitat survey	Collection of baseline data to characterise topographic features, benthic habitats and macrofaunal communities in the vicinity of the Barossa field location and surrounding areas, including around Evans Shoal, Tassie Shoal and Lynedoch Bank, through the use of a specialised ROV.	Jacobs, 2016a
Underwater noise survey	Collection of baseline data on ambient underwater noise (physical, biological and anthropogenic sources) at three locations from July 2014 to July 2015 within the vicinity of the Barossa field and surrounding areas.	JASCO Applied Sciences, 2016a
Shoals and shelf survey 2015: • benthic habitats • fish communities	A seabed biodiversity survey of three shoals to the west of the Barossa field (Evans Shoal, Tassie Shoal and Blackwood Shoal) and two mid- continental shelf regions relevant to the potential Gas Export Pipeline route. The survey was undertaken in September/October 2015 by AIMS and involved characterisation of the seabed habitats, associated biota and fish communities (shoals only).	Heyward et al., 2017

Study type	Description of study	Reference
Oceanic Shoals Marine Park benthic habitat and fish diversity assessment	A seabed and fish biodiversity survey conducted between September and October 2017 by AIMS. The survey focused on six key sites inside and outside of the Oceanic Shoals Marine Park, including in the Habitat Protection Zone and Shepparton Shoal. The objective was to incorporate this new data to update the predictive habitat model an undertake statistical comparison of the proportion and spatial diversity of habitats within and outside the Oceanic Shoals Marine Park.	Radford et al., 2019
Desktop/modelling studies		
Environmental literature review and gap analysis	Collection and collation of all available publicly available information pertaining to the marine environment within the vicinity of the Barossa field and gap analysis to determine whether there is sufficient information to inform an environmental impact assessment and any future regulatory approvals for a potential full field development.	Jacobs SKM, 2014
Hydrodynamic model validation study	Data from the metocean study and through the deployment of drifter buoys in the vicinity of the Barossa field and surrounding areas, were used to validate the underlying hydrodynamic model used to develop the spill and discharge models.	RPS APASA, 2015
Geophysical survey	This survey undertook a preliminary geophysical survey of the offshore development area and potential pipeline routes.	Fugro, 2016
Geophysical survey report	This report provides the results from a geophysical survey carried out in the Barossa Project Infield Area. It provides comprehensive details regarding the seafloor and shallow geological features in the infield project area (including the drilling operational area).	DOF Subsea, 2018

3.2.3 Benthic habitats

The water depths in the operational area are between approximately 204 and 376 m. Within the EMBA, water depths range from lowest astronomical tide down to over 6000 m.

Based on the available information, including the bathymetry and seabed topography data derived from previous seismic surveys acquired in 2007 and 2016, geophysical surveys in 2015 and 2017, ROV footage collected during pre and post-spud surveys during exploration and appraisal drilling campaigns and from the extensive baseline studies undertaken across the area (refer **Section 3.2.2**), the seabed within the area is generally flat and located on a plain feature that is devoid of any significant bathymetric features. The geophysical surveys undertaken also reported that the seabed was smooth and featureless with the sediments interpreted to comprise predominantly fine clayey sand (Fugro 2016). The only relic seabed features observed were slight undulating sand waves (< 25 cm in height) and widespread bioturbation (i.e. burrows, mounds and tracks) (Jacobs 2016c). The marine sediments are predominantly silty sand and generally lack hard substrate..

In general, the benthic habitats observed in these studies which included the operational area were typical of those expected in offshore environments and were consistent with studies conducted both in areas with similar features and in areas of a similar geographic location (Jacobs 2016c). Santos is not aware of any information indicating that the Barossa offshore development area contains any critical or sensitive habitat, nor any benthic habitats that are not represented across other areas and/or regions.

Within the EMBA there are several submerged and emergent shoals and banks, including Evans Shoal, Tassie Shoal and Lynedoch Bank. Research undertaken as part of the Barossa Marine Studies Program has included surveys of these features**.** There are also some notable geophysical features within international waters, such as the Timor Trench (a large trench also known as the Timor Trough), which may be associated with high productivity/upwelling of nutrients and thus may feature greater abundance and/or diversity of marine flora and fauna.

The distances to the nearest shoals and banks (within the EMBA) from the operational area, are provided in **Table 3-3**.

Table 3-4 provides a summary of the benthic habitats within the operational area and EMBA.

The operational area and EMBA overlap several KEFs which include values relating to their seabed features (CoA, 2012a, b). These are discussed in more detail in **Section 3.2.4.2**.

Table 3-3: Distances to the nearest shoals and banks from operational area

Geomorphic feature	Water depth range (m)	Approximate distance/direction from operational area
Lynedoch Bank	9.8 – 30.0	38 km south-east
Evans Shoal	13.2 – 50.0	62 km west
Tassie Shoal	11.5 – 20.0	71 km west
Blackwood Shoal	15.0 – 50.0	82 km west
Franklin Shoal	10.5 – 30.0	93 km west
Flinders Shoal	6.8 – 30.0	95 km west
Martin Shoal	10.6 – 30.0	141 km west
Loxton Shoal	10.1 – 30.0	158 km west
Margaret Harries Banks	17.1 – 30.0	159 km west
Troubadour Shoal	10.6 – 30.0	164 km west
Sunset Shoal	15.0 – 30.0	177 km west
Bellona Banks	21.0 – 30.0	304 km west
Echo Shoals	18.0 – 30.0	343 km west

Table 3-4: Habitats associated with receptors identified within the operational area and environment that may be affected

Category	Receptor	Operational area presence	EMBA presence					Relevant events that may impact on the receptors
			Northwest Transition	Northwest Shelf Transition	Timor Province	Timor Transition	International Waters	
Benthic habitats	Coral reefs	✗	✓	✓	✓	✗	✓	Unplanned Hydrocarbon release due to loss of well control Diesel release from vessel collision
	Seagrass	✗	✓	✓	✓	✗	✓	
	Macroalgae	✗	✓	✓	✓	✓	✓	
	Non-coral benthic invertebrates	✓	✓	✓	✓	✓	✓	Planned Seabed disturbance Planned operational discharges Unplanned Hydrocarbon release due to loss of well control Diesel release from vessel collision Unplanned release of solids
Shoreline habitats	Mangroves	✗	✗	✓	✓	✗	✓	Unplanned Hydrocarbon release due to loss of well control Diesel release from vessel collision
	Intertidal platforms	✗	✓	✓	✗	✗	✓	
	Sandy beaches	✗	✗	✓	✓	✗	✓	
	Rocky shorelines	✗	✓	✓	✗	✗	✓	

3.2.4 Protected and significant areas

Protected and significant areas identified in the operational area and EMBA are listed in **Table 3-5** and are illustrated in **Figure 3-2** to **Figure 3-4**. Note: protected and significant areas that are terrestrial and not linked to the shoreline but occur in the Protected Matters Search Tool (PMST) of the EMBA have been excluded as they are not relevant to hydrocarbon spill scenarios assessed in this EP.

Table 3-5: Distance from operational area boundary to protected areas, key ecological features and threatened ecological communities within the environment that may be affected

Value/sensitivity name	Within operational area	Presence in EMBA	Distance to operational area (km)
Australian marine parks			
Oceanic Shoals Marine Park	✗	✓	33
Arafura Marine Park	✗	✓	230
Ashmore Reef Marine Park	✗	✓	796
Cartier Island Marine Park	✗	✓	770
State marine parks, management areas and reserves			
Scott Reef Nature Reserve	✗	✓	1004
Commonwealth heritage places			
Scott Reef and surrounds – Commonwealth area	✗	✓	1004
Wetlands of international importance			
Ashmore Reef Ramsar Site	✗	✓	796
Wetlands of national importance			
Ashmore Reef Marine Park	✗	✓	796
Key ecological features			
North-west Marine Region			
Ancient coastline at 125 m depth contour	✗	✓	698
Ashmore Reef and Cartier Island and surrounding Commonwealth Waters	✗	✓	765
Continental slope demersal fish communities	✗	✓	771
Carbonate bank and terrace system of the Sahul Shelf	✗	✓	321
Seringapatam Reef and Commonwealth waters in the Scott Reef Complex	✗	✓	971
North Marine Region			
Carbonate bank and terrace system of the Van Diemen Rise	✗	✓	50
Pinnacles of the Bonaparte Basin	✗	✓	191
Shelf break and slope of the Arafura Shelf	✓	✓	0
Tributary canyons of the Arafura Depression	✗	✓	242

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

The operational area does not intercept any Australian or State marine parks, management areas or reserves, however the EMBA overlaps four Australian Marine Parks (AMPs): the Oceanic Shoals Marine Park, Arafura Marine Park, Ashmore Reef Marine Park and the Cartier Island Marine Park and one nature reserve; the Scott Reef Nature Reserve (**Figure 3-2**).

AMPs are divided into management zones (**Figure 3-2**) and managed in accordance with the North-West Marine Parks Network Management Plan (DNP, 2018a) and North Marine Parks Network Management Plan (DNP, 2018b) (**Table 3-6**) as are the four KEFs identified in the North marine region. All other features in **Table 3-5** are described and managed under the North-West Marine Parks Network Management Plan (DNP, 2018a).

Table 3-6: Prescription/condition from the North-West and North Marine Parks Network management plans relevant to the activities in this environment plan

Prescription/ condition number	Prescription/condition	Relevant section of EP
North-West Marine Park Network Management Plan (MPNMP) (DNP, 2018a) and North MPNMP (DNP, 2018b)		
4.2.9.8	…actions required to respond to oil pollution incidents, including environmental monitoring and remediation, in connection with mining operations authorised under the OPGGS Act, may be conducted in all zones without an authorisation issued by the Director, provided that the actions are taken in accordance with an environment plan that has been accepted by NOPSEMA, and the Director is notified in the event of oil pollution within a marine park, or where an oil spill response action must be taken within a marine park, so far as reasonably practicable, prior to response action being taken.	**Section 4** (Stakeholder consultation), reporting under **Section 8** and the OPEP

3.2.4.2 Key ecological features

KEFs are those components of the marine ecosystem that are important for biodiversity or the ecosystem function and integrity of a Commonwealth marine area. The operational area overlaps the 'Shelf break and slope of the Arafura Shelf' KEF. The EMBA overlaps nine KEFs, of which the Shelf break and slope of the Arafura Shelf KEF is located within the operational area (**Figure 3-3**):

+ ancient coastline at 125 m depth contour
+ Ashmore Reef and Cartier Island and surrounding Commonwealth waters
+ carbonate bank and terrace system of the Sahul Shelf
+ carbonate bank and terrace system of the Van Diemen Rise
+ Continental Slope Demersal Fish Communities
+ pinnacles of the Bonaparte Basin
+ Seringapatam Reef and Commonwealth waters in the Scott Reef Complex
+ shelf break and slope of the Arafura Shelf
+ tributary canyons of the Arafura Depression.

These KEFs are noted to have values of 'unique seafloor features with ecological properties of regional significance' and as supporting enhanced biological productivity and high productivity that attract large aggregations of marine life.

The seafloor features associated with the Shelf break and slope of the Arafura Shelf KEF (i.e., the shelf break and patch reefs, hard substrate pinnacles and submerged reefs of the shelf slope KEF) were not observed during the Barossa marine studies program, nor are these topographically distinct features evident from the bathymetry data derived from multiple surveys undertaken across this area. Therefore, the activity is not expected to impact the seafloor features of the KEF. However, other values of the KEF that require evaluation include the oceanic currents, demersal fish species, whale sharks, sharks and marine turtles.

3.2.4.3 Heritage areas

Australia's heritage is managed by various levels of government and peak bodies that identify and list places for their heritage values. Significant heritage places are identified and grouped (by type) into lists that guide the protection and management of heritage values. No heritage areas are located within the operational area; however, one is within the EMBA: the Scott Reef and surrounds Commonwealth area (around 971 km from the operational area).

3.2.4.4 Wetlands of international and national importance

No wetlands of international or national importance are located within the operational area, but a Ramsar wetland is present within the Ashmore Reef AMP and hence within the EMBA (**Figure 3-4**).

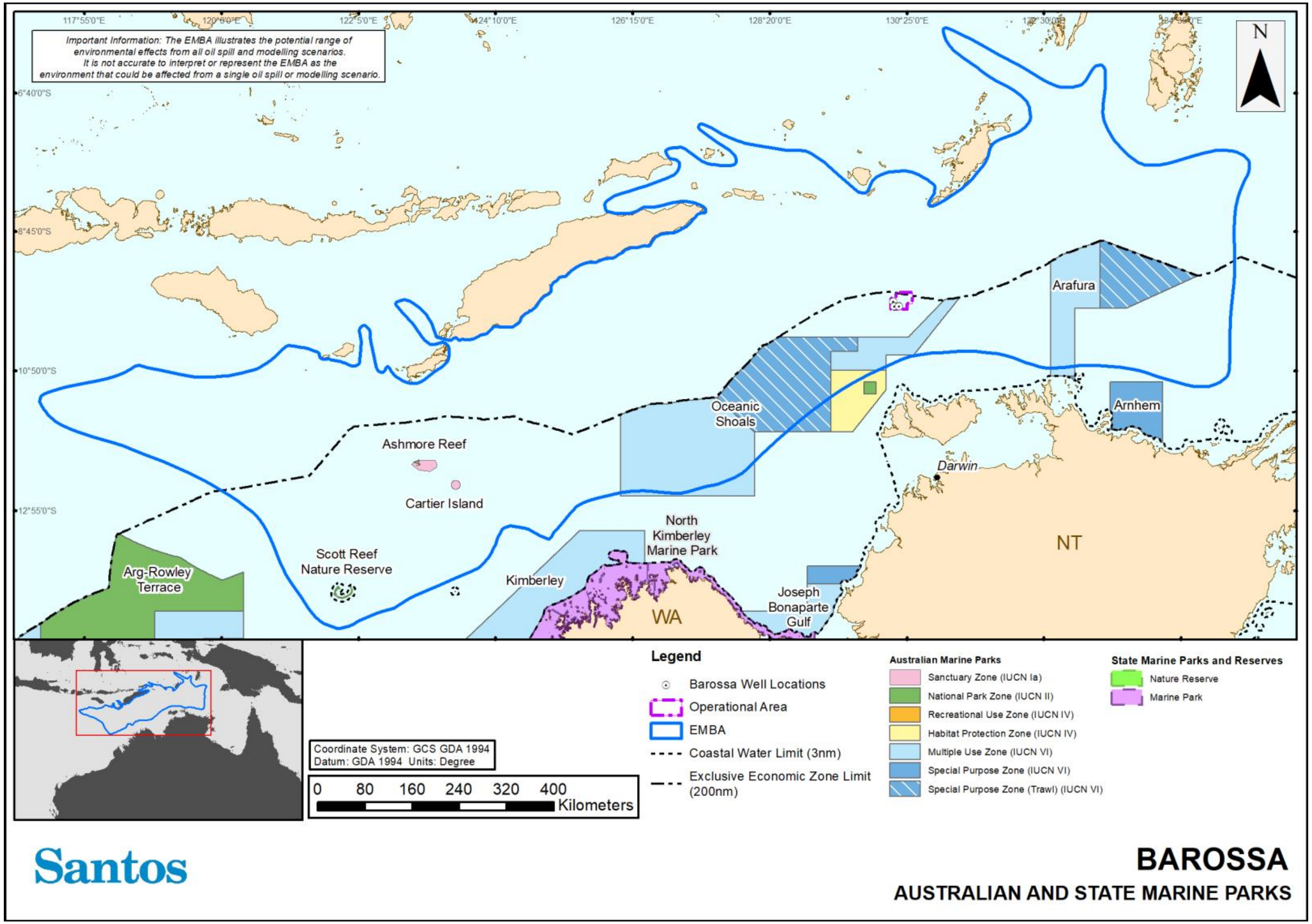

Figure 3-2: Australian and State marine parks within the environment that may be affected

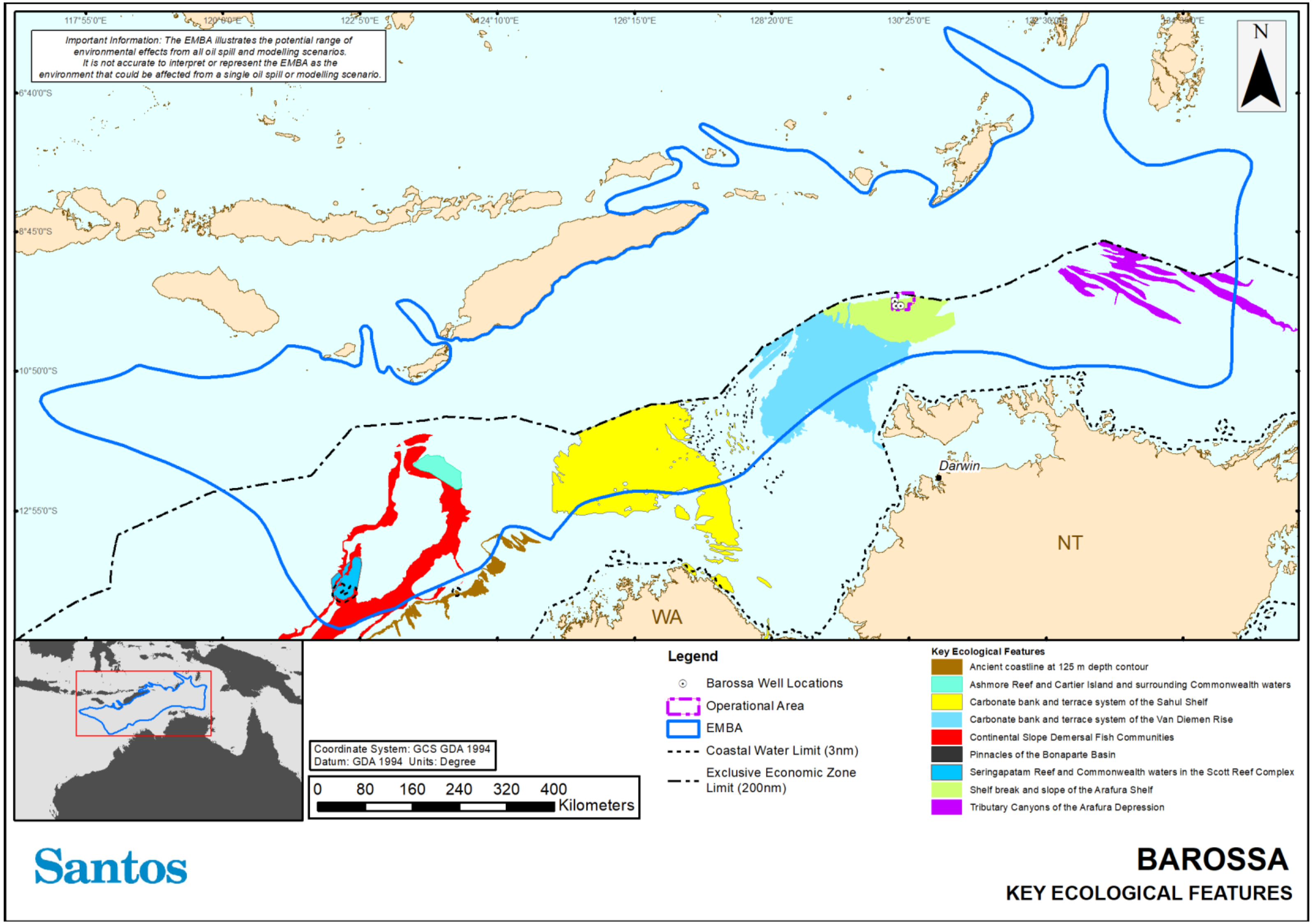

Figure 3-3: Key ecological features within the environment that may be affected

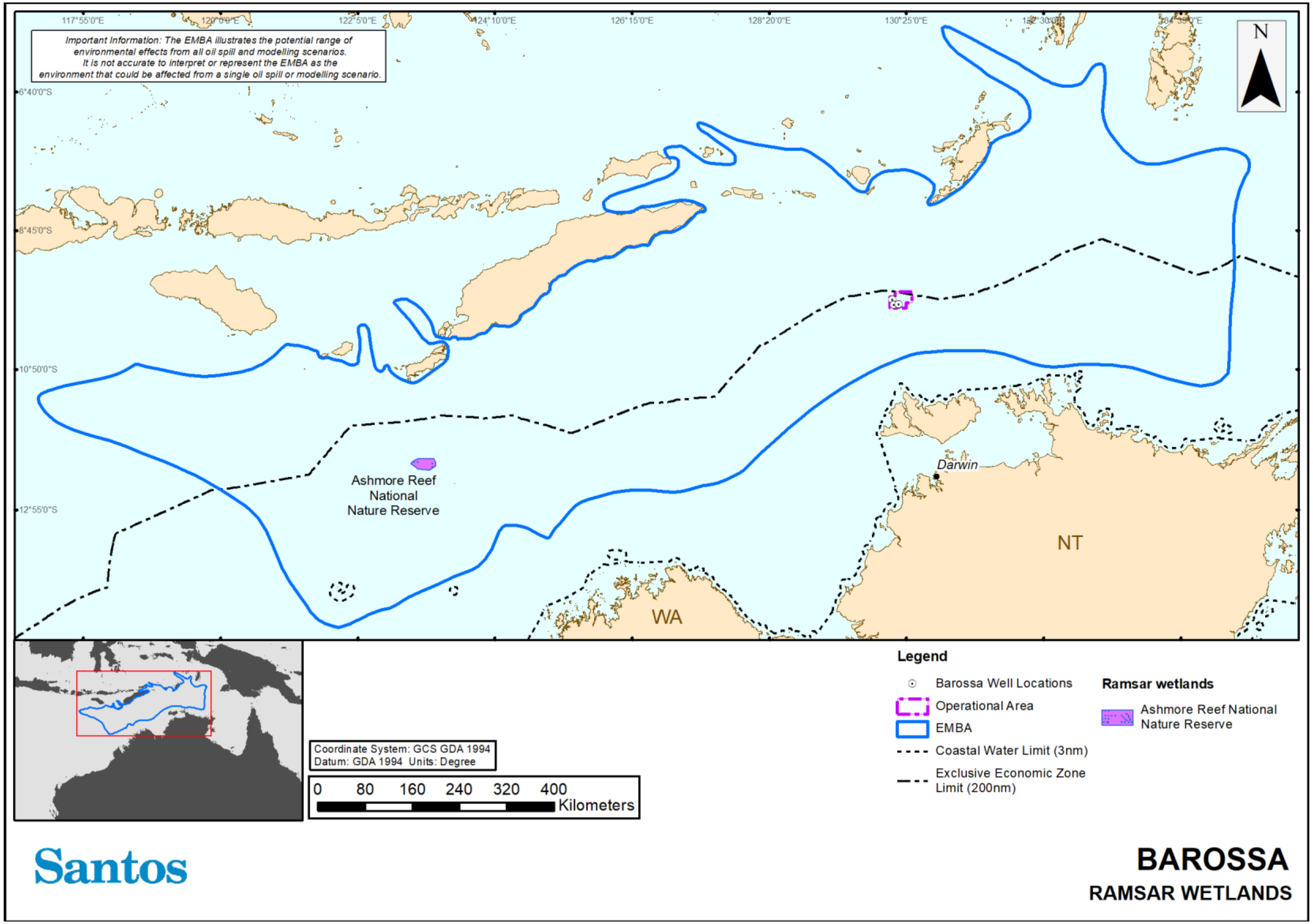

Figure 3-4: Ramsar wetlands within the environment that may be affected

3.2.5 Threatened and migratory fauna

The PMST identified 98 marine species and 58 migratory species listed under the EPBC Act that may occur in the EMBA. Of those, 25 were threatened species with the potential to occur in marine or shoreline habitats (**Table 3-7**).

The PMST identified 19 threatened species and 33 migratory species with the potential to occur in the operational area (**Table 3-7**).

An examination of the species profile and threats database (DoEE, 2019) showed that some threatened species were not expected to occur in significant numbers in the marine and coastal environments due to their terrestrial distributions. Species that may occur on shorelines include shorebirds, but terrestrial mammals, reptiles (such as pythons) and bird species that do not have core habitats along shorelines have been excluded. These species are unlikely to come into contact with an oil spill and therefore are not discussed further.

An additional three species, the grey nurse shark (*Carcharias taurus*; EPBC-listed 'vulnerable'), Omura's whale (*Balaenoptera omurai; not EPBC-listed* and the turtle-headed sea snake (*Emydocephalus annulatus*; EPBC-listed 'marine'), are included in the following sections as they were reported as occurring within or near the operational area as part of the Barossa Marine Studies Program.

Table 3-7: Threatened and migratory marine fauna that may be present in the operational area and/or environment that may be affected

Marine fauna		EPBC Act status	Operational area		EMBA		Relevant activity events
Common name	Scientific name		Presence	Particular values or sensitivities	Presence	Particular values or sensitivities	
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 biologically important area (BIA).	<u>Planned</u> Noise emissions Light emissions Seabed disturbance Operational discharges Spill response operations <u>Unplanned</u> Release of solid objects Introduction of invasive marine species (IMS) Marine fauna interaction Hazardous liquid releases Release of hydrocarbons
Great white shark	*Carcharodon carcharias*	Vulnerable, Migratory	✓	Species or species habitat may occur within area.	✓	Species or species habitat may occur within area.	
Northern river shark	*Glyphis garricki*	Endangered	✓	Species or species habitat may occur within area.	✓	Species or species habitat may occur within area.	
Speartooth shark	*Glyphis glyphis*	Critically endangered	✓	Species or species habitat may occur within area.	✓	Species or species habitat may occur within area	
Oceanic whitetip shark	*Carcharhinus longimanus*	Migratory	✓	Species or species habitat may occur within area.	✓	Species or species habitat may occur within area.	
Freshwater sawfish	*Pristis pristis*	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 may occur within area.	✓	Species or species habitat may occur within area.	
Reef manta ray	*Manta alfredi*	Migratory	✓	Species or species habitat may occur within area.	✓	Species or species habitat known to occur within area.	
Giant manta ray	*Manta birostris*	Migratory	✓	Species or species habitat may occur within area.	✓	Species or species habitat likely to occur within area.	
Longfin mako	*Isurus paucus*	Migratory	✓	Species or species habitat likely to occur within area.	✓	Species or species habitat likely to occur within area.	
Grey nurse shark	*Carcharias taurus*	Vulnerable	✓	Reported as occurring within or near the permit area as part of the Barossa Marine Studies Program.	✓	Reported as occurring within or near the permit area as part of the Barossa Marine Studies Program.	
Shortfin mako	*Isurus oxyrinchus*	Migratory	✗	N/A.	✓	Species or species habitat likely to occur within area.	<u>Unplanned</u> Release of hydrocarbons
Dwarf sawfish	*Pristis clavata*	Vulnerable, Migratory	✗	N/A.	✓	Species or species habitat known to occur within area.	

Marine fauna		EPBC Act status	Operational area		EMBA		Relevant activity events
Common name	Scientific name		Presence	Particular values or sensitivities	Presence	Particular values or sensitivities	
Marine mammals							
Humpback whale	*Megaptera novaeangliae*	Vulnerable, Migratory	✓	Species or species habitat may occur within area.	✓	Species or species habitat known to occur within area.	<u>Planned</u> Noise emissions Light emissions Operational discharges Spill response operations <u>Unplanned</u> Marine fauna interaction Hazardous liquid releases Release of hydrocarbons
Blue whale[3]	*Balaenoptera musculus*	Endangered, Migratory	✓	Species or species habitat likely to occur within area.	✓	Migration route known to occur within area.	
Bryde's whale	*Balaenoptera edeni*	Migratory	✓	Species or species habitat may occur within area.	✓	Species or species habitat likely to occur within area.	
Killer whale	*Orcinus orca*	Migratory	✓	Species or species habitat may occur within area.	✓	Species or species habitat may occur within area.	
Spotted bottlenose dolphin	*Tursiops aduncus* (Arafura/Timor Sea Populations)	Migratory	✓	Species or species habitat may occur within area.	✓	Species or species habitat likely to occur within area.	
Sei whale	*Balaenoptera borealis*	Vulnerable, Migratory	✓	Species or species habitat likely to occur within area.	✓	Foraging, feeding or related behaviour likely to occur within area.	
Fin whale	*Balaenoptera physalusk*	Vulnerable, Migratory	✓	Species or species habitat likely to occur within area.	✓	Foraging, feeding or related behaviour likely to occur within area.	
Sperm whale	*Physeter macrocephalus*	Migratory	✓	Species or species habitat may occur within area.	✓	Species or species habitat may occur within area.	
Omura's whale	*Balaenoptera omurai*	N/a	✓	Reported as occurring within or near the permit area as part of the Barossa Marine Studies Program	✓	Reported as occurring within or near the permit area as part of the Barossa Marine Studies Program.	
Indo-Pacific humpback dolphin	*Sousa chinensis*	Migratory	✗	N/A.	✓	Species or species habitat may occur within area.	<u>Unplanned</u> Release of hydrocarbons
Australian snubfin dolphin	*Orcaella heinsohni*	Migratory	✗	N/A.	✓	Species or species habitat may occur within area.	
Dugong	*Dugong dugon*	Migratory	✗	N/A.	✓	Breeding known to occur within area.	
Marine reptiles							
Loggerhead turtle	*Caretta*	Endangered, Migratory	✓	Species or species habitat likely to occur within area.	✓	Foraging, feeding or related behaviour known to occur within area. Overlap with foraging BIA.	<u>Planned</u> Noise emissions Light emissions Seabed disturbance Operational discharges Spill response operations <u>Unplanned</u> Introduction of IMS Marine fauna interaction
Green turtle	*Chelonia mydas*	Vulnerable, Migratory	✓	Species or species habitat likely to occur within area.	✓	Foraging, feeding or related behaviour known to occur within area. Overlap with foraging, nesting, internesting, internesting buffer and mating BIAs.	
Leatherback turtle	*Dermochelys coriacea*	Endangered, Migratory	✓	Species or species habitat likely to occur within area.	✓	Species or species habitat known to occur within area.	

[3] In Australian waters there are two subspecies of blue whale, the pygmy blue whale (*B. m. brevicauda*) and the Antarctic blue whale (*B. m. intermedia*). It is more likely that the pygmy blue whale could be encountered given the presence of a BIA in the operational area.

Marine fauna		EPBC Act status	Operational area		EMBA		Relevant activity events
Common name	Scientific name		Presence	Particular values or sensitivities	Presence	Particular values or sensitivities	
Hawksbill turtle	*Eretmochelys imbricata*	Vulnerable, Migratory	✓	Species or species habitat likely to occur within area.	✓	Foraging, feeding or related behaviour known to occur within area. Overlap with foraging, internesting and internesting buffer BIAs.	Hazardous liquid releases Release of hydrocarbons
Olive Ridley turtle	*Lepidochelys olivacea*	Endangered, Migratory	✓	Species or species habitat likely to occur within area.	✓	Foraging, feeding or related behaviour known to occur within area. Overlap with foraging and internesting BIAs.	
Flatback turtle	*Natator depressus*	Vulnerable, Migratory	✓	Species or species habitat known to occur within area.	✓	Foraging, feeding or related behaviour known to occur within area. Overlap with foraging and internesting BIAs.	
Turtle-headed sea snake	*Emydocephalus annulatus*	Listed marine	✓	Reported as occurring within or near the permit area as part of the Barossa Marine Studies Program.	✓	Reported as occurring within or near the permit area as part of the Barossa Marine Studies Program.	
Short-nosed sea snake	*Aipysurus apraefrontalis*	Critically endangered	✗	N/A.	✓	Species or species habitat known to occur within area.	<u>Unplanned</u> Release of hydrocarbons
Leaf-scaled sea snake	*Aipysurus foliosquama*	Critically endangered	✗	N/A.	✓	Species or species habitat known to occur within area.	
Saltwater crocodile	*Crocodylus porosus*	Migratory	✗	N/A.	✓	Species or species habitat likely to occur within area.	
Birds							
Curlew sandpiper	*Calidris ferruginea*	Critically endangered, Migratory	✓	Species or species habitat may occur within area.	✓	Species or species habitat known to occur within area.	<u>Planned</u> Light emissions Atmospheric emissions Operational discharges Spill response operations <u>Unplanned</u> Release of hydrocarbons
Red knot	*Calidris canutus*	Endangered, Migratory	✓	Species or species habitat may occur within area.	✓	Species or species habitat known to occur within area.	
Eastern curlew	*Numenius madagascariensis*	Critically endangered, Migratory	✓	Species or species habitat may occur within area.	✓	Species or species habitat known to occur within area.	
Common noddy	*Anous stolidus*	Migratory	✓	Species or species habitat may occur within area.	✓	Breeding known to occur within area.	
Streaked shearwater	*Calonectris leucomelas*	Migratory	✓	Species or species habitat likely to occur within area.	✓	Species or species habitat known to occur within area.	
Lesser frigatebird	*Fregata ariel*	Migratory	✓	Species or species habitat may occur within area.	✓	Breeding known to occur within area. Overlap with breeding BIA.	
Common sandpiper	*Actitis hypoleucos*	Migratory	✓	Species or species habitat may occur within area.	✓	Species or species habitat known to occur within area.	
Sharp-tailed sandpiper	*Calidris acuminata*	Migratory	✓	Species or species habitat may 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.	
Greater frigatebird	*Fregata minor*	Migratory	✓	Species or species habitat may occur within area.	✓	Breeding known to occur within area. Overlap with breeding BIA.	

Marine fauna		EPBC Act status	Operational area		EMBA		Relevant activity events
Common name	Scientific name		Presence	Particular values or sensitivities	Presence	Particular values or sensitivities	
Australian lesser noddy	*Anous tenuirostris melanops*	Vulnerable	✗	N/A.	✓	Breeding known to occur within area.	Unplanned Release of hydrocarbons
Roseate tern	*Stern dougallii*	Migratory	✗	N/A.	✓	Breeding known to occur within area.	
Abbott's booby	*Papasula abbotti*	Endangered	✗	N/A.	✓	Species or species habitat may occur within area.	
Osprey	*Pandion haliaetus*	Migratory	✗	N/A.	✓	Species or species habitat known to occur within area.	
Brown booby	*Sula leucogaster*	Migratory	✗	N/A.	✓	Breeding known to occur within area. Overlap with breeding BIA.	
Bar-tailed godwit	*Limosa lapponica*	Migratory	✗	N/A.	✓	Species or species habitat known to occur within area.	
Northern Siberian bar-tailed godwit	*Limosa lapponica menzbieri*	Critically endangered	✗	N/A.	✓	Species or species habitat known to occur within area.	
Masked booby	*Sula dactylatra*	Migratory	✗	N/A.	✓	Breeding known to occur within area.	
Red-footed booby	*Sula sula*	Migratory	✗	N/A.	✓	Breeding known to occur within area. Overlap with breeding BIA.	
White-tailed tropicbird	*Phaethon lepturus*	Migratory	✗	N/A.	✓	Breeding known to occur within area. Overlap with breeding BIA.	
Red-tailed tropicbird	*Phaethon rubricauda*	Migratory	✗	N/A.	✓	Breeding known to occur within area.	
Little tern	*Sternula albifrons*	Migratory	✗	N/A.	✓	Congregation or aggregation known to occur within area. Overlap with breeding BIA.	
Wedge-tailed shearwater	*Ardenna pacifica*	Migratory	✗	N/A.	✓	Breeding known to occur within area. Overlap with breeding BIA.	
Caspian tern	*Hydroprogne caspia*	Migratory	✗	N/A.	✓	Breeding known to occur within area.	
Bridled tern	*Onychoprion anaethetus*	Migratory	✗	N/A.	✓	Breeding known to occur within area.	
Oriental reed-warbler	*Acrocephalus orientalis*	Migratory	✗	N/A.	✓	Species or species habitat known to occur within area.	
Greater crested tern	*Thalasseus bergii*	Migratory	✗	N/A.	✓	Breeding known to occur within this area. Overlap with breeding BIA.	

3.2.5.1 Biologically important areas and critical habitat

No BIAs intersect with the operational area. **Table 3-8** lists and **Figure 3-5** to **Figure 3-12** show the BIAs that overlap the EMBA.

Habitat critical to the survival of four EPBC Act-listed marine turtles occurs within the EMBA, as listed in **Table 3-8** and shown in **Figure 3-8** to **Figure 3-11**.

Table 3-8: Biologically important areas identified in the environment that may be affected

Species	BIA area	Distance to operational area (km)	Habitat critical within EMBA and distance to operational area
Whale shark	Foraging	506	✗
Pygmy blue whale	Migration	171	✗
	Distribution	51	✗
	Foraging	974	✗
Dugong	Foraging (high density seagrass beds)	828	✗
	Breeding	828	✗
	Nursing	828	✗
	Calving	828	✗
	Foraging	828	✗
Loggerhead turtle	Foraging	358	✗
Green turtle	Nesting	662	Scott Reef – 20 km internesting buffer (981 km) Ashmore Reef and Cartier Reef 20 km internesting buffer (751 km)
	Internesting buffer	642	
	Foraging	316	
	Mating	822	
Hawksbill turtle	Nesting	815	New Year Island 20 km internesting buffer (281 km)
	Internesting	243	
	Foraging	776	
Flatback turtle	Internesting	50	Soldier Point to Pirlangimpi, including Seagull Island 60 km internesting buffer (72 km)
	Foraging	358	
Olive Ridley turtle	Internesting	112	Soldier Point to Pirlangimpi, including Seagull Island 20 km internesting buffer (112 km) Brace Point to One Tree Point, including all offshore islands 20 km internesting buffer (112 km)
	Foraging	250	
Brown booby	Breeding	770	✗
Greater frigatebird	Breeding	708	✗
Crested tern	Breeding (high numbers)	111	✗

Species	BIA area	Distance to operational area (km)	Habitat critical within EMBA and distance to operational area
Lesser frigatebird	Breeding	525	✗
Little tern	Breeding	654	✗
Red-footed booby	Breeding	708	✗
Wedge-tailed shearwater	Breeding	714	✗
White-tailed tropic bird	Breeding	717	✗

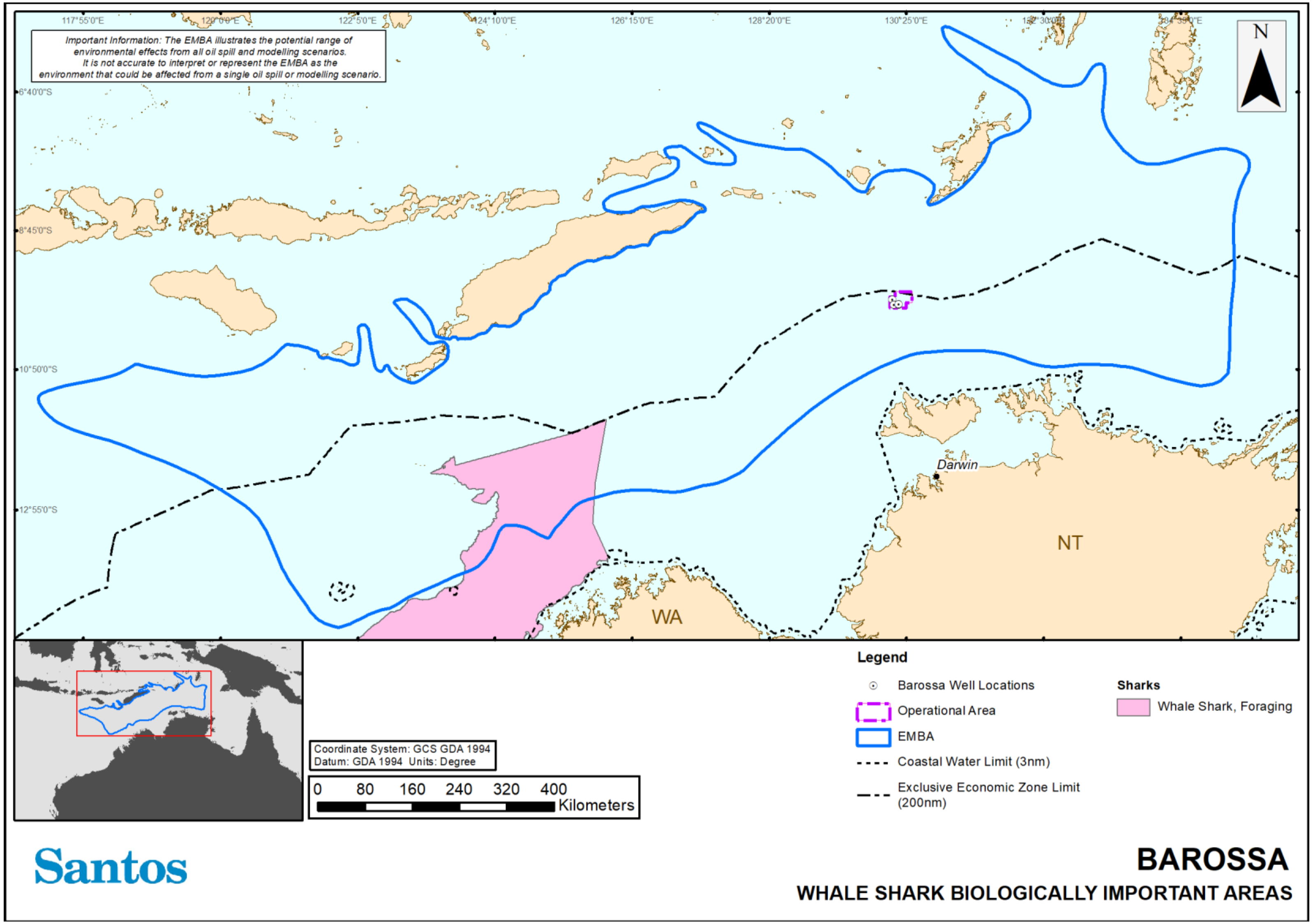

Figure 3-5: Whale shark biologically important areas overlapping the environment that may be affected

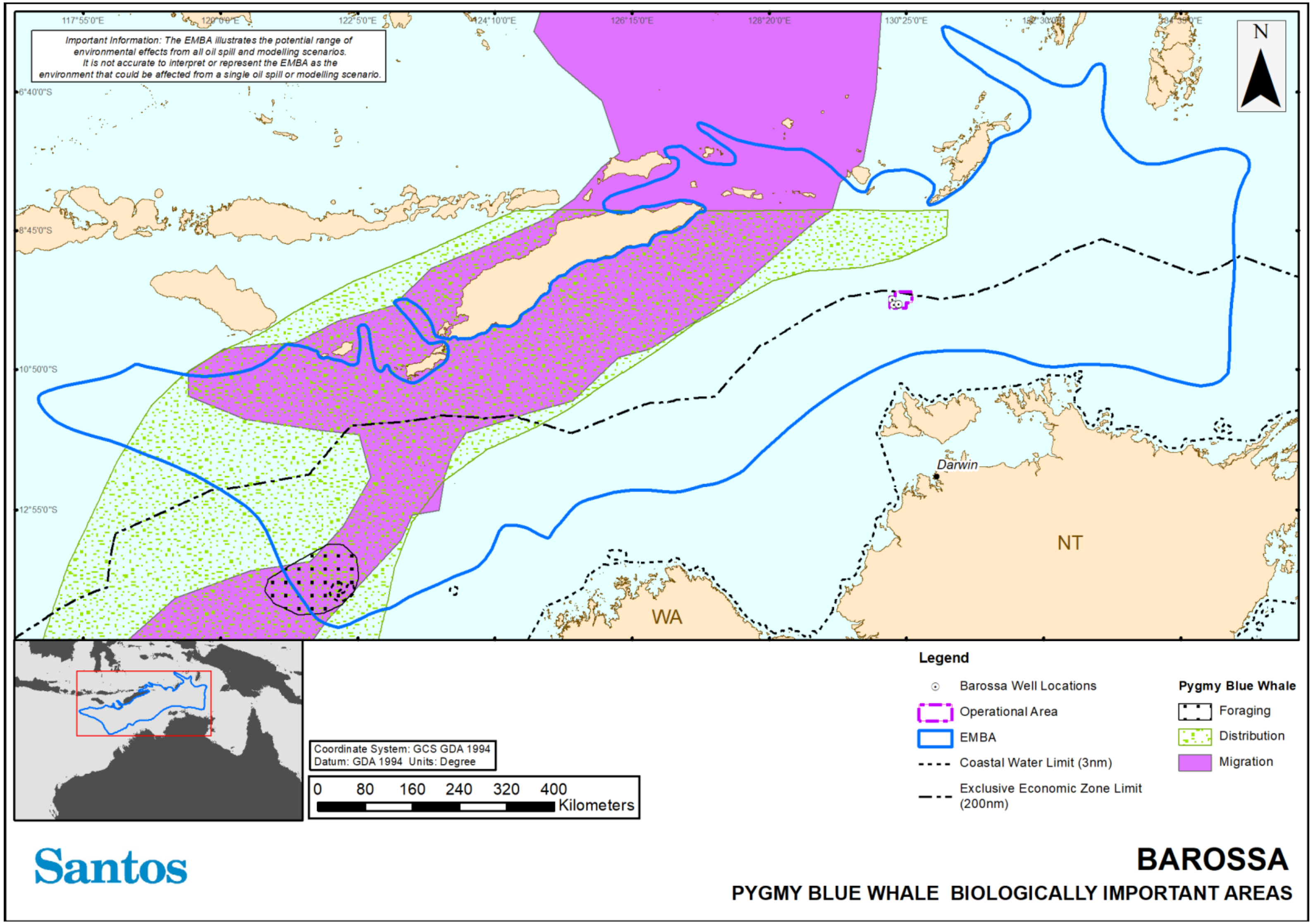

Figure 3-6: Pygmy blue whale biologically important areas overlapping the environment that may be affected

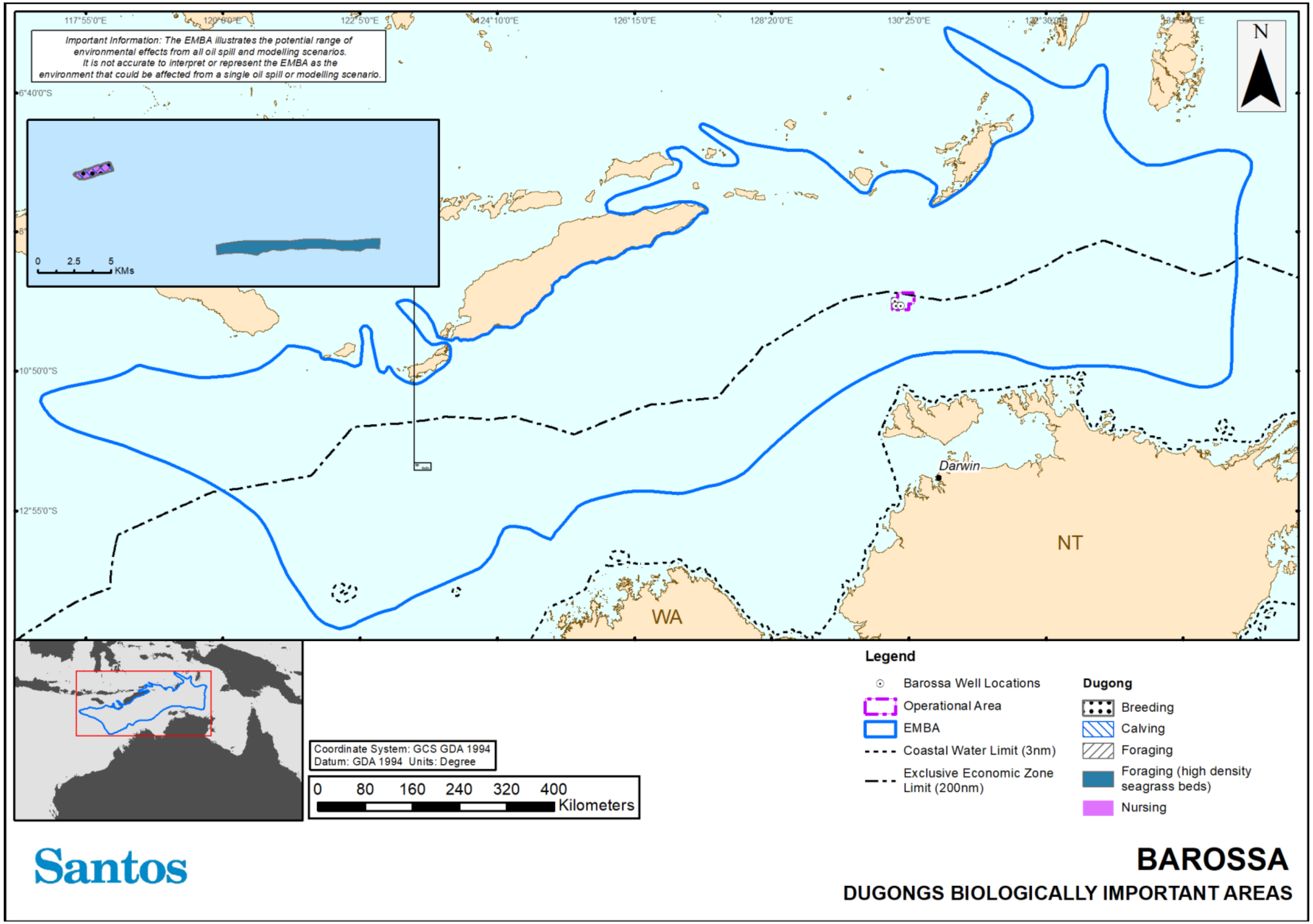

Figure 3-7: Dugong biologically important areas overlapping the environment that may be affected

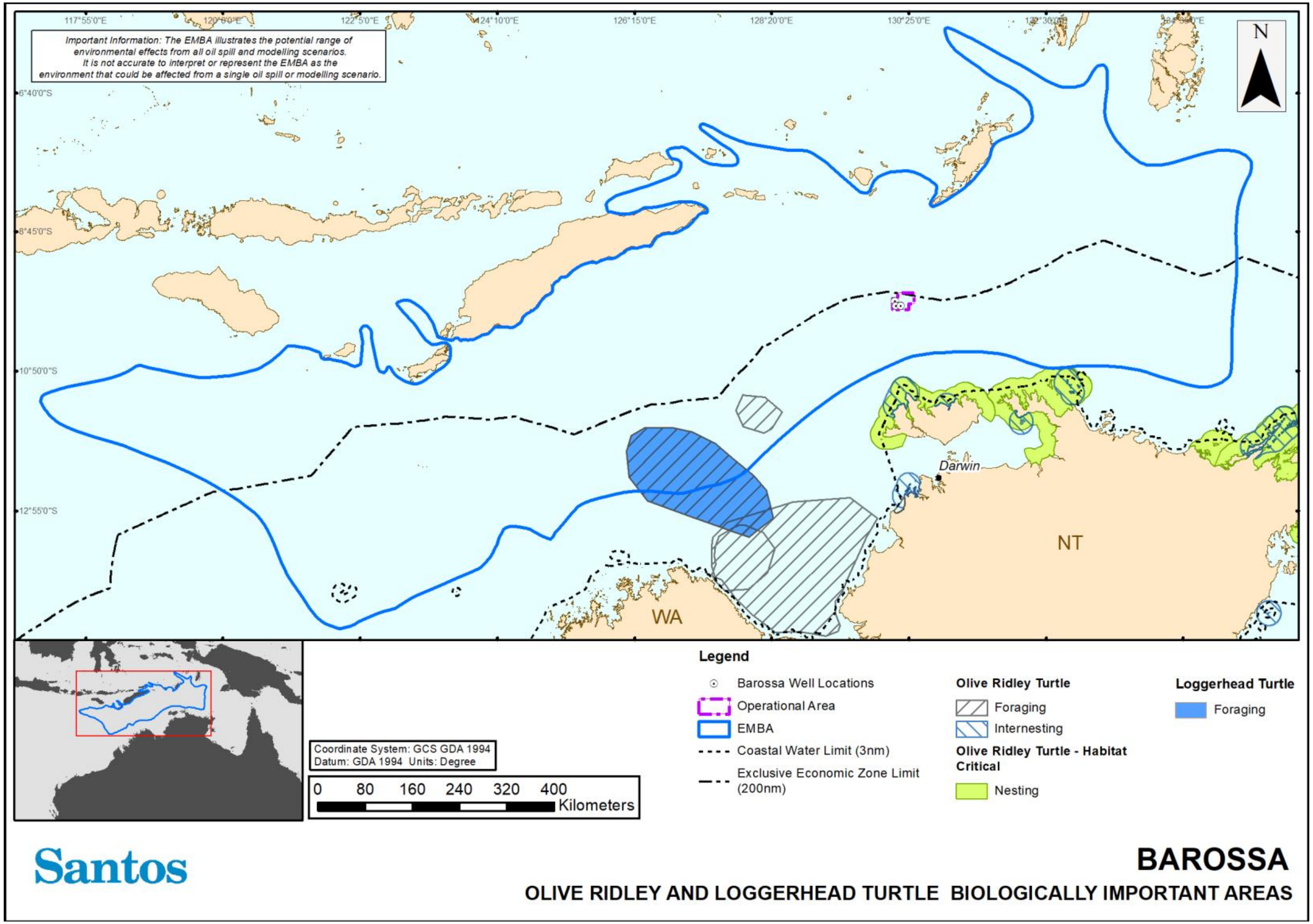

Figure 3-8: Olive Ridley and loggerhead turtle biologically important areas and critical habitat overlapping the environment that may be affected

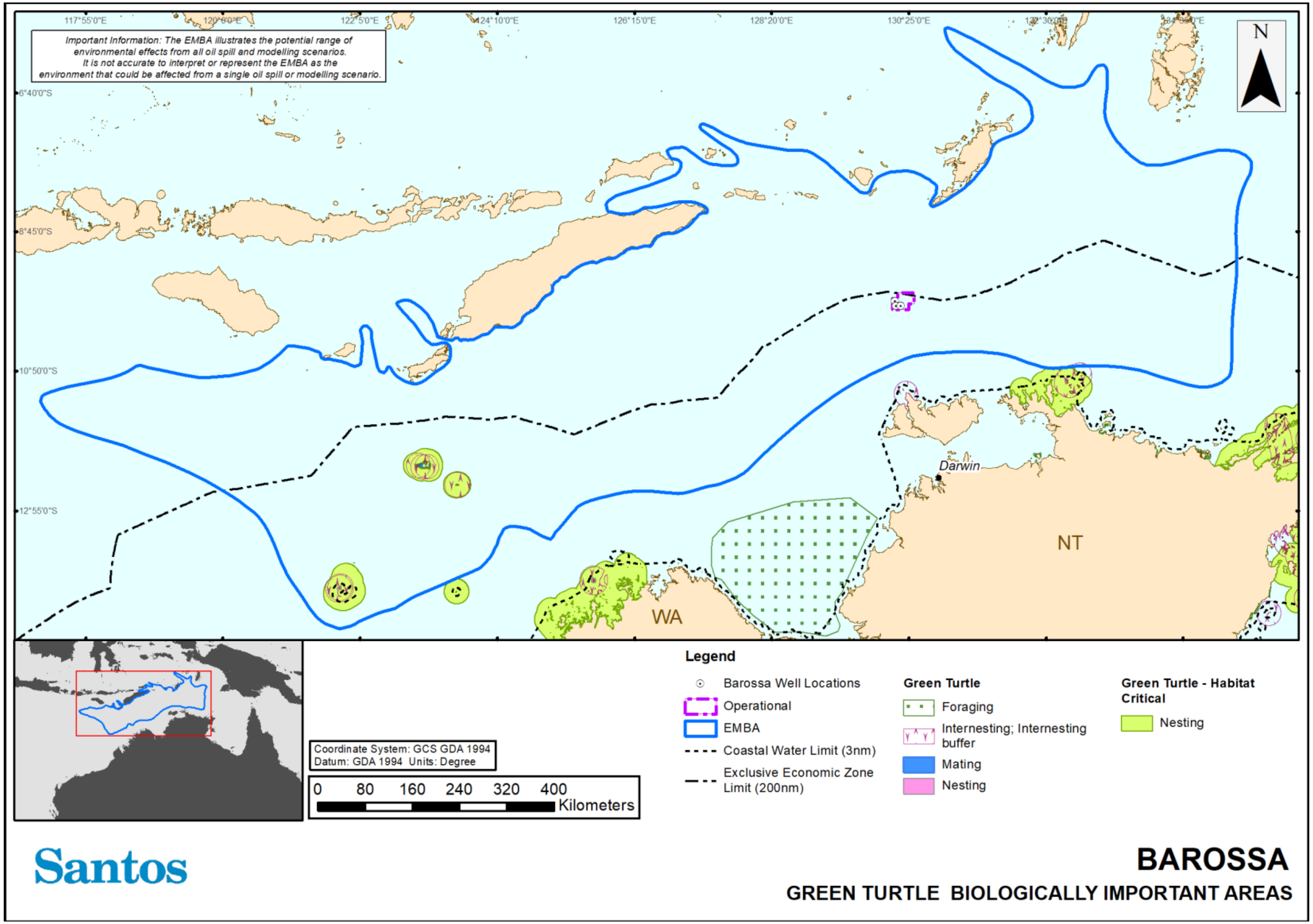

Figure 3-9: Green turtle biologically important areas and critical habitat overlapping the environment that may be affected

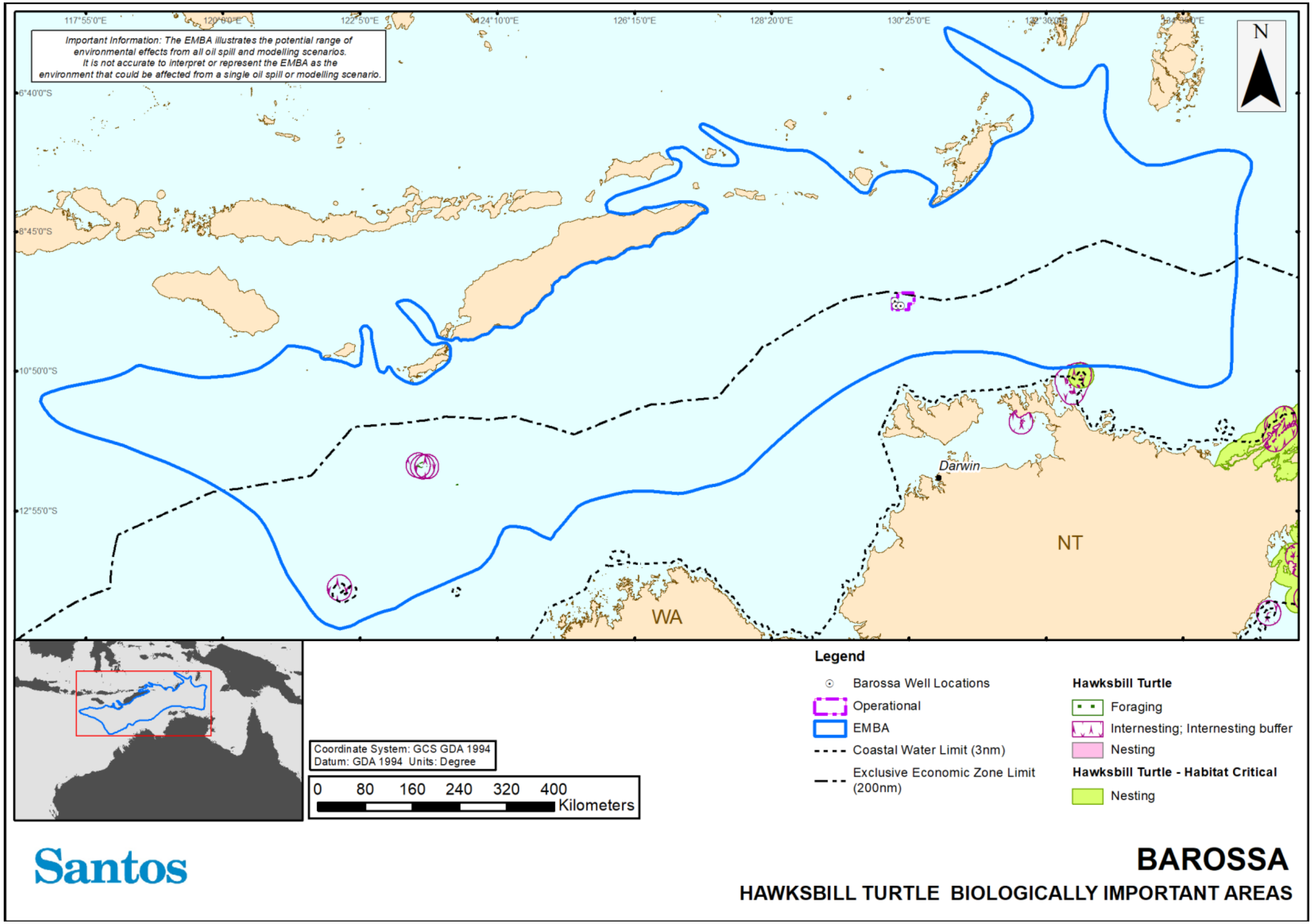

Figure 3-10: Hawksbill turtle biologically important areas and critical habitat overlapping the environment that may be affected

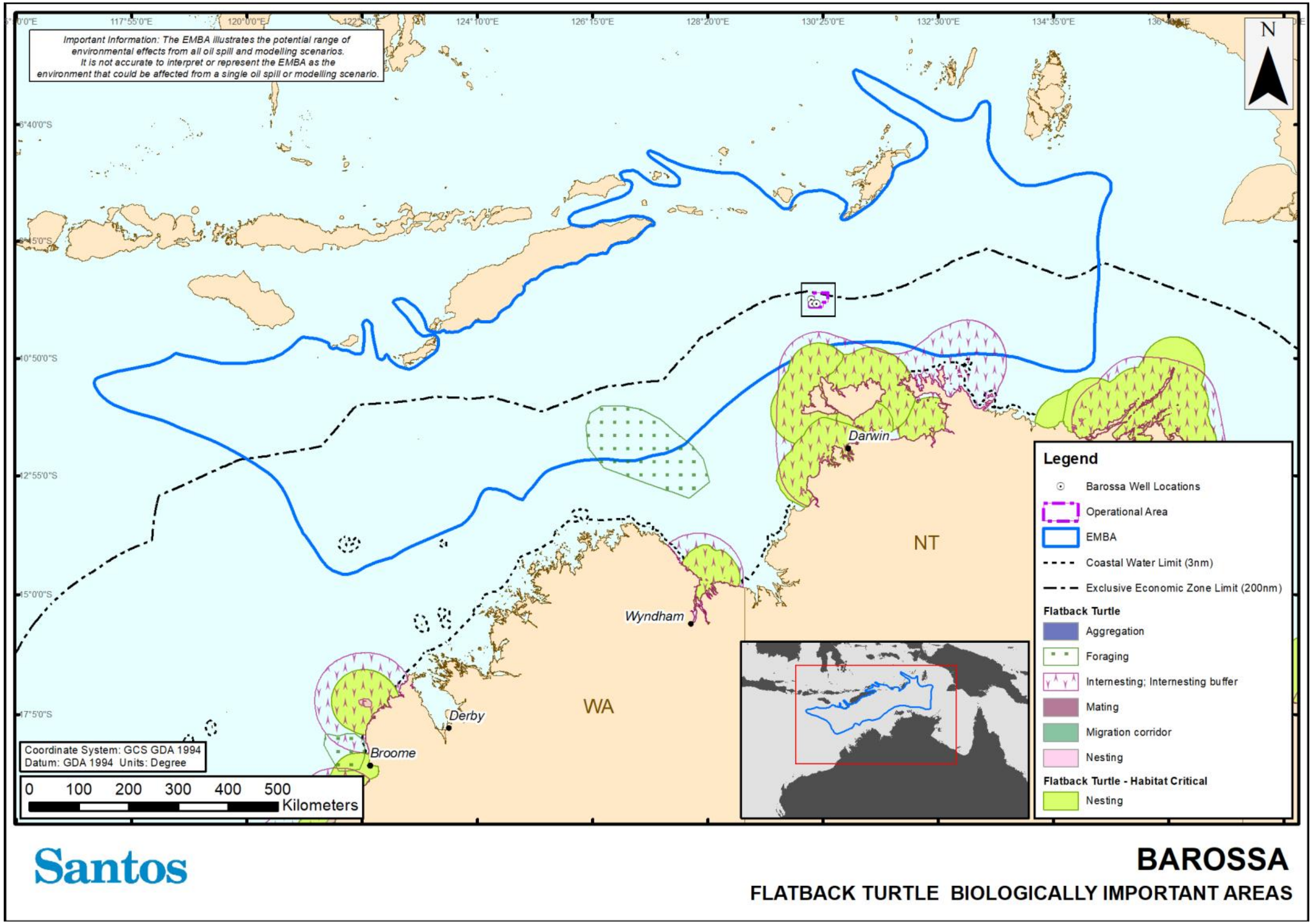

Figure 3-11: Flatback turtle biologically important areas and critical habitat overlapping the environment that may be affected

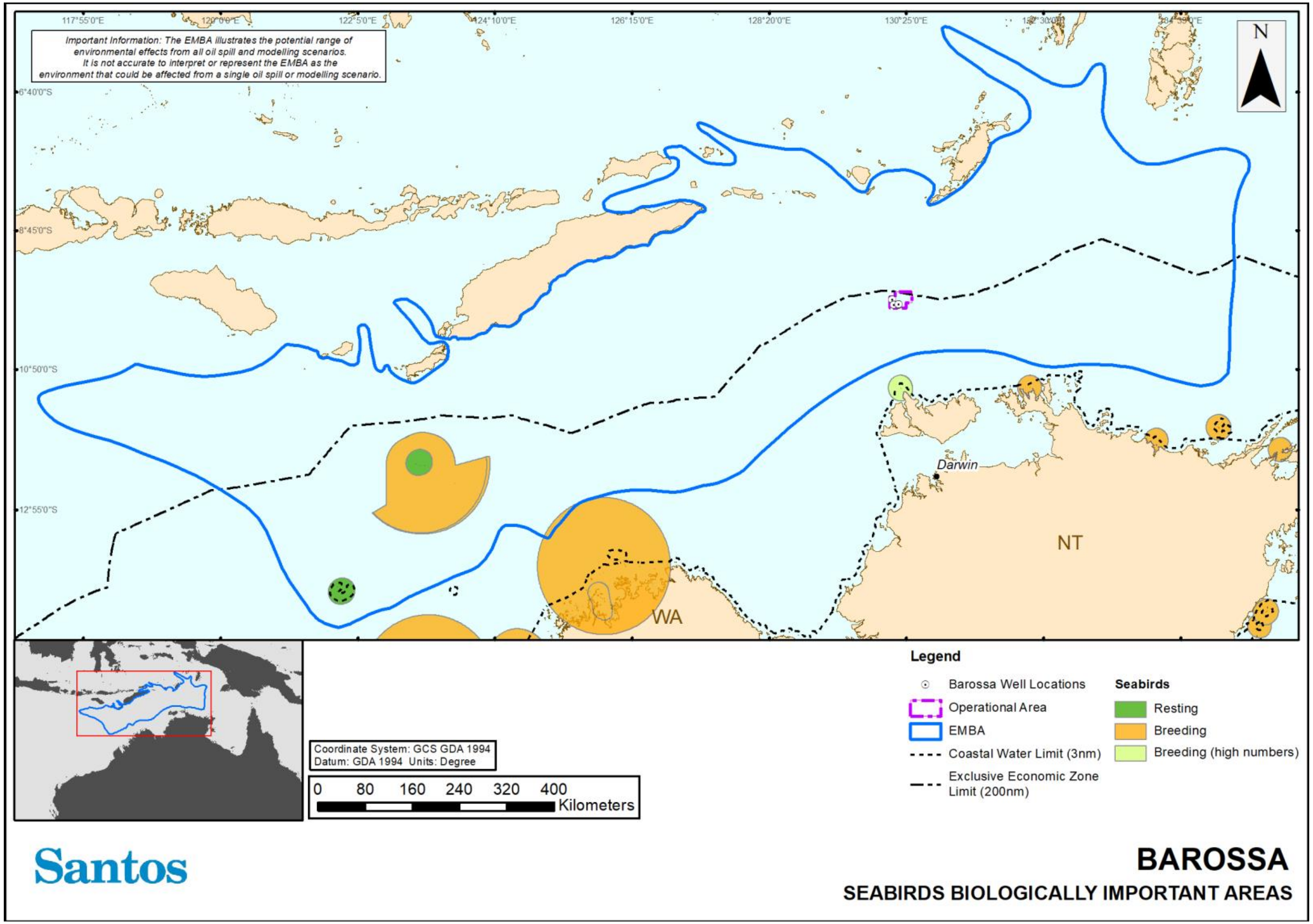

Figure 3-12: Seabird biologically important areas overlapping the environment that may be affected

3.2.5.2 Recovery plans

Recovery plans set out the necessary research and management actions to stop the decline of listed threatened species and support their recovery. **Table 3-9** summarises the actions relevant to the activity with more information on the requirements of the relevant plans of management (including conservation advice, recovery plans and management plans for marine fauna), and demonstrates where this EP considers those management requirements.

Table 3-9: Relevant threats identified in recovery plans, conservation advice and management plans for species that occur or may occur within the operational area and environment that may be affected

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**
Fish and Sharks	Dwarf sawfish	Sawfish and River Sharks Multispecies Recovery Plan (CoA, 2015a)	Habitat degradation and modification	**6.4, 6.6, 6.7, 7.1, 7.2, 7.4, 7.5, 7.6, 7.7, 7.8**
	Green sawfish	Sawfish and River Sharks Multispecies Recovery Plan (CoA, 2015a)	Habitat degradation and modification	**6.4, 6.6, 6.7, 7.1, 7.2, 7.4, 7.5, 7.6, 7.7, 7.8**
	Freshwater sawfish	Sawfish and River Sharks Multispecies Recovery Plan (CoA, 2015a)	Habitat degradation and modification	**6.4, 6.6, 6.7, 7.1, 7.2, 7.4, 7.5, 7.6, 7.7, 7.8**
			Marine debris	**7.1**
	Great white shark	Recovery Plan for the White Shark (*Carcharodon carcharias*) (DSEWPaC, 2013)	Ecosystem effects	**6.4, 6.6, 6.7, 7.1, 7.2, 7.4, 7.5, 7.6, 7.7, 7.8**
	Whale shark	Approved Conservation Advice for *Rhincodon typus* (whale shark) (TSSC, 2015d)	Boat strike from large vessels	**7.3**
			Habitat disruption from mineral exploration, production and transportation	**6.4, 6.6, 6.7, 7.1, 7.2, 7.4, 7.5, 7.6, 7.7, 7.8**
			Marine debris	**7.1**
	Northern river shark	Approved Conservation Advice for *Glyphis garricki* (northern river shark) (TSSC, 2014a)	Habitat degradation and modification	**6.4, 6.6, 6.7, 7.1, 7.2, 7.4, 7.5, 7.6, 7.7, 7.8**
			Marine debris	**7.1**
	Grey nurse shark	Recovery Plan for the Grey Nurse Shark (*Carcharias taurus*) (DoE, 2014a)	Marine pollution	**6.6, 6.7, 7.1, 7.4, 7.6, 7.7, 7.8**
			Habitat modification	**6.4, 6.6, 6.7, 7.1, 7.2, 7.4, 7.5, 7.6, 7.7, 7.8**
Mammals	Blue whale (includes pygmy blue whale)	Blue Whale Conservation Management Plan 2015–2025 (CoA, 2015a)	Noise interference	**6.1**
			Habitat modification	**6.4, 6.6, 6.7, 7.1, 7.2, 7.4, 7.5, 7.6, 7.7, 7.8**
			Vessel disturbance	**7.3**
	Fin whale	Approved Conservation Advice for *Balaenoptera physalus* (fin whale) (TSSC, 2015b)	Habitat degradation including pollution	**6.4, 6.6, 6.7, 7.1, 7.2, 7.4, 7.5, 7.6, 7.7, 7.8**
			Pollution (persistent toxic pollutants)	**6.4, 7.4, 7.5, 7.6, 7.7, 7.8**
			Anthropogenic noise and acoustic disturbance	**6.1**
			Vessel strike	**7.3**
	Sei whale	Approved Conservation Advice for *Balaenoptera borealis* (sei whale) (TSSC, 2015a)	Habitat degradation including pollution	**6.4, 6.6, 6.7, 7.1, 7.2, 7.4, 7.5, 7.6, 7.7, 7.8**
			Pollution	**6.4, 7.4, 7.5, 7.6, 7.7, 7.8**
			Vessel strike	**7.3**
			Anthropogenic noise and acoustic disturbance	**6.1**
	Humpback whale	Approved Conservation Advice for *Megaptera novaeangliae* (humpback whale) (TSSC, 2015c)	Noise interference	**6.1**
			Habitat degradation	**6.4, 6.6, 6.7, 7.1, 7.2, 7.4, 7.5, 7.6, 7.7, 7.8**
			Vessel disturbance and strike	**7.3**

Receptor	Name	Recovery plan/conservation advice/management plan	Threats/strategies identified as relevant to the activity	Addressed (where relevant) in EP section
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 (CoA, 2017)	Marine debris	**7.1**
			Vessel disturbance	**7.3**
			Light pollution	**6.2**
			Chemical and terrestrial discharge	**6.6, 6.7, 7.4, 7.6, 7.7, 7.8**
			Noise interference	**6.1**
	Green turtle	Recovery Plan for Marine Turtles in Australia 2017–2027 (CoA, 2017)	Deteriorating water quality	**6.6, 6.7, 7.4, 7.6, 7.7, 7.8**
			Marine debris	**7.1**
			Vessel disturbance	**7.3**
			Light pollution	**6.2**
			Chemical and terrestrial discharge	**6.6, 6.7, 7.4, 7.6, 7.7, 7.8**
			Noise interference	**6.1**
	Leatherback turtle	Commonwealth Conservation Advice on *Dermochelys coriacea* (DoEE, 2008)	Boat strike	**7.3**
			Changes to breeding sites	**6.6, 6.77.4, 7.6, 7.7, 7.8**
			Ingestion of marine debris	**7.1**
			Degradation of foraging areas	**6.6, 6.7, 7.4, 7.6, 7.7, 7.8**
		Recovery Plan for Marine Turtles in Australia (CoA, 2017)	Chemical and terrestrial discharge	**6.6, 6.7, 7.4, 7.6, 7.7, 7.8**
			Marine debris	**7.1**
			Habitat modification	**6.4, 6.6, 6.7, 7.1, 7.2, 7.4, 7.5, 7.6, 7.7, 7.8**
			Vessel disturbance	**7.3**
			Light pollution	**6.2**
			Noise interference	**6.1**
	Hawksbill turtle	Recovery Plan for Marine Turtles in Australia 2017–2027 (CoA, 2017)	Chemical and terrestrial discharge	**6.6, 6.7, 7.4, 7.6, 7.7, 7.8**
			Marine debris	**7.1**
			Habitat modification	**6.4, 6.6, 6.7, 7.1, 7.2, 7.4, 7.5, 7.6, 7.7, 7.8**
			Vessel disturbance	**7.3**
			Light pollution	**6.2**
			Noise interference	**6.1**
	Flatback turtle	Recovery Plan for Marine Turtles in Australia 2017–2027 (CoA, 2017)	Chemical and terrestrial discharge	**6.6, 6.7, 7.4, 7.6, 7.7, 7.8**
			Marine debris	**7.1**
			Habitat modification	**6.4, 6.6, 6.7, 7.1, 7.2, 7.4, 7.5, 7.6, 7.7, 7.8**
			Vessel disturbance	**7.3**
			Light pollution	**6.2**

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Receptor	Name	Recovery plan/conservation advice/management plan	Threats/strategies identified as relevant to the activity	Addressed (where relevant) in EP section
			Noise interference	**6.1**
	Olive Ridley turtle	Recovery Plan for Marine Turtles in Australia 2017 – 2027 (CoA, 2017)	Chemical and terrestrial discharge	**6.6**, **6.7**, **7.4**, **7.6**, **7.7**, **7.8**
			Marine debris	**7.1**
			Habitat modification	**6.4**, **6.6**, **6.7**, **7.1**, **7.2**, **7.4**, **7.5**, **7.6**, **7.7**, **7.8**
			Vessel disturbance	**7.3**
			Light pollution	**6.2**
	Short-nosed sea snake	Approved Conservation Advice on *Aipysurus apraefrontalis* (Short-nosed seasnake) (DSEWPaC, 2011)	Oil and gas exploration	**6** and **7**
	Leaf-scaled sea snake	Approved Conservation Advice on *Aipysurus foliosquama* (Leaf-scaled seasnake) (DSEWPaC, 2011)	Oil and gas exploration	**6** and **7**
Birds	All seabirds and shorebirds	National Light Pollution Guidelines for Wildlife Including Marine Turtles, Seabirds and Migratory Shorebirds (DoEE, 2020)	Light pollution	**6.2**
	Bar-tailed godwit Curlew sandpiper Eastern curlew Red knot Streaked shearwater	Wildlife Conservation Plan for Migratory Shorebirds (CoA, 2015c)	Pollution and contaminants	**6.6**, **6.7**, **7.4**, **7.6**, **7.7**, **7.8**
			Habitat loss and degradation	**6.6**, **7.1**, **7.4**, **7.5**, **7.6**, **7.7**, **7.8**
	Curlew sandpiper	Approved Conservation Advice for *Calidris ferruginea* (Curlew Sandpiper) (TSSC, 2015e)	Habitat loss and degradation from pollution	**6.6**, **7.1**, **7.4**, **7.5**, **7.6**, **7.7**, **7.8**
			Marine pollution	**6.6**, **6.7**, **7.4**, **7.6**, **7.7**, **7.8**
	Eastern curlew	Approved Conservation Advice for *Numenius madagascariensis* (Eastern Curlew) (TSSC, 2015f)	Habitat loss and degradation from pollution	**6.6**, **7.1**, **7.4**, **7.5**, **7.6**, **7.7**, **7.8**
	Red knot	Approved Conservation Advice for *Calidris canutus* (Red knot) (TSSC, 2016b)	Pollution/contamination impacts	**6.6**, **6.7**, **7.4**, **7.6**, **7.7**, **7.8**
			Habitat loss and degradation	**6.6**, **7.1**, **7.4**, **7.5**, **7.6**, **7.7**, **7.8**
	Northern Siberian bar-tailed godwit	Conservation Advice *Limosa lapponica menzbieri* (Bar-tailed godwit (northern Siberian)) (TSSC, 2016a)	Habitat loss disturbance and modifications	**6.6**, **7.1**, **7.4**, **7.5**, **7.6**, **7.7**, **7.8**
			Pollution/contamination impacts	**6.6**, **6.7**, **7.4**, **7.6**, **7.7**, **7.8**
	Abbott's booby	Conservation Advice for the Abbott's booby *Papasula abbotti* (2020)	Marine debris – plastics	**7.1**

3.2.6 Socio-economic receptors

The EMBA encompasses both Australian and international waters, as shown in **Figure 3-1**. The Indonesian Exclusive Economic Zone (EEZ) and Timor-Leste EEZ are within the EMBA.

The coastlines of Indonesia and Timor-Leste are approximately 149 km and 347 km from the operational area respectively. The EMBA extends to the Indonesian and Timor-Leste coastlines.

Socio-economic activities that may occur in the operational area and EMBA include commercial fishing, Indonesian commercial and subsistence fishing, aquaculture, petroleum industry activities, defence activities, shipping and, to a lesser extent in the deeper offshore waters, recreational fishing and tourism, as summarised in **Table 3-10**.

Table 3-10: Socio-economic-related activities that occur or may occur in the operational area and/or environment that may be affected

Value/sensitivity	Operational area presence	Relevant activity events within operational area	EMBA presence	Relevant activity events within EMBA
Commercial fisheries – Commonwealth (**Figure 3-13**)	Four Commonwealth-managed fisheries overlap the operational area (**Figure 3-13**): + Northern Prawn Fishery + Southern Bluefin Tuna Fishery + Western Skipjack Tuna Fishery + Western Tuna and Billfish Fishery.	Planned Interaction with other users (**Section 6.5**)	Commonwealth fisheries within the EMBA (**Figure 3-13**): + Northern Prawn Fishery + Southern Bluefin Tuna Fishery + Western Skipjack Tuna Fishery + Western Tuna and Billfish Fishery + North-West Slope Trawl Fishery.	Unplanned Hydrocarbon release loss of well control (LOWC) and marine diesel oil (MDO) spill from vessel collision (**Sections 7.6 and 7.7**)
Commercial fisheries – state (**Figure 3-14**)	Four NT-managed fisheries overlap the operational area (**Figure 3-14**): + Aquarium Fishery + Offshore Net and Line Fishery + Timor Reef Fishery + Spanish Mackerel Fishery.	Planned Interaction with other users (**Section 6.5**)	NT fisheries within the EMBA (**Figure 3-14**): + Coastal Line Fishery + Aquarium Fishery + Demersal Fishery + Offshore Net and Line Fishery + Timor Reef Fishery + Spanish Mackerel Fishery. WA fisheries within the EMBA (**Figure 3-14**): + Mackerel Managed Fishery + Northern Demersal Scalefish Fishery.	Unplanned Hydrocarbon release LOWC and MDO spill from vessel collision (**Sections 7.6 and 7.7**)

Value/sensitivity	Operational area presence	Relevant activity events within operational area	EMBA presence	Relevant activity events within EMBA
Aquaculture	No aquaculture activities operate within the operational area.	<u>Planned</u> Interaction with other users (**Section 6.5**)	One operator may occasionally conduct activity within the EMBA near Evans Shoal 62 km west of the operational area. Seaweed farming occurs off the Indonesian coastline.	<u>Unplanned</u> Hydrocarbon release LOWC and MDO spill from vessel collision (**Sections 7.6 and 7.7**)
Traditional Indonesian fishing and Australian recreational fishing	Given the water depths in the operational area, traditional and recreational fishing activity is not expected. However, fishers may transit the operational area when travelling between sites.	<u>Planned</u> Interaction with other users (**Section 6.5**)	Indonesian and Timorese traditional fishers, as well as Australian recreational fishers, are expected to transit and fish in the EMBA.	<u>Unplanned</u> Hydrocarbon release LOWC and MDO spill from vessel collision (**Sections 7.6 and 7.7**)
Petroleum industry (**Section 3.2.6.3**)	There are no established petroleum operations within, or immediately adjacent to the operational area.	N/A	The nearest offshore operating facility to the operational area is the Santos-operated Bayu-Undan platform, located approximately 409 km south-west of the operational area. Oil and gas exploration permits are operated by other titleholders throughout the EMBA.	<u>Unplanned</u> Hydrocarbon release LOWC and MDO spill from vessel collision (**Sections 7.6 and 7.7**)
Defence (**Section 3.2.6.4**)	There are no designated military/defence exercise areas within or in the immediate vicinity of the operational area. During their surveillance, Australian Border Force vessels may transit the operational area.	<u>Planned</u> Interaction with other users (**Section 6.5**)	The EMBA intersects a practice area of the North Australian Exercise Area (NAXA) (Figure 3-15). During their surveillance, Australian Border Force vessels may transit the EMBA.	<u>Unplanned</u> Hydrocarbon release LOWC and MDO spill from vessel collision (**Sections 7.6 and 7.7**)

Value/sensitivity	Operational area presence	Relevant activity events within operational area	EMBA presence	Relevant activity events within EMBA
Telecommunications cables (**Figure 3-15**)	The North-West Cable System is located approximately 227 km south of the operational area.	N/A	This cable intersects the EMBA though a hydrocarbon spill will not have any impact on submarine cables.	N/A
Shipping (**Section 3.2.6.6**)	The closest major commercial port to the operational area is Darwin Port, located 263 km away. No designated shipping fairways intersect the operational area.	<u>Planned</u> Interaction with other users (**Section 6.5**)	**Figure 3-16** shows the vessels recorded in the AUSREP system in 2021 and shipping density within the region. It shows the main commercial shipping channel tracking to the west of the operational area. Vessel traffic is expected within the EMBA.	<u>Unplanned</u> Hydrocarbon release LOWC and MDO spill from vessel collision (**Sections 7.6 and 7.7**)
Tourism (**Section 3.2.6.7**)	The operational area is located in offshore waters that are highly unlikely to be accessed for tourism activities (e.g., recreational fishing and boating and charter boat operations). These tend to be centred around nearshore waters, islands and coastal areas.	N/A	There are several shoals and banks within the EMBA, and some these may be visited by small numbers of recreational fishers/charter vessels targeting fish that inhabit these shallower features.	<u>Unplanned</u> Hydrocarbon release LOWC and MDO spill from vessel collision (**Sections 7.6 and 7.7**)
Shipwrecks	No shipwrecks are recorded within the operational area.	N/A	One known shipwreck listed under the *Underwater Cultural Heritage Act 2018* is located at the Cartier Island Marine Park: the *Ann Millicent* (wrecked in 1888).	<u>Unplanned</u> Hydrocarbon release LOWC and MDO spill from vessel collision (**Sections 7.6 and 7.7**)

Value/sensitivity	Operational area presence	Relevant activity events within operational area	EMBA presence	Relevant activity events within EMBA
Cultural heritage	Use of marine resources by Aboriginal and Torres Strait Islander peoples is generally restricted to coastal waters and therefore not expected within the offshore deeper waters of the operational area.	N/A	The Arafura Marine Park is significant sea country for Traditional Owners (Director of National Parks, 2018b). The Ashmore Reef Marine Park contains Indonesian artefacts and grave sites and Ashmore lagoon is still accessed as a rest or staging area for traditional Indonesian fishers travelling to and from fishing grounds within the Memorandum of Understanding (MoU) Box (Director of National Parks, 2018a). There is limited information about the cultural significance of the Ashmore Reef Marine Park, Cartier Island Marine Mark and Oceanic Shoals AMP to Traditional Owners (Director of National Parks, 2018a, 2018b). Due to uncertainty, it is assumed waters of these parks contain significant sea country for Traditional Owners.	<u>Unplanned</u> Hydrocarbon release LOWC and MDO spill from vessel collision (**Sections 7.6 and 7.7**)

3.2.6.1 Commercial fisheries

The Timor and Arafura seas support a variety of shark, demersal and pelagic finfish and crustacean species of commercial importance. The operational area overlaps four Commonwealth commercial fisheries, and four NT-managed commercial fisheries. The EMBA overlaps one additional Commonwealth fishery **Figure 3-13**, as well as two additional NT-managed commercial fisheries and two WA-managed commercial fisheries (**Figure 3-14)** (NT Government, 2019a,b,c,d, 2021). Santos' understanding of fishing effort within these commercial fisheries is provided in **Table 3-11**.

Table 3-11: Commonwealth and state fisheries that overlap the operational area and/or environment that may be affected

Fishery	Overlap		Description	Likelihood of interaction with fishers
	Op area	EMBA		
Commonwealth-managed fisheries				
Northern Prawn Fishery	✓	✓	**Area**: Extends from 126° E near Cape Londonderry in WA across to the northernmost tip of Cape York in Queensland. Most of the Northern Prawn Fishery effort lies in the Gulf of Carpentaria, Joseph Bonaparte Gulf and along the Arnhem Land coast (DoA, 2014). **Gear**: trawl. **Key target species**: The key target species are banana prawns, tiger prawns and endeavour prawns. There are two fishing seasons, with the season end date depends on catch rates: + Season 1 (mainly banana prawns caught): 1 April to 15 June + Season 2 (mainly tiger prawns caught): 1 August to end of November. Fishing for scampi also occurs in deeper waters, with fishing effort spread across two-to-three months of the year (December to February). **Effort (2019)**: 52 active vessels, around 8500 tonnes (ABARES fishery status reports, 2020).	The areas of low, medium and high fishing effort are distant from the operational area. Based on previous industry consultation prawn fishing is not expected in water depths greater than around 130 m, therefore interaction with this fishery is unlikely. Scampi is targeted in deeper waters (>250 m) within and surrounding the operational area. There is a low level of fishing effort, with December and January the peak scampi fishing periods. Therefore, interaction with this fishery is possible during these months.

Fishery	Overlap		Description	Likelihood of interaction with fishers
	Op area	EMBA		
Southern Bluefin Tuna Fishery	✓	✓	**Area**: The Southern Bluefin Tuna Fishery (SBTF) spans the Australian Fishing Zone. However, it is only active in waters offshore of South and South Eastern Australia. **Gear**: purse seine and pelagic long line. **Key target species**: southern bluefin tuna. **Effort (2019)**: 27 active vessels, around 6,000 tonnes (ABARES Fishery status reports, 2020).	No active commercial fishing effort reported in the operational area or EMBA, therefore interaction with this fishery is unlikely.
Western Skipjack Tuna Fishery	✓	✓	**Area**: The Western Skipjack Tuna Fishery (SBTF) spans the Australian EEZ and adjacent high seas, from Cape York to the Victoria – South Australia border, including waters around Tasmania and the high seas of the Pacific Ocean. **Gear**: purse seine **Key target species**: skipjack tuna **Effort (2019)**: None. There has been no fishing effort since the 2008–09 season, and in that season, activity concentrated off South Australia (ABARES Fishery status reports, 2020).	No recent active commercial fishing effort reported in the operational area or EMBA, therefore interaction with this fishery is unlikely.
Western Tuna and Billfish Fishery	✓	✓	**Area:** Operates in Australia's EEZ and high seas of the Indian Ocean. In recent years, fishing effort has concentrated off south-west Western Australia, with occasional activity off South Australia. **Gear**: pelagic longline. **Key target species**: bigeye tuna, yellowfin tuna, striped marlin, swordfish. **Effort (2019)**: Four active vessels, around 200 tonnes (ABARES Fishery status reports, 2020).	No recent active commercial fishing effort reported in the operational area or EMBA, therefore interaction with this fishery is unlikely.

Fishery	Overlap		Description	Likelihood of interaction with fishers
	Op area	EMBA		
North-West Slope Trawl Fishery	✗	✓	**Area:** Operates off north-western Australia from 114°E to 125°E, roughly between the 200 m isobath and the outer boundary of the Australian Fishing Zone. A large area of the Australia–Indonesia MoU Box falls within the North West Shelf (NWS) throughflow. **Gear**: demersal trawl. **Key target species**: scampi. **Effort (2019)**: Four active vessels, around 70 tonnes (ABARES Fishery status reports, 2020).	No fishery overlaps with the operational area. Effort known within the EMBA.
State managed fisheries – NT				
Aquarium Fishery	✓	✓	**Area**: It includes freshwater, estuarine and marine habitats to the outer boundary of the Australian fishing zone. Most marine species are collected within 100 km of Nhulunbuy and Darwin. A specimen shell collection enterprise occurs around Ashmore Reef and Cartier Island (NT Government, 2021). **Gear**: handheld, nets and pots (dive-based). **Key target species**: fish, invertebrates and plants for aquariums. **Effort**: unknown – no restriction on number of licences.	No known recent effort within the operational area. Therefore, interaction with this fishery is unlikely. Effort could occasionally occur within the EMBA near Evans Shoal.

Fishery	Overlap		Description	Likelihood of interaction with fishers
	Op area	EMBA		
Spanish Mackerel Fishery	✓	✓	**Area**: Commercial fishing for Spanish mackerel is allowed from the high water mark to the outer boundary of the Australian fishing zone, which is 200 nautical miles offshore. The majority of the fishing effort occurs in the vicinity of reefs, headlands and shoals and includes waters near Bathurst Island, New Year Island, northern and western Groote Eylandt, the Gove Peninsula, the Wessel Islands, the Sir Edward Pellew Group and suitable fishing grounds on the western and eastern mainland coasts. Fishing generally takes place around reefs, headlands and shoals (NT Government, 2021). **Gear**: trolling, handline. **Key target species**: Spanish mackerel. **Effort**: 15 licences allowed.	No known recent effort within the operational area. Therefore, interaction with this fishery is unlikely. Effort is known within the EMBA.

Fishery	Overlap		Description	Likelihood of interaction with fishers
	Op area	EMBA		
Timor Reef Fishery	✓	✓	**Area**: The Timor Box extends north-west of Darwin to the WA/NT border and to the outer boundary of the Australian fishing zone. The fishery has an area of approximately 8,400 square nm (NT Government, 2021). Fishing occurs primarily in the 100 to 200-m depth range. Previous consultation indicates that the main target species is goldband snapper, with other tropical snappers (e.g., crimson snapper and saddletail snapper) also making up part of the catch; there are two active fishing licence holders currently operating in the fishery; main fishing method is trap fishing; fishery is most productive between October and May, with less activity during the dry season months of June-August due to strong northerly winds. Due to the water depth and based on a review of available historical catch data, fishing activity is not expected across the operational area. **Gear**: line and trap. **Key target species**: snapper, red emperor and cods. **Effort**: 15 licences allowed.	Effort possible within the operational area and expected in the EMBA. Therefore, interaction with this fishery is possible.

Fishery	Overlap: Op area	Overlap: EMBA	Description	Likelihood of interaction with fishers
Offshore Net and Line Fishery	✓	✓	**Area**: It operates in NT waters from the low water mark to the boundary of the Australian Fishing Zone (AFZ) (NT Government, 2020). Most fishing is done in the coastal zone within 12 nautical miles of the coast, and immediately offshore in the Gulf of Carpentaria (NT Government, 2021). **Gear**: longlines or pelagic nets (there are restrictions on where certain gear can be used). **Key target species**: blacktip sharks, grey mackerel. **Effort**: Unknown – no restriction on number of licences.	Interaction with this fishery in the operational area is possible but highly unlikely due to the concentration of fishing effort in near coastal areas and distribution of the targeted species.
Demersal Fishery (NT)	✗	✓	**Area**: Demersal fishing is allowed from 15 nautical miles from the low water mark to the outer boundary of the Australian fishing zone, excluding the area of the Timor Reef fishery (NT Government, 2021). **Gear**: lines, fish traps and semi-demersal trawl nets. **Key target species**: snapper (various species). **Effort**: Unknown – 18 licences currently issued.	No fishery overlaps with the operational area. Effort expected within the EMBA only.
State Managed Fisheries – WA				
Mackerel Managed Fishery	✗	✓	**Area**: Commercially fished between Geraldton and the WA/NT border. **Gear**: trolling. **Key target species**: Spanish mackerel. **Effort**: Active vessels less than three (FishCube data, 2019), around 300 tonnes (Gaughan and Santoro, 2021).	No fishery overlaps with the operational area. Effort expected within the EMBA.

Fishery	Overlap		Description	Likelihood of interaction with fishers
	Op area	EMBA		
Northern Demersal Scalefish Managed Fishery (WA)	✗	✓	**Area**: Operates off WA's coast in waters east of 120° E longitude. **Gear**: handline, dropline and fish traps, although the fishery has essentially operated as a trap-based fishery since 2002. **Key target species**: goldband snapper and red emperor. **Effort**: active vessels: (unknown) around 1500 tonnes (Gaughan & Santoro, 2021).	No fishery overlaps with the operational area. Effort expected within the EMBA.

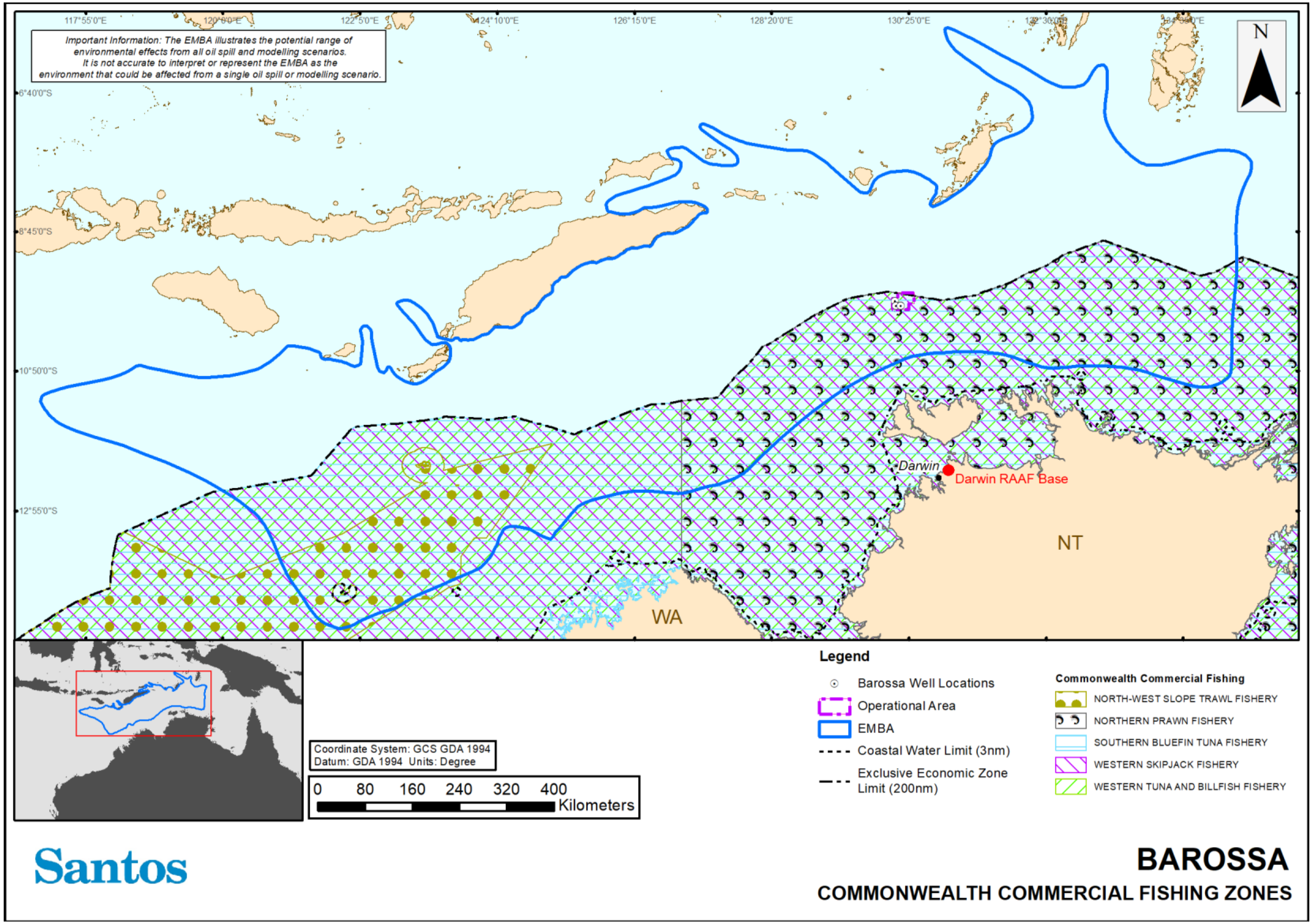

Figure 3-13: Commonwealth-managed fisheries overlapping the environment that may be affected

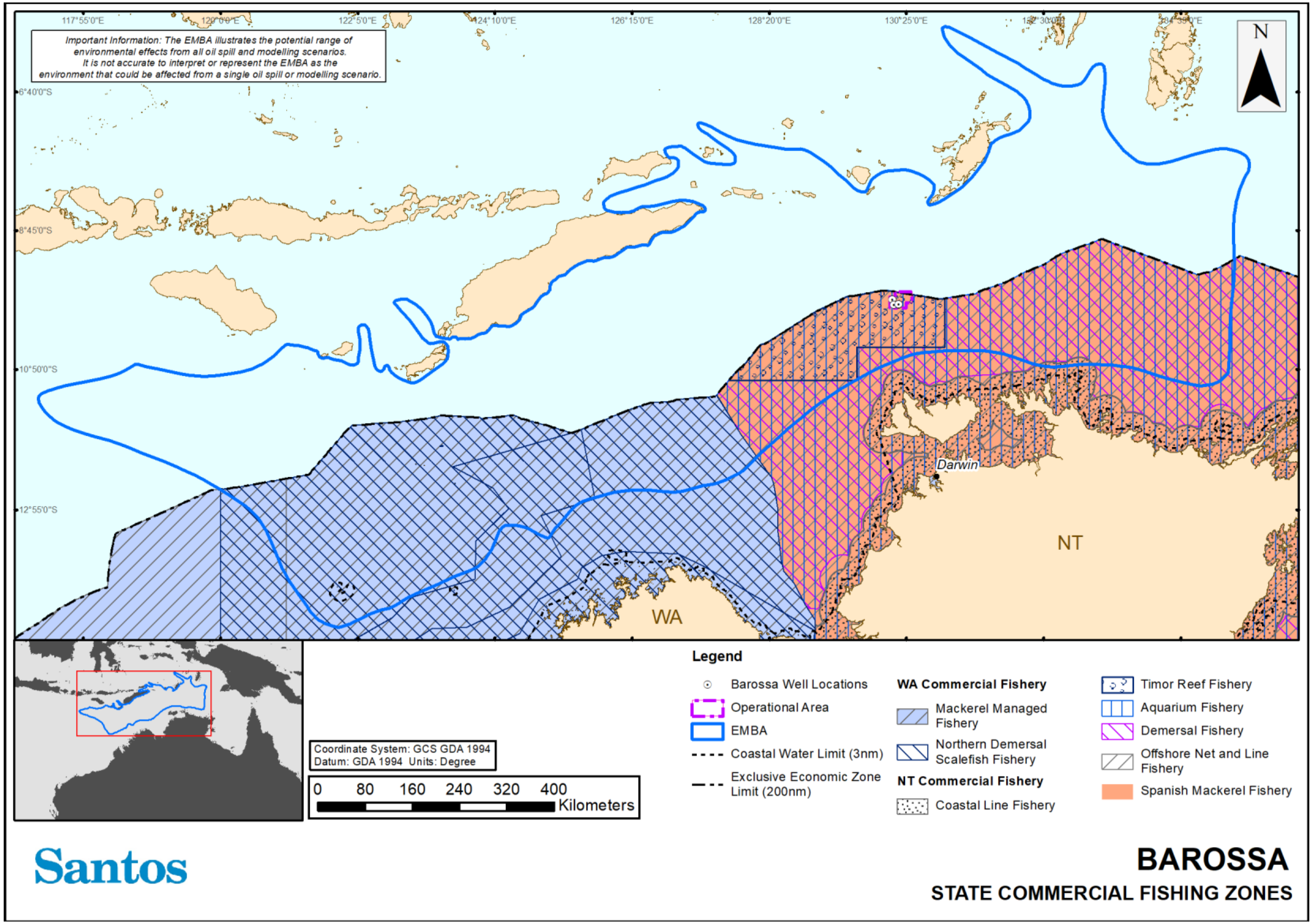

Figure 3-14: Western Australian and Northern Territory managed fisheries overlapping the environment that may be affected

3.2.6.2 Indonesian commercial and subsistence fishing

Indonesian and Timorese traditional fishermen generally fish in the Timor Sea, typically at locations such as Hibernia Reef, Ashmore Reef and Scott Reef (more than 770 km south-west of the operational area). Fishing occurs from April to December, with most activity occurring in September and October. The Big Bank shoals (located to the west of the operational area, in the centre of the EMBA) lie in the Indonesian EEZ and Indonesian commercial vessels may fish in and around the shoals (Heyward *et al*., 1997a). Species that are likely to be targeted by Indonesian fishers are shark, tuna, mackerel and reef fish such as snapper.

As the operational area is located in remote offshore waters with no geomorphic features such as shoals, banks, or reefs, traditional Indonesian fishing is unlikely to occur within this area. As there are shoals in the EMBA, it is possible that Indonesian fishers may transit and fish in the EMBA.

An MoU between the Australian and Indonesian governments, officially known as the Australia-Indonesia *Memorandum of Understanding on the Operations of Indonesian Traditional Fishermen in Areas of the Australian Fishing Zone and Continental Shelf – 1974* exists to:

> "provide the framework for fisheries and marine cooperation between Australia and Indonesia, and facilitates information exchange on research, management and technological developments, complementary management of shared stocks, training and technical exchanges, aquaculture development, trade promotion and cooperation to deter illegal fishing." (DAWE, 2020)

The MoU enables traditional fishing to occur within sections of the Australian EEZ. The fishers focus their activities in and around the shallow water lagoons of Scott Reef primarily targeting trepang; and opportunistically gather trochus shells, generally from July to October, and to a lesser extent from April to June. They also catch fish largely for subsistence purposes.

3.2.6.3 Petroleum industry

There are several oil and gas companies that hold petroleum permits near the operational area; however, no established oil and gas operations are located within, or in the immediate surrounds of the operational area. The closest operational offshore production facilities and in-field subsea infrastructure are associated with the Santos-operated Bayu-Undan platform, located approximately 409 km to the south-west of the operational area.

Petroleum retention lease area and exploration permit leases within the EMBA are currently held by various oil and gas operators (and subsidiaries), including Carnarvon Petroleum Limited, Woodside Energy Ltd, Shell Development (Australia) Pty Ltd, Osaka Gas Australia Pty Ltd, Eni Australia Limited, Origin Energy and Timor Sea Oil & Gas Australia Pty Ltd.

3.2.6.4 Telecommunications cables

The North-West Cable System (NWCS) is located approximately 227 km south of the operational area. Extending 2,100 km from Darwin to Port Hedland, the NWCS connects Australia's remote northern and western regions, including offshore oil and gas facilities, with onshore locations.

3.2.6.5 Defence activities

There are no designated military/defence exercise areas within or near the operational area. However, the EMBA intersects a practice area of the NAXA, a maritime military zone administered by the Department of Defence (**Figure 3-15**). The NAXA comprises practice and training areas and extends approximately 290 km north and west from just east of Darwin into the Arafura Sea. The area is used for offshore naval exercises and onshore weapon-firing training.

The Australian Border Force also undertake civil and maritime surveillance (and enforcement) in Australian offshore maritime waters, which includes the Australian EEZ. During their surveillance, Australian Border Force vessels may transit through the operational area and EMBA.

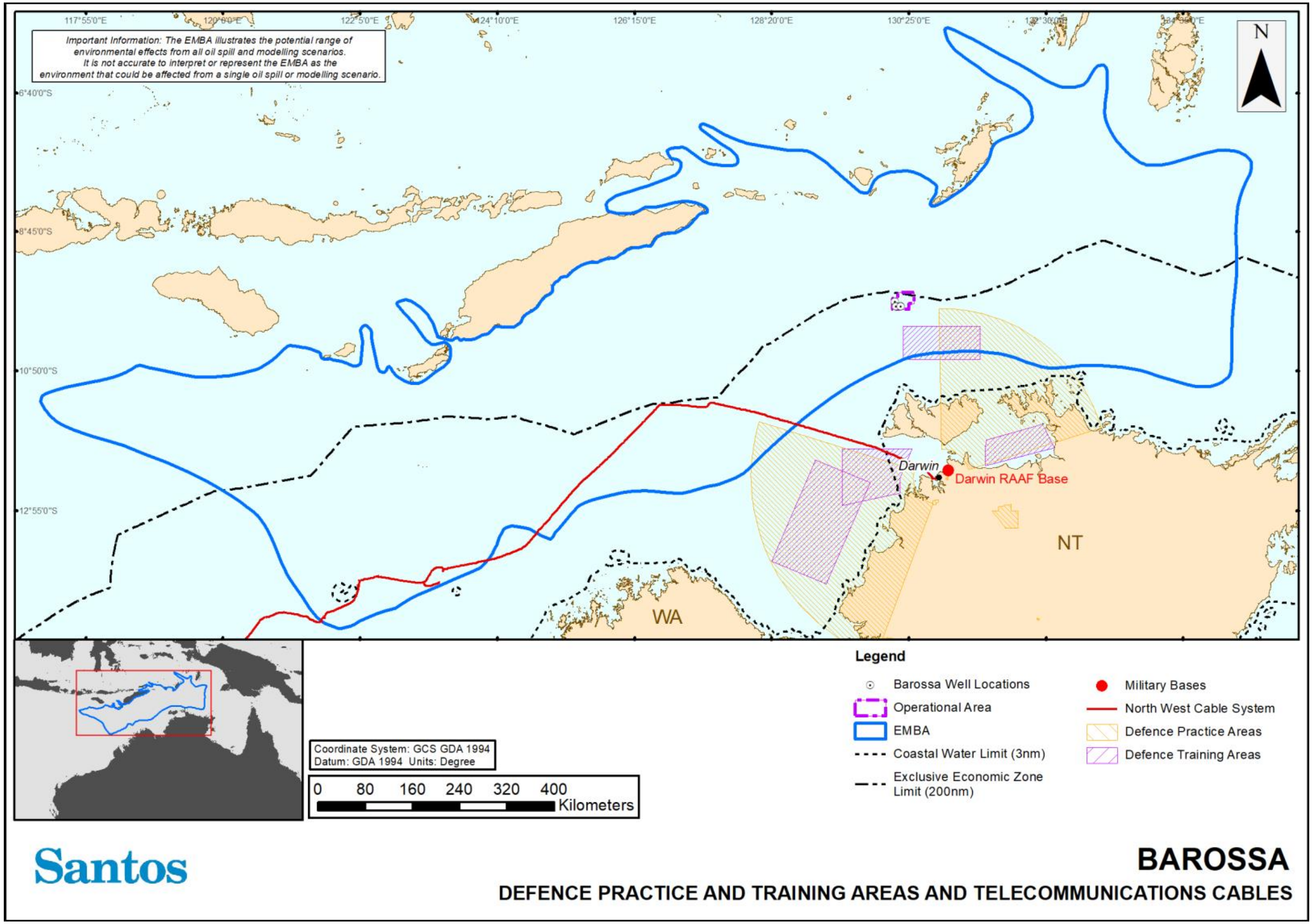

Figure 3-15: Defence training and exercise areas and telecommunications cables within the environment that may be affected

3.2.6.6 Shipping

The closest major commercial port to the operational area is Darwin Port, located approximately 263 km to the south east. Darwin Port is a major shipping port in Australia. In 2018–19, there were a total of 511 commercial vessel calls to port (Ports Australia, 2019).

Darwin Port is a major port of call for vessels servicing operations offshore from north-west Australia. There is also small-scale port activity to the south and east of the operational area at the Tiwi Islands (outside the EMBA).

The main preferred shipping routes that occur within the EMBA are between Darwin and ports in South-East Asia. Average vessel displacements and speeds for shipping vessels transiting the EMBA and operational area include:

+ bulk carriers averaging 55,300 tonnes with speeds of 14 knots
+ livestock carriers averaging 2,800 tonnes with speeds of 12 knots
+ general cargo vessels averaging 4,900 tonnes with speeds of approximately 12 knots.

Figure 3-16 presents Australian Maritime Safety Authority (AMSA) recorded vessel movements through the AUSREP system in 2021. The records show limited vessel movements through the operational area.

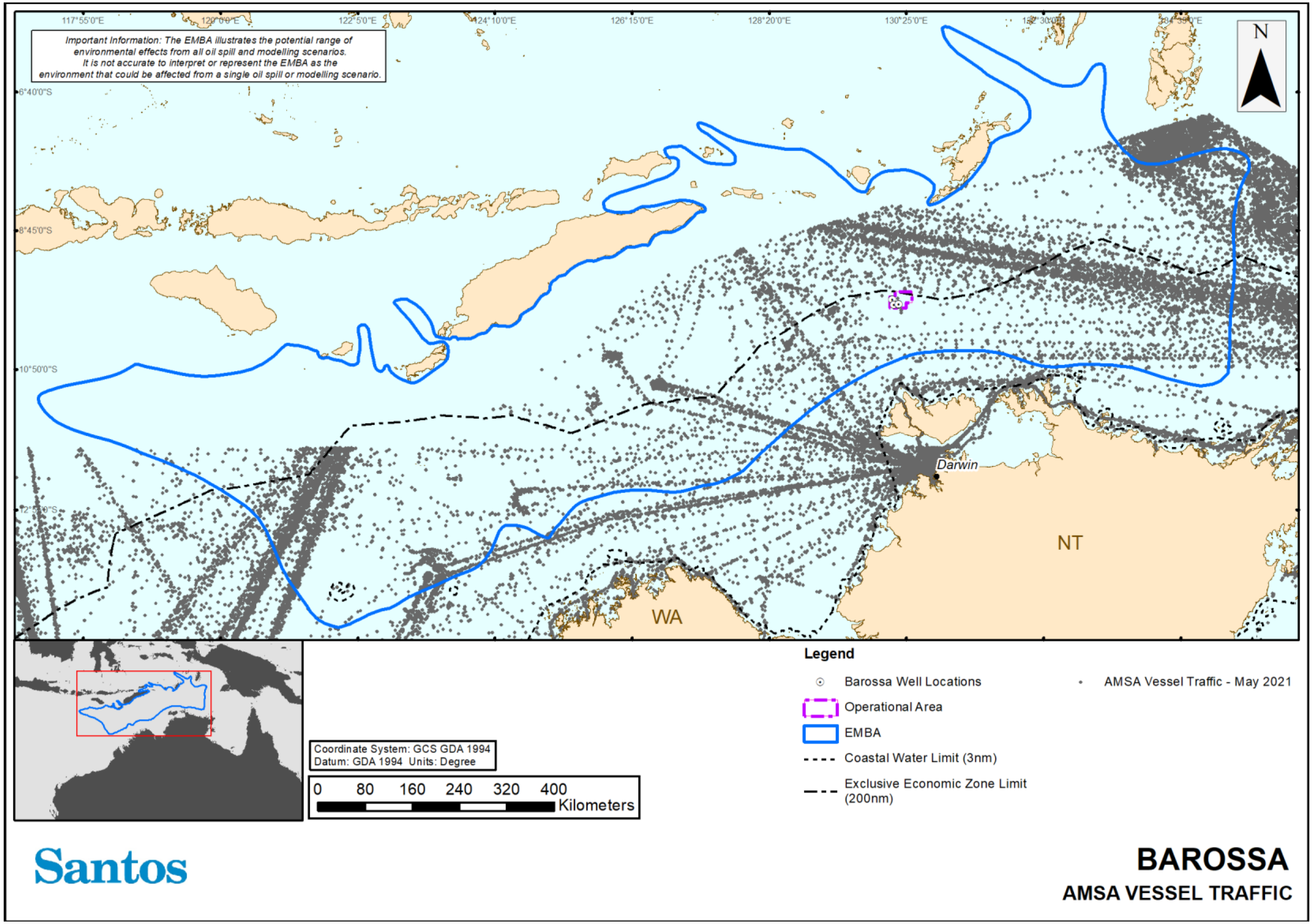

Figure 3-16: Australian Maritime Safety Authority recorded vessel movements and shipping routes overlapping the environment that may be affected

3.2.6.7 Tourism

The operational area is located in offshore waters that are not likely to be accessed for tourism activities (e.g., recreational fishing and boating and charter boat operations), as these tend to be centred around nearshore waters, islands and coastal areas. Several shoals and banks within the EMBA, may be visited by small numbers of recreational fishers/charter vessels targeting fish inhabiting these shallower features. Consultation undertaken for the Barossa Development OPP identified one fishing charter operator who conducts tours in open offshore waters near Evans Shoal and Goodrich Bank during the main fishing season (September to December).

Fishing and diving charter companies offer tours to fishing spots off the WA coast, including Seringapatam Reef, and dive spots which include Cartier Island and Ashmore Hibernia and Seringapatam reefs. These offshore areas are encompassed in the EMBA.

3.2.6.8 Heritage

There are no world heritage properties, national heritage places or Commonwealth heritage places within the operational area, however the EMBA intersects the ‘Scott Reef and surrounds – Commonwealth area’ and the Ashmore Reef AMP.

There are no recorded Aboriginal heritage sites within the operational area. The waters of Australian Marine Parks, such as the Arafura AMP, are considered to be significant sea country for Aboriginal and Torres Strait Islanders (DEWHA, 2008a).

No shipwrecks are located within the operational area. One known shipwreck listed under the *Underwater Cultural Heritage Act 2018* is located at the Cartier Island Marine Park: the *Ann Millicent* (wrecked in 1888).

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 11A
(1) In the course of preparing an environment plan, or a revision of an environment plan, a titleholder must consult each of the following (a relevant person): (a) each Department or agency of the Commonwealth to which the activities to be carried out under the environment plan, or the revision of the environment plan, may be relevant; (b) each Department or agency of a State or the Northern Territory to which the activities to be carried out under the environment plan, or the revision of the environment plan, may be relevant; (c) the Department of the responsible State Minister, or the responsible Northern Territory Minister; (d) a person or organisation whose functions, interests or activities may be affected by the activities to be carried out under the environment plan, or the revision of the environment plan; (e) any other person or organisation that the titleholder considers relevant. (2) For the purpose of the consultation, the titleholder must give each relevant person sufficient information to allow the relevant person to make an informed assessment of the possible consequences of the activity on the functions, interests or activities of the relevant person. (3) The titleholder must allow a relevant person a reasonable period for the consultation. (4) The titleholder must tell each relevant person the titleholder consults that: (a) the relevant person may request that particular information the relevant person provides in the consultation not be published; and (b) information subject to such a request is not to be published under this Part.
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: (iii) a summary of each response made by a relevant person; and (iv) an assessment of the merits of any objection or claim about the adverse impact of each activity to which the environment plan relates; and (v) a statement of the operator's response, or proposed response, if any, to each objection or claim; and (vi) a copy of the full text of any response by a relevant person.

4.1 Summary

Stakeholder consultation on petroleum activities within the Barossa permit area and surrounds has been ongoing since 2004. During this time a range of relevant persons have been consulted, including Commonwealth and NT government departments, commercial fishing associations and licence holders, scientific and educational organisations (including recognised experts), spill response agencies, local business associations, other oil and gas industry operators, contractors and non-government organisations.

Since 2012, consultation has been undertaken on an ongoing basis on the plans to develop the Barossa area as a source for future backfill gas supply for the Darwin liquefied natural gas (LNG) facility. With this history, Santos is familiar with local communities and other marine users in the Barossa permit area and wider region.

Consultation with relevant persons was undertaken during development of environment plans for Barossa appraisal drilling campaigns in 2012–13 and 2016, and a marine seismic survey in 2016.

The public was invited to comment on the *Barossa Development Area Offshore Project Proposal*, accepted and published by NOPSEMA in March 2018.

Consultation also occurred with relevant persons during development of the *Barossa Gas Export Pipeline Installation EP*, accepted and published by NOPSEMA in March 2020.

Consultation on the *Barossa Development Drilling and Completions EP* (this EP) was undertaken in 2019, but the EP was not submitted to NOPSEMA at this time.

Due to the time that had elapsed since the previous consultation, Santos elected to consult again before submission of the EP.

In May 2021, relevant persons (**Table 4-1**) were informed of activities covered in this EP via several consultation channels, including:

+ meetings in May and June 2021
+ distribution of the Barossa Development Drilling and Completions Stakeholder Consultation Package in June 2021 (**Appendix E**).
+ distribution of the Barossa Development Drilling and Completions Additional Information for Commercial Fishers Package in June 2021 (**Appendix E**).

Santos has considered all relevant persons' responses and assessed the merits of all objections and claims about the potential impacts and risks of the proposed activities. The process adopted to assess these objections and claims is outlined in **Section 4.3**. A summary of Santos' response statements to the objections and claims is provided in **Table 4-2**.

Santos considers that consultation with relevant persons has been adequate to inform the development of this EP. Notwithstanding this, Santos recognises the importance of ongoing consultation and notification.

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 stakeholders is an important part of this process.

Santos began the process of identifying relevant persons for this EP with a review of its stakeholder database, including relevant persons consulted for other recent activities in the area. This list was then reviewed and refined based on the defined operational area (refer to **Section 2**) and the relevance of the stakeholder according to Regulation 11A of the OPGGS (E) Regulations.

More specifically, relevant persons for this EP were identified through:

- review of legislation applicable to petroleum and marine activities
- identification of marine user groups (e.g., commercial fisheries, other oil and gas producers, merchant shipping, etc.)
- a request for the most recent commercial fishing data and other relevant information available via the Department of Industry, Tourism and Trade in the Northern Territory (DITT-NT), the Australian Fisheries Management Authority (AFMA) and the Northern Prawn Fishing Industry Pty Ltd (NPFI)
- updated fishing licence holder contact details, from these identified fisheries, as provided by DITT-NT and AFMA
- discussions with identified relevant persons
- records from previous consultation
- active participation in industry bodies and collaborations
- review of correspondence received from relevant persons or organisations requesting to be consulted as relevant persons.

Currently identified relevant persons are listed in **Table 4-1**.

Table 4-1: Drilling activity relevant persons

Stakeholder	Relevant to activity	Reason for engagement
Commonwealth Government departments/agencies		
Australian Communications and Media Authority (ACMA)	Considered relevant persons under Regulation 11A(1) (a)	ACMA is an independent Commonwealth statutory authority responsible for the regulation of broadcasting, radio and telecommunications. It provides information on relevant subsea communications infrastructure.
Australian Fisheries Management Authority	Considered relevant persons under Regulation 11A(1) (a)	AFMA is responsible for managing Commonwealth fisheries and is a relevant agency where the activity has the potential to impact on fisheries resources in AFMA managed fisheries. The operational area intersects with Commonwealth-managed fisheries.
Australian Hydrographic Office (AHO)	Considered relevant persons under Regulation 11A(1) (a)	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 Agriculture, Water and the Environment (DAWE) – Biosecurity (marine pests)	Considered relevant persons under Regulation 11A(1) (a)	DAWE (marine pests) has primary policy and regulatory responsibility for managing biosecurity for incoming goods and conveyances, including biosecurity for marine pests. The operational area is in Commonwealth waters.
Department of Agriculture, Water and the Environment – Fisheries	Considered relevant persons under Regulation 11A(1) (a)	DAWE (fisheries) has primary policy responsibility for promoting the biological, economic and social sustainability of Australian fisheries.
Department of Defence (DoD)	Considered relevant persons under Regulation 11A(1) (a)	The department is the relevant agency where the activity has the potential to negatively impact fishing operations and/or fishing habitats in Commonwealth waters. The operational area intersects Commonwealth-managed fisheries.
Department of Foreign Affairs and Trade (DFAT)	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, with nearby DoD training areas.
Director of National Parks (DNP)	Considered relevant persons under Regulation 11A(1) (a)	DFAT is responsible for any required discussions with foreign governments due to potential impact from activities in international or foreign territory waters. The operational area is in Commonwealth waters and near the Perth Treaty Area.
Northern Territory Government departments/agencies		
NT Department of Industry, Tourism and Trade – Fisheries Division	Considered relevant persons under Regulation 11A(1) (b)	DITT is responsible for NT-managed fisheries. The operational area overlaps the Timor Reef Fishery which is jointly managed by the NT and Commonwealth.
NT Department of Industry, Tourism and Trade – Energy Division	Considered relevant persons under Regulation 11A(1) (b)	DITT is the NT's coordinating agency for economic and industry development.
NT Department of Infrastructure, Planning and Logistics (DIPL) – Transport Division	Considered relevant persons under Regulation 11A(1) (b)	DIPL is responsible for marine safety in NT coastal waters. The operational area is in

		Commonwealth waters, but vessels will traverse NT coastal waters.
Neighbouring Oil and Gas operators/exploration companies		
Eni Australia B.V.	Considered relevant persons under Regulation 11A(1) (d)	Operator of nearby permit NT/RL7.
INPEX	Considered relevant persons under Regulation 11A(1) (d)	Operator of nearby permits.
Woodside	Considered relevant persons under Regulation 11A(1) (d)	Operator of adjacent permit NT/P86.
Industry bodies		
Australian Marine Oil Spill Centre (AMOSC)	Considered relevant persons under Regulation 11A(1) (d)	AMOSC operates the Australian oil industry's major oil spill response facility.
Australian Southern Bluefin Tuna Industry Association (ASBTIA)	Considered relevant persons under Regulation 11A(1) (d)	ASBTIA is listed by AFMA as a contact for petroleum operators to use when consultation with Commonwealth fishing operators is required for a range of tuna fishing activities. The operational area intersects with the fishery. No ASBTIA fishing activity occurs in or near the operational area.
Commonwealth Fisheries Association (CFA)	Considered relevant persons under Regulation 11A(1) (d)	CFA is listed by AFMA as a contact for petroleum operators to use when consultation with fishing operators is required. The operational area intersects with several Commonwealth-managed fisheries.
Darwin Port	Considered relevant persons under Regulation 11A(1) (d)	Private consortium responsible for the management of shipping and other commercial activities requiring use of Darwin Harbour. Santos contracted vessels plan on using the Darwin Harbour.
Northern Prawn Fishing Industry Pty Ltd	Considered relevant persons under Regulation 11A(1) (d)	NPFI is listed by AFMA as a contact for petroleum operators to use when consultation with Commonwealth fishing operators in the Northern Prawn Fishery is required. The operational area intersects with the Northern Prawn Fishery.
Northern Territory Guided Fishing Industry Association	Considered relevant persons under Regulation 11A(1) (d)	NTGFIA is an organisation representing marine-based tourism operators in the NT.
Northern Territory marine-based tourism operators	Considered relevant persons under Regulation 11A(1) (d)	Known operators in the region that may transit the operational area.
Northern Territory Seafood Council	Considered relevant persons under Regulation 11A(1) (d)	NTSC represents NT commercial fishing licence holders operating in Territory managed fisheries. The operational area intersects with the Timor Reef Fishery.
NT Port and Marine	Considered relevant persons under Regulation 11A(1) (d)	Private company that operates port facilities in the region, including at Port Melville on the Tiwi Islands.

Pearl Producers Association (PPA)	Considered relevant persons under Regulation 11A(1) (d)	The PPA is the peak body representing pearl fishery licence holders in Australia. No activity occurs in the operational area.
Western Australian Fishing Industry Council	Considered relevant persons under Regulation 11A(1) (d)	WAFIC is the peak body representing WA-based commercial fishing licence holders, some of whom also have licences in Commonwealth- managed fisheries.
WA Seafood Exporters	Considered relevant persons under Regulation 11A(1) (d)	WA Seafood Exporters is listed by AFMA as a contact for petroleum operators to use when consultation with Commonwealth fishing operators in the Northern Prawn Fishery is required. The operational area intersects with the Northern Prawn Fishery.
Commercial fisheries – NT managed		
Timor Reef Fishery licence holders	Considered relevant persons under Regulation 11A(1) (d)	The Timor Reef Fishery (TRF) extends north-west of Darwin to the WA-NT border and to the outer limit of the AFZ. The operational area intersects with the Timor Reef Fishery.
Demersal Fishery licence holders	Considered relevant persons under Regulation 11A(1) (d)	The fishery extends from waters 15 nm from the coastal waters mark to the outer limit of the AFZ, excluding the area of the Timor Reef Fishery. Hence, this fishery does not overlap with the operational area.
Spanish Mackerel Fishery licence holders	Considered relevant persons under Regulation 11A(1) (d)	The fishery extends seaward from the high-water mark to the edge of the AFZ. The operational area intersects with the Spanish Mackerel Fishery.
Aquarium Fishery licence holders	Considered relevant persons under Regulation 11A(1) (d)	The Aquarium Fishery is a small-scale, multi-species fishery that prospects freshwater, estuarine and marine habitats to the outer boundary of the AFZ. The operational area intersects with the Aquarium Fishery.
Commercial fisheries – Commonwealth managed		
Austral Fisheries	Considered relevant persons under Regulation 11A(1) (d)	Northern Prawn Fishery licence-holder active in the operational area.
Australia Bay Seafoods	Considered relevant persons under Regulation 11A(1) (d)	**Fishing l**icence-holder active in the region.
Northern Prawn Fishery licence holders	Considered relevant persons under Regulation 11A(1) (d)	The Northern Prawn Fishery extends over the northern coast between Cape York in Queensland and Cape Londonderry in WA, from the low water mark to the outer edge of the AFZ. **The operational area intersects this fishery.**
Southern Bluefin Tuna/ Western Skipjack Tuna and Western Tuna and Billfish Fisheries licence holders	Considered relevant persons under Regulation 11A(1) (d)	The operational area intersects with these fisheries.
Community-based stakeholders		

Amateur Fisherman's Association of the NT (AFANT)	Considered relevant persons under Regulation 11A(1) (e)	AFANT is the peak body representing NT recreational fishers.
Australian Marine Sciences Association – NT	Considered relevant persons under Regulation 11A(1) (d)	AMSA made a submission to Santos requesting to be consulted. AMSA is Australia's peak professional body for marine scientists, with a branch in the NT. Their listed interests include promoting all aspects of marine science in the NT and making formal comment on NT marine development assessments.
Australian National University (ANU)	Considered relevant persons under Regulation 11A(1) (e)	A Professor from the ANU (Northern Australian Research Unit) made a submission to Santos, requesting to be consulted. The Professor's interests include the Arafura and Time Seas **region and** is a coastal marine biodiversity and marine environment specialist with the NT government.
Environment Centre Northern Territory (ECNT)	Considered relevant persons under Regulation 11A(1) (d)	ECNT wrote to Santos requesting to be consulted. The ECNT is the peak community sector environment organisation in the Northern Territory. Their interests include the NT environment, climate change and biodiversity conservation.
Northern Land Council	Considered relevant persons under Regulation 11A(1) (d)	Their function is to represent indigenous people in the Northern Territory.
Sea Turtle Foundation	Considered relevant persons under Regulation 11A(1) (d)	Consulted due to submission received during OPP public comment period. Sea Turtle Foundation is a non-profit, non-government group based in Australia interested in protecting sea turtles through research, education and action.
Tiwi Land Council	Considered relevant persons under Regulation 11A(1) (d)	Their function is to represent indigenous residents of the Tiwi Islands. They are the nearest Australian mainland island to the operational area.

4.3 Stakeholder consultation

Relevant persons were contacted by phone or email before or when the *Stakeholder consultation packages* were provided to increase activity awareness and encourage two-way communication. Other users of the marine environment, principally the commercial fishing sector, were provided personal emails with information tailored to their functions, interests and activities..

The consultation package provided to relevant persons contained details such as an activity summary, location map, coordinates, water depth, distance to key regional features, exclusion zone details and estimated timing and duration. The consultation package also outlined relevant potential risks and impacts together with a summary of selected management control measures. All relevant persons were encouraged to provide feedback on the proposed activity.

Commercial fishers were provided additional information specific to the fishery within which they operate. Individual fishing licence holders, as identified through sourced data and in consultation with fisheries organisations, were provided the *Stakeholder consultation package* and *Additional information for commercial fishers package* by email or post.

Stakeholders were afforded four weeks to review consultation packs and provide feedback or indicate their intention to provide feedback or seek further information, although Santos accepted and responded to stakeholder feedback throughout the EP preparation period covering a further eight weeks..

4.4 Assessment of stakeholder objections and claims

A summary of the stakeholder consultation undertaken for this EP, including Santos' assessment of all comments received from relevant persons, is outlined in **Table 4-2**.

Full transcripts between Santos and relevant persons are provided in the *Barossa Development drilling and completions environment plan sensitive stakeholder information report* (*BAD-200 0013)* as a confidential submission to NOPSEMA.

Santos adopted the following process to address objections and claims from relevant persons:

+ Santos acknowledged receiving all comments made by relevant persons.
+ Santos assessed the merits of all objections and claims made by relevant persons. This included assessing all reasonably available options for resolving or mitigating the degree to which their functions, interests or activities may be affected. Control measures were proposed and adopted where reasonably practicable.
+ Santos responded to all objections and claims, and advised the relevant person how each of their objections and claims would be addressed in the EP.
+ A similar process was applied to information provided and requests made by stakeholders not deemed to be an objection or claim.
+ Santos recognises the importance of ensuring a high degree of transparency in how a titleholder manages ongoing stakeholder consultation during the planning and execution of approved activities. As such, should comments be received from any relevant persons additional to those described in **Table 4-2**, Santos will assess and respond to the comments.

In relation to consultation with relevant persons, Santos is of the opinion that Regulation 11A of the OPGGS(E) Regulations has been met.

Table 4-2: Relevant persons consultation summary

<table>
<tr><th>Relevant person</th><th colspan="2">Relevant persons consultation summary (OPGGS(E) Regulation 16 (b)(i))</th></tr>
<tr><td colspan="3">Commonwealth departments/agencies</td></tr>
<tr><td rowspan="3">Australian Communications and Media Authority (ACMA)</td><td colspan="2">ACMA was provided the Barossa Development Drilling and Completions Stakeholder Consultation package via email on 11 June 2021 inviting comment.
ACMA was provided a follow-up email on 2 July 2021 inviting comment.
ACMA responded via email on 7 July 2021 and advised that the proposed activities are not in the vicinity of any existing protection zones for subsea communications infrastructure and therefore it had no comments. ACMA encouraged Santos to contact the operator of any submarine cables in the area. [CLAIM 001]
Santos responded to ACMA on 15 July 2021 and addressed each of the matters raised in their correspondence of 7 July 2021.
ACMA receives the Barossa Development Quarterly Consultation Update. The Q2 2021 Update was distributed on 11 June 2021.
Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.</td></tr>
<tr><th>Assessment of the merits of objections and claims (OPGGS(E) Regulation 16 (b)(ii))</th><th>Statement of response, or proposed response, to the objections and claims (OPGGS(E) Regulation 16 (b)(iii))</th></tr>
<tr><td>[CLAIM 001] Santos reviewed ACMA’s advice and on assessment confirmed there are no operators of any submarine cables within the operational area.</td><td>Santos responded to ACMA on 15 July 2021 confirming the information would be taken into consideration in the drafting of the EP.
Due to the absence of any submarine cables within the operational area (refer to Section 3.2.6.4) no further consultation or action related to this claim is required.</td></tr>
<tr><td>Australian Fisheries Management Authority</td><td colspan="2">AFMA was provided the Barossa Development Drilling and Completions Stakeholder Consultation package via email on 11 June 2021 inviting comment.
AFMA responded on 16 June 2021 and advised that due to limited resources, it is unable to comment on individual proposals; however, it is important to consult with all fishers who have entitlements to fish within the proposed area, either through the relevant fishing industry associations or directly with fishers who hold entitlements in the area. [CLAIM 001]</td></tr>
</table>

Relevant person	Relevant persons consultation summary (OPGGS(E) Regulation 16 (b)(i))	
	AFMA was provided a follow-up email on 2 July 2021 inviting any further comment. AFMA provided the same response (as above) on 5 July 2021. Santos responded to AFMA on 15 July 2021 and addressed each of the matters raised in their correspondence of 16 June and 5 July 2021. AFMA receives the Barossa Development Quarterly Consultation Update. The Q2 2021 Update was distributed on 11 June 2021. Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.	
	Assessment of the merits of objections and claims (OPGGS(E) Regulation 16 (b)(ii))	**Statement of response, or proposed response, to the objections and claims (OPGGS(E) Regulation 16 (b)(iii))**
	[CLAIM 001] On assessment of the advice and in consideration of AFMA's consultation guidelines, Santos identified the relevant commercial fishing organisations as the Northern Prawn Fishery Pty Ltd, NT Seafood Council, Commonwealth Fisheries Association and Australian Southern Bluefin Tuna Industry Association and consulted with these organisations as well as the lists of licence holders provided by AMSA and NT DITT-Fisheries as listed in **Table 4-1**.	Santos responded to AFMA on 15 July 2021 and advised that consultation with relevant commercial fishers has occurred as evidenced in **Table 4.2** and the **Sensitive Stakeholder Consultation Report.** All relevant fisheries are described in **Section 3.2.6.1**. Potential impacts and risks to fisheries and fishers (including traditional, recreational and commercial) have been assessed as environmentally acceptable and ALARP (primarily **Sections 6.4.4**, **6.5.4, 6.6.4, 6.7.4, 7.6.4** and **7.7.4**).
Australian Hydrographic Office	AHO was provided the Barossa Development Drilling and Completions Stakeholder Consultation package via email on 11 June 2021 inviting comment. AHO acknowledged receipt of the email on 15 June 2021 and confirmed the data supplied would now be registered, assessed, prioritised and validated in preparation for updating AHO's Navigational Charting products. **[CLAIM 001]** AHO was provided a follow-up email on 2 July 2021 inviting any further comment. AHO receives the Barossa Development Quarterly Consultation Update. The Q2 2021 Update was distributed on 11 June 2021. Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.	
	Assessment of the merits of objections and claims (OPGGS(E) Regulation 16 (b)(ii))	**Statement of response, or proposed response, to the objections and claims (OPGGS(E) Regulation 16 (b)(iii))**
	[CLAIM 001] On assessment of the AHO's advice, Santos reviewed its processes to ensure the AHO's notification requirements will be part of the ongoing communications for this activity (refer to **Table 8-4)**.	No response was required. The AHO's notification requirements and advice will be part of the ongoing

<table>
<tr><th>Relevant person</th><th colspan="2">Relevant persons consultation summary (OPGGS(E) Regulation 16 (b)(i))</th></tr>
<tr><td></td><td></td><td>communications for this activity (refer to Section 8.9.1and Section 4.5).</td></tr>
<tr><td rowspan="3">Australian Maritime Safety Authority</td><td colspan="2">AMSA was provided the Barossa Development Drilling and Completions Stakeholder Consultation package via email on 11 June 2021 inviting comment.
AMSA was provided a follow-up email on 2 July 2021 inviting comment.
AMSA responded on 6 July 2021 advising:
Santos should contact AHO no less than four working weeks before operations, with relevant details. AHO will then promulgate the appropriate Notice to Mariners (NTM), which will ensure other vessels are informed of activities. [CLAIM 001]
Santos 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. [CLAIM 002]
Santos should plan to provide updates to both AHO and JRCC on progress and any changes to the intended operations. [CLAIM 003]
To obtain a vessel traffic plot showing Automatic Identification System (AIS) traffic data for the area of interest, Santos should visit AMSA’s spatial data gateway and portal to download digital data sets and maps.[CLAIM 004]
Vessels must comply with the International Rules for Preventing Collisions at Sea, in particular the use of appropriate lights and shapes to reflect the nature of operations. They should also ensure their navigation status is set correctly in the AIS unit. [CLAIM 005]
Santos responded to AMSA on 15 July 2021 and addressed each of the matters raised in their correspondence of 6 July 2021.
AMSA also receives the Barossa Development Quarterly Consultation Update. The Q2 2021 Update was also distributed on 11 June 2021.
Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.</td></tr>
<tr><th>Assessment of the merits of objections and claims (OPGGS(E) Regulation 16 (b)(ii))</th><th>Statement of response, or proposed response, to the objections and claims (OPGGS(E) Regulation 16 (b)(iii))</th></tr>
<tr><td>[CLAIM 001] [CLAIM 002] [CLAIM 003] [CLAIM 004] [CLAIM 005] On assessment of AMSA’s advice, Santos reviewed the ongoing communications plan and notification requirements for this EP (Refer Table 8-4).</td><td>Santos responded to AMSA on 15 July 2021 confirming its notification requirements and advice will be part of the ongoing communications for this activity and be addressed in the EP (Refer Section 4.5 and 8.9.1).</td></tr>
<tr><td>Department of Defence (DoD)</td><td colspan="2">DoD was provided the Barossa Development Drilling and Completions Stakeholder Consultation package via email on 11 June 2021 inviting comment.
DoD was provided a follow-up email on 2 July 2021 inviting comment. No response has been received.
DoD receives the Barossa Development Quarterly Consultation Update. The Q2 2021 Update was also distributed on 11 June 2021.</td></tr>
</table>

<table>
<tr><th>Relevant person</th><th colspan="2">Relevant persons consultation summary (OPGGS(E) Regulation 16 (b)(i))</th></tr>
<tr><td rowspan="3"></td><td colspan="2">Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.</td></tr>
<tr><th>Assessment of the merits of objections and claims (OPGGS(E) Regulation 16 (b)(ii))</th><th>Statement of response, or proposed response, to the objections and claims (OPGGS(E) Regulation 16 (b)(iii))</th></tr>
<tr><td>No assessment required</td><td>No response required.</td></tr>
<tr><td rowspan="2">Department of Agriculture, Water and the Environment – Biosecurity (marine pests)</td><td colspan="2">DAWE – Biosecurity was provided the Barossa Development Drilling and Completions Stakeholder Consultation package via email on 11 June 2021 inviting comment.
DAWE – Biosecurity responded on 30 June 2021, providing the following advice on the Australian Government’s vessel movement requirements:
+ The department will assess whether the project and the level of biosecurity risk is low, within the meaning of the Biosecurity (Exposed Conveyances – Exceptions from Biosecurity Control) Determination 2016; [CLAIM 001]
+ To have risk status assessed, offshore installation projects must apply to the department at least one month prior to the project’s commencement; [CLAIM 002]
+ Please review the department’s offshore installations webpage, Offshore Installations Biosecurity Guide, ballast water and biofouling requirements, pre-arrival reporting using MARS and airport biosecurity reporting requirements. [CLAIM 003]
DAWE – Biosecurity was provided a follow-up email on 2 July 2021 inviting any further comment.
Santos responded to DAWE – Biosecurity on 15 July 2021 and addressed each of the matters raised in their correspondence of 30 June 2021.
DAWE’s ongoing notification requirements will be part of the ongoing communications for this activity and are addressed in Table 8-4.
DAWE also receives the Barossa Development Quarterly Consultation Update. The Q2 2021 Update was also distributed on 11 June 2021.
Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.</td></tr>
<tr><th>Assessment of the merits of objections and claims (OPGGS(E) Regulation 16 (b)(ii))</th><th>Statement of response, or proposed response, to the objections and claims (OPGGS(E) Regulation 16 (b)(iii))</th></tr>
<tr><td></td><td>[CLAIM 001] [CLAIM 002] [CLAIM 003] On assessment of DAWE’s advice, Santos reviewed the biosecurity arrangements for this activity and inclusion of DAWE’s advice and requirements in this EP.</td><td>Santos responded to DAWE on 15 July 2021 confirming its requirements and advice will be addressed in the EP, including the application process that would be required for the DAWE biosecurity risk assessment.
Management of invasive marine pest species is addressed in Section 7.2 and notifications in Section 8.9.1.</td></tr>
</table>

<table>
<tr><th>Relevant person</th><th colspan="2">Relevant persons consultation summary (OPGGS(E) Regulation 16 (b)(i))</th></tr>
<tr><td rowspan="3">Department of Agriculture, Water and the Environment – Fisheries</td><td colspan="2">DAWE – Fisheries was provided the Barossa Development Drilling and Completions Stakeholder Consultation package via email on 11 June 2021 inviting comment.
DAWE – Fisheries was provided a follow-up email on 2 July 2021 inviting comment. No other response has been received.
DAWE – Fisheries also receives the Barossa Development Quarterly Consultation Update. The Q2 2021 Update was also distributed on 11 June 2021.
No response has been received. DAWE – Fisheries’ responsibilities in commercial fisheries management are filled by one of its agencies, the Australian Fisheries Management Authority, which is also consulted for this EP.
Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.</td></tr>
<tr><td>Assessment of the merits of objections and claims (OPGGS(E) Regulation 16 (b)(ii))</td><td>Statement of response, or proposed response, to the objections and claims (OPGGS(E) Regulation 16 (b)(iii))</td></tr>
<tr><td>No assessment required.</td><td>No response required.</td></tr>
<tr><td rowspan="3">Department of Foreign Affairs and Trade (DFAT)</td><td colspan="2">DFAT was provided the Barossa Development Drilling and Completions Stakeholder Consultation package via email on 11 June 2021 inviting comment.
DFAT was provided a follow-up email on 2 July 2021 inviting any further comment.
DFAT responded via email on 5 July 2021, acknowledging receipt of Santos’ emails and advising it would respond if it had any comment. No response has been received.
DFAT receives the Barossa Development Quarterly Consultation Update. The Q2 2021 Update was also distributed on 11 June 2021.
Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.</td></tr>
<tr><td>Assessment of the merits of objections and claims (OPGGS(E) Regulation 16 (b)(ii))</td><td>Statement of response, or proposed response, to the objections and claims (OPGGS(E) Regulation 16 (b)(iii))</td></tr>
<tr><td>No assessment required.</td><td>No response required.</td></tr>
<tr><td>Director of National Parks (DNP)</td><td colspan="2">DNP was provided the Barossa Development Drilling and Completions Stakeholder Consultation package via email on 11 June 2021 inviting comment.
DNP was provided a follow-up email on 2 July 2021 inviting comment.
DNP provided feedback via email on 2 July 2021 with the key points summarised as follows:
The planned activities do not overlap any Australian Marine Parks and are located around 50 km from the Oceanic Shoals Marine Park, therefore there are no authorisation requirements from the DNP. [CLAIM 001]</td></tr>
</table>

Relevant person	Relevant persons consultation summary (OPGGS(E) Regulation 16 (b)(i))
	NOPSEMA has worked closely with Parks Australia to develop and publish a guidance note (N-04750-GN1785 A620236) that outlines what titleholders need to consider and evaluate when preparing an EP, including consideration of Australian marine parks and their representativeness. In the context of the management plan objectives and values, the EP should identify and manage all impacts and risks on Australian marine park values (including ecosystem values) to an acceptable level and consider all options to avoid or reduce them to as low as reasonably practicable and clearly demonstrate that the activity will not be inconsistent with the management plan. **[CLAIM 002]** The North Marine Parks Network Management Plan 2018 (management plan) came into effect in 2018 and provides further information on values for the Oceanic Shoals Marine Park. Information on the values for the marine parks is also located on the Australian Marine Parks Science Atlas. **[CLAIM 003]** DNP does not require further notification of progress made in relation to this activity unless details regarding the activity change and result in an overlap with or new impact to a marine park, or for emergency responses. **[CLAIM 004]** The DNP should be made aware of oil/gas pollution incidences likely to impact on a marine park as soon as possible. Details of the notification process and required content was also provided. **[CLAIM 005]** Santos responded on 15 July 2021 and addressed each of the matters raised in their correspondence of 2 July 2021. DNP also receives the Barossa Development Quarterly Consultation Update. The Q2 2021 Update was also distributed on 11 June 2021. Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.

Assessment of the merits of objections and claims (OPGGS(E) Regulation 16 (b)(ii))	Statement of response, or proposed response, to the objections and claims (OPGGS(E) Regulation 16 (b)(iii))
[CLAIM 001] DNP's assessment confirms Santos' understanding that no DNP authorisations are required.	Santos responded to and advised the DNP on 15 July 2021 that the relevant sections of these documents had been reviewed and the expectations incorporated into relevant sections of the EP. Refer to **Section 3.2** and **Section 6.8**, while the DNP's notification requirements are incorporated into **Table 8-4.**
[CLAIM 002] [CLAIM 003] On assessment of the DNP's advice, Santos has ensured the cited documentation (North Marine Parks Network Management Plan 2018, guidance note and Australian Marine Parks Science Atlas) has been considered for this activity and referenced in the EP (refer **Section 6.8**).	
[CLAIM 004] [CLAIM 005] Santos confirms the EP will reflect DNP incident notification requirements (refer to **Table 8-4**).	

<table>
<tr><th>Relevant person</th><th colspan="2">Relevant persons consultation summary (OPGGS(E) Regulation 16 (b)(i))</th></tr>
<tr><td colspan="3">Northern Territory Government Departments</td></tr>
<tr><td rowspan="3">Department of Infrastructure, Planning and Logistics (DIPL)</td><td colspan="2">DIPL was provided the Barossa Development Drilling and Completions Stakeholder Consultation package via email on 11 June 2021 inviting comment.
DIPL was provided a follow-up email on 2 July 2021 inviting any further comment.
DIPL responded to Santos on 20 July 2021 requesting a briefing on the Barossa Project, including the Development Drilling and Completions EP.
Santos responded on 20 July advising it could provide a briefing on the date requested by DIPL.
Santos provided a briefing to DIPL on 29 July 2021 at which no specific issues or concerns were raised in relation to the Development Drilling & Completions EP or the proposed activities.
DIPL receives the Barossa Development Quarterly Consultation Update. The Q2 2021 Update was also distributed on 11 June 2021.
Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.</td></tr>
<tr><td>Assessment of the merits of objections and claims (OPGGS(E) Regulation 16 (b)(ii))</td><td>Statement of response, or proposed response, to the objections and claims (OPGGS(E) Regulation 16 (b)(iii))</td></tr>
<tr><td>No assessment required.</td><td>No response required</td></tr>
<tr><td>Department of Industry, Tourism and Trade (DITT) – Fisheries Division</td><td colspan="2">Santos contacted DITT – Fisheries via email on 21 May 2021 to offer a briefing on the Barossa Project, including the Barossa Development Drilling and Completions EP.
Santos provided a briefing to DITT – Fisheries on 2 June 2021. Discussion points on Barossa Development Drilling and Completions EP were as follows:
DITT – Fisheries asked about the extent/impacts from turbidity during drilling. [CLAIM 001]
In relation to exclusion zones around wells, DITT – Fisheries stated the future management framework for the combined Timor Reef Fishery and Demersal Fishery would mean no trawling would occur in the area of the Barossa Development, just trap and line. [CLAIM 002]
DITT – Fisheries stated while the Barossa field was in deeper water and little fishing occurred there, there was more fishing activity further south near the Caldita Field. [CLAIM 003]
DITT – Fisheries asked whether inclement weather impacted drilling activities. [CLAIM 004]
Santos advised that meetings were also being held with Austral Fisheries, NT Seafood Council, Northern Prawn Fishery and some licence holders and that DITT – Fisheries, fishing organisations and licence-holders would receive a quarterly update from now on and opportunity to meet on an ongoing basis to discuss planning and execution of on-water activities.
A meeting record was provided to DITT – Fisheries by Santos on 5 July 2021. Santos has addressed each of the matters raised. DITT’s CEO acknowledged receipt of the meeting record via email on 5 July 2021.</td></tr>
</table>

<table>
<tr><th>Relevant person</th><th colspan="2">Relevant persons consultation summary (OPGGS(E) Regulation 16 (b)(i))</th></tr>
<tr><td rowspan="4"></td><td colspan="2">DITT – Fisheries was provided the Barossa Development Drilling and Completions Stakeholder Consultation package and additional information for commercial fishers via email on 11 June 2021 inviting comment.
DITT – Fisheries was provided a follow-up email on 2 July 2021 inviting any further comment. No further response has been received.
DITT – Fisheries receives the Barossa Development Quarterly Consultation Update. The Q2 2021 Update was also distributed on 11 June 2021.
Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.</td></tr>
<tr><th>Assessment of the merits of objections and claims (OPGGS(E) Regulation 16 (b)(ii))</th><th>Statement of response, or proposed response, to the objections and claims (OPGGS(E) Regulation 16 (b)(iii))</th></tr>
<tr><td>[CLAIM 001] Santos responded at the meeting that it had not seen any significant impacts from any drilling activities in the past, plumes did not extend very far from the drill rig and dispersion is rapid in the open ocean.
[CLAIM 004] Santos stated at the meeting that drilling is suspended in certain weather conditions but the rig itself is built to withstand the conditions and remains on location</td><td rowspan="2">Santos responded to DITT – Fisheries’ queries at the meeting held on 2 July 2021 and in a written response on 5 July 2021, advising that the information provided by the department would be taken into consideration in the drafting of the EP.
All relevant fisheries are described in Section 3.2.6.1. Potential impacts and risks to fisheries and fishers (including traditional, recreational and commercial) have been assessed as environmentally acceptable and ALARP (primarily Sections 6.4.4, 6.5.4, 6.6.4, 6.7.4, 7.6.4 and 7.7.4).</td></tr>
<tr><td>[CLAIM 002][CLAIM 003] On Assessment of the Department’s advice, Santos determined that the information on fishing effort and process correlated with Santos’ understanding and previous information provided by the Department.</td></tr>
<tr><td>Department of Industry, Tourism and Trade (DITT) – Energy Division</td><td colspan="2">Santos contacted DITT – Energy via email on 21 May 2021 to offer a briefing on the Barossa Project, including the Barossa Development Drilling and Completions EP.
DITT – Energy met with Santos on 5 June and was provided a briefing. No specific issues or concerns were raised in respect to the Barossa Development Drilling and Completions EP.
DITT – Energy was provided the Barossa Development Drilling and Completions Stakeholder Consultation package via email on 11 June 2021 inviting comment.
DITT – Energy was provided a reminder email on 2 July 2021 inviting comment.
A meeting record was provided by Santos to DITT – Energy on 5 July 2021.
DITT’s CEO acknowledged receipt, via email on 5 July 2021, of Santos’ reminder email of 5 July 2021.
DITT – Energy receives the Barossa Development Quarterly Consultation Update. The Q2 2021 Update was also distributed on 11 June 2021.
Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.</td></tr>
</table>

Santos

Relevant person	Relevant persons consultation summary (OPGGS(E) Regulation 16 (b)(i))	
	Assessment of the merits of objections and claims (OPGGS(E) Regulation 16 (b)(ii))	**Statement of response, or proposed response, to the objections and claims (OPGGS(E) Regulation 16 (b)(iii))**
	No assessment required.	No response required.
Other stakeholders		
Australian Marine Oil Spill Centre	AMOSC was provided the Barossa Development Drilling and Completions Stakeholder Consultation package via email on 11 June 2021 inviting comment. AMOSC was provided a follow-up email on 2 July 2021 inviting any further comment. No response has been received. AMOSC receives the Barossa Development Quarterly Consultation Update. The Q2 2021 Update was also distributed on 11 June 2021. Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.	
	Assessment of the merits of objections and claims (OPGGS(E) Regulation 16 (b)(ii)), information and requests	**Statement of response, or proposed response, to the objections and claims (OPGGS(E) Regulation 16 (b)(iii)), and information and requests**
	No assessment required.	No response required.
Australian Marine Sciences Association – NT (AMSA-NT)	AMSA-NT was provided the Barossa Development Drilling and Completions Stakeholder Consultation package via email on 15 June 2021 inviting comment. AMSA-NT advised Santos via email on 30 June 2021 that two representatives had extensive experience in tropical marine environments and industry engagement and would appreciate Santos engaging with them as the Barossa project continues. They could provide impartial scientific comment on marine matters and looked forward to working with Santos as the Barossa project progresses. AMSA-NT was provided a follow-up email on 2 July 2021 inviting any further comment. Santos responded to AMSA-NT via email on 5 July 2021 and asked whether the representatives would be available to meet during the week of 12 to 16 July. One of the representatives responded via email on 9 July 2021 advising their availability during 14 to 16 July. However, meeting did not occur due to unavailability of AMSA-NT second representative. AMSA-NT provided a formal response on 9 July 2021, via letter and covering email, to Santos' email of 15 June 2021. AMSA's response is summarised as follows: Santos should lead a best practice approach to address potentially complex impacts and implement the sustainability principles incorporated into the EPBC Act (as per the Convention for Biological Diversity) and consider complexities of cumulative pressures, multiple stressors and various spatial and temporal scales in the EP. **[CLAIM 001]**	

Santos

Relevant person	Relevant persons consultation summary (OPGGS(E) Regulation 16 (b)(i))	
	The Proposed Consultation and 4-page Information Brochure does not provide sufficient information to provide appropriate technical input and make an 'informed assessment'. Santos should expand or supplement the 4-page Information Brochure with information upon which AMSA-NT can provide expert comment, including external context, thresholds of acceptable impact and risk, risk mitigation strategies, and implementation of control measures. **[CLAIM 002]** The following information should be made public: **[CLAIM 003]** – the draft Drilling EP or, if the draft is not yet prepared, then information, including any reports, analyses, assessments, modelling and/or other documents, in relation to the potential environmental impacts and risks of activities, including in relation to a worst case oil spill, greenhouse gas (GHG) emissions and cumulative impacts. – information, including any reports, assessments and/or other documents that assess the potential international and transboundary environmental and social-ecological impacts and risks of activities, including in relation to a worst case oil spill. – information, including any reports, analyses, assessments and/or other documents, that demonstrates that the environmental impacts and risks of the activities will be reduced to as low as reasonably practicable and be of an acceptable level. Santos responded to AMSA-NT on 15 July 2021 acknowledging the correspondence received on 9 July 2021 and advising it would make further contact after reviewing the information. Santos responded to AMSA-NT on 18 August 2021 and addressed each of the matters raised in their correspondence of 9 July 2021. AMSA-NT has been added to the distribution list for the Barossa Development Quarterly Consultation Update. Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.	
	Assessment of the merits of objections and claims (OPGGS(E) Regulation 16 (b)(ii)), information and requests	**Statement of response, or proposed response, to the objections and claims (OPGGS(E) Regulation 16 (b)(iii)), and information and requests**
	[CLAIM 001] Santos considered AMSA-NT's claim relating to strategic and cumulative impact assessment. The EP will be prepared in accordance with requirements of the OPGGS(E) Regulations.	Santos responded to AMSA-NT on 15 July 2021. Santos advised it will comply with Australian legislated requirements for environmental assessment. Santos included information relating to strategic and cumulative assessment in the Barossa Area Development Offshore Project Proposal (OPP), Section 6.5 (Cumulative Impacts) commencing on page 435.

Relevant person	Relevant persons consultation summary (OPGGS(E) Regulation 16 (b)(i))	
	[CLAIM 002] [CLAIM 003] Santos considered AMSA-NT's claim and provided supplementary information to that contained in the initial consultation package.	Santos provided AMSA-NT with supplementary information relevant to the Drilling and Completions EP and, wherever practicable, information already publicly available specifically in the NOPSEMA-accepted Barossa OPP. This included information on GHG emissions as relevant to the proposed drilling and completions activities. In relation to information requests on project GHG emissions, Santos will present in the Barossa Production Operations Environment Plan a greenhouse gas (Scopes 1 to 3) life cycle analysis associated with production operations. Relevant persons, including AMSA-NT, will be consulted during the development of this EP. Should AMSA-NT request information on GHG emissions associated with production operations during this consultation then Santos will provide sufficient information to allow AMSA-NT to make an informed assessment of the possible consequences of the activity on its functions, interests or activities. Since Santos' response to AMSA-NT, the Barossa Drilling and Completions EP containing all relevant environmental impact and risk information has been made available for public review (October 2021). AMSA-NT has access to this information and was advised that the EP would be made publicly available. Santos also advised AMSA-NT that consultation for this activity would be ongoing until activity completion. Santos considers that AMSA-NT has all relevant information and has been afforded sufficient time to raise any further objections or claims.

Australian National University (ANU) – individual	A Professor working at the Australian National University, also a representative of the Australian Marine Sciences Association NT, was provided the Barossa Development Drilling and Completions Stakeholder Consultation package on 15 June 2021 after requesting to be consulted. Santos also advised it was available to meet with the individual. AMSA-NT advised Santos via email on 30 June 2021 that two representatives, including this individual (from ANU), had extensive experience in tropical marine environments and industry engagement and would appreciate Santos engaging with them as the Barossa project continues. They could provide impartial scientific comment on marine matters and looked forward to working with Santos as the Barossa project progresses. Santos responded via email on 5 July 2021 and suggested a meeting date. The individual responded on 7 July and 15 July advising they would confirm a meeting date. However, the meeting did not occur due to unavailability of an AMSA-NT representative. The Professor, in their capacity at ANU, provided a formal response to Santos on 9 July 2021 via letter and covering email which presented information and technical advice to assist in the development of the EP, focusing on the importance and relevance of international and transboundary issues in the assessing and/or undertaking of development activities in the Arafura and Timor Seas region. Identified ANU claims are as follows: **[CLAIM 1]** There is an unresolved Australia-Indonesia maritime seabed boundary, and that the drilling activity and indeed, the entire Barossa Offshore Gas project would firmly sit within Indonesian territorial waters, if the current seabed boundary (negotiated in 1972) reflected the latest agreed understanding of maritime boundaries under UNCLOS. **[CLAIM 2]** The waters of the tropical Arafura and Timor Seas (ATS) are 'shared' by Indonesia, Timor-Leste, Papua New Guinea (PNG) and Australia. As such, they are legally defined as a 'semi-enclosed seas' under Article 122 of the 1982 United Nations Convention on the Law of the Sea (UNCLOS). Significantly, Article 123 of UNCLOS places a responsibility and an obligation on countries bordering 'enclosed' and 'semi-enclosed seas' to cooperate in resource management, the protection of the marine environment and marine scientific research. **[CLAIM 3]** Transboundary issues are highly relevant in the shared ATS 'semi-enclosed seas', particularly in relation to the Barossa Offshore Gas Project and the offshore oil/gas industry in the Timor Sea. This very high level of 'ecological connectivity' and vulnerability of the ATS 'semi-enclosed seas' and the following relevant 'transboundary' issues should be fully acknowledged and addressed in formal consultation processes, and relevant environmental assessments and EPs for the Barossa Offshore Gas Project: – a). Potential impacts on transboundary, straddling 'fish stocks' and commercial fisheries in the Timor Sea – particularly snapper fisheries. – b). Potential impacts on known migratory, rare, threatened, endangered, and protected marine species in the Timor Sea – particularly cetaceans, sea turtles and sharks/rays. – c). Potential impacts of maritime transport and marine pollution in the Timor Sea – particularly shipping impacts, oil/gas spills and acoustic noise. **[CLAIM 4**] In developing potential 'environmental offsets' for the Barossa Offshore Gas Project, NOPSEMA and the Proponent should also consider UNCLOS obligations and include activities with broader, transboundary environmental and socio-economic benefits. ATSEA23 is currently now being implemented (2019-2023) with US$10M of GEF/UNDP IW funding with a joint commitment to a 'regional response for improving management and governance of the Arafura and Timor Seas (ATS) ecosystems'. To this end, there remains significant opportunities for the

Relevant person	Relevant persons consultation summary (OPGGS(E) Regulation 16 (b)(i))	
	Proponent to help support the development of ATS-wide and 'transboundary' environmental activities... Significantly, the Barossa Offshore Gas Project (with its location, scale and transboundary nature of potential impacts) not only has the potential to protect the ATS's global ecological values (through risk reduction/minimization), but also, has significant opportunities (through environmental offsets) to potentially support and assist with the improved regional-level, ecosystem-based conservation and management of this globally-significant but vulnerable ecosystem. **[CLAIM 5]** The Proponent (and NOPSEMA) need to recognize the global significance of the 'semi-enclosed' Arafura and Timor Seas and also, it's high levels of 'ecological connectivity' and also, vulnerability to human impacts. In informing the development of Drilling EP (and other EPs) and assessing and considering the overall environmental risk and potential impact of the Barossa Offshore Gas Project, attention is drawn to the following global values and also, vulnerabilities of the region: – Global significance of the marine habitats and ecosystems of northern Australia. – Global stronghold for marine megafauna. – Major marine megafauna migration corridor. – The waters of the Timor Sea also include the eastern Indian Ocean migration corridor for the endangered Blue Whale *Balaenoptera musculus brevicauda* (Austral-Indonesian population). – The Barossa Offshore Gas Project is in close proximity to the Timor Trough, one of the three major outflow channels of the Indonesian Throughflow, and one of the most important 'marine megafauna migration corridors' in the Western Indo-Pacific. – Globally-significant fisheries within the ATS region, particularly in the Indonesian waters of the ATS. – Impacts on fisheries stock has major impacts on food security, poverty and human health in the ATS. Santos responded to the individual on 18 August 2021 and addressed the information provided in their correspondence of 9 July 2021. The individual has been added to the distribution list for the Barossa Development Quarterly Consultation Update. Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.	
	Assessment of the merits of objections and claims (OPGGS(E) Regulation 16 (b)(ii)), information and requests	**Statement of response, or proposed response, to the objections and claims (OPGGS(E) Regulation 16 (b)(iii)),**
	[CLAIM 1] Santos has reviewed the claim and has determined that there are well established and operational agreements/seabed treaties between the Australian and Indonesian governments. The seabed and its resources are governed by the continental shelf regime under international law. In 1971 and 1972, Australia and Indonesia agreed to maritime boundaries establishing the limits of their respective continental shelves. These seabed treaties have been ratified. Australia has jurisdiction over the seabed area relevant to the Barossa project.	Santos responded to ANU's claims on 18 August 2021 confirming the information would be taken into consideration in the drafting of the EP. Australia has current jurisdiction over the seabed area relevant to the drilling activity. Santos is proposing to conduct development drilling activities in accordance with its petroleum production licence, as granted and

Relevant person	Relevant persons consultation summary (OPGGS(E) Regulation 16 (b)(i))	
	The Barossa operational area is located within Australian Commonwealth petroleum production licence NT/L1, as offered in July 2020 by the Commonwealth-Northern Territory Offshore Petroleum Joint Authority in accordance with the Commonwealth *Offshore Petroleum and Greenhouse Gas Storage Act 2006*.	regulated by the Australian government. Santos will act on any Australian government advice on international boundary and/or petroleum licencing issues should they arise in the future.
	[CLAIM 2] Santos has reviewed the claim and understands that the Australian government is actively involved in the management of the ATS and supports the Arafura and Timor Seas Ecosystems Action (ATSEA) program. The Australian government has developed the Australian Marine Parks North Marine Parks Network Management Plan (2018) which includes the Arafura and Timor seas. The plan contemplates a range of Commonwealth as well as international conventions and agreements that relate to protection of the marine environment including UNCLOS. The proposed drilling activity is not within the northern marine parks network.	The Australia government is actively involved in the management of the ATS. Santos has consulted with relevant Australian government departments including DFAT, DAWE and DNP. No issue relating to the ATS has been raised. The North Marine Parks Network Management Plan 2018 (**Section 3.2.4**), which considers the ATS, has been considered in the development of this EP. Acceptable levels of impact and risks have been informed by relevant Australian government management plans, including the Australian Marine Parks North Marine Parks Network Management Plan (**Section 6.8, 7.5 and 7.6**).
	[CLAIM 3a] Santos has reviewed the claim and has assessed potential impacts on commercial fisheries in the Timor Sea including the snapper fisheries (Timor Reef and Demersal fisheries; refer to **Section 3.2.6.1** and **3.2.6.2**). Santos has consulted with relevant Australian government departments responsible for fisheries management being AFMA and NT Department of Industry, Tourism and Trade – Fisheries Division in the development of this plan. Potential impacts to fisheries and fishers (traditional, recreational, and commercial) from planned activities and unplanned events have been assessed).	Santos has engaged with relevant Australian government departments responsible for fisheries management, and no significant fisheries-related issues have been raised (**Table 4-2**). Potential impacts and risks to fisheries and fishers (including traditional, recreational and commercial) have been assessed as environmentally acceptable and ALARP (primarily **Sections 6.4.4**, **6.5.4**, **6.6.4**, **6.7.4**, **7.6.4** and **7.7.4**).
	[CLAIM 3b] Santos has reviewed the claim and has assessed potential impacts on known migratory, rare, threatened, endangered, and protected marine species in the Timor Sea – particularly cetaceans, sea turtles and sharks/rays. Acceptable levels of impact and risks to marine species have been informed by relevant Australian government species recovery plans, threat abatement plans, conservation advice and marine park management plans throughout **Sections 6**and **7**.	Santos has assessed potential impacts on known migratory, rare, threatened, endangered, and protected marine species in the Timor Sea – including cetaceans, sea turtles and sharks/rays (as described in **Section 3.2.5**). Potential impacts and risks to marine fauna have been assessed as environmentally acceptable and ALARP.

Relevant person	Relevant persons consultation summary (OPGGS(E) Regulation 16 (b)(i))	
	[CLAIM 3c] Santos has reviewed the claim and has assessed potential impacts of maritime transport and marine pollution in the Timor Sea – particularly shipping impacts, oil/gas spills and acoustic noise.	Santos has assessed potential impacts of maritime transport and marine pollution in the Timor Sea – including shipping impacts (**Sections 6.2, 6.3, 6.5, 6.6, 7.1, 7.2 and 7.3**), oil/gas spills (**Section 6.8, 7.5, 7.6, 7.7** and **7.8**) and acoustic noise (**Section 6.1**). Potential impacts and risks have been assessed as environmentally acceptable and ALARP.
	[CLAIM 4] Santos has reviewed the claim that there are significant opportunities through environmental offsets to potentially support and assist with the improved regional-level, ecosystem-based conservation and management of the globally-significant ATS. Through consultation with the Australian government, including DAWE and DNP, environmental offsets have not been raised. Using the method described in **Section 5.1**, Santos has conducted an environmental assessment for the proposed drilling activities and concluded that environmental impacts and risks are acceptable and ALARP. Through reasoned and supported arguments throughout **Sections 6** and **7**, Santos has demonstrated that there are no other practicable control measures that could reasonably be adopted to reduce impacts or risks further. As such, environmental offsets are not proposed for this petroleum activity.	Santos has assessed the claim and concluded that environmental impacts and risks will be managed to levels that are acceptable and ALARP without the requirement for environmental offsets. The Australian government has not identified the requirement for environmental offsets.
	[CLAIM 5] Santos has reviewed the claim and recognises the environmental significance of the 'semi-enclosed' Arafura and Timor Seas. Relevant environmental sensitives and values are described in Santos' *Barossa Development Values and Sensitivities of the Marine and Coastal Environment* document (**Appendix C**) and **Section 3** of this Environment Plan.	Santos has assessed the claim and recognises the environmental significance of the semi-enclosed Arafura and Timor Seas. The relevant values and sensitives of these seas have been considered in the environmental impact and risks assessment. In terms of the specific values listed by ANU: Marine habitats and ecosystems of northern Australia are described in **Section 3.2**. Marine megafauna are described in **Section 3.2.5**, including the Blue Whale *Balaenoptera musculus brevicauda.* Timor Trough is referenced in **Section 3.2** being a notable geophysical feature within international waters.

Santos

<table>
<tr><th>Relevant person</th><th colspan="2">Relevant persons consultation summary (OPGGS(E) Regulation 16 (b)(i))</th></tr>
<tr><td></td><td></td><td>Significant fisheries are described in Section 3.2.6.1(Commercial fisheries) and Section 3.2.6.2 (Indonesian commercial and subsistence fishing).</td></tr>
<tr><td rowspan="3">Darwin Port</td><td colspan="2">Darwin Port was provided the Barossa Development Drilling and Completions Stakeholder Consultation package via email on 11 June 2021 inviting comment.
Darwin Port was provided a follow-up email on 2 July 2021 inviting management. No response has been received.
Darwin Port receives the Barossa Development Quarterly Consultation Update. The Q2 2021 Update was distributed on 11 June 2021.
Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.</td></tr>
<tr><th>Assessment of the merits of objections and claims (OPGGS(E) Regulation 16 (b)(ii))</th><th>Statement of response, or proposed response, to the objections and claims (OPGGS(E) Regulation 16 (b)(iii))</th></tr>
<tr><td>No assessment required.</td><td>No response required.</td></tr>
<tr><td>Environment Centre – NT (ECNT)</td><td colspan="2">Following a letter from ECNT to Santos' CEO, Santos contacted ECNT via email on 21 May 2021 to offer a briefing on the Barossa Project.
ECNT responded via email on 31 May 2021 advising a key representative was away until 16 June 2021 and would a meeting be possible after this date. Santos responded via email on 31 May 2021 advising it would contact ECNT again after that date.
ECNT was provided the Barossa Development Drilling and Completions Stakeholder Consultation package via email on 11 June 2021 inviting comment.
Santos contacted ECNT via email on 18 June 2021 to organise a date for a briefing on the Barossa Project.
ECNT responded on 28 June 2021 via a letter prepared by the Environmental Defender's Office – NT. The issues raised are summarised as follows:
ECNT stated the reasons why it considered itself to be a 'relevant person' under the Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009 [CLAIM 001]
ECNT summarised the consultation requirements under cl.11A of the Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009 and ECNT's functions, interests and activities
The consultation activities, including the stated deadline, proposed in the information sent by Santos on 11 June fell short of the consultation that Santos is required to undertake with ECNT in relation to the activities under the Regulations, specifically it had not been provided 'sufficient information' [CLAIM 002] to allow it to make an informed decision or a 'reasonable period' for consultation [CLAIM 003]
ECNT requested [CLAIM 004] the draft Drilling EP or, if that is not yet prepared, information in relation to the activities the subject of the Drilling EP, including any reports, analyses, assessments, modelling and/or other documents, in relation to:</td></tr>
</table>

Santos

Relevant person	Relevant persons consultation summary (OPGGS(E) Regulation 16 (b)(i))
	– a description of the environment that may be affected by the activities, including in relation to a worst case oil spill – the potential extent and area of a worst case oil spill – the potential environmental impacts and risks of the activities, including in relation to a worst case oil spill, on any species listed under the *Environment Protection and Biodiversity Conservation Act 1999*), on the Oceanic Shoals Marine Park and any other significant marine ecosystem and on Tiwi Islands Sea Country and other areas of marine or terrestrial Aboriginal Cultural significance and/or heritage – the potential cumulative impacts of the above listed impacts or risks considered in the context of existing and proposed developments and/or activities in the vicinity of the area – range of detailed information related to greenhouse gas emissions and management of the associated impacts and risks. + ECNT also requested **[CLAIM 005]** information including any reports, analyses, assessments and/or other documents, that: – demonstrates that the environmental impacts and risks of the activities will be reduced to as low as reasonably practicable – demonstrates that the environmental impacts and risks of the activities will be of an acceptable level – details the environmental performance outcomes, standards and measurement criteria to be adopted in relation to the activities – details the implementation strategy and monitoring, recording and reporting arrangements in relation to the environmental impacts and risks of the activities. Santos responded to EDO-NT via email on 29 June 2021 acknowledging receipt of the letter provided on ECNT's behalf and advised it would respond as soon as possible. ECNT was provided a follow-up email on 2 July 2021 inviting any further comment. Santos provided acknowledgement of receipt to ECNT via email on 5 July 2021 and reiterated the offer to meet with representatives. ECNT responded via email on 8 July 2021 advising it would check and revert back to Santos regarding a meeting date. Santos responded to the EDO-NT on 19 July 2021 acknowledging their letter of 28 June 2021 on behalf of client ECNT and advising that Santos would provide its response to EDO-NT on or before 13 August 2021. Santos responded to ECNT on 13 August 2021 and addressed each of the matters raised in their correspondence of 28 June 2021. Santos also suggested a further time frame to meet with ECNT to discuss any further queries. ECNT responded on 19 August and a meeting was organised for 3 September 2021. At the 3 September 2021 meeting, Santos responded to a range of questions from ECNT on the topics of: + The project's status to date, in particular with regard to the Commonwealth Government's offshore regulatory process + The process around public availability of documentation, including EPs and associated compliance reports, Oil Pollution Emergency Plans and Well Operations Management Plans

Relevant person	Relevant persons consultation summary (OPGGS(E) Regulation 16 (b)(i))
	+ The time frames for submittal and assessment by NOPSEMA of an EP + Location of documentation of decommissioning activity + How worst-case oil spill scenarios are presented + The time frame and process involved in the drilling campaign. ECNT thanked Santos for the information provided to date and the opportunity to meet and advised it intended to provide further written correspondence to Santos by mid-September. ECNT provided further correspondence to Santos on 24 September, again via the Environmental Defender's Office – NT. A summary of the issues raised are as follows: + The information provided by Santos on 13 August 2021, addressing the matters raised in ECNT's correspondence of 28 June 2021, again falls short of the consultation that Santos is required to undertake with ECNT in relation to the activities under cl.11A of the Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations, specifically it does not provide 'sufficient information' to allow ECNT to make an informed decision or a 'reasonable period' for consultation. **[CLAIM 006]** + In the absence of the provision of comprehensive information in response to ECNT's questions, a copy of any draft EP is required in order to make an informed assessment of the possible consequences of the activity. **[CLAIM 007]** Further detail is specifically required about general matters, including: – information about the Oceanic Shoals Marine Park as part of the activity EMBA – controls proposed to manage environmental impacts of the drilling activity – risk assessments related to hydrocarbon spills from the pipeline infrastructure – potential environmental impacts and risks not directly within the permit area – risks and impacts on the activities of every species listed under the EPBC Act – potential cumulative impacts in the context of the development, including from, oil spills – clarification of the nature and availability of any peer-reviewed or independent assessments used to prepare the EP – the implementation strategy and its various elements, Santos Management System and Environment, Health and Safety Policy and how they relate to the environmental impacts and risks of the activities – proposed environmental performance outcomes, control measures performance standards and measurement criteria. + In relation to GHG emissions, ECNT requested information on: – total estimated GHG (Scopes 1, 2 and 3) for the Barossa project, including information on how atmospheric emissions have been assessed **[CLAIM 008]**

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<tr><th>Relevant person</th><th colspan="2">Relevant persons consultation summary (OPGGS(E) Regulation 16 (b)(i))</th></tr>
<tr><td rowspan="3"></td><td colspan="2">– information on the amount of emissions from flaring / venting [CLAIM 009]
– IEA warming scenarios the project is consistent with [CLAIM 010]
– physical risks to the project itself from climate change [CLAIM 011]
– the effect of global GHG concentrations at the time of the project’s completion [CLAIM 012]
– proposed GHG emission control measures, claiming that those outlined by Santos in previous correspondence are wholly inadequate [CLAIM 013]
+ ECNT requires confirmation that Santos will undertake its assessment of activities as part of the Drilling EP in good faith and in accordance with the objects of the legislation and regulations, acknowledging that the information in the OPP may have developed since the date of that document. [CLAIM 014]
Santos responded to ECNT on 06 October 2021 and addressed each of the matters raised in their correspondence of 24 September 2021.
On 9 December 2021, Santos wrote to ECNT advising that the Development Drilling and Completions EP had been made publicly available on the NOPSEMA website on 15 October 2021. Santos further stated that it welcomed ECNT’s participation in the formal consultation process and would respond to reasonable information requests as per the OPGGS(E) Regulations. Santos stated its understanding that ECNT’s public position on the Barossa Project continues to demonstrably be one of fundamental objection. In the case of each specific EP, Santos will continue to ensure all its obligations to stakeholder consultation with relevant persons on the activities covered by each EP are satisfied. In the case of the Development Drilling and Completions EP, Santos believes it has met these obligations and the ECNT has sufficient information to make an informed assessment of the possible consequences of the proposed Development Drilling and Completions on their interests, functions and activities.
As at 10 March 2022, Santos has not received any further correspondence from the ECNT on the 09 December 2021 letter or this EP.
Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.</td></tr>
<tr><th>Assessment of the merits of objections and claims (OPGGS(E) Regulation 16 (b)(ii))</th><th>Statement of response, or proposed response, to the objections and claims (OPGGS(E) Regulation 16 (b)(iii)</th></tr>
<tr><td>[CLAIM 001] Santos acknowledges that ECNT is a relevant person for this activity. Santos is aware of its obligations under the Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009 and will continue to engage with the ECNT in accordance with the Regulations.</td><td>Santos has acknowledged ECNT as a relevant person in the letter dated 09 December, and as listed in Table 4-1. Santos will continue to engage with the ECNT as a relevant person in accordance with the OPGGS(E) Regulations.</td></tr>
</table>

Relevant person	Relevant persons consultation summary (OPGGS(E) Regulation 16 (b)(i))	
	[CLAIM 002] Santos acknowledges ECNT's claim and provided additional written information.	Santos responded to ECNT on 13 August 2021 and provided supplementary information relevant to the Drilling and Completions EP and, wherever practicable, information already publicly available specifically in the NOPSEMA-accepted Barossa OPP. Since Santos' response to ECNT, the Barossa Drilling and Completions EP containing all relevant environmental impact and risk information has been made available for public review (October 2021). ECNT has access to this information and was advised that the EP would be made publicly available. Santos also advised ECNT that consultation for this activity would be ongoing until activity completion. Santos considers that ECNT has all relevant information and has been afforded sufficient time to raise any further objections or claims.
	[CLAIM 003] ECNT was afforded four weeks to review and comment on the initial consultation package. This initial consultation time frame is consistent with other Santos and industry environment plans. Santos acknowledges ECNT's request for additional time to review and comment on consultation material. As such, Santos will continue to assess and respond to objections and claims raised by the ECNT at any time during the development or implementation of this EP. This commitment is reflected in **Section 4.5.2**.	Santos responded to ECNT on 13 August 2021 and provided supplementary information to that contained in the initial consultation package. Since this time, Santos has met with ECNT on 03 September 2021 and provided a response on 06 October 2021 to further objections and claims. The Barossa Drilling and Completions EP containing all relevant environmental impact and risk information has been public available since October 2021. ECNT has access to this information and was advised that the EP would be made publicly available. Santos also advised ECNT that consultation for this activity would be ongoing until activity completion. Santos considers that ECNT has all relevant information and has been afforded sufficient time to raise any further objections or claims.
	[CLAIM 004] [CLAIM 005] Santos acknowledges ECNT's claims and provided additional information, as relevant to the Barossa Drilling and Completions EP.	Santos responded to ECNT on 13 August 2021 and provided supplementary information to that contained

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Relevant person	Relevant persons consultation summary (OPGGS(E) Regulation 16 (b)(i))	
		in the initial consultation package, including (but not limited to): + A description of the environment that may be affected by the proposed activities including detailed maps illustrating the EMBA; + Information on protected marine fauna, marine parks and areas of aboriginal significance; + Information on potential environmental impacts and risks; + Information on GHG emissions, impacts and risks and control measures as relevant to the proposed drilling and completions activities; + Details on proposed environmental performance outcomes and standards, control measures and measurement criteria; and + Details on the proposed implementation strategy. The Barossa Drilling and Completions EP containing all relevant environmental impact and risk information has been public available since October 2021. ECNT has access to this information and was advised that the EP would be made publicly available. Santos also advised ECNT that consultation for this activity would be ongoing until activity completion. Santos considers that ECNT has all relevant information and has been afforded sufficient time to raise any further objections or claims.
	[CLAIM 006] [CLAIM 007] Santos acknowledges ECNT's claim and provided additional information, as relevant to the Barossa Drilling and Completions EP.	Santos responded to ECNT on 06 October 2021 providing further supplementary information, including (but not limited to): + Environmental sensitivities associated with the Oceanic Shoals Marine Park and the Arafura

Relevant person	Relevant persons consultation summary (OPGGS(E) Regulation 16 (b)(i))	
		KEF, and Santos' assessment of the environmental risks associated with drilling and completions activities; + Draft **Section 8** (Implementation Strategy) of the EP containing proposed control measures and associated environmental performance standards; + Information relating to the identified environmental values and sensitivities within the EMBA, and Santos' assessment of environmental risks associated with a worst case oil spill; + Information on potential environmental impacts and risks outside the drilling permit area (including IMS, unplanned discharges and marine fauna interactions); and + Information on decommissioning. The Barossa Drilling and Completions EP containing all relevant environmental impact and risk information has been public available since October 2021. ECNT has access to this information and was advised that the EP would be made publicly available. Santos also advised ECNT that consultation for this activity would be ongoing until activity completion. Santos considers that ECNT has all relevant information and has been afforded sufficient time to raise any further objections or claims.

	[CLAIM 008] Santos acknowledges ECNT's claim and provided GHG emissions information relevant to the Barossa Drilling and Completions EP. GHG emissions associated with the whole-of-project are presented in the Barossa Development Area OPP, which is publicly available and known to the ECNT. Additional information on GHG emissions will be made available to relevant persons during the development of future Barossa activity-specific environment plans, including emissions associated with production operations.	Santos responded to ECNT on 06 October 2021 reiterating the position that the Drilling and Completions EP would only assess consequences pertaining to the proposed drilling and completions activities (i.e. not whole-of-project). Santos advised that the total Scope 1 GHG emissions (assuming an eight-well campaign, with two of these wells being contingency) is estimated to be 166,000 tonnes CO_2-e. Further, that there are no Scope 2 or 3 emissions for the activities covered by the Drilling and Completions EP. Santos advised that Scope 1 emissions had been calculated using the Clean Energy Regulator's Method 1, detailed in the National Greenhouse and Energy Reporting (Measurement) Determination 2008 and utilising the calculation tools provided through their website. In relation to information requests on project GHG emissions, Santos will present in the future Barossa Production Operations Environment Plan a greenhouse gas (Scopes 1 to 3) life cycle analysis associated with production operations. Relevant persons, including ECNT, will be consulted during the development of this EP. Should ECNT request information on GHG emissions associated with production operations during this consultation then Santos will provide sufficient information to allow ECNT to make an informed assessment of the possible consequences of the activity on its functions, interests or activities.

Relevant person	Relevant persons consultation summary (OPGGS(E) Regulation 16 (b)(i))	
	[CLAIM 009] Santos acknowledges ECNT's claim and provided an explanation of flaring associated with drilling and completions activities.	Santos responded to ECNT on 06 October 2021 explaining that once completed, each Barossa well will be flowed back to the MODU to remove drilling fluids and impurities/debris from the wellbore. Further, that the well will be flowed until pre-defined clean-up criteria have been met and the necessary production data and samples have been collected, which will take approximately 24 to 36 hours pending well and surface process conditions. Flammable hydrocarbons will be flared (not vented) via an air-atomized burner. Well flowback is standard industry practice and flaring is a safety critical operation. The amount of GHG emissions from flaring is included in the above Scope 1 estimate (refer to CLAIM 008). In response to ECNT questions on information contained within the OPP, the OPP reference to "non-routine flaring" relates to the FPSO facility and associated process upsets or emergency shut-in of production. The consultation for the Drilling and Completions EP addresses the possible consequences of drilling and completions activities where flaring will only occur intermittingly during well flowback operations.
	[CLAIM 010] Santos acknowledges ECNT's claim and provided an explanation of Santos' position on IEA global warming scenarios.	Santos responded to ECNT on 06 October 2021 explaining that it does not consider the IEA scenarios to be relevant at an individual drilling campaign level. Santos stated that it considers such scenarios at a company strategy level as disclosed in its publicly available annual Climate Change Report.

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Relevant person	Relevant persons consultation summary (OPGGS(E) Regulation 16 (b)(i))	
	[CLAIM 011] Santos acknowledges ECNT's claim and provided an assessment of the physical risk to the drilling and completions activities from climate change. Climate change risk for the project will be further evaluated in the future Barossa Production Operations EP.	Santos responded to ECNT on 06 October 2021 stating that it undertakes climate change risk assessments across all its operations. Santos provided a risk assessment for the drilling and completions activities, indicating that the risk for a short term activity is considered 'very low'.
	[CLAIM 012] Santos acknowledges ECNT's claim and responded to information about the likely effect of the global concentration of greenhouse gases at the completion of the drilling and completions activities. While ECNT requested that Santos consider this effect at project completion (i.e. end of production) such consideration is not warranted for a short-term activity-specific EP.	Santos responded to ECNT on 06 October explaining that consultation for the Drilling and Completions EP only considers the possible consequences of drilling and completions activities. Further, that the estimated 166,000 tonnes $C0_2$-e emissions caused by the drilling and completions activities will be a negligible contributor (<0.0004%) to global annual greenhouse gas levels. In relation to information requests on project GHG emissions, Santos will present in the future Barossa Production Operations Environment Plan a greenhouse gas (Scopes 1 to 3) life cycle analysis associated with production operations. Relevant persons, including ECNT, will be consulted during the development of this EP. Should ECNT request information on GHG emissions associated with production operations during this consultation then Santos will provide sufficient information to allow ECNT to make an informed assessment of the possible consequences of the activity on its functions, interests or activities.

Relevant person	Relevant persons consultation summary (OPGGS(E) Regulation 16 (b)(i))	
	[CLAIM 013] Santos acknowledges ECNT's claim and provided additional information relevant to GHG emission control measures for the Drilling and Completions EP.	Santos responded to ECNT on 06 October 2021 with the following information on GHG emissions: Santos has industry-leading emissions reduction targets for the emissions from Santos' activities, including a net-zero Scope 1 and 2 2040 target. Santos is focused on the responsible and safe conduct of all of its operations, including those relating to the Drilling and Completions EP. Santos is an experienced operator, having undertaken drilling activities in Australia for over 50 years within the detailed regulatory frameworks governing all of our activities. All impacts of activities are considered as required by these regulatory frameworks and Santos undertakes appropriate preventative and mitigation measures to address impacts of activities in accordance with legal and regulatory requirements. The consultation for the Drilling and Completions EP addresses the possible consequences of the drilling and completions activities. Scope 1 emissions are largely associated with hydrocarbon combustion for MODU and vessel operations, and flaring of reservoir hydrocarbons during well flowback operations. Santos has considered alternative fuel types (power sources) for the MODU and vessels. Reasonably practical and reliable alternatives have not been identified for the proposed activity. Flaring during well flowback operations is considered a safety critical activity and no reasonably practicable alternatives have been identified. Santos' Climate Change Policy references Santos' commitment to identify and pursue opportunities to

Relevant person	Relevant persons consultation summary (OPGGS(E) Regulation 16 (b)(i))	
		reduce greenhouse gas emissions within Santos' operations and also where relevant, offset emissions in pursuit of Santos' emission reduction targets. Santos will apply various levers to abate emissions across our portfolio and examples of these are included in our annual Climate Change Report. The activities to which this consultation relates are specific to the Drilling and Completions EP. At the current time, carbon offsets are not proposed to be used in relation to these specific activities.
	[CLAIM 014] On assessment, Santos considers that all required regulatory requirements have been acknowledged and will be met.	Santos confirms that the Drilling and Completions EP will be prepared in accordance with relevant regulatory requirements.
Northern Land Council (NLC)	NLC was provided the Barossa Development Drilling and Completions Stakeholder Consultation package via email on 11 June 2021 inviting comment. NLC was provided a follow-up email on 2 July 2021 inviting comment. No response has been received. NLC receives the Barossa Development Quarterly Consultation Update. The Q2 2021 Update was distributed on 11 June 2021. Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.	
	Assessment of the merits of objections and claims (OPGGS(E) Regulation 16 (b)(ii))	**Statement of response, or proposed response, to the objections and claims (OPGGS(E) Regulation 16 (b)(iii))**
	No assessment required.	No response required.
NT Port and Marine	NT Port and Marine was provided the Barossa Development Drilling and Completions Stakeholder Consultation package via email on 11 June 2021 inviting comment. NT Port and Marine responded on 11 June 2021 acknowledging receipt of Santos' email and advising to email another person who was already included on Santos' stakeholder contacts list to receive all emails. NT Port and Marine was provided a follow-up email on 2 July 2021 inviting comment. No response has been received. NT Port and Marine also receives the Barossa Development Quarterly Consultation Update. The Q2 2021 Update was distributed on 11 June 2021. Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.	

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Relevant person	Relevant persons consultation summary (OPGGS(E) Regulation 16 (b)(i))	
	Assessment of the merits of objections and claims (OPGGS(E) Regulation 16 (b)(ii))	**Statement of response, or proposed response, to the objections and claims (OPGGS(E) Regulation 16 (b)(iii))**
	No assessment required.	No response required.
Sea Turtle Foundation (STF)	STF was provided the Barossa Development Drilling and Completions Stakeholder Consultation package via email on 11 June 2021 inviting comment. STF responded on 11 June 2021 acknowledging receipt of Santos' email. STF was provided a follow-up email on 2 July 2021 inviting any further comment. No response has been received. STF receives the Barossa Development Quarterly Consultation Update. The Q2 2021 Update was distributed on 11 June 2021. Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.	
	Assessment of the merits of objections and claims (OPGGS(E) Regulation 16 (b)(ii))	**Statement of response, or proposed response, to the objections and claims (OPGGS(E) Regulation 16 (b)(iii))**
	No assessment required.	No response required.
Tiwi Land Council (TLC)	Santos contacted TLC via email on 11 June 2021 to offer a briefing on the Barossa Project, including Barossa Development Drilling and Completions EP. TLC was provided the Barossa Development Drilling and Completions Stakeholder Consultation package via email on 11 June 2021 inviting comment. TLC was provided a follow-up email on 2 July 2021 inviting comment. Further contact attempts were made via phone. No response raising issues or concerns has been received to date. TLC receives the Barossa Development Quarterly Consultation Update. The Q2 2021 Update was distributed on 11 June 2021. Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.	
	Assessment of the merits of objections and claims (OPGGS(E) Regulation 16 (b)(ii))	**Statement of response, or proposed response, to the objections and claims (OPGGS(E) Regulation 16 (b)(iii))**
	No assessment required.	No response required.
Other operators		
Woodside	Woodside was provided the Barossa Development Drilling and Completions Stakeholder Consultation package via email on 11 June 2021 inviting comment.	

Relevant person	Relevant persons consultation summary (OPGGS(E) Regulation 16 (b)(i))	
	Woodside was provided a follow-up email on 2 July 2021 inviting any further comment. No response has been received. Woodside receives the Barossa Development Quarterly Consultation Update. The Q2 2021 Update was distributed on 11 June 2021. Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.	
	Assessment of the merits of objections and claims (OPGGS(E) Regulation 16 (b)(ii))	**Statement of response, or proposed response, to the objections and claims (OPGGS(E) Regulation 16 (b)(iii))**
	No assessment required.	No response required.
Eni Australia	Eni was provided the Barossa Development Drilling and Completions Stakeholder Consultation package via email on 11 June 2021 inviting comment. Eni was provided a follow-up email on 2 July 2021 inviting any further comment. No response has been received. Eni receives the Barossa Development Quarterly Consultation Update. The Q2 2021 Update was also distributed on 11 June 2021. Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.	
	Assessment of the merits of objections and claims (OPGGS(E) Regulation 16 (b)(ii))	**Statement of response, or proposed response, to the objections and claims (OPGGS(E) Regulation 16 (b)(iii))**
	No assessment required.	No response required.
INPEX	INPEX was provided the Barossa Development Drilling and Completions Stakeholder Consultation package via email on 11 June 2021 inviting comment. INPEX was provided a follow-up email on 2 July 2021 inviting any further comment. No response has been received. INPEX receives the Barossa Development Quarterly Consultation Update. The Q2 2021 Update was distributed on 11 June 2021. Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.	
	Assessment of the merits of objections and claims (OPGGS(E) Regulation 16 (b)(ii))	**Statement of response, or proposed response, to the objections and claims (OPGGS(E) Regulation 16 (b)(iii))**
	No assessment required.	No response required.
Fishing bodies		
Western Australian Fishing Industry Council (WAFIC)	WAFIC was included in the consultation for this EP as some of its members are also licence-holders in Commonwealth and/or NT fisheries relevant to this activity. The dual licence-holders are also identified through the lists provided by AFMA and the NT DITT-Fisheries. Consultation with these licence-holders is conducted directly and through the NT Seafood Council and the Northern Prawn Fishery.	

<table>
<tr><th>Relevant person</th><th colspan="2">Relevant persons consultation summary (OPGGS(E) Regulation 16 (b)(i))</th></tr>
<tr><td rowspan="3"></td><td colspan="2">WAFIC was provided the Barossa Development Drilling and Completions Stakeholder Consultation package including additional information for commercial fishers via email on 11 June 2021 inviting comment.
WAFIC was provided a follow-up email on 2 July 2021 inviting comment.
WAFIC responded via email on 5 July 2021 advising that given the proposed activities are in the NT jurisdiction, WAFIC will not be providing any comments.
Santos emailed WAFIC on 6 July 2021 acknowledging its response of 5 July 2021.
WAFIC receives the Barossa Development Quarterly Consultation Update. The Q2 2021 Update was distributed on 11 June 2021.
Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.</td></tr>
<tr><th>Assessment of the merits of objections and claims (OPGGS(E) Regulation 16 (b)(ii))</th><th>Statement of response, or proposed response, to the objections and claims (OPGGS(E) Regulation 16 (b)(iii))</th></tr>
<tr><td>No assessment required.</td><td>No response required.</td></tr>
<tr><td>Northern Territory Seafood Council (NTSC)</td><td colspan="2">Santos contacted NTSC via email on 21 May 2021 to offer a briefing on the Barossa Project, including Barossa Development Drilling and Completions EP.
Santos met with an NTSC representative on 1 June 2021. Discussion points on Barossa Development Drilling and Completions EP were as follows:
NTSC advised that it did not think trawling would be allowed in the proposed drilling area under future management changes for the Timor Reef and Demersal fisheries but asked Santos to confirm with DITT-Fisheries. [CLAIM 001]
NTSC reiterated the need for Santos to also send information to the relevant licence holders via post and to ensure key stakeholders in the Timor Reef Fishery, the most relevant to the drilling activities, were consulted. [CLAIM 002]
Santos advised the information to be sent to commercial fishers would address the issue of exclusion zones and confirm these would be the standard around the active drilling location
NTSC was provided the Barossa Development Drilling and Completions Stakeholder Consultation package including additional information for commercial fishers via email on 11 June 2021 inviting comment.
NTSC advised that the request for feedback would be included in an NTSC business update to licence-holders with email addresses.
NTSC licence-holders in the relevant fisheries were also provided the consultation package via email on 11 June 2021 and via post on 14 June 2021, as requested by NTSC.
NTSC was provided a reminder email on 2 July 2021 inviting comment.
NTSC receives the Barossa Development Quarterly Consultation Update. The Q2 2021 Update was distributed on 11 June 2021.
All fisheries are described in Section 3.2.6.1, and potential impact to fisheries, fish habitat and commercial fishers are discussed in Section 6.</td></tr>
</table>

Relevant person	Relevant persons consultation summary (OPGGS(E) Regulation 16 (b)(i))	
	Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.	
	Assessment of the merits of objections and claims (OPGGS(E) Regulation 16 (b)(ii))	**Statement of response, or proposed response, to the objections and claims (OPGGS(E) Regulation 16 (b)(iii))**
	[CLAIM 001] Santos met with DITT – Fisheries which confirmed the NTSC's understanding that trawling would not be allowed under the future management changes for the Timor Reef and Demersal fisheries. This non-trawling area includes the proposed Barossa drilling locations.	Based on feedback from both the NTSC and DITT, it is Santos' understanding that trawling maynot be a permitted future activity in the drilling operational area. Santos will continue to engage with relevant commercial fishing licence holders, as evidenced in **Table 4-2**, to minimise impacts and risks to both parties.
	[CLAIM 002] In response Santos checked licence-holder lists provided by DITT-Fisheries to ensure that all appropriate licence-holders were being directly consulted in addition to via the NTSC.	Santos has responded that consultation with relevant commercial fishers, including licence holders, has occurred as evidenced in **Table 4-2** and the **Sensitive Stakeholder Consultation Report.**
Northern Prawn Fishing Industry Pty Ltd (NPFI)	Santos contacted NPFI via email on 21 May 2021 to offer a briefing on the Barossa Project, including the Development Drilling and Completions EP. NPFI accepted the invitation via email response to Santos on 26 May 2021. Santos met with representatives of NPFI and NPF licence-holder Austral Fisheries on 3 June 2021. Discussion points on Barossa Development Drilling and Completions EP were as follows: Santos was asked to what depth the production wells would be drilled and advised approximately 3,000 to 4,000 metres. NPFI confirmed that some scampi fishers (less than five boats) operated on occasions in the deep waters north of the operational area and south of the edge of Australia's EEZ. **[CLAIM 001]** NPFI would check the data to determine exactly where and the level of effort. Santos advised that it had had spoken to one of the scampi fishers who was also checking whether there would be any overlap with his activities. NPFI advised it would provide Santos with written comment on the activities discussed at the meeting. NPFI was provided the Barossa Development Drilling and Completions Stakeholder Consultation package including additional information for commercial NPF fishers via email on 11 June 2021 inviting comment. NPF has previously advised that it prefers to provide the information to its licence-holders. NPFI was provided a follow-up email on 2 July 2021 inviting any further comment as well as a separate email with the record of the meeting held on 3 June 2021.	

Relevant person	Relevant persons consultation summary (OPGGS(E) Regulation 16 (b)(i))	
	NPFI provided a response via email to Santos on 20 July 2021. A summary of the comments is as follows: Due to confidentiality restrictions NPFI is unable to share the fishery catch and effort data but can confirm that scampi fishing does occur in the area of the proposed Barossa development drilling activity. **[CLAIM 001]** December and January are the peak NPF scampi fishing periods. NPFI notes that the survey of the pipeline route is scheduled to occur between October and November 2021. NPFI strongly recommends that this activity is completed before the commencement of the Scampi season on 1 December 2021. **[CLAIM 002]** NPFI has investigated fishing activity and interactions with Threatened, Endangered and Protected (TEP) species in the area of the Barossa Development Drilling project. Our records indicate that the proposed activity will also occur in areas inhabited by endangered sawfish. There are four species of sawfish in Australia, all inhabit the inshore and offshore waters of the NPF including the area of this proposal and when they do so depends on their life stage (i.e., pups inhabit riverine habitat and move offshore as juveniles/sub-adults). **[CLAIM 003]** NPFI is concerned that due consideration has not been given to the potential immediate and long-term impacts on sawfish, particularly given that NPFI invests considerable time and resources to better understand sawfish populations, mitigate interactions with the species and protect important sawfish habitat. **[CLAIM 004]** NPFI requests that the impacts of both the pipeline survey and production drilling on both the NPF Scampi fishery and endangered sawfish are specifically addressed in the development EP. **[CLAIM 005]** Santos responded to NPFI on 18 August 2021 and addressed each of the matters raised in their correspondence of 20 July 2021. NPFI receives the Barossa Development Quarterly Consultation Update. The Q2 2021 Update was distributed on 11 June 2021. Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.	
	Assessment of the merits of objections and claims (OPGGS(E) Regulation 16 (b)(ii))	**Statement of response, or proposed response, to the objections and claims (OPGGS(E) Regulation 16 (b)(iii))**
	[CLAIM 001] Santos acknowledges that scampi fishing occurs in the 'area of the proposed Barossa drilling activity'. Through consultation with scampi fishers, it is Santos' understanding that fishers primarily target deeper water closer to the Australian EEZ boundary which is at the northern extremity of the petroleum production licence (NT/L1). Drilling will be undertaken at three locations in the southern end of the petroleum production licence at water depths between 230 and 280 metres. Santos understands that there is a low level of fishing effort spread across two-to-three months of the year (December to February).	Santos responded to NPFI on 18 August 2021. Scampi fishers whose activities could be affected by the proposed drilling activities have been asked to engage with Santos directly or through the NPFI. Santos' understanding of the scampi fishery and fishing effort is described in **Section 3.2.6.1**.

Relevant person	Relevant persons consultation summary (OPGGS(E) Regulation 16 (b)(i))	
	[CLAIM 002] Santos' assessment of the claim is that while valid it does not relate to the development drilling activity covered by this EP. The pipeline route survey is covered under the ongoing communications and notifications requirements in the NOPSEMA-accepted Barossa Gas Export Pipeline Installation EP.	Santos responded to the NPFI with information on the planned pipeline survey activity and time frame, and the required advance notification process. The pipeline survey was completed before 1 December as requested.
	[CLAIM 003], [CLAIM 004] [CLAIM 005] Potential impacts to the endangered sawfish were specifically addressed in the Barossa Development Area OPP and the Gas Export Pipeline Installation EP as accepted by NOPSEMA in March 2018 and 2020 respectively. During the consultation phase for the Barossa GEP Installation EP specific information on sawfish was provided to the NPFI. Santos has addressed potential impacts to the scampi fishery and endangered sawfish in the Development Drilling and Completions EP.	All relevant fisheries are described in **Section 3.2.6.1**. Potential impacts and risks to fisheries and fishers,including scampi fisheries and fishers, have been assessed as environmentally acceptable and ALARP (primarily **Sections 6.4.4**, **6.5.4, 6.6.4, 6.7.4, 7.6.4** and **7.7.4**). Potential impacts to the endangered sawfish have been specifically addressed in the Barossa Development Area OPP and the Gas Export Pipeline Installation EP as accepted by NOPSEMA in March 2018 and 2020 respectively. Additional information and impact assessment on endangered sawfish is provided in this EP including in **Table 3-7**, **Table 3-9**, **Sections 6.4** and **6.7**.
Commonwealth Fisheries Association	CFA was provided the Barossa Development Drilling and Completions Stakeholder Consultation package via email on 11 June 2021 inviting comment. CFA was provided a follow-up email on 2 July 2021 inviting any further comment. No response has been received. CFA receives the Barossa Development Quarterly Consultation Update. The Q2 2021 Update was distributed on 11 June 2021. Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.	
	Assessment of the merits of objections and claims (OPGGS(E) Regulation 16 (b)(ii))	**Statement of response, or proposed response, to the objections and claims (OPGGS(E) Regulation 16 (b)(iii))**
	No assessment required.	No response required.

<table>
<tr><th>Relevant person</th><th colspan="2">Relevant persons consultation summary (OPGGS(E) Regulation 16 (b)(i))</th></tr>
<tr><td rowspan="3">Pearl Producers Association (PPA)</td><td colspan="2">Neither the NTSC or WAFIC advised that pearl oyster fisheries were relevant for this activity. This correlated with Santos’ understanding.
Nonetheless, the PPA was provided the Barossa Development Drilling and Completions Stakeholder Consultation package and Barossa Development Drilling and Completions Additional Information for Commercial Fishers package on 11 June 2021.
PPA provided alternative contact details via email on 11 June 2021. These were used by Santos for communications from that date on. The above information was re-sent to these contacts on 11 June 2021.
Santos sent a follow-up email on 2 July 2021 inviting comment. No response has been received.
PPA receives the Barossa Development Quarterly Consultation Update. The Q2 2021 Update was distributed on 11 June 2021.
Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.</td></tr>
<tr><th>Assessment of the merits of objections and claims (OPGGS(E) Regulation 16 (b)(ii))</th><th>Statement of response, or proposed response, to the objections and claims (OPGGS(E) Regulation 16 (b)(iii))</th></tr>
<tr><td>No assessment required.</td><td>No response required.</td></tr>
<tr><td rowspan="3">Australian Southern Bluefin Tuna Industry Association</td><td colspan="2">ASBTIA has previously advised that no fishing activity occurs in the operational area.
Nonetheless, ASBTIA was provided the Barossa Development Drilling and Completions Stakeholder Consultation package via email on 29 September 2020.
ASBTIA was provided a follow-up email on 2 July 2021 inviting comment. No response has been received.
ASBTIA receives the Barossa Development Quarterly Consultation Update. The Q2 2021 Update was distributed on 11 June 2021.
Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.</td></tr>
<tr><th>Assessment of the merits of objections and claims (OPGGS(E) Regulation 16 (b)(ii))</th><th>Statement of response, or proposed response, to the objections and claims (OPGGS(E) Regulation 16 (b)(iii))</th></tr>
<tr><td>No assessment required.</td><td>No response required.</td></tr>
<tr><td>Amateur Fisherman’s Association of the Northern Territory (AFANT)</td><td colspan="2">AFANT has previously advised that recreational fishing activity does not occur in the area within which development drilling activities would occur.
Nonetheless, AFANT was provided the Barossa Development Drilling and Completions Stakeholder Consultation package via email on 11 June 2021 inviting comment.
AFANT was provided a follow-up email on 2 July 2021 inviting any further comment.
AFANT receives the Barossa Development Quarterly Consultation Update. The Q2 2021 Update was distributed on 11 June 2021.
Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.</td></tr>
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Relevant person	Relevant persons consultation summary (OPGGS(E) Regulation 16 (b)(i))	
	Assessment of the merits of objections and claims (OPGGS(E) Regulation 16 (b)(ii))	**Statement of response, or proposed response, to the objections and claims (OPGGS(E) Regulation 16 (b)(iii))**
	No assessment required.	No response required.
NT Guided Fishing Industry Association (NTGFIA)	NTGFIA has previously advised that fishing tourism activities are unlikely to occur in the operational area due to the distance from the NT mainland. Nonetheless, NTGFIA was provided the Barossa Development Drilling and Completions Stakeholder Consultation package via email on 11 June 2021 inviting comment. NTGFIA was provided a follow-up email on 2 July 2021 inviting any further comment. NTGFIA receives the Barossa Development Quarterly Consultation Update. The Q2 2021 Update was distributed on 11 June 2021. Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.	
	Assessment of the merits of objections and claims (OPGGS(E) Regulation 16 (b)(ii))	**Statement of response, or proposed response, to the objections and claims (OPGGS(E) Regulation 16 (b)(iii))**
	No assessment required.	No response required.
Fishing tourism operators: Clearwater Island Resort Tiwi Adventures Tiwi Island Retreat Top End Arafura Charters	Some operators who may transit the operational area were provided the Barossa Development Drilling and Completions Stakeholder Consultation package via email on 11 June 2021 inviting comment. The operators were provided a follow-up email on 2 July 2021 inviting any further comment. No responses have been received. The operators also receive the Barossa Development Quarterly Consultation Update. The Q2 2021 Update was distributed on 11 June 2021. Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.	
	Assessment of the merits of objections and claims (OPGGS(E) Regulation 16 (b)(ii)), information and requests	**Statement of response, or proposed response, to the objections and claims (OPGGS(E) Regulation 16 (b)(iii)), and information and requests**
	No assessment required.	No response required.
Commercial fishing licence-holders		
Austral Fisheries	Santos contacted Austral Fisheries via email on 21 May 2021 to offer a briefing on the Barossa Project, including the Development Drilling and Completions EP. Austral Fisheries accepted the invitation via email response to Santos on 21 May 2021.	

<table>
<tr><th>Relevant person</th><th colspan="2">Relevant persons consultation summary (OPGGS(E) Regulation 16 (b)(i))</th></tr>
<tr><td rowspan="3"></td><td colspan="2">Santos met with Austral Fisheries on 28 May 2021. Discussion points on Barossa Development Drilling and Completions EP were as follows:
Austral is the largest Goldband Snapper licence-holder in the Timor Reef Fishery and plans to increase its TRF operations (from one to four trap vessels) over the next two years. The Barossa operational area overlaps the TRF area. Austral is also a major operator in the Northern Prawn Fishery with 11 of the 52 vessels. The Barossa GEP will overlap the NPF area. [CLAIM 001]
Austral advised that while it was happy to hold discussions with Santos when specifically required, its preference is for formal consultation to be undertaken via the representative bodies, NT Seafood Council and NPF Limited. Austral would like to continue to be informed during EP preparations, but responses would be co-ordinated via the two organisations. [CLAIM 002]
Austral requested that Santos seeks the views of a specific NPF licence-holder who is the predominant scampi fisher conducting activities to the north of the Barossa operational area. [CLAIM 003]
Santos provided Austral via email on 4 June 2021 with a record of the meeting held 28 May 2021 and information on the actions being taken as a result.
An Austral Fisheries representative attended the meeting held on 3 June 2021 between Santos and the NPFI. Refer to separate NPFI entry for details.
Austral Fisheries was provided the Barossa Development Drilling and Completions Stakeholder Consultation package, including additional information for commercial fishers, via email on 11 June 2021 inviting comment.
Austral Fisheries was provided a follow-up email on 2 July 2021 inviting any further comment.
Austral Fisheries receives the Barossa Development Quarterly Consultation Update. The Q2 2021 Update was distributed on 11 June 2021.
Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.</td></tr>
<tr><th>Assessment of the merits of objections and claims (OPGGS(E) Regulation 16 (b)(ii))</th><th>Statement of response, or proposed response, to the objections and claims (OPGGS(E) Regulation 16 (b)(iii))</th></tr>
<tr><td>[CLAIM 001] On assessment, the information provided correlates with Santos’ understanding that the development drilling operational area is within the Timor Reef Fishery (TRF) while the Barossa Gas Export Pipeline (GEP) operational area is relevant to the Northern Prawn Fishery (NPF). Santos acknowledges that some scampi fishers are active within the NPF that target deeper water to the north of the development drilling operational area.</td><td>Santos responded to Austral Fisheries via email on 4 June 2021 with a record of the meeting held 28 May 2021 and information on the actions being taken as a result.
All relevant fisheries are described in Section 3.2.6.1, including the NPF and TRF. Santos acknowledges that both fisheries overlap the drilling operational area, and that there maybe active fishing within this area.</td></tr>
</table>

Relevant person	Relevant persons consultation summary (OPGGS(E) Regulation 16 (b)(i))	
	[CLAIM 002] Santos notes Austral Fisheries' preferred consultation process, i.e. through the relevant representative organisations. It is also noted that the two identified organisations adopt different processes for consultation with their licence-holders and these are followed by Santos.	Santos understands that Austral Fisheries' preferred consultation process is via representative organisations and confirms that this process will be followed.
	[CLAIM 003] Santos included the requested licence-holder in its consultation process.	Santos confirms that the licence-holder identified by Austral Fisheries was one of the relevant persons being consulted for this EP and on an ongoing basis.
Australia Bay Seafoods	Santos contacted NPFI via email on 21 May 2021 to offer a briefing on the Barossa Project, including the Development Drilling and Completions EP. NPFI passed the invitation on to a licence holder at Australia Bay Seafoods. Santos met with representatives of two licence-holders, including one from Australia Bay Seafoods, on 1 June 2021. Discussion points on Barossa Development Drilling and Completions EP were as follows: The Australia Bay Seafoods representative sought clarification from Santos that meeting and providing feedback did not preclude his right to potentially seek compensation from Santos in the future if he determined his business had been impacted by the company's activities. **[CLAIM 001]** The representatives acknowledged that Santos had been given approval to conduct its activities, but it was important that the rights and entitlements of commercial fishers were respected and impacts minimised on their activities. **[CLAIM 002]** One representative advised he was one of two NPF licence-holders who fished for scampi north of the operational area along the Australian side of the EEZ. He would check on the drilling location co-ordinates to determine whether these impacted his activities. **[CLAIM 003]** In response to a question, Santos advised that water depths in the operational area ranged from 220m to 280m. Santos advised it understood this water depth was too deep for prawn fishing and not deep enough for scampi fishing. The Australia Bay Seafoods representative stated that from his perspective there was no impact in the operational area, but fishing did occur in the vicinity of the proposed pipeline route. He reiterated that this could be managed through consultation between both parties, but fishers may still seek compensation if their activities were impacted. **[CLAIM 004]** Santos was advised to also contact two other specific licence-holders. **[CLAIM 005]** Australia Bay Seafoods was provided a summary of Santos' actions resulting from the meeting, via email on 23 July 2021. Australia Bay Seafoods was provided the Barossa Development Drilling and Completions Stakeholder Consultation package, including additional information for commercial fishers, via email on 11 June 2021 inviting comment. Australia Bay Seafoods was provided a follow-up email on 2 July 2021 inviting any further comment. Australia Bay Seafoods receives the Barossa Development Quarterly Consultation Update. The Q2 2021 Update was distributed on 11 June 2021. Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.	

Relevant person	Relevant persons consultation summary (OPGGS(E) Regulation 16 (b)(i))	
	Assessment of the merits of objections and claims (OPGGS(E) Regulation 16 (b)(ii))	**Statement of response, or proposed response, to the objections and claims (OPGGS(E) Regulation 16 (b)(iii))**
	[CLAIM 001] Santos agrees that the provision of feedback by a stakeholder during a consultation process should not preclude the right to potentially seek evidenced-based compensation in the future.	Santos responded at the meeting held on 1 June 2021, that Santos confirmed to Australia Bay Seafoods that this right was not precluded.
	[CLAIM 002] Santos agrees that the rights and entitlements of commercial fishers should be respected and efforts taken to minimise impacts on their activities. Both Santos and commercial fisheries have legitimate rights to conduct their business within the drilling operational area.	Santos responded at the meeting held on 1 June 2021, that Santos confirmed to Australia Bay Seafoods that the rights and entitlements of commercial fishers would be respected and efforts taken to minimise impacts on their activities. Such efforts (control measures) are described in **Section 6.5**.
	[CLAIM 003] Santos will consider any additional information provided by any licence-holder and/or their representative organisation.	Santos responded that the catch effort information that has been provided by the Northern Prawn Fishery indicated the targeted scampi grounds would not be affected but Santos would be pleased to receive further information. This understanding of scampi fishing effort is reflected in **Table 3-11**.
	[CLAIM 004] Santos acknowledges the fishing effort within the operational area and surroundings, that ongoing consultation will assist in minimise interference with commercial fishers and that commercial fishers with licence rights may seek compensation for their activities being impacted.	Santos responded at the meeting held on 1 June 2021 to Australia Bay Seafoods that it acknowledged their right to claim compensation. Santos' understanding of fishing effort is reflected in **Table 3-11**, and ongoing consultation commitments with commercial fishers are described in **Table 6-10**.
	[CLAIM 005] On assessment, Santos reviewed its licence-holder lists to ensure those identified by the stakeholder were being consulted.	Santos responded at the meeting held on 1 June 2021 that Santos confirmed that the identified relevant persons were being consulted.
	Refer to separate entry for NPFI Pty Ltd as the representative body for licence-holders. Individual licence-holders contacted by Santos in each instance stated that the NPFI would provide the consolidated, formal comment to Santos on their behalf.	

<table>
<tr><th>Relevant person</th><th colspan="2">Relevant persons consultation summary (OPGGS(E) Regulation 16 (b)(i))</th></tr>
<tr><td rowspan="3">Northern Prawn Fishery (Commonwealth) licence-holders</td><td colspan="2">NPFI licence holders were provided with the Barossa Development Drilling and Completions Stakeholder Consultation package and Barossa Development Drilling and Completions Additional Information for Commercial Fishers package (for Northern Prawn Fishery) via their representative body NPFI Pty Ltd or directly by Santos via email on 11 June 2021.
NPFI was provided a follow-up email on 2 July 2021 inviting any further comment.
NPFI receives the Barossa Development Quarterly Consultation Update. The Q2 2021 Update was distributed on 11 June 2021.
Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.</td></tr>
<tr><th>Assessment of the merits of objections and claims (OPGGS(E) Regulation 16 (b)(ii))</th><th>Statement of response, or proposed response, to the objections and claims (OPGGS(E) Regulation 16 (b)(iii))</th></tr>
<tr><td>Refer to separate entry for NPFI.</td><td>Refer to separate entry for NPFI.</td></tr>
<tr><td rowspan="3">Timor Reef Fishery Licence-Holders</td><td colspan="2">TRF licence-holders were provided the Barossa Development Drilling and Completions Stakeholder Consultation package and Barossa Development Drilling and Completions Additional Information for Commercial Fishers package via email on 11 June 2021 or post on 14 June 2021.
Their representative body, the NTSC, was also provided the Barossa Development Drilling and Completions Stakeholder Consultation package including additional information for commercial fishers, via email on 11 June 2021 inviting comment.
NTSC advised that the request for feedback would also be included in an NTSC business update to licence-holders with email addresses.
The licence-holders and NTSC were provided a reminder email on 2 July 2021 inviting comment. Refer to NTSC comments received. No comments received to date from individual fishers in this fishery.
The licence-holders and the NTSC receive the Barossa Development Quarterly Consultation Update. The Q2 2021 Update was distributed on 11 June 2021.
Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.</td></tr>
<tr><th>Assessment of the merits of objections and claims (OPGGS(E) Regulation 16 (b)(ii))</th><th>Statement of response, or proposed response, to the objections and claims (OPGGS(E) Regulation 16 (b)(iii))</th></tr>
<tr><td>Refer to separate entry for NTSC.</td><td>Refer to separate entry for NTSC.</td></tr>
</table>

<table>
<tr><th>Relevant person</th><th colspan="2">Relevant persons consultation summary (OPGGS(E) Regulation 16 (b)(i))</th></tr>
<tr><td rowspan="3">Spanish Mackerel Fishery (NT) Licence-Holders</td><td colspan="2">This fishery currently does not overlap with the operational area. DITT – Fisheries has also advised that little fishing activity occurs in the Barossa Field area, within which drilling activities would occur.
Nonetheless, SMF licence-holders were provided the Barossa Development Drilling and Completions Stakeholder Consultation package and Barossa Development Drilling and Completions Additional Information for Commercial Fishers package via email on 11 June 2021 or post on 14 June 2021.
Their representative body, the NTSC, was also provided the Barossa Development Drilling and Completions Stakeholder Consultation package including additional information for commercial fishers, via email on 11 June 2021 inviting comment.
NTSC advised that the request for feedback would also be included in an NTSC business update to licence-holders with email addresses.
The licence-holders and NTSC were provided a reminder email on 2 July 2021 inviting comment. Refer to NTSC comments received. No comments received to date from individual fishers in this fishery.
The licence-holders and the NTSC receive the Barossa Development Quarterly Consultation Update. The Q2 2021 Update was distributed on 11 June 2021.
Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.</td></tr>
<tr><th>Assessment of the merits of objections and claims (OPGGS(E) Regulation 16 (b)(ii))</th><th>Statement of response, or proposed response, to the objections and claims (OPGGS(E) Regulation 16 (b)(iii))</th></tr>
<tr><td>Refer to separate entry for NTSC.</td><td>Refer to separate entry for NTSC.</td></tr>
<tr><td rowspan="2">Demersal Fishery (NT) Licence-Holders</td><td colspan="2">DF licence-holders were provided the Barossa Development Drilling and Completions Stakeholder Consultation package and Barossa Development Drilling and Completions Additional Information for Commercial Fishers package via email on 11 June 2021 or post on 14 June 2021.
Their representative body, the NTSC, was also provided the Barossa Development Drilling and Completions Stakeholder Consultation package including additional information for commercial fishers, via email on 11 June 2021 inviting comment.
NTSC advised that the request for feedback would also be included in an NTSC business update to licence-holders with email addresses.
The licence-holders and NTSC were provided a reminder email on 2 July 2021 inviting comment. Refer to NTSC comments received. No comments received to date from individual fishers in this fishery.
The licence-holders and the NTSC receive the Barossa Development Quarterly Consultation Update. The Q2 2021 Update was distributed on 11 June 2021.
Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.</td></tr>
<tr><th>Assessment of the merits of objections and claims (OPGGS(E) Regulation 16 (b)(ii))</th><th>Statement of response, or proposed response, to the objections and claims (OPGGS(E) Regulation 16 (b)(iii))</th></tr>
</table>

Relevant person	Relevant persons consultation summary (OPGGS(E) Regulation 16 (b)(i))	
	Refer to separate entry for NTSC.	Refer to separate entry for NTSC.
Aquarium Fishery (NT) Licence-Holders	Aquarium Fishery licence-holders were provided the Barossa Development Drilling and Completions Stakeholder Consultation package and Barossa Development Drilling and Completions Additional Information for Commercial Fishers package via email on 11 June 2021 or post on 14 June 2021. Their representative body, the NTSC, was also provided the Barossa Development Drilling and Completions Stakeholder Consultation package including additional information for commercial fishers, via email on 11 June 2021 inviting comment. NTSC advised that the request for feedback would also be included in an NTSC business update to licence-holders with email addresses. The licence-holders and NTSC were provided a reminder email on 2 July 2021 inviting comment. Refer to NTSC comments received. No comments received to date from individual fishers in this fishery. The licence-holders and the NTSC receive the Barossa Development Quarterly Consultation Update. The Q2 2021 Update was distributed on 11 June 2021.. Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.	
	Assessment of the merits of objections and claims (OPGGS(E) Regulation 16 (b)(ii))	**Statement of response, or proposed response, to the objections and claims (OPGGS(E) Regulation 16 (b)(iii))**
	Refer to separate entry for NTSC.	Refer to separate entry for NTSC.

4.5 Future activity consultation

Future consultation for this activity will include the following:

- Santos will continue to update relevant persons listed in **Table 4-1** via the Barossa Development Quarterly Consultation update.
- Before the activity begins, Santos will notify the relevant persons listed in **Table 8-4** with information including timing and duration, vessel movements and vessel details.
- Upon completion of the activity, Santos will notify the relevant persons listed in **Table 8-4.**

Should new relevant persons be identified[4], they will be added to Santos' database and included in future correspondence as requested.

Provision of additional information to stakeholders relating to potential EP changes will be managed as described in **Section 8**.

In the event of a Level 2 or 3 spill event as defined in the OPEP, Santos will apply the stakeholder identification process described in **Section 4.2** to identify relevant persons in addition to those listed in **Table 4-1**. Relevant persons whose functions, interests or activities that will, or may, be directly affected by the spill event or response arrangements will be notified of the event in accordance with Santos' Incident Management Process. Refer also to **Section 6.8.6**.

4.5.1 Future development consultation

Barossa Development regulatory approval and activity status will be included in a *Quarterly Barossa Development consultation update*.

The quarterly consultation update is circulated to a broad group of Santos' stakeholders as well as the relevant persons listed in **Table 4-1**.

The quarterly consultation update will be used to introduce future environment plans, including production operations, and provide relevant persons an opportunity to request further information and engagement.

4.5.2 Addressing consultation feedback

Santos will maintain ongoing dialogue with relevant persons to ensure feedback opportunities are available.

Santos will assess all feedback, information requests, objections and claims in accordance with **Section 4.4**.

Records of all consultation will be maintained.

4.6 Stakeholder-related control measures, performance outcomes and standards

Control measures and performance outcomes and standards for stakeholder consultation are included in **Table 8-2**.

[4] who meets the following qualification: a person or organisation whose functions, interests or activities may be affected by the activities to be carried out under the environment plan, or the revision of the Environment Plan.

5. Impact and risk assessment methodology

OPGGS(E)R 2009 Requirements
Regulation 13 Environmental assessment
Evaluation of environmental impacts and risks 13(5) The environment plan must include: (a) details of the environmental impacts and risks for the activity; and (b) an evaluation of all the impacts and risks, appropriate to the nature and scale of each impact or risk; and (c) details of the control measures that will be used to reduce the impacts and risks of the activity to as low as reasonably practicable and an acceptable level. 13(6) To avoid doubt, the evaluation mentioned in paragraph (5)(b) must evaluate all the environmental impacts and risks arising directly or indirectly from: (a) all operations of the activity; and (b) potential emergency conditions, whether resulting from accident or any other reason.

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

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

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

+ terminology used
+ summary of the approach.

A full description of the process applied in identifying, analysing and evaluating environmental impacts and risks is documented in Santos' *Offshore Division environmental hazard identification and assessment guideline* (EA-91-IG-00004_5).

5.1 Impact and risk assessment methodology

Common terms applied during the environmental impact and risk assessment process, and used in this EP, are defined in **Table 5-1**.

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

Term	Definition
Acceptability	Determined for both impacts and risks. Acceptability of events is in part determined by the consequence of the impact following management controls. Acceptability of unplanned events is in part determined from its risk ranking following management controls. For both impacts and risks, acceptability is also determined from a demonstration of the ALARP principle, consistency with Santos Policies, consistency with all applicable legislation and consideration of relevant stakeholder consultation when determining management controls.
Activity	Specific tasks and actions undertaken throughout the lifecycle of oil and gas exploration, development, production and decommissioning.
ALARP	As Low as Reasonably Practicable The term refers to reducing impact and risk to a level that is As Low as Reasonably Practicable. In practice, this means showing through reasoned and supported arguments, that there are no other reasonably practicable options that could reasonably be adopted to reduce impacts or risks further.
Authorised person	Person with authority to make the decision or take the action. Examples are Vessel Master, Superintendent, Supervisor, Person-in-charge, Company Authorised Representative, and Project Manager.
Control measure	Means a system, an item of equipment, a person or a procedure, that is used as a basis for managing environmental impacts and risks[5].
Environment	Includes the natural and socio-economic values and sensitivities which will or may be affected by the activity. Is defined by NOPSEMA as: (a) ecosystems and their constituent parts, including people and communities (b) natural and physical resources (c) the qualities and characteristics of locations, places and areas (d) the heritage value of places (e) the social, economic and cultural features of the matters mentioned in paragraphs (a), (b), (c) and (d).
Environmental consequence	A consequence is the outcome of an event affecting objectives. Note 1 An event can be one or more occurrences and can have several cases. Note 2 An event can consist of something not happening. (Reference ISO 73:2009 Risk Vocabulary)
Environmental impact	Defined by NOPSEMA[1] as any change to the environment, whether adverse or beneficial, wholly or partly resulting from a planned or unplanned event[1].
ENVID	Environmental hazard identification workshop.
Environmental risk	Applies to unplanned events. Risk is a function of the likelihood of the unplanned event occurring and the consequence of the environmental impact that arises from that event.
Hazard	A situation with the potential to cause harm.
Grossly disproportionate	Where the sacrifice (cost and effort) of implementing a control measure to reduce impact or risk, grossly exceeds the environmental benefit to be gained.

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

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

5.2 Summary of the environmental impact and risk assessment approach

5.2.1 Overview

Santos operates under an overarching Risk Policy. The company Risk Management Operating Standard (SMS-LRG-OS01) and supporting Procedure (SMS-LRG-OS01-PD01) underpins the Risk Policy and is consistent with the requirements of *AS/NZS ISO 31000:2018, Risk Management – Guidelines* (ISO, 2018). The key steps to environmental risk management are illustrated in **Figure 5-1**, as defined in the *Santos' Offshore Division Environmental Hazard Identification and Assessment Guideline* (EA-91-IG-00004_5).

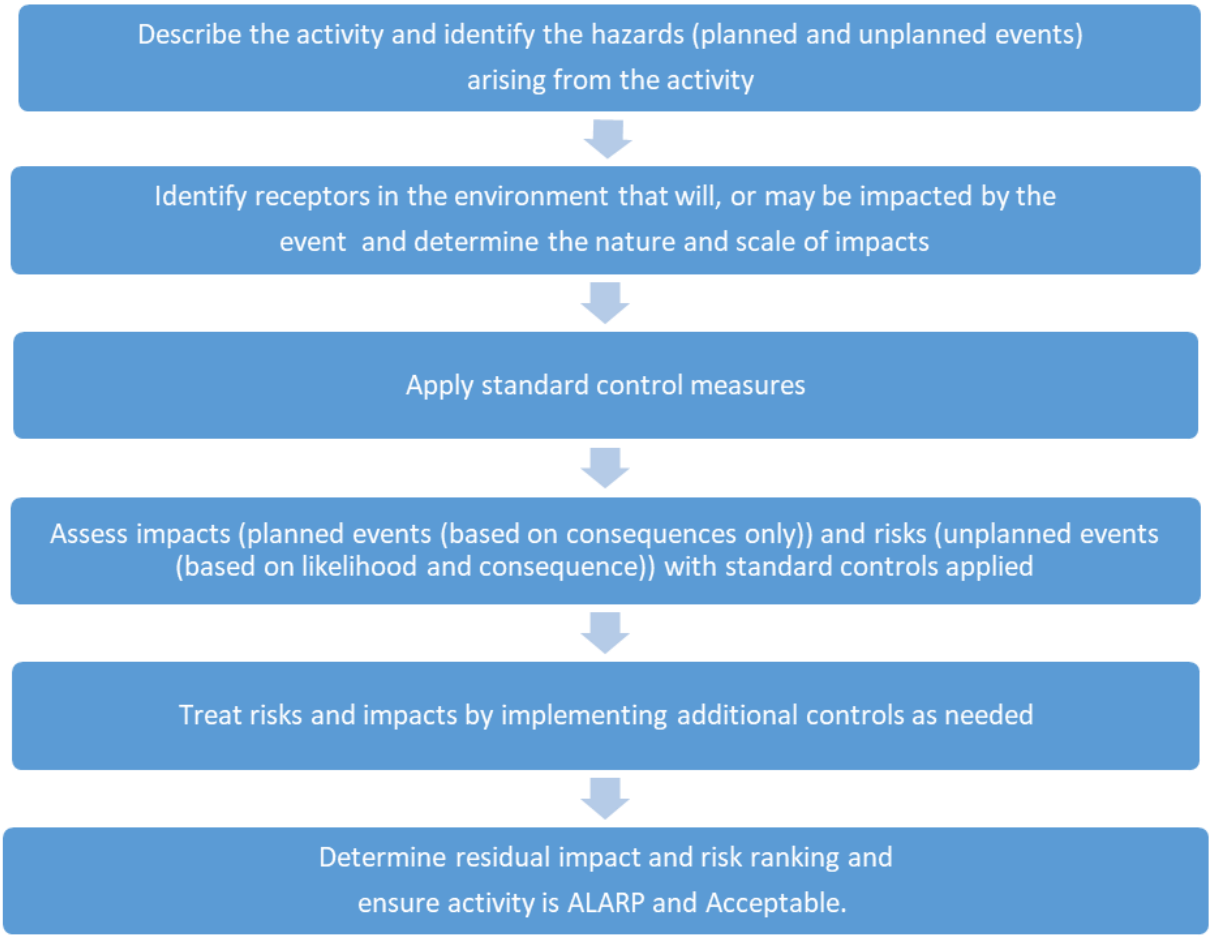

Figure 5-1: Hazard identification and assessment guideline

These steps are considered in activity-specific environmental assessment workshop(s) (ENVID workshop) and in the development of this EP. The workshop involves participants from Santos' Health, Safety and Environment (HSE), Spill Response and Drilling departments and specialist environmental consultants.

5.2.2 Describe the activity and hazards (planned and unplanned events)

The location, timing and scope of the activity must be understood to define the hazards and determine the impacts from planned events, and the impacts and risks from unplanned events since these have a bearing upon the environment that may be affected by the activity.

The outcome of this assessment is detailed in the relevant sub-sections of **Sections 6** and **7**.

5.2.3 Identify receptors and determine nature and scale of impacts

Santos has developed the *Barossa Development values and sensitivities of the marine and coastal environment* (BAA-200-0312, **Appendix C**) reference document which describes the existing environment that may be affected by the Barossa Development. Receptors identified as occurring or potentially occurring within the EMBA for the Barossa Development Drilling Campaign are detailed in **Section 3**.

The extent of impacts from planned events or risks from unplanned events, were assessed using, where required, modelling (for example, hydrocarbon spills) and scientific reports. The expected duration of each event was also defined using subject matter expertise.

5.3 Describe the environmental performance outcomes and control measures

As required by the OPGGS(E)R, environmental performance outcomes(s) (EPO), control measures, environmental performance standards (EPSs) and measurement criteria (MC) were identified for the identified environmental impacts and risks.

All reasonably practicable control measures were considered and either accepted for use or rejected based on whether impacts and risks had been reduced to levels considered acceptable and ALARP.

Accepted control measures were allocated in order of preference according to **Figure 5-2**.

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

Figure 5-2: Hierarchy of controls

5.4 Determine the impact consequence level and risk rankings

The consequence level of a potential impact was determined for each planned and unplanned event using the Santos environment consequence descriptors (**Appendix F**) on the basis that all control measures have been implemented.

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

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

Consequence descriptors are based on set criteria for each receptor category, and take 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.

As planned events are expected to occur during the activity, the likelihood of their occurrence was not considered during the environmental assessment, and only a consequence level was assigned.

Table 5-2: Summary environmental consequence descriptors

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

For unplanned events, the consequence level of the impact was combined with the likelihood of the impact occurring (**Table 5-3**), to determine a residual risk ranking using the Santos corporate risk matrix (**Table 5-4**).

Table 5-3: Likelihood description

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

Table 5-4: Santos risk matrix

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

5.5 Evaluate if impacts and risks are as low as reasonably practicable

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

5.6 Evaluate impact and risk acceptability

Santos considers an impact or risk associated with the activities to be acceptable if:

+ the consequence of a planned event is ranked as I or II; or a risk of impact from an unplanned event is ranked Very Low to Medium
+ an assessment has been completed to determine that sufficient information or studies have been considered to validate the consequence assessment
+ the principles of ecologically sustainable development have been assessed
+ the acceptable levels of impact and risks have been informed by relevant species recovery plans, threat abatement plans and conservation advice
+ performance outcomes, control measures and associated performance standards are consistent with legal and regulatory requirements
+ performance outcomes, control measures and associated performance standards are consistent with the Santos Environment, Health and Safety Policy
+ performance outcomes, control measures and associated performance standards are consistent with industry standards
+ performance outcomes, control measures and associated performance standards take into consideration stakeholder feedback
+ performance outcomes, control measures and associated 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 ALARP 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.

An ENVID workshop (as described in **Section 5**) for planned activities was held in June 2021. Santos' environmental assessment identified eight causes 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** and described in the next subsections.

Table 6-1: Environmental impact assessment summary

EP section reference	Hazard	Residual consequence level
6.1	Noise emissions	I – Negligible
6.2	Light emissions	I – Negligible
6.3	Atmospheric emissions	I – Negligible
6.4	Seabed and benthic habitat disturbance	II – Minor
6.5	Interaction with other marine users	I – Negligible
6.6	Operational discharges	II – Minor
6.7	Drilling and completions discharges	II – Minor
6.8	Contingency spill response operations	II – Minor

6.1 Noise emissions

6.1.1 Description of event

Event	Potential impacts from noise emissions may occur in the operational area from: + vessel activities (e.g., vessel engines, thrusters and other machinery) + MODU activities (e.g., drilling, well construction and machinery) + flaring + helicopter activities.
Extent	Noise emissions will be concentrated around the above-mentioned sources, with studies supporting the assessment of only localised effects; i.e., in the order of 12 km. Underwater noise from flaring will be limited to two to three days per well test and is not expected to exceed vessel/MODU operational noise levels. Neither additive or cumulative effects from other activities are expected due to the scale of the activities and their sound fields and distance between activities.
Duration	Continuous MODU and vessel noise emissions for the duration of the activity, with intermittent emissions associated with discrete activities, e.g., flaring, helicopter arrivals, etc. Noise from flaring will be limited to two to three days per well flowback.

6.1.1.1 Introduction

During the activity, noise will be generated by the MODU undertaking drilling activities and flaring, vessels providing support and light well intervention, and helicopters providing support.

The MODU does not have self-propulsion so will not generate noise from propellers. Underwater noise emissions from MODUs primarily originate from on-board equipment vibrations, although some emissions are transmitted directly into the water through vibration of the drill string and potentially also from interaction between the drill bits and the seafloor (Austin *et al*., 2018). MODU related operations will include:

+ normal drilling operations
+ flaring activities.

During normal operations the vessels will generate continuous noise from propeller cavitation, thrusters, hydrodynamic flow around the hull, and operation of machinery and equipment. Vessel related operations will include:

+ manoeuvring during pre-lay anchoring operations (under dynamic positioning)
+ standby activities related to the MODU
+ resupply activities for the MODU (vessels under dynamic positioning).

Other noise sources will include helicopters that will generate noise during take-off and landing on the MODU.

Santos has recently commissioned a technical study into Underwater Noise Impacts on Marine Fauna (JASCO, 2020a). Although not publicly available, Santos has used the findings of this study to update the underwater noise emissions impact assessment section of the EP. All of the noise sources involved in the activity are non-impulsive. Non-impulsive sounds have a longer duration than impulsive ones, and they usually do not have the high peak sound pressure and rapid rise and decay time that impulsive sounds have. However, especially in respect to their auditory effects on marine fauna, the term non-impulsive does not imply long duration signals (JASCO, 2020a).

The relevant terminology for underwater acoustic levels relevant to non-impulsive sources are sound pressure levels (SPL), and accumulated sound exposure levels (SEL).

Previous assessments for the Barossa Development (ConocoPhillips, 2018) examined the noise from an FPSO facility and associated support vessels. The modelling scenarios include the modelling of an operational FPSO facility and an FPSO facility with offloading tanker and a support vessel in attendance located at the proposed FPSO facility site in the Barossa field. This modelling study is the only study conducted within the Barossa area for non-impulsive sources.

Site and operational specific modelling were not conducted for this activity, therefore the approach taken within this assessment was to contrast the noise associated with the drilling campaign to relevant existing information and thus estimate the range of potential effect. This process was completed through a conservative approach, primarily using the modelling completed for the Barossa Development, but also literature where relevant.

Previous studies do not always contain the most relevant current criteria, for instance the assessment undertaken for the Barossa Development (ConocoPhillips, 2018) applied Southall *et al.* (2007) to assess potential hearing impairment in marine mammals as this was the best available information at the time of the assessment. Results calculated using the approach within Southall *et al.* (2007) cannot be directly contrasted to possible ranges to effect that would result from the application of Southall *et al.* (2019). Where this issue exists, for low-frequency cetaceans, the approach taken within this assessment is to determine the ranges to effect using ranges from the unweighted SEL results but apply the low-frequency hearing group specific threshold from Southall *et al*. (2019). This approach is conservative, as it does not account for the weighting of frequencies for fauna do not hear as well. This approach is not appropriate for mid-frequency and high-frequency cetaceans as is it unrepresentative or justifiable.

The Artisan-1 Exploration Well Drilling Environment Plan (Beach, 2020) contains an assessment of an anchored MODU and resupply operations (Koessler *et al*., 2020, Appendix F). This assessment did not predict a range to Temporary Threshold Shift (TTS) in high-frequency cetaceans (using the Southall *et al*., 2019 terminology) at ranges beyond 30 m for the most impactful activity, resupply operations. At very close range, the source levels of the vessels involved in the operations dominates over environmental influences, therefore these results are likely applicable to this assessment also.

The relevant other criteria within ConocoPhillips (2018) to the current assessment are as follows:

+ Marine mammal behavioural response criteria are unchanged, with 120 dB re 1 µPa (SPL) still the threshold, however the reference has been updated from NMFS (2014) to National Oceanic and Atmospheric Administration (NOAA, 2019).
+ Sound exposure guidelines for fish, fish eggs, sea turtles and larvae from Popper *et al*. (2014) remain unchanged. This will be applied for hearing impairment in sea turtles in the absence of the ability to assess the frequency-weighted thresholds presented in Finneran *et al*. (2017).

The recently released Southall et al. (2021) paper on behavioural response criteria does not provide new numerical thresholds for onset of behavioural responses for marine mammals, and thus has not been applied in this assessment. This paper does provide significant context and guidance for future work to better determine such thresholds.

A summary of the modelling results within ConocoPhillips (2018) which pertain to this assessment are detailed below. The terminology used to refer to the distances to thresholds are:

+ Rmax, the maximum range to the given sound level over all azimuths
+ R95%, the range to the given sound level after the 5% farthest points were excluded.

Results summary from ConocoPhillips (2018):

+ FPSO in isolation during normal operations:
  – For this scenario, the range to the 120 dB re 1 µPa NMFS (2014) and NOAA (2019) criterion for behavioural responses in marine mammals was 1.33 km (R95%) and 1.42 km (Rmax).
+ FPSO under dynamic positioning (DP) during offload to a tanker, with both the FPSO and tanker represented using a conservative power level approximation for the thrusters of 50% load, attended by a support vessel, also under DP:
  – For this scenario, the range to the marine mammal behavioural response criterion of 120 dB re 1 µPa NMFS (2014) and NOAA (2019) was 8.9 km (R95%) and 11.4 km (Rmax).
+ For both of these scenarios, neither permanent threshold shift (PTS) or TTS was predicted beyond the FPSO extents using the applied criteria in that assessment (Southall *et al*., 2007).
+ Applying the Southall *et al*. (2019) criteria to the unweighted 24 h SEL results indicates:
  – FPSO in isolation during normal operations: PTS and TTS in low-frequency cetaceans could occur within approximately 20 or 200 m respectively
  – FPSO, tanker and support vessel during offload operations: PTS and TTS in low-frequency cetaceans could occur within approximately 70 or 1860 m respectively.
+ Considering modelling assessments of other similar drilling operations (such as the aforementioned Artisan-1 Exploration Well), and applying a conservative approach, a range to TTS of 50 m for high-frequency cetaceans will be used to represent potential effects on odontocetes within this assessment.

6.1.1.2 Noise generated by mobile offshore drilling unit

The noise generated by the MODU is similar to that of an FPSO not using its thruster; however, comparing results presented in Austin *et al*. (2018) and Erbe *et al*. (2013) the MODU is expected to be quieter (170.5 dB re 1 µPa m versus a median of 181 dB re 1 µPa m).

The extent of thresholds associated with operations of the MODU can be estimated by considering those determined for the FPSO in isolation during normal operations as detailed in **Section 6.1.1.1**.

6.1.1.3 Noise generated by vessels

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

Three types of typical vessel operations will occur, two of which involve dynamic positioning:

+ manoeuvring during MODU anchor handling operations (vessels under dynamic positioning)
+ resupply activities for the MODU (vessels under dynamic positioning).

To represent vessels under dynamic positioning in the presence of the MODU, the modelling scenario in ConocoPhillips (2018) which included three vessels using dynamic positioning – the FPSO offload scenario, has been applied to conservatively estimate ranges to effect. This included both the FPSO and tanker represented using a conservative power level approximation for the thrusters of 50% load, and a support vessel also using dynamic positioning to maintain station.

The activity scenario which does not involve dynamic positioning is standby of the support vessel near the MODU. A reasonable representation of vessel noise during this activity is a vessel under slow transit.

McCauley (1998) measured underwater sound levels from the Pacific Ariki, a 64 m long support vessel with 8000 HP (6,000 kW) main engines during calm conditions in the Timor Sea in 110 m of water while transiting at 11 knots. This measurement determined that the 120 dB re 1 µPa NOAA (2019) criterion for behavioural responses in marine mammals would not be exceeded at approximately 1 km. Vessels when mobile have a shorter range to PTS and TTS thresholds than when stationary, as the sound accumulation is distributed over a wider area. McCauley (1998) calculated the Pacific Ariki to have a monopole source level equivalent to approximately 182 dB re 1 µPa m while holding position using both main engines and an unspecified bow thruster. This dynamic positioning source level is similar to that for the FPSO not using a thruster (181 dB re 1 µPa m), and the source level for the vessel during transit will be lower as it is more efficient. Therefore, using the FPSO without thruster is a reasonable approximation to determine ranges for SEL criteria.

6.1.1.4 Noise generated by helicopters

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

Helicopter engine noise is emitted at various frequencies however, the dominant tones are generally of a low frequency below 500 Hz (Richardson et al. 1995). Sound pressure in the water directly below a helicopter is greatest at the surface and diminishes with increasing receiver depth. Noise also reduces with increasing helicopter altitude, but the duration of audibility often increases with increasing altitude, with sound penetrating water at angles <13°. The noise from the flyover of a Bell 214ST helicopter has been recorded underwater (Richardson et al., 1995), with the maximum recorded sound level for the dominant 22 Hz tone was 109 dB re 1 µPa (SPL) when the helicopter was 152 m from the surface and the hydrophone 3 and 18 m under the surface.

For context, the Bell 214 uses a single powerful Lycoming LTC4B-8 engine (2,930 shaft horsepower (shp); 2,185 kW) (Frawley, 2003), while more the more modern Bell 412, often used as a rescue helicopter in Australia (Air Services Australia, 2020) uses twin 1,250 shp (930 kW) turboshaft engines (Bell Helicopter, 2012). Typical offshore crew change and medivac helicopters in Australia are the Leonardo AW139s (Milne, 2019), which have been measured to be 2dB(A) quieter than the Bell 412 helicopters (Air Services Australia, 2020).

Although helicopters are expected to land/take-off from the MODU several days per week, the duration of helicopter operation within close proximity to the marine environment is limited and intermittent. Further helicopter operations are expected to result in received underwater noise levels lower than those associated with vessel operations.

6.1.1.5 Noise from flaring during well flowback

Noise from flaring is caused by high exit velocities of hydrocarbons through the flare.

The noise from in-air flaring is typically reported in A-weighted units to assist with assessing potential effects on humans. For instance, Hantschk & Schorer (2008) reported an A-weighted sound power level (L_{wA}) of 108 dB (source level). The underwater noise from flaring has not been estimated, however the concepts of transmission are similar to those for helicopters, with sound penetrating the water at angles <13°, and experiencing loss during the transition between air and water. The underwater sound levels can be approximated to be lower than those for a helicopter, and therefore any potential effects less. This approximation is justified by contrasting flaring source level ((108 dBA) with that of a helicopter, an L_{wA} around 139 dB during take-off or the final stages of approach (flaring) (James and Zoontjens, 2012).

6.1.1.6 Summary of noise sources and rationale for assessment

Of the noise sources described in **Sections 6.1.1.1** to **6.1.1.5**, noise from helicopters and flaring are expected to be intermittent during the activity and underwater received levels will not exceed that of activity vessels including the MODU.

Therefore, the assessment has focused on the operations of the project support vessels and the moored MODU.

6.1.2 Nature and scale of environmental impacts

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

+ Marine fauna use sound in a variety of functions, including social interactions, foraging, orientation, and responding to predators. Underwater noise can affect marine fauna in three main ways, being:
  - injury to hearing or other organs. Hearing loss may be temporary (TTS) or permanent (PTS)
  - disturbance leading to behavioural changes or displacement of fauna; the occurrence and intensity of disturbance is highly variable and depends on a range of factors relating to the animal and situation
  - masking or interfering with other biologically important sounds (including vocal communication, echolocation, signals and sounds produced by predators or prey).

Receptors with the potential to be impacted by underwater noise include:

+ plankton consisting of fish, coral and invertebrate eggs and larvae
+ benthic invertebrates
+ fish
+ sharks
+ marine mammals (cetaceans and dugongs)
+ marine reptiles.

The levels of acoustic exposure that may result in injury or behavioural changes in marine fauna is an area of increasing research. Due to differences in experimental design, methodology and units of measure, comparison of studies to determine likely sound exposure thresholds can be difficult. On assessment of the available science, thresholds have been defined for informing the impact assessment, and interpreting the estimated ensonification ranges. These are discussed for each receptor in JASCO (2020a).

The assessment is conducted by comparing modelled received underwater sound levels to defined noise effect criteria, as determined by scientific research and academic papers (JASCO, 2020a), for the identified environmental and social receptors.

Although the relationship between received sound levels and impacts to marine species is the subject of ongoing research, the science underlying noise modelling is well understood (Farcas *et al*., 2016).

6.1.2.1 Marine mammals

There are no known significant feeding, breeding or aggregation areas for marine mammals within the operational area, though Omura's whales (not EPBC listed) have been detected consistently within the operational area. The closest BIA to the operational area is the pygmy blue whale distribution BIA which is approximately 51 km away. Dugongs are not expected to occur in the operational area.

Several species of baleen whales may occur in the operational area, including the Omura's, pygmy blue, humpback and Bryde's whales. Based on their hearing range, these whales have been classified as low-frequency cetaceans. A number of odontocetes (including dolphins) may also be present in the operational area. Odontocetes have been classified as high-frequency cetaceans using the hearing group classification from Southall *et al*. (2019).

To better reflect the auditory similarities between closely related species, but also significant differences between species groups among the marine mammals, Southall *et al*. (2007) assigned the extant marine mammal species to functional hearing groups based on their hearing capabilities and sound production. This division into broad categories was intended to provide a realistic number of categories for which individual noise exposure criteria were developed. These groups were revised by NMFS (2018) and most recently by Southall *et al*. (2019). The categorisation as such has proven to be a scientifically justified and useful approach in developing auditory weighting functions and deriving noise exposure criteria for marine mammals. These auditory weighting functions are referred to as frequency weighting.

For non-impulsive noise such as that expected during the drilling activity, NMFS currently uses step function (all-or-none) threshold of 120 dB re 1 µPa SPL (unweighted) to assess and regulate noise-induced behavioural impacts for marine mammals (NOAA, 2019). The behavioural disturbance threshold criteria applied summates the most recent scientific literature on the impacts of sound on marine mammal hearing so considered the most relevant to this activity. **Table 6-2** details cetacean behavioural, TTS and PTS thresholds for continuous noise.

Table 6-2: Continuous noise: summary of cetacean impact thresholds as derived from Southall *et al*. (2019) and National Oceanic and Atmospheric Administration (2019)

Hearing group	NOAA (2019)	Southall *et al*. (2019)	
	Behaviour	PTS onset thresholds (received level)	TTS onset thresholds (received level)
	SPL (dB re 1 µPa)	Weighted SEL24h (dB re 1 µPa²·s)	Weighted SEL24h (dB re 1 µPa²·s)
Low-frequency cetaceans	120	199	179
High-frequency cetaceans		198	178

<u>Potential impacts from MODU and vessels</u>

Using predicted noise levels as described in **Section 6.1.1.6**, estimated distances from activity vessels to behavioural and physiological thresholds (as listed in **Table 6-2**) for cetaceans are provided below.

The extent of thresholds associated with operations of the MODU can be estimated by considering those determined for the FPSO in isolation during normal operations:

- The range to the 120 dB re 1 µPa NOAA (2019) criterion for behavioural responses in marine mammals is approximated to be 1.42 km (Rmax)
- PTS and TTS in low-frequency cetaceans could occur within approximately 20 or 200 m respectively if the animal remains within that range for 24 h
- PTS is not predicted in high-frequency cetaceans, although they could experience TTS within 50 m if the animal remains within that range for 24 h.

The extent of thresholds associated with dynamic positioning vessel operations are estimated considering the FPSO offload scenario, therefore:

+ the range to the 120 dB re 1 µPa NOAA (2019) criterion for behavioural responses in marine mammals is approximated to be 11.4 km (Rmax)
+ PTS and TTS in low-frequency cetaceans could occur within approximately 70 or 1860 m respectively, if the animal remains within that range for 24 h
+ PTS is not predicted in high-frequency cetaceans, although they could experience TTS within 50 m if the animal remains within that range for 24 h.

These predictions are conservative, as they considered 24 h of operations, whilst resupply activities either typically take less than this, or during the operations there are periods of idle time for the vessels.

The extent of thresholds for a vessel in transit have been estimated using measurements of the Pacific Ariki (McCauley, 1998) and the FPSO operating in isolation, being:

+ the range to the 120 dB re 1 µPa NOAA (2019) criterion for behavioural responses in marine mammals is approximated to be 1 km
+ PTS and TTS in low-frequency cetaceans could occur within approximately 20 or 200 m respectively, if the animal remains within that range for 24 h
+ PTS is not predicted in high-frequency cetaceans, although they could experience TTS within 50 m if the animal remains within that range for 24 h.

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).

A qualitative assessment of masking was included in ConocoPhillips (2018), which considered the noise from the FPSO facility operations (including offload), the sound levels recorded during the baseline monitoring program (JASCO, 2015). This assessment determined that pygmy blue whales, Omura's and Bryde's whales will experience masking when in the vicinity of the FPSO facility (and therefore the MODU) and, given the lower vocalisation source levels for the latter two species, the area over which masking will occur will be larger than for pygmy blue whales. Masking from the MODU associated activities is expected to be more relevant for Omura's and Bryde's whales because of their more regular presence within the region encompassing the Barossa field from summer through to early spring, whereas the migratory pygmy blue whales will only be affected for a short period of time.

Generally, the spatial and temporal scale of behavioural response effects on marine mammals would be limited to the localised area surrounding the proposed MODU (thousands of metres) and the periods of intensified activities. These ranges will be greater during resupply operations. Because the operations will be focused at a static site, and therefore only influence a small region within the Timor Sea not known to be a critical habitat, significant effects at the population level are not expected.

6.1.2.2 Marine reptiles

The operational area does not overlap any BIAs for marine reptiles, however individual turtles and seasnakes may occur within the operational area. The closest turtle BIA is >50 km from the operational area.

While numerical thresholds have been developed for impacts of impulsive noise sources to marine turtles (e.g., Finneran *et al*., 2017), these were not assessed. Rather, the approach defined by Popper *et al*. (2014), also applied in the Barossa Development OPP (ConocoPhillips, 2018) has been applied. This is the risk-based criteria presented in **Table 6-3**.

Table 6-3: Acoustic effects of continuous noise on sea turtles

Potential marine fauna receptor	Popper *et al.*, 2014	
	Masking	Behaviour
Marine turtle	(N) High (I) High (F) Moderate	(N) High (I) Moderate (F) Low

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

Potential impacts from MODU and vessels

Based on the criteria detailed within **Table 6-3** there is a low risk of any injury to marine turtles from activity vessel noise. Behavioural changes, such as avoidance and diving, are only predicted for individuals near 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 metres of the vessel, and a moderate risk of masking within thousands of metres from the vessel.

6.1.2.3 Sharks, rays and fish

There are no known fish aggregation areas in the operational area; however, individuals or schools may pass through. The closest area that is considered likely to support site-attached fish is Lynedoch Bank which is located approximately 38 km from the operational area. The closest fish or shark BIA is 506 km from the operational area (whale sharks).

Potential impacts from MODU and vessels

The criteria defined in Popper *et al*. (2014) for continuous noise sources has been applied to the assessment of impacts to sharks, rays and fish (**Table 6-4**).

Table 6-4: Continuous noise: criteria for noise exposure for fish (adapted from Popper *et al.*, 2014)

Potential marine fauna receptor	Mortality and potentially mortal injury	Impairment			Behaviour
		Recoverable injury	TTS	Masking	
Type 1 Fish: No swim bladder (particle motion detection) includes sharks and rays.	(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
Type 2 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
Type 3 Fish: Swim bladder involved in hearing (primarily pressure detection)	(N) Low (I) Low (F) Low	170 dB SPL for 48 h	158 dB SPL for 12 h	(N) High (I) High (F) High	(N) High (I) Moderate (F) Low
Fish eggs and fish larvae	(N) Low (I) Low (F) Low	(N) Low (I) Low (F) Low	(N) Low (I) Low (F) Low	(N) High (I) Moderate (F) Low	(N) Moderate (I) Moderate (F) Low

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

Based on this study, vessel noise has a low risk of resulting in mortality for all fish types. The risk of recoverable injury to Type 1 and 2 fish is low, however is moderate for TTS and behavioural impacts when fish are within tens of metres of an activity vessel (Popper *et al.*, 2014). For Type 3 fish, recoverable injury and TTS may occur within 60 m of the source (McPherson *et al.*, 2019), with a high risk of behavioural impacts occurring within tens of metres of an activity vessel (Popper *et al.*, 2014).

6.1.2.4 Invertebrates

Benthic invertebrates are unlikely to be negatively impacted from noise generated from vessel operations. There are no thresholds or guidelines regulating the exposure of marine invertebrates to underwater noise.

Stress responses to non-impulsive sound exposure have been documented for marine invertebrates. The worst-case consequence for individual animals can be expected to be moderate to major, but due to the limited spatial extent of the affected area population consequences are considered to be minor.

There is no systematic information available if and to which extent marine invertebrates use acoustic cues to communicate with conspecifics or their environment. Anecdotal information indicates no functional relevance of sound for these animals; vibration, such as ground-borne or near-field particle motion, however, can be assumed to have functional relevance as it provides information about potential food availability or approaching predators. This information could potentially be masked by the noise/particle motion emitted by the vessels even though this effect would be limited to the direct vicinity to noise generating sources. The consequence of (acoustic/vibrational) masking is considered to be, in the worst case, moderate for individuals. Due to an expected limited number of individuals experiencing this masking, it would have a negligible on a population level.

There are limited and inconclusive data available on the potential for behavioural responses and noise-induced physical effects on marine invertebrates. Theoretically, behavioural responses as well as significant sensory impairment or injury can have moderate consequences for an individual. In the absence of conclusive scientific information on the scope of these effects and the animals' ability to compensate for the effects, however, it is impossible to assess the consequences of behavioural responses and noise-induced impairment or injury.

Plankton, including fish eggs and larvae, and pelagic invertebrates could drift close to high energy noise sources (for example, bow thrusters). However, any negative impacts that could occur would be restricted to within metres of the sound source.

6.1.2.5 Summary

Noise levels from the MODU, helicopters and vessels that may cause behavioural responses to marine fauna are expected to generally be confined to the operational area and concentrated within a radius of a few hundred metres of the noise source metres to within 11.4 km, depending upon the noise sources and operations.

No biologically important areas occur within the operational area.

Noise effects to fish of potential commercial value would be restricted to within hundreds of metres of the noise source.

No effects to benthic invertebrates expected, including those of commercial value (e.g., scampi).

6.1.3 Environmental performance outcomes and control measures

The EPO relating to this event is:

- No injury or mortality to EPBC Act listed marine fauna. (EPO-05)

An assessment of the environmental benefits and the potential costs or issues associated with control measures for this activity are shown in **Table 6-5** to demonstrate the potential impacts from this aspect are ALARP. Control measures that are adopted have associated EPSs and measurement criteria which are presented in **Table 8-2**. Rejected control measures have an ALARP evaluation provided to justify their rejection.

Table 6-5: Control measure evaluation for noise emissions

CM reference	Control measure	Environmental benefit	Potential cost/issues	Evaluation
Standard controls				
BAD-CM-001	Procedure for interacting with marine fauna	Reduces risk of physical and behavioural impacts to marine fauna, because if they are sighted, vessels can slow down or move away.	Marine fauna interaction restrictions, such as vessel and helicopter 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. Control drives compliance with EPBC Regulations (Part 8).

CM reference	Control measure	Environmental benefit	Potential cost/issues	Evaluation
Additional controls				
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.	Additional cost of contracting several specialist marine fauna observers. Even if marine fauna are identified, noise sources cannot be shut down in the event marine fauna are detected, since they are integral to safe operation of vessels.	**Rejected** – cost disproportionate to increase in environmental benefit given no biologically important areas overlap the operational area (or are close to the operational area).
N/A	Manage the timing of the activity to avoid sensitive periods such as migration (whales), spawning (fish) or nesting (turtles)	Reduces potential impacts to fauna during key life stages.	Reduces the window of opportunity for undertaking the activity.	**Rejected** – not considered necessary or feasible. The operational area does not overlap with any BIAs and therefore seasonal presence of species is not expected to be higher at certain times of the year. It is recognised that the Omura's whale has seasonal variability in the region, but this is not an EPBC listed species. Additionally, given the low potential impacts to individual fauna, significant impacts to migratory or nesting behaviours are not expected, therefore, no impact at population level are predicted.

6.1.4 Environmental impact assessment

Receptor	Consequence level
Noise from operations of vessels, MODU and equipment	
Threatened, migratory or local fauna	Potential impacts due to underwater noise are limited to within 12 km of operating activity vessels (LWIV, MODU, support vessel) for all threatened or migratory marine fauna. Within this extent, no BIAs have been delineated. Several cetacean species may occur in the operational area. Behavioural impacts may include increased swimming speed, changes in dive behaviour and/or avoidance of the area. Such impacts will be temporary with no significant impacts to individuals or populations. The operation within the activity which is associated with the greatest ranges to effect is when vessels are under dynamic positioning, which is either during MODU anchor handling operations or resupply. During these activities, there is potential for TTS to occur within the order of 50 m and 1,860 m from the source for high frequency and low frequency cetaceans, respectively. Further, the potential for PTS in low frequency cetaceans is estimated to be within 70 m of the source. It is, however, anticipated that individuals will show avoidance behaviour in response to the continuous noise sources before respective TTS and PTS thresholds are exceeded. In the Recovery Plan for Marine Turtles in Australia, noise interference to marine turtles is dependent on whether the exposure is short (acute) or long-term (chronic). The noise generated by this activity is acute with impacts restricted to localised changes in behaviour within hundreds of metres of the source. The operational area is greater than 50 km from the nearest BIA for turtles, and no aggregations are expected. Therefore, potential behavioural impacts to marine turtles are expected to be localised and not significant at the individual and population level. Potential impacts to threatened or migratory shark or ray species are limited to the potential for behavioural responses within hundreds of metres of the source. While there is the potential for TTS within this range, this is not expected due to noise avoidance behaviour. Site attached fish are not expected within approximately 38 km of the operational area. Potentially present demersal and pelagic fish are expected to move away from noise at levels that could cause PTS and TTS, hence, any potential impacts are likely to be behavioural in nature.
Physical environment or habitat	Not applicable – noise will not impact the physical environment itself (including the 'Shelf break and slope of the Arafura Shelf' KEF that overlaps the operational area). Species associated with the continental slope and patch reefs that characterise this KEF (such as demersal fish, whale sharks, sharks and turtles) are unlikely to aggregate within the operational area due to the lack of seafloor features. However, potential impacts to these species are described above.
Threatened ecological communities	Not applicable – no threatened ecological communities identified in the area over which noise emissions are expected.
Protected areas	Not applicable – no protected areas identified in the area over which noise emissions are expected.
Socio-economic receptors	Noise is not expected to impact socio-economic receptors, including commercial fisheries, due to low noise levels and low socio-economic activity levels within and near the operational area.
Overall worst-case consequence	I – Negligible

6.1.5 Demonstration of as low as reasonably practicable

The use of the MODU and vessels is unavoidable if the operational activities are to proceed as required on a 24-hour-a-day basis.

The vessels are expected to produce similar noise emissions to other marine vessels that frequent or transit through the vicinity of the operational area.

The use of helicopters to transfer personnel to and from the MODU is necessary to allow operational activities to occur safely and effectively, with some personnel required to be rotated to and from other locations, and to provide for a rapid method of transferring to and from the MODU in the case of an emergency. A performance standard prohibiting helicopters from landing or taking-off in the presence of marine megafauna would introduce an unacceptable risk to human life.

Intermittent flaring during well flowback is essential for safety reasons.

All reasonably practicable control measures have been reviewed and those adopted are considered appropriate to manage the impacts such that the residual consequence is assessed to be I – Negligible. The proposed management controls are in accordance with the Santos risk management criteria and are considered appropriate to manage impacts to ALARP.

6.1.6 Acceptability evaluation

Is the consequence ranked as I or II?	Yes – maximum consequence from noise emissions is I – Negligible.
Is further information required to validate the consequence assessment?	No – potential impacts and risks are well understood through the information available.
Are the risks and impacts consistent with the principles of ecologically sustainable development (ESD)?	Yes – activity evaluated in accordance with Santos' *Environmental Hazard Identification and Assessment Procedure* which considers principles of ESD.
Have the acceptable levels of impact and risks been informed by relevant species recovery plans, threat abatement plans and conservation advice and Australian marine park zoning objectives)?	Yes – 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 noise emissions. Consistent with relevant species recovery plans, conservation management plans and management actions set out in **Table 3-9**, including: + Recovery Plan for Marine Turtles in Australia 2017–2027 (DoEE, 2017) + Approved Conservation Advice for *Megaptera novaeangliae* (humpback whale) (TSSC, 2015c) + Blue Whale Conservation Management Plan 2015–2025 (CoA, 2015a) + Approved Conservation Advice for *Balaenoptera borealis* (sei whale) (TSSC, 2015a) + Approved Conservation Advice for *Balaenoptera physalus* (fin whale) (TSSC, 2015b) + Marine Bioregional Plan for the North-West Marine Region (CoA, 2012b).
Are performance outcomes, control measures and associated performance standards consistent with legal and regulatory requirements?	Yes – management consistent with EPBC Regulations Part 8. Through acceptance of this EP, legislative and regulatory requirements will be met as per **Section 1.6.2**.
Are performance outcomes, control measures and associated performance standards consistent with Santos' Environment, Health and Safety Policy?	Yes – aligns with Santos' Environment, Health and Safety Policy.
Are performance outcomes, control measures and associated performance standards consistent with industry standards?	Yes – the most recent and comparable Drilling and Completions EPs accepted by NOPSEMA have been reviewed for consistency with the performance outcomes, control measures and associated performance standards proposed in this EP.
Have Performance outcomes, control measures and associated performance standards taken into consideration stakeholder feedback?	Yes – no objections or claims raised relating to activity noise emissions and potential environmental impacts to marine fauna or commercial fisheries.
Are performance standards such that the impact or risk is considered to be ALARP?	Yes – ALARP assessment conducted, with no additional control measures adopted.

The consequence of noise emissions on receptors is assessed as I – Negligible. Based on an assessment of Santos' acceptability criteria and with the control measures in place, potential impacts are considered acceptable.

6.2 Light emissions

6.2.1 Description of event

Event	Potential impacts from light emissions may occur in the operational area from: + safety and navigational lighting on the MODU + safety and navigational lighting on the vessels + spot lighting used on an as-needed basis, such as equipment deployment and retrieval + light from flaring during well flowback. Lighting will consist of bright white (i.e., metal halide, halogen, fluorescent) lights typical of lighting used in the offshore petroleum and maritime industries, including shipping and fishing.
Extent	Localised light 'spill' on surface waters surrounding the MODU and vessels. Direct line of sight may be visible up to 52.4 km from the MODU (intermittent flaring).
Duration	Navigational and task lighting is required 24 hours a day for the duration of the activity. Flaring is an intermittent source of light emission which typically occurs for an average of two to three days during well flowback.

6.2.2 Nature and scale of environmental impacts

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

Due to the size and height of the MODU, light from the MODU will be more visible than from the largest activity vessel and therefore MODU lighting has been used to determine the worst-case distance that light may be visible during the activity.

Lighting from a MODU was assessed in detail in the *Browse to NWS Project Draft Environmental Impact Statement (EIS)/Environmental Review Document (ERD)* (Woodside, 2019). A line-of-sight assessment was undertaken and predicted that direct light may be visible up to 26.6 km from the rig (derrick lights), increasing to 52.4 km during intermittent emergency flare (best available analogue to well flowback) (Woodside, 2019). At these distances, the light sources would be visible as small points on the horizon. The line-of-sight calculations are considered conservative as they do not allow for attenuation of light with distance.

Lighting impacts are not only related to the amount of artificial light, but also the types of light and the wavelengths that the different light types emit. Measurements of light emitted from a MODU recorded peak wavelengths between 530 to 620 nm, which is within the range that is visible to marine turtles and seabirds (300 to >700 nm) (Woodside, 2019). Light emitted from a natural gas flare recorded peak wavelengths between 750 to 900 nm (Pendoley, 2000 in Woodside, 2019). While this peak is outside the visible spectrum which is most disruptive to wildlife, including marine turtles and seabirds (CoA, 2019), light emissions from gas flares tend to be high intensity which is also an important factor. Therefore, light emissions from gas flares still pose a potential risk to wildlife.

Continuous lighting in the same location for an extended period of time may result in alterations to fauna behaviour, the specific impacts on different fauna groups is described below. The combinations of colour, intensity, closeness, direction and persistence of a light source are key factors in determining the magnitude of environmental impact (EPA, 2010).

6.2.2.1 Marine mammals

While no marine mammal BIAs overlap the operational area, individual species are likely to be present. Marine mammals are not known to be attracted to light sources at sea. Cetaceans predominantly use acoustic senses to monitor their environment rather than visual cues (Simmonds *et al*., 2004).

6.2.2.2 Marine reptiles

The operational area does not intersect any BIAs for marine reptiles. The closest BIA lies over 50 km away, which is an internesting buffer for flatback turtles.

Individual species may traverse the operational area and likely forage at the shoals and banks in the region.

Marine turtles are particularly sensitive to artificial lighting, which is known to disrupt breeding adult turtles, post-emergent hatchlings and hatchlings dispersing in nearshore waters (Limpus, 1971; Salmon et al., 1992; Limpus, 2007, 2008a, 2008b, 2009a, 2009b; Wilson *et al*., 2018). However, potential impacts to foraging turtles are limited to local attraction to prey species attracted to light (Kebodeaux, 1994). Marine turtles do not feed during the breeding season (Limpus *et al*., 2013), and light is not a cue to internesting behaviours. Therefore, potential impacts of artificial light to internesting turtles are not considered likely, and not discussed further.

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

+ inhibiting nesting by females
+ disrupting hatchling orientation and sea-finding behaviour
+ creating pools of light that attract swimming hatchlings and increase their risk of predation.

The most significant risk posed to marine turtles from artificial lighting is the potential disorientation of hatchlings following their emergence from nests by light spill on beaches, although breeding adult turtles can also be disoriented (Longcore & Rich, 2016, in EPA, 2010). The nearest turtle nesting beaches are greater than 138 km from the operational area.

Adult turtles have been observed feeding on prey presumed to be attracted by lights of oil production platforms in the Gulf of Mexico (Kebodeaux, 1994). However, illuminating fishing nets has been shown to reduce the bycatch of green turtles as they are thought to alert them to the presence of a net (Ortiz *et al*., 2016). This suggests that, although aggregation of foraging turtles may occur around light sources as a secondary response to effects of light on prey distribution, light does not appear to act as a cue to foraging behaviour.

6.2.2.3 Sharks, rays and fish

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

Sharks and rays are not known to be significantly attracted to light sources at sea. However, they may be attracted to the fish that are attracted to the light.

6.2.2.4 Seabirds

Seabirds may either be attracted by the light source itself or indirectly as structures in offshore environments tend to attract marine life at all tropic levels, creating food sources and providing artificial shelter for seabirds (Surman, 2002). Offshore light sources may also provide enhanced capability for seabirds to forage at night. Artificial light can disorient seabirds, disrupt natural foraging and migratory behaviours, and potentially cause injury through interaction with infrastructure.

Species with a nocturnal component to their life history, such as fledging shearwaters, are most vulnerable to negative effects of artificial light. Two shearwater species were identified in **Section 3.2.5**, of these, only the wedge-tailed shearwater breeds in Australia. While individuals may be present within the operational area, the nearest wedge-tailed shearwater BIA is located more than 700 km from the operational area (**Table 3-8**), and the nearest breeding colony further still. At these distances, fledglings are not expected to occur in the operational area. While adult shearwaters may traverse the operational area, they will not be undertaking behaviours that are vulnerable to impacts of artificial light.

6.2.2.5 Protected and significant areas

The operational area is 33 km from the nearest protected area (Oceanic Shoals AMP), which is a submerged receptor. At this distance MODU lighting would only potentially be detectable for short durations while flaring during well flowback.

6.2.3 Environmental performance outcomes and control measures

The EPO relating to this event is:

+ No significant impacts to marine fauna from lighting emissions. (EPO-08)

An assessment of the environmental benefits and the potential costs or issues associated with control measures for this activity are shown in **Table 6-6** to demonstrate the potential impacts from this aspect are ALARP. Control measures that are adopted have associated EPSs and measurement criteria which are presented in **Table 8-2**. Rejected control measures have an ALARP evaluation provided to justify their rejection.

Table 6-6: Control measure evaluation for light emissions

CM reference	Control measure	Environmental benefit	Potential cost/issues	Evaluation
Standard controls				
BAD-CM-034	Minimum lighting for maritime safety	Light spill from unnecessary lighting reduced, further lowering potential additional light pollution to the environment, thus reducing the potential impacts to fauna.	Lighting is required to ensure safe working conditions, and to alert other users of the sea to the MODU and vessel presence.	**Adopted** – requirement to comply with maritime and safety regulations.
Additional controls				
N/A	Manage the timing of the activity to avoid sensitive periods	Negligible due to the remote offshore location, absence of receptors in vulnerable life stages, and nature and scale of potential light impacts.	As the activity will be greater than 12 months in duration there would be a high cost to demobilise and remobilise the MODU and vessels.	**Rejected** – the high financial cost would be grossly disproportionate to negligible environmental benefits. The operational area is not located in an area that is likely to cause impact to turtle nesting or hatching, or seabird breeding, and

CM reference	Control measure	Environmental benefit	Potential cost/issues	Evaluation
				therefore timing the activity to avoid this would not change the potential environmental impacts
N/A	Implement light management actions recommended in the National Light Pollution Guidelines for Wildlife Including Marine Turtles, Seabirds and Migratory Shorebirds (DoEE, 2020), including: + switch off outdoor/deck lights when not in use + use available block-out blinds on portholes and windows not necessary for safety or navigation at night + manage and report seabird interactions	Would result in reduced light spill from internal lighting onto the sea surface, potential reduce overall light emissions, and reduce the consequence of any seabird interactions.	Cost of maintaining records and to train staff. Potential re-engineering of vessel (lighting management systems and blackout blinds).	**Rejected** – control considered irrelevant considering the operational area is not located in an area that is likely to cause impact to turtle nesting or hatching, or seabird breeding, and therefore would not change the potential environmental impacts. 24 hour/day drilling activities require a safe standard of lighting.
N/A	Change the wavelength of outdoor lights to avoid wavelengths within the peak sensitivity of turtles and seabirds	Negligible due to the absence of turtle and seabirds in vulnerable life stages within the operational area.	High cost to change MODU and vessel lights. Navigational lighting colours are stipulated by law. Working and egress areas are required to be illuminated for health and safety reasons.	**Rejected** – the high financial cost would be grossly disproportionate to negligible environmental benefits. Health and safety reasons, and maritime regulations, dictate lighting requirements.
N/A	Limit or exclude night-time operations	Would reduce light emissions to the marine environment.	Would double the duration of the activity resulting in significant financial costs. Minimum maritime and safety lighting would still be required.	**Rejected** – the high financial cost would be grossly disproportionate to negligible environmental benefits.

CM reference	Control measure	Environmental benefit	Potential cost/issues	Evaluation
N/A	Use of dark, matte surfaces on MODU and vessels	Would reduce reflection and scattering of light resulting in skyglow.	Additional cost to repaint surfaces. Some areas may require lighter surfaces to manage heat conduction for health and safety. Unlikely to result in a material light reduction.	**Rejected** – the high financial cost would be grossly disproportionate to negligible environmental benefits. May compromise health and safety in some circumstances.

6.2.4 Environmental impact assessment

Receptor	Consequence level
Light emissions	
Threatened, migratory or local fauna	Sensitive receptors that may be impacted by light emissions in the same location for an extended period of time include fish at the surface, marine turtles and seabirds. The National Light Pollution Guidelines for Wildlife Including Marine Turtles, Seabirds and Migratory Shorebirds (DoEE, 2020) states a 20 km threshold provides a precautionary limit based on observed effects of sky glow on marine turtle hatchlings and fledgling seabirds. The closest turtle BIA is >50 km from the operational area. The closest land from which seabirds may fledge is around 138 km (Tiwi Islands), which do not support breeding colonies of wedge-tailed shearwaters, the species most vulnerable to impacts to artificial light. Therefore, night-time activity lighting from the activity is expected to have a negligible impact on breeding or hatchling turtles and seabirds. Considering the distance from the nearest nesting beach and wedge-tailed shearwater breeding colony, the density of post-dispersal turtle hatchlings and wedge-tailed shearwater fledglings in the operational area is also considered low. In considering the distance to the nearest marine turtle BIA (>50 km), impacts to turtles from operational activity lighting are expected to be restricted to localised attraction and temporary disorientation, but with no long-term or residual impact. It is considered that the activity will not compromise the objectives as set out in the Recovery Plan for Marine Turtles in Australia 2017–2027 (DoEE, 2017). Fish and sharks have been shown to be attracted to artificial light sources however, the activity is unlikely to lead to large-scale changes in species abundance or distribution. Overall, a short-term localised increase in fish activity is expected to occur as a result of lighting from the MODU and vessels and from flaring during well flowback; however, with negligible impacts to the local fish population. Impacts to transient fish and sharks will therefore be limited to short-term behavioural effects with no decrease in local population size or area of occupancy of species, loss or disruption of critical habitat, or disruption to the breeding cycle. Therefore, the consequence level for threatened, migratory or local fauna is considered to be I – Negligible.
Physical environment or habitat	Not applicable – no impacts to physical environments and/or habitats from light emissions are expected. Impacts from light are not predicted at the seabed and therefore no impact to the ‘Shelf break and slope of the Arafura Shelf’ KEF and its values is predicted.

Receptor	Consequence level
Threatened ecological communities	Not applicable – no threatened ecological communities identified in the area over which light emissions are expected.
Protected areas	Not applicable – the operational area does not intercept any protected areas.
Socio-economic receptors	Lighting is not expected to cause an impact to socio-economic receptors other than to act as a visual cue for avoidance of the area by other marine users for safety purposes. The consequence level for socio-economic receptors is considered to be I – Negligible.
Overall worst-case consequence	I – Negligible

6.2.5 Demonstration of as low as reasonably practicable

Artificial lighting is required 24 hours a day for operational and navigational safety during the activity. All reasonably practicable control measures have been reviewed and those adopted are considered appropriate to manage the impacts such that the residual consequence is assessed to be I – Negligible. The proposed management controls are in accordance with the Santos risk management criteria and are considered appropriate to manage impacts to ALARP.

6.2.6 Acceptability evaluation

Is the consequence ranked as I or II?	Yes – maximum consequence from light emissions is I – Negligible.
Is further information required to validate the consequence assessment?	No – potential impacts and risks are well understood through the information available.
Are risks and impacts consistent with the principles of ESD?	Yes – activity evaluated in accordance with Santos' *Environmental Hazard Identification and Assessment Procedure* which considers principles of ESD.
Have the acceptable levels of impact and risks been informed by relevant species recovery plans, threat abatement plans and conservation advice and Australian marine park zoning objectives)?	Yes – consistent with relevant species recovery plans, conservation management plans and management actions set out in **Table 3-9** include: + National Light Pollution Guidelines for Wildlife Including Marine Turtles, Seabirds and Migratory Shorebirds (DoEE, 2020) + Marine Bioregional Plan for the North-West Marine Region (CoA, 2012b) + Recovery Plan for Marine Turtles in Australia 2017–2027 (DoEE, 2017). The activity will not compromise the objectives as set out in the Recovery Plan for Marine Turtles in Australia or the National Light Pollution Guidelines for Wildlife Including Marine Turtles, Seabirds and Migratory Shorebirds (DoEE, 2020) as biologically important behaviours of nesting adults and emerging/dispersing hatchlings can continue given the distance from the nearest nesting beaches.
Are performance outcomes, control measures and associated performance standards consistent with legal and regulatory requirements?	Yes – management consistent with International Convention of the Safety of Life at Sea (SOLAS) 1974 and the *Navigation Act 2012*. Through acceptance of this EP, legislative and regulatory requirements will be met as per **Section 1.6.2**.
Are performance outcomes, control measures and associated performance standards consistent with Santos' Environment, Health and Safety Policy?	Yes – aligns with Santos' Environment, Health and Safety Policy.
Are performance outcomes, control measures and associated performance standards consistent with industry standards?	Yes – the most recent and comparable Drilling and Completions EPs accepted by NOPSEMA have been reviewed for consistency with the performance outcomes, control measures and associated performance standards proposed in this EP.
Have performance outcomes, control measures and associated performance standards taken into consideration stakeholder feedback?	Yes – no objections or claims raised relating specifically to lighting and potential environmental impacts to marine fauna or commercial fisheries.
Are performance standards such that the impact or risk is considered to be ALARP?	Yes – see ALARP.

The consequence of light emissions on receptors is assessed as I – Negligible. Based on an assessment of Santos' acceptability criteria and with the control measures in place, potential impacts are considered acceptable.

6.3 Atmospheric emissions

6.3.1 Description of event

Event	Atmospheric emissions may occur from: + hydrocarbon combustion through the MODU flare during well flowback. Other gasses (CO_2 and H_2S) may also be produced from the reservoir + hydrocarbon combustion to operate the MODU, vessels and helicopters + operation of vessel incinerators + when transferring dry bulk drill products (e.g., barite, bentonite, cement), tank venting is necessary to prevent tank overpressure. The vent air will contain minor quantities of product particles, which will suspend in the air or settle on the sea surface. Although the MODU and vessels may use ozone-depleting substances (ODS), this will be in a closed rechargeable refrigeration system and there is no plan to release ODS to the atmosphere.
Extent	Localised: The quantities of gaseous emissions are relatively small and will, under normal circumstances, quickly dissipate into the surrounding atmosphere.
Duration	For the activity duration, with intermittent emissions associated with discrete activities, e.g., flaring.

6.3.2 Nature and scale of environmental impacts

Potential receptors: physical environment (air quality), socio-economic receptors, threatened, migratory or local fauna (seabirds).

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

+ deterioration of local air quality
+ contribution to national greenhouse gas (GHG) levels.

Hydrocarbon combustion emissions may result in a temporary, localised reduction of air quality. A reduction in local air quality could affect threatened, migratory or local fauna (seabirds), and the workforce. Atmospheric emissions may be harmful, odoriferous or aesthetically unpleasing.

Direct GHG emissions associated with the Barossa Development Drilling Campaign activities are detailed in **Table 6-7**. Emissions have been calculated based on forecast fuel usage using the NGER Emissions and Energy Threshold Calculator 2020[6]. The total estimated direct GHG emissions for this petroleum activity is approximately 167,568 t $C0_2$-e. The total annual Australian GHG emissions for the year from July 2020 to June 2021 are estimated by the Commonwealth Government to be 498.9 Mt CO_2-e (DISER, 2021). The estimated Barossa Development Drilling Campaign direct emissions are estimated to be less than 0.04% of the total annual Australian GHG emissions.

[6] http://www.cleanenergyregulator.gov.au/NGER/Forms-and-resources/Calculators#Emissions-and-Energy-Threshold-Calculator-202021-and-user-guide

Table 6-7: Estimated direct GHG emissions in tonnes of carbon dioxide equivalent (t CO_2-e)

Source	Approximate volume (metric tonnes)	Approximate volume (cubic metres)	Approximate fuel usage (kilolitres)	Greenhouse gases			Total Scope 1 emissions per well (t CO_2e)	Total Scope 1 emissions for all wells (t CO_2e)
				CO_2	CH_4	N_20		
Fuel Use	-	-	4780	12897	17	21	12974	103800
Unprocessed natural gas - flared	-	3390256	-	6848	13	4	6865	54920
Crude oil (including condensates) - flared	349.86	-	-	1103	1	3	1107	8856
TOTAL	**349.86**	**3390256**	**4780**	**20848**	**31**	**67**	**20946**	**167568**

In consideration of the EPBC Act Section 527E (**Appendix B**), Santos does not consider that there are material indirect GHG emissions associated with this petroleum activity, being limited to the Barossa Development Drilling Campaign. Refer to **Appendix B2** for additional information.

Santos will present in the future Barossa Production Operations Environment Plan a greenhouse gas (Scopes 1 to 3) life cycle analysis for production operations. This analysis will inform the environmental assessment of greenhouse gas emissions.

The operational area is in a remote offshore environment where there are no other permanent sources of air pollution and the air quality is expected to be nearly pristine. Atmospheric emissions from combustion engines and the flaring of well flowback hydrocarbons could result in deterioration of local air quality, while direct greenhouse gas (GHG) emissions would cause an incremental increase in global GHG concentrations.

GHG emissions refers to gases that trap heat within the atmosphere through the absorption of longwave radiation reflected from the Earth's surface. The emissions of carbon dioxide (CO_2), nitrous oxide (N_2O) and methane (CH_4), as relevant to this petroleum activity, are recognised as GHG emissions. GHG emissions are linked to global warming and climate change.

Santos recognises the science of climate change and supports the objective of limiting global temperature rise to less than 2°C and pursuing efforts to limit the temperature rise to 1.5°C. In recognition of the global need to reduce GHG emissions, Santos has had a Climate Change Policy since 2008, guiding the management of emissions and climate change risks. Santos also has gas emission reduction targets, including a new long-term target of achieving zero Scope 1 and 2 absolute emissions by 2040. Santos' strategy focuses on natural gas as a reliable transition fuel source and the development of technologies such as carbon capture and storage and clean fuels, such as hydrogen, as foundations for our decarbonisation pathway.

Potential impacts as a result of climate change have been modelled by Commonwealth Scientific and Industrial Research Organisation (CSIRO). The modelling indicates that temperatures will increase across Australia; rainfall patterns will change significantly; and extreme events, such as droughts, floods and wildfires, will become more common. These changes are likely to impact on individual species, ecosystems and ecosystem services, such as food and water availability. Within decades, environments across Australia may be substantially different (CSIRO and Bureau of Meteorology, 2015).

To date, the currently observed global warming and the associated anthropogenic climate changes cannot be directly attributed to any one development or activity, as they are the result of net global GHG emissions and GHG sinks that have accumulated in the atmosphere since the industrial revolution began.

It is therefore not possible to directly attribute any one activity, such as the Barossa Development Drilling Campaign, to climate change impacts globally or upon potential Australian receptors due to the spatial (global) and temporal (since the industrial revolution) extent of GHG emissions. Therefore, consideration for the purpose of this Environment Plan is framed by the contribution that this petroleum activity will make to national and global atmospheric emissions of GHG. This contribution is small, being less than 0.04% of the total current annual Australian GHG emissions.

The transparent reporting of GHG emissions under the NGER Act is a clear statutory mechanism within which Santos and its contractors will disclose emissions (refer to **Appendix B** and **Table 8-5**).

ODSs are used in closed refrigeration systems. ODS have the potential to contribute to ozone-layer depletion if accidentally released to the atmosphere. ODS air emissions would only occur in the event of damaged or faulty refrigeration equipment, or due to human error.

Venting of bulk dry drilling products is a necessary safety control, and any dust emissions will be negligible and limited to the immediate vicinity of the MODU.

6.3.3 Environmental performance outcomes and control measures

The EPOs relating to this event are:

+ No unplanned objects, emissions or discharges to sea or air. [EPO-04]
+ No significant changes to air, sediment and water quality. [EPO-06]

An assessment of the environmental benefits and the potential costs or issues associated with control measures for this activity are shown in **Table 6-8** to demonstrate the potential impacts from this aspect are ALARP. Control measures that are adopted have associated EPSs and measurement criteria which are presented in **Table 8-2**. Rejected control measures have an ALARP evaluation provided to justify their rejection.

Table 6-8: Control measures evaluation for atmospheric emissions

CM reference	Control measure	Environmental benefit	Potential cost/issues	Evaluation
Standard control measures				
BAD-CM-011	Bulk solid transfer procedure (tank venting during bulk product (powder) transfer)	Vents are monitored during transfers to observe for excessive powder discharge. Venting prevents over-pressure which would result in a potential larger release of bulk powders to the marine environment during filling.	No additional cost, it is a health and safety requirement to prevent tank over-pressure.	**Adopted** – the health and safety requirement outweigh the negligible environmental impact.
BAD-CM-019	Waste incineration procedures	Incinerator air emissions minimised by complying with International Convention for the Prevention of Pollution from Ships (MARPOL) Annex VI/ Marine Order 97.	Cost of maintaining certification, equipment and records, and to train staff.	**Adopted** – procedure ensures compliance with regulatory requirements.

CM reference	Control measure	Environmental benefit	Potential cost/issues	Evaluation
BAD-CM-020	Fuel oil quality	Reduces emissions through use of low sulphur fuel in accordance with MARPOL Annex VI (and Marine Order 97).	None identified.	**Adopted** – it is a legislated requirement.
BAD-CM-021	Air pollution prevention certification	Reduces emissions by ensuring compliance with MARPOL Annex VI (and Marine Order 97).	Cost of maintaining certification.	**Adopted** – it is a legislated requirement. The use of offshore marine vessels is unavoidable for this petroleum activity. However, Santos will attempt to minimise emissions by ensuring compliance with MARPOL Annex VI (Prevention of Air Pollution from Ships), which requires vessels to have a valid International Air Pollution Prevention Certificate (for vessels more than 400 tonnage).
BAD-CM-032	Ozone-depleting substance handling procedures	Reduces risk of accidentally releasing ozone-depleting substances.	Cost of maintaining equipment and records, and to train staff.	**Adopted** – benefit of preventing ODS emissions outweighs procedural compliance costs.
BAD-CM-033	Well flowback procedures	Includes control measures that ensure effective flaring of hydrocarbons during well flowback.	Cost associated with implementing procedures.	**Adopted** – benefit of ensuring effective flaring outweighs procedure compliance costs.

CM reference	Control measure	Environmental benefit	Potential cost/issues	Evaluation
	Well flowback procedures - Reduce well flowback to minimum required to clean up wells, i.e. testing to remove solids and mud invasion but not performing extended deliverability testing.	Reduces air emissions to ALARP for the proposed activity.	Reducing the well flowback forgoes the ability to get detailed reservoir performance data prior to first gas (i.e. production operations).	**Adopted** – Flowback will be reduced to a clean-up criterion (to ensure brine and solids from drilling are recovered) before short step down rate tests. The step down tests are expected to be <12hrs (pending reservoir performance). No extended production tests for assessing reservoir depletion will be performed and maximum rate will only be used to remove solids from the well that the FPSO cannot readily manage.

	Well flowback procedures - Utilise high efficiency burner heads and a specialist noise silenced flare.	Gives the highest likelihood of complete hydrocarbon combustion	Additional cost for both the gas and oil burners compared to a 'basic' flare.	**Adopted** - The well test vendor will provide a high efficiency oil burner for the oil line and a noise silenced flare for the gas line (to reduce velocities and improve flare stability). The oil burner selected for use, has a demonstrated burning efficiency of greater than 99.99% (SPE, 1996). In addition, CO_2 content in the gas feed to flare will be monitored. In the event CO_2 trends upwards, flare stability will be monitored and well test parameters adjusted to ensure clean and stable flaring. US EPA Parameters for Properly Designed and Operated Flares (EPA, 2012) was reviewed for relevance to temporary, variable rate well test flaring with horizontal flares. Recommendations such as avoiding over-steaming and excess aeration can be adopted given the non-steam and air assisted design of the horizontal flare stack. High wind impacts on flare efficiency are mitigated with the use of a dual flare boom on the MODU. Flare

CM reference	Control measure	Environmental benefit	Potential cost/issues	Evaluation
				watching will be utilised to monitor for flame lift off or flame stability issues. Adoption of all the above is considered to reduce the risks of incomplete hydrocarbon combustion to ALARP.
BAD-CM-037	Marine Assurance Standard	Reduces emissions by ensuring contracted vessels are operated, maintained and manned in accordance with industry standards and regulatory requirements.	Cost associated with implementing procedures.	**Adopted** – benefit of assuring vessels outweighs procedure compliance costs.
BAD-CM-040	MODU planned maintenance system	Reduces emissions by ensuring contracted MODU is operated, maintained and manned in accordance with industry standards and regulatory requirements.	Personnel costs of implementing.	**Adopted** – benefits of ensuring MODU is maintained outweighs the potential costs.
BAD-CM-041	Vessel planned maintenance system	Reduces emissions by ensuring contracted vessels are operated, maintained and manned in accordance with industry standards and regulatory requirements.	Personnel costs of implementing.	**Adopted** – benefits of ensuring vessels are maintained outweigh the costs.
Additional control measures				
N/A	No incineration during activities	Eliminates waste incineration emissions.	Increase in health risk from storage of some wastes. Requirement to transfer waste for onshore disposal. Cost of waste disposal.	**Rejected** – waste incineration is a permissible maritime activity if done so in accordance with regulations.
N/A	Removal of all ODS containing equipment	Eliminates potential of ODS emissions occurring.	Lack of refrigeration systems on board the vessels would lead to unacceptable workplace conditions.	**Rejected** – based on unacceptable workplace conditions (health and safety reasons).

CM reference	Control measure	Environmental benefit	Potential cost/issues	Evaluation
N/A	Alternative fuel type selected for vessels and MODU	Could reduce pollutants associated with marine diesel combustion.	Practical and reliable alternative fuel types (and power sources) have not been identified for the vessels and MODU required for this activity.	**Rejected** – not practically feasible.
N/A	Eliminate well flowback	Eliminates air emissions during this petroleum activity.	Not cleaning the wells up would result in loss of recovery from the reservoir as well as potential safety issues with the future production operations facility (FPSO).	**Rejected** - Cleaning the wells up by flowing is required to prevent damage to the reservoir and remove drilling solids from the wells that may not be able to be handled by the FPSO in the future. Once this is achieved the well flowback will cease. Santos is not planning any extended flowbacks, typical of a well appraisal campaign, during the activity.

6.3.4 Environment impact assessment

Key receptors	Consequence level
Atmospheric emissions	
Threatened, migratory or local fauna	Short-term behavioural impacts to seabirds could be expected if they fly over the location; they may avoid the area. No decrease in local population size or area of occupancy of species, loss or disruption of critical habitat or disruption to the breeding cycle. The consequence level for threatened, migratory or local fauna (seabirds) is considered to be I – Negligible.
Physical environment/ habitat	The activity will occur in the open ocean and offshore waters. The quantities of atmospheric emissions are relatively small and will, under normal circumstances (i.e., windy conditions), quickly dissipate into the surrounding atmosphere. Greenhouse gas emissions will be released during the activity accounting for less than 0.04% of annual Australian GHG emissions. Given the relatively small quantity, detectable environmental impacts are not predicted.

Key receptors	Consequence level
	No impacts will occur to subsea features including the 'Shelf break and slope of the Arafura Shelf' KEF and its values that overlaps the operational area. The consequence level for physical environment/habitat is assessed as I – Negligible.
Threatened ecological communities	Not applicable – no threatened ecological communities identified in the area over which air emissions are expected.
Protected areas	Not applicable – no protected areas over which air emissions are expected.
Socio-economic receptors	As the activity occurs in offshore waters, the air quality in coastal towns or settlements will not be affected. The consequence level for socio-economic receptors is considered to be I – Negligible
Overall worst-case consequence level	I – Negligible

6.3.5 Demonstration of as low as reasonably practicable

Atmospheric emissions are largely unavoidable due to operational and health and safety requirements. All reasonably practicable control measures have been reviewed and those adopted are considered consistent with maritime/petroleum industry standards and appropriate to manage the impacts such that the residual consequence is assessed to be I – Negligible. The proposed management controls are in accordance with the Santos risk management criteria and are considered appropriate to manage impacts to ALARP.

6.3.6 Acceptability evaluation

Is the consequence ranked as I or II?	Yes – maximum consequence from atmospheric emissions is I – Negligible.
Is further information required to validate 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' *Offshore Division Environmental Hazard Identification and Assessment Guideline* which considers principles of ESD. Santos concludes that the activity-related impacts of atmospheric emissions will not compromise the health, diversity or productivity of the environment.
Have the acceptable levels of impact and risks been informed by relevant species recovery plans, threat abatement plans and conservation advice and Australian marine park zoning objectives)?	Yes – Marine Bioregional Plan for the North Marine Region (CoA, 2012a) includes consideration of effects of climate change on species.
Are performance outcomes, control measures and associated performance standards consistent with legal and regulatory requirements?	Yes – management consistent with *Ozone Protection and Synthetic Greenhouse Gas Management Act 1989* (and associated regulations), MARPOL VI/Marine Order 97 and *Protection of the Sea (Prevention of Pollution from Ships) Act 1983*. Through acceptance of this EP, legislative and regulatory requirements will be met as per **Section 1.6.2**.
Are performance outcomes, control measures and associated performance standards consistent with Santos Environment, Health and Safety Policy?	Yes – aligns with Santos' Environment, Health and Safety Policy.
Are performance outcomes, control measures and associated performance standards consistent with industry standards?	Yes – the most recent and comparable Drilling and Completions EPs accepted by NOPSEMA have been reviewed for consistency with the performance outcomes, control measures and associated performance standards proposed in this EP. Well flowback procedures are consistent with relevant industry practices defined in Environmentally Safe Burner For Offshore Well Testing Operations (SPE,1996) and Parameters for Properly Designed and Operated Flares (EPA, 2012).
Have performance outcomes, control measures and associated performance standards taken into consideration stakeholder feedback?	Yes – objections or claims raised relating to activity atmospheric emissions and potential environmental impacts to fauna or commercial fisheries have been considered. GHG-related matters raised by ECNT are addressed in **Section 4**.
Are performance standards such that the impact or risk is considered to be ALARP?	Yes – see ALARP above.

The consequence of atmospheric emissions on receptors is assessed as I – Negligible. Based on an assessment of Santos' acceptability criteria and with the control measures in place, there will be no substantial change in air quality that may adversely impact biodiversity, ecological integrity, social amenity or human health, and the potential impacts are considered acceptable.

6.4 Seabed and benthic habitat disturbance

6.4.1 Description of event

Event	Disturbance to the seabed will occur as a result of: + anchoring of the MODU + construction of wells + placement of objects on the seabed such as the riserless mud recovery (RMR) system, spare mooring lines and anchors, etc. Seabed disturbance may also cause a temporary increase in water quality turbidity. Note that seabed disturbance from the discharge of drill cuttings and fluids is specifically addressed in **Section 6.7**.
Extent	Localised: within the operational area.
Duration	For the duration of the activity.

6.4.2 Nature and scale of environmental impacts

Potential receptors: physical environment (benthic habitat and KEF); threatened, migratory or local fauna (benthic fauna); and socio-economic (commercial fisheries).

The MODU will need to moor (anchor) at each of the three drill centres and then kedge between drill centre wells. The MODUs mooring system will involve deploying up to 12 anchors, laid out not normally greater than 1.8 km from the MODU. Each anchor and parts of the connected line will make contact with the seabed. The extent of seabed contact will vary depending on the operation and amount of tension on the mooring line; for example, retrieving/deploying anchors, kedging (skidding) and station keeping. Excess lengths of mooring line may also be temporarily stored on the seabed. Pre-laid anchors may be installed before the MODU arrives in the operational area. Due to the catenary curve of the mooring lines, in the order of 500 to 800 m of each mooring line will be in contact with the seabed. The anchor itself has a footprint of approximately 130 m^2. The total direct seabed disturbance area from the MODU mooring system is estimated to be 1560 m^2; repeated at each of the three drill centres. In circumstances where anchors need to be reset, this may result in a larger area of disturbance.

Direct well construction footprints, including placement of the RMR system, are estimated at <5 m^2 per well.

6.4.2.1 Physical environment

The activity will involve equipment being in direct contact with the seafloor and will inevitably result in localised impact to benthic habitat (and associated fauna) in the operational area.

Benthic habitats and fauna assemblages that are expected to be impacted are considered widespread throughout the region (**Section 3.2.1.1**). Depressions on the seabed caused by the activity are predicted to infill with sediments and detrital matter over time and recovery and re-colonisation of soft sediment habitats happens in a short period of time (weeks to months).

The operational area overlaps the ‘Shelf break and slope of the Arafura Shelf’ KEF. The seafloor features associated with this KEF (i.e., the shelf break and patch reefs, hard substrate pinnacles and submerged reefs on the shelf slope) were not observed within the operational area during the Barossa marine studies program, nor are these topographically distinct features evident from the bathymetry data derived from multiple surveys undertaken across this area.

6.4.2.2 Threatened, migratory or local fauna

Habitat modification is identified as a potential threat to several marine fauna species in relevant recovery plans and conservation advice (**Table 3-9**); however, seabed disturbance at the proposed scale is not anticipated to significantly affect mobile marine fauna, such as marine mammals, marine reptiles, fish, sharks and rays. No BIAs are present in the operational area.

Based on the habitat preferences (shallower coastal and estuarine waters) of sawfish and the deep offshore marine environment of the operational area, it is considered highly unlikely that they will be present in large numbers. It is recognised that individuals may be encountered, as advised by NPF, and four sawfish species were identified within the PMST report for the operational area.

The area of seabed to be disturbed within the operational area also represents a negligible portion of the habitat available for threatened, migratory or local fauna.

6.4.2.3 Commercial fisheries

Potential impacts to benthic habitats, and subsequently to associated 'fish' species of commercial importance (e.g., scampi), will be localised with the impact to, and displacement of, fish insignificant at a stock level.

6.4.3 Environmental performance outcomes and control measures

The EPO relating to this event is:

- Seabed disturbance limited to planned activities and defined locations within the operational area. [EPO-07]

An assessment of the environmental benefits and the potential costs or issues associated with control measures for this activity are shown in **Table 6-9** to demonstrate the potential impacts from this aspect are ALARP. Control measures that are adopted have associated EPSs and measurement criteria which are presented in **Table 8-2**. Rejected control measures have an ALARP evaluation provided to justify their rejection.

Santos

Table 6-9: Control measures evaluation for seabed and benthic habitat disturbance

CM reference	Control measure	Environmental benefit	Potential cost/issues	Evaluation
Standard control measure				
BAD-CM-003	MODU station keeping system	Maintains the MODU at the desired location and provides for minimising length of mooring line deployed during anchor installation, therefore reducing potential risks to seabed habitat.	No cost/issue identified.	**Adopted** – safety critical feature that maintains the MODU on location.
Additional control measures				
BAD-CM-039	Recovery of deployed equipment	Allows for natural recovery of the seabed and benthic habitat over time.	Cost to recover equipment. Cost to replace equipment left in situ.	**Adopted** – intent is to recover equipment placed on the seabed where reasonably practicable to do so.
N/A	Use of alternative MODU so that no anchoring is required	No disturbance to seabed from anchoring.	The water depth is shallower than the minimum safe operating depth for a dynamically positioned MODU with a BOP, and too deep for a jack-up MODU.	**Rejected** – not technically feasible to use anything but a semi-submersible anchored MODU

Table 6-15 of the accepted OPP states a number of commitments to manage seabed disturbance during drilling. Of these, two are considered to have been met already and are not included as control measures within this EP:

+ OPP Commitment 1: *The MODU/FPSO facility mooring design analysis will include environmental sensitivity and seabed topography analysis to inform selection of mooring locations to avoid areas of seabed that are associated with the seafloor features/ values of the shelf break and slope of the Arafura Shelf KEF (i.e. patch reefs and hard substrate pinnacles).*

  As described in **Section 3.2.3,** the seafloor features associated with this KEF have not been observed or recorded in the operational area of this EP, therefore the required analysis is considered complete and there are no KEF seabed features to avoid during mooring.

+ OPP Commitment 2: *Shallow Hazards Study report will be completed prior to drilling of the development wells and include a review of seabed features to inform well location.*

  Section 3.2.3 summarises the geophysical and benthic habitat studies undertaken in the operational area. As no seabed features of environmental significance have been identified, no further seabed surveys, studies or reports are planned under this EP to inform the placement of wells or MODU anchors. Therefore, this commitment is considered completed.

6.4.4 Environmental impact assessment

Key receptors	Consequence level
Seabed disturbance	
Threatened/migratory fauna	Given the relatively small scale of seabed disturbance and knowledge of the existing environment, significant impacts to threatened/migratory/local marine fauna species will not occur. Marine invertebrates that may inhabit disturbed soft sediment benthic habitats are expected to occur elsewhere within the operational area and surrounds and therefore the disturbance is not expected to affect prey availability, or protected fauna species. Habitat modification is identified as a potential threat to several marine fauna species in relevant recovery plans and conservation advice (**Table 3-9**). However, benthic habitat within the operational area is well represented in the wider surrounds, and the operational area is not recognised as a BIA for marine fauna. Seabed disturbance is not expected to cause a decrease in local population size, area of occupancy of species, loss or disruption of critical habitat, or disruption to the breeding cycle of any threatened or migratory marine fauna. Hence, the consequence level is considered to be I – Negligible.
Physical environment/ habitat	The operational area overlaps the 'Shelf break and slope of the Arafura Shelf' KEF. The seafloor features associated with this KEF (i.e., the shelf break and patch reefs, hard substrate pinnacles and submerged reefs on the shelf slope) were not observed within the operational area during the Barossa marine studies program, nor are these topographically distinct features evident from the bathymetry data derived from multiple surveys undertaken across this area. The seabed disturbance footprint represents a very small portion of this KEF (<0.001 %). Species associated with the continental slope and patch reefs that characterise this KEF (such as demersal fish, whale sharks, sharks and turtles) are unlikely to aggregate within the operational area due to the lack of seafloor features. However, potential impacts to these species are described above. Localised turbidity caused by seabed disturbance is expected to be minor in nature and limited to within the operational area. Given seabed disturbance and associated turbidity caused by the activity will be detectable, the consequence level is considered to be II – Minor.
Threatened ecological communities	Not applicable – no threatened ecological communities are identified in the area where seabed disturbance could occur.
Protected areas	Not applicable – no protected areas over which seabed disturbance could occur.
Socio-economic	Not applicable – seabed disturbance is not expected to impact commercial fisheries based on the small size of disturbance compared with the total available fishing area.
Worst-case consequence level	II – Minor

6.4.5 Demonstration of as low as reasonably practicable

There are no reasonably practicable alternatives to the use of an anchored MODU in order to undertake the activity. All reasonably practicable control measures have been reviewed and those adopted are considered appropriate to manage the impacts such that the residual consequence is assessed to be II – Minor. The proposed control measures are in accordance with the Santos risk management criteria and are considered appropriate to manage the impacts to ALARP.

6.4.6 Acceptability evaluation

Is the consequence ranked as I or II?	Yes – maximum consequence to seabed and benthic habitats is II – Minor.
Is further information required to validate the consequence assessment?	No – potential impacts and risks are well understood through the information available. Extensive marine studies have been completed within the operational area to inform the assessment.
Are risks and impacts consistent with the principles of ESD?	Yes – activity evaluated in accordance with Santos' *Offshore Division Environmental Hazard Identification and Assessment Guideline* which considers principles of ESD.
Have the acceptable levels of impact and risks been informed by relevant species recovery plans, threat abatement plans and conservation advice and AMP zoning objectives)?	Yes – while several plans identify habitat modification as a threat to marine fauna, significant impacts are not predicted for this activity. Marine Bioregional Plan for the North Marine Region (CoA, 2012a) includes consideration of the 'Shelf break and slope of the Arafura Shelf' KEF. Significant impacts to this KEF are not predicted for this activity.
Are performance outcomes, control measures and associated performance standards consistent with legal and regulatory requirements?	Yes – through acceptance of this EP, legislative and regulatory requirements will be met as per **Section 1.6.2**.
Are performance outcomes, control measures and associated performance standards consistent with Santos' Environment, Health and Safety Policy?	Yes – aligns with Santos' Environment, Health and Safety Policy.
Are performance outcomes, control measures and associated performance standards consistent with industry standards?	Yes – the most recent and comparable Drilling and Completions EPs accepted by NOPSEMA have been reviewed for consistency with the performance outcomes, control measures and associated performance standards proposed in this EP.
Have performance outcomes, control measures and associated performance standards taken into consideration stakeholder feedback?	Yes – no specific objections or claims raised relating to activity seabed and benthic habitat disturbance, and potential environmental impacts to marine fauna. Matters raised by the NPF on potential impacts to sawfish species and scampi fishers have been considered in this section and addressed in **Section 4**.
Are performance standards such that the impact or risk is considered to be ALARP?	Yes – see ALARP above.

The consequence of seabed and benthic habitat disturbance is assessed as II – Minor. Based on an assessment of Santos' acceptability criteria and with the control measures in place, potential impacts are considered acceptable.

6.5 Interactions with other marine users

6.5.1 Description of event

Event	Sources of impact to other marine users may occur as a result of: + vessels on standby and frequently moving through the operational area + MODU presence during drilling and completions activities + the ongoing presence of wellheads + helicopter operations + ROVs. Other marine users within the operational area are most likely to include commercial shipping and fishing.
Extent	Operational area.
Duration	Temporary and intermittent interaction with third party vessels when transiting the operational area.

6.5.2 Nature and scale of environmental impacts

Potential receptors: socio-economic (primarily commercial fisheries and shipping traffic).

There are four Commonwealth fisheries and four NT fisheries that overlap the operational area (**Section 3.2.6**). 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 there is a low potential for interaction with commercial fisheries. Only the Northern Prawn Fishery, Timor Reef Fishery and Offshore Net and Line Fishery are likely to be active in the operational area, albeit in low density.

A number of Indonesian fishers may traverse the operational area but significant disruption to these fisheries is not expected, given the typical water depths they operate in and the vast areas available to the fisheries.

The closest shipping lane and oil and gas facility (Santos Bayu-Undan Platform) are approximately 60 km and 409 km from the operational area respectively. There are no designated military/defence exercise areas within the operational area. Hence, general shipping traffic within the operational area is expected to be low.

Tourism and recreational fishing are not expected in the operational area given the water depths and distance from land.

Other marine users may be inhibited by the temporary presence and activities of the moored MODU and/or vessels. The ongoing presence of the wellheads and associated 500 m PSZ may be an inconvenience for a limited number of marine users; i.e., commercial fishers.

Helicopter operations within the operational area will be infrequent and unlikely to interfere with other marine users.

6.5.3 Environmental performance outcomes and control measures

The EPO relating to this event is:

+ No significant impacts to other marine users. (EPO-01)

An assessment of the environmental benefits and the potential costs or issues associated with control measures for this activity are shown in **Table 6-10** to demonstrate the potential impacts from this aspect are ALARP. Control measures that are adopted have associated EPSs and measurement criteria which are presented in **Table 8-2**. Rejected control measures have an ALARP evaluation provided to justify their rejection.

Table 6-10: Control measures evaluation for interaction with other marine users

CM reference	Control measure	Environmental benefit	Potential cost/issues	Evaluation
Standard control measures				
BAD-CM-015	Maritime notices	Maritime notifications ensure marine users are informed of the proposed activities, reducing the likelihood of unplanned interactions.	Negligible costs.	**Adopted** – it is a regulatory requirement.
BAD-CM-016	Support vessel	Minimises the risk of a third-party vessel colliding with the MODU and vessels through visual identification and communication with other vessels.	Significant cost to charter support vessels. MODU safety case requires a standby vessel during drilling for emergency response purposes and therefore the cost is not identified as an issue.	**Adopted** – benefits considered to outweigh costs.
BAD-CM-022	Santos stakeholder consultation	Stakeholder consultation ensures marine users are aware of the proposed activities, reducing the likelihood of unplanned interactions; and provides marine users an opportunity to request practicable interface control measures.	Cost to prepare and distribute information, and to address any feedback provided.	**Adopted** – benefits considered to outweigh costs.
BAD-CM-024	MODU identification systems	MODU automatic identification systems (AIS) aid in their detection at sea by third party vessels, thereby reducing the potential for interaction and collision.	Standard maritime navigational equipment; SOLAS regulated and therefore the cost is not identified as an issue.	**Adopted** – it is a regulatory requirement.
BAD-CM-034	Minimum lighting for maritime safety	Ensures the MODU and vessels are seen by other marine users, thereby reducing the potential for interaction and collision.	Standard maritime safety and navigational equipment; regulatory requirement and therefore the cost is not identified as an issue.	**Adopted** – it is a regulatory requirement.
BAD-CM-035	No fishing from MODU or vessels	Avoids impacts to fish stocks.	Negligible costs.	**Adopted** – benefits considered to outweigh costs. Standard Santos commitment for its offshore activities.

CM reference	Control measure	Environmental benefit	Potential cost/issues	Evaluation
BAD-CM-036	Seafarer certification	Demonstrates appropriately trained and competent personnel to navigate vessels to reduce interaction with other marine users.	Costs associated with personnel time in obtaining qualifications.	**Adopted –** it is a regulatory requirement.
BAD-CM-038	Petroleum Safety Zone (500 m) established	PSZ alerts other marine users to the presence of the MODU and wellheads, thereby reducing the likelihood of vessel collision and fishing gear snagging.	Negligible costs; regulatory requirement. Excludes commercial fishers from prospective fishing grounds.	**Adopted** – it is a regulatory requirement; exclusion area is insignificant compared to the expansive fishing grounds.
Additional control measures				
N/A	Eliminate the use of vessels	Would eliminate potential impacts to other marine users.	Not technically feasible to conduct a drilling operation without support vessels given the need to transfer large volumes of equipment and products.	**Rejected** – not technically feasible.
N/A	Manage the timing of the activity to avoid marine users	Would eliminate potential impacts to other marine users. Northern Prawn Fishery (NPF) scampi fishing occurs between December and February.	Not considered reasonably practicable as the drilling activity is longer than 12 months in duration. Significant costs to demobilise/re-mobilse the MODU and vessels.	**Rejected** – marine users could be present in the operational area at any time of the year. The area that marine users will be excluded from is small when compared to the large area available for their use. As detailed in **Section 4**, Santos understands scampi fishing occurs in the northern extremity of the operational area and surrounding deep water (where drilling and vessel activities will not occur). Hence, avoidance of the fishing period is not considered necessary.

6.5.4 Environmental impact assessment

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 other incidental marine traffic in the area is expected to be low. The area that marine users will be excluded from is small when compared to the large area available for their use. Marine users within the operational area have coexisted with previous Barossa petroleum activities (e.g., exploration drilling) and other nearby marine users (e.g., military exercises). Communication before and during the activity will reduce the likelihood of unplanned interaction with other marine users. Hence, the consequence level for potential interaction with other marine users is considered to be I – Negligible.
Overall worst-case consequence	I – Negligible

6.5.5 Demonstration of as low as reasonably practicable

There are no alternatives to the use of a MODU and vessels to undertake the activity, and a 500 m PSZ around the MODU/wellheads is required in accordance with the OPGGS Act. No objections or claims have been raised by relevant stakeholders about the PSZ.

All reasonably practicable control measures have been reviewed and those adopted are considered appropriate to manage the impacts such that the residual consequence is assessed to be I – Negligible. The proposed control measures are in accordance with the Santos risk management criteria and are considered appropriate to manage impacts to ALARP.

6.5.6 Acceptability evaluation

Is the consequence ranked as I or II?	Yes – maximum consequence from interaction with other marine users is I – Negligible.
Is further information required to validate the consequence assessment?	No – potential impacts and risks are well understood through the information available and stakeholder consultation.
Are the risks and impacts consistent with the principles of ecological sustainable development?	Yes – activity evaluated in accordance with Santos' *Offshore Division environmental hazard identification and assessment guideline* which considers principles of ESD.
Have the acceptable levels of impact and risks been informed by relevant species recovery plans, threat abatement plans and conservation advice and Australian marine park zoning objectives)?	Not applicable.
Are performance outcomes, control measures and associated performance standards consistent with legal and regulatory requirements?	Yes – management consistent with the International Convention for the SOLAS 1974, *Marine Safety (Domestic Commercial Vessel) National Law Act* 2012, *Navigation Act 2012* and the OPGGS Act (requirement for a PSZ). Through acceptance of this EP, legislative and regulatory requirements will be met as per **Section 1.6.2**.
Are performance outcomes, control measures and associated performance standards consistent with Santos' Environment, Health and Safety Policy?	Yes – aligns with Santos' Environment, Health and Safety Policy.
Are performance outcomes, control measures and associated performance standards consistent with industry standards?	Yes – the most recent and comparable Drilling and Completions EPs accepted by NOPSEMA have been reviewed for consistency with the performance outcomes, control measures and associated performance standards proposed in this EP.
Have performance outcomes, control measures and associated performance standards taken into consideration stakeholder feedback?	Yes – requests relating to managing activity interaction with other marine users including the NPF have been considered in **Section 4**.
Are performance standards such that the impact or risk is considered to be ALARP?	Yes – see ALARP above.

The consequence of interaction with other marine users is assessed as I – Negligible. Based on an assessment of Santos' acceptability criteria and with the control measures in place, potential impacts are considered acceptable.

6.6 Operational discharges

6.6.1 Description of event

Event	Potential impacts may occur in the operational area from operational discharges of: + deck drainage/runoff + sewage and grey water + food wastes + cooling water + bilge water + brine (if a reverse osmosis unit is used for water treatment) + ballast water. *Deck drainage* Drainage water on offshore facilities (i.e., MODU and vessels) consists of rainwater, seawater and wash-down water. Such discharge may potentially contain small residual quantities of oil, grease and detergents if present or used on the decks. Assessment of the unplanned spillage of hydrocarbons and other environmentally hazardous liquids is discussed in **Section 7**. *Sewage and grey water* The volume of sewage and grey water is directly proportional to the number of persons on-board the MODU and vessels. Up to 30 to 40 L of sewage/grey water may be generated per person (pp) per day. Approximately 140 pp onboard the MODU and 18 pp per vessel (up to four vessels) results in an estimated 8,480 L/day. *Food waste* Putrescible waste potential discharge to sea is estimated to consist of approximately 1 L of food waste per person per day. Approximately 140 pp onboard the MODU and 18 pp per vessel (up to four vessels) results in an estimated 212 L/day. *Cooling water* Seawater will be used as a heat exchange medium for the cooling of machinery engines. Seawater is drawn from the ocean and flows counter current through closed-circuit heat exchangers, transferring heat from engines and machinery to the seawater. The seawater is then discharged to the ocean (i.e., it is a once-through system). Cooling water temperatures may vary depending on engine workload and activity. *Bilge water* While in the operational area, the MODU and vessels may discharge oily bilge water after treatment to 15 ppm via an oily water filter system. *Brine* Brine generated from the water supply systems on board the MODU and vessels will be discharged to the ocean at a salinity of approximately 10% higher than seawater. The volume of the discharge depends on the requirement for fresh (or potable) water and will vary between the MODU/vessels and the number of people on board. The effluent may contain scale inhibitors to control inorganic scale formation, such as the formation of calcium carbonate and magnesium hydroxide, in water-making plants. Other water purification and plant cleaning chemicals may be used and discharged to sea after completion of the cleaning process. *Ballast water* Ballast water could potentially be discharged to the marine environment from the MODU or vessel ballast tanks.

	Firefighting foam Firefighting foam used on board the MODU and vessels will not be discharged to sea during testing of the firefighting system in the operational area.
Extent	The small volumes of operational discharges may cause localised nutrient enrichment, organic and particulate loading, ecotoxicological effects, and increase water temperature and salinity around discharge points and in the direction of the prevailing current. The environment that may be affected by operational discharges will likely be contained within the operational area.
Duration	During the period of the activity, localised changes to water quality will occur, however, water quality conditions will return to normal within minutes to hours of cessation of discharges.

6.6.2 Nature and scale of environmental impacts

Potential receptors: physical environment (water quality, benthic habitats including KEF), threatened, migratory or local fauna (marine mammals, marine turtles, sharks, rays and fish (pelagic) and seabirds).

6.6.2.1 Physical environment

Small volumes of operational discharges will be released to the marine environment and result in a localised reduction in water quality.

Discharges will be temporary (minutes to hours), localised and limited to surface waters. The discharges are expected to be dispersed and diluted rapidly.

The operational area occurs within the 'Shelf break and slope of the Arafura Shelf' KEF. The seafloor features associated with this KEF (i.e., the shelf break and patch reefs, hard substrate pinnacles and submerged reefs on the shelf slope) were not observed within the operational area during the Barossa marine studies program, nor are these topographically distinct features evident from the bathymetry data derived from multiple surveys undertaken across this area. Hence, operational discharges are unlikely to impact the KEF. Species associated with the continental slope and patch reefs that characterise this KEF (such as demersal fish, whale sharks, sharks and turtles) are unlikely to aggregate within the operational area due to the lack of seafloor features. However, potential impacts to these species are described below.

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

Eutrophication impacts from sewage, grey water and putrescible wastes

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

However, dispersion and dilution of discharges is expected to be rapid, as the discharges are of low volume. The organic components of discharges are subject to biodegradation through bacterial action, oxidation and evaporation, and the operational area is located in deep offshore waters dominated by high currents, resulting in short-term changes to surface water quality within the operational area. Modelling of wastewater discharges from an FPSO was undertaken for the Barossa Development (ConocoPhillips, 2018) and indicated that discharges would be mixed to very low levels within a maximum distance of 53 m (based on higher flow rates expected during commissioning). The volumes and discharge rates expected during this drilling activity would be much less and therefore likely to result in dilution within a smaller radius.

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

Salinity increases

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

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

Changes in temperature

Cooling water will be discharged at a temperature above ambient seawater temperature. Upon discharge it will be subjected to turbulent mixing and transfer of heat to the surrounding waters. Cooling water discharge to the marine environment could result in a localised and temporary increase in the ambient water temperature which may cause alteration of the physiological processes (particularly enzyme-mediated processes) in marine biota.

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

Temperature dispersion modelling undertaken for the Barossa Development (RPS APASA, 2017) for an FPSO shows that the temperature of discharged water will decrease rapidly as the discharge mixes with the receiving waters, returning to within 3^{o}C of ambient water temperature within approximately 12 m of the discharge location (horizontally) and less than 70 m below the sea surface. The discharge volumes from an FPSO would be expected to be much higher rates than those of a MODU and vessels used for this activity due to the difference in size and equipment type used, and it is considered unlikely to extend beyond the area described by this modelling.

Contamination from releases of bilge water

Discharges of oily bilge water could result in a localised reduction in water quality with impacts on protected marine fauna and plankton. If not properly managed, the discharge of oily water has the potential to create an oil sheen on surface waters and a temporary localised decline in water quality and toxic effects to marine fauna. Toxicity to marine organisms would be from small amounts of dissolved hydrocarbons in the oily water drainage after treatment. 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.

Toxicity

Discharges from vessel and MODU systems may include typical chemicals used within standard maritime sewage systems, desalination systems and residues of those used for cleaning decks. Discharges are expected to be intermittent and similar to other permitted discharges from vessels.

On discharge to the marine environment, the low volumes of these types of chemicals are expected to rapidly disperse in the offshore marine environment. There may be a localised and temporary (hours) reduction in water quality in the immediate vicinity of the release.

Toxic environmental effects on environmental receptors along the food chain, namely, plankton, fish, marine reptiles, birds and cetaceans are therefore not expected in deep open waters.

6.6.2.2 Threatened, migratory or local fauna

As discussed in the sections above, the extent of impact for planned discharges is localised, and rapid dilution is predicted to occur within the offshore waters. Marine fauna within the operational area are likely to be transient. If contact does occur with marine fauna, it will be for a short duration likely not of sufficient duration to cause a toxic effect.

Discharges may cause changes to behaviour in marine fauna (avoidance or attraction). Fishes and oceanic seabirds may be attracted to the discharge of macerated food scraps. However, such discharges would be isolated occurrences, so no prolonged influence on faunal behaviour is expected.

6.6.3 Environmental performance outcomes and control measures

The EPOs relating to this event include:

+ No injury or mortality to EPBC Act-listed marine fauna. (EPO-05)
+ No significant changes to air, sediment and water quality. (EPO-06)

An assessment of the environmental benefits and the potential costs or issues associated with control measures for this activity are shown in **Table 6-11** to demonstrate the potential impacts from this aspect are ALARP. Control measures that are adopted have associated EPSs and measurement criteria which are presented in **Table 8-2**. Rejected control measures have an ALARP evaluation provided to justify their rejection.

Table 6-11: Control measures evaluation for operational discharges

CM reference	Control measure	Environmental benefit	Potential cost/issues	Evaluation
Standard control measures				
BAD-CM-004	Waste (garbage) management procedure (food waste)	Ensures food waste is disposed to sea in accordance with MARPOL Annex V (and Marine Order 95: Marine pollution prevention – garbage).	Cost of compliance with MARPOL. Significant health risks from storing putrescible waste onboard in a tropical environment.	**Adopted** – health risks outweigh any potential environmental impacts; permissible activity by maritime regulations.
BAD-CM-006	Deck cleaning product selection	Ensures deck cleaning products are not harmful to the marine environment according to MARPOL Annex V (and Marine Order 93: Noxious liquid substances).	Personnel costs of implementing. Limits deck cleaning products available for use.	**Adopted** – benefits of ensuring MODU/ vessels are compliant outweighs the potential costs.
BAD-CM-007	Chemical selection procedure (firefighting foam)	Reduces potential impacts from firefighting foam by preventing discharge during testing.	No cost.	**Adopted** – benefits the environment by preventing firefighting foam discharge.

CM reference	Control measure	Environmental benefit	Potential cost/issues	Evaluation
BAD-CM-026	Sewage treatment system	Ensures sewage is treated and discharged in accordance with MARPOL Annex VI (and Marine Order 96: Marine pollution prevention – sewage).	Cost of compliance with MARPOL.	**Adopted** – benefits of ensuring MODU/ vessels are compliant outweighs the potential costs; permissible activity by maritime regulations.
BAD-CM-027	Oily water treatment system	Ensures oily water is treated and discharged in accordance with MARPOL Annex I (and Marine Order 91: Marine pollution prevention – oil).	Cost of compliance with MARPOL.	**Adopted** – benefits of ensuring MODU/ vessels are compliant outweighs the potential costs; permissible activity by maritime regulations.
Additional control measures				
N/A	Zero discharge of deck water	Would eliminate potential contaminants being discharged to sea.	Increased 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 environmental benefit for a remote offshore location. It is a permissible maritime discharge.
N/A	Zero discharge of bilge water	Would eliminate treated oily water from being discharged to sea.	Costs associated with containment and onshore disposal of oily water. Storage of oily water would create an additional hazard for working on deck.	**Rejected** – safety considerations outweigh the environmental benefit for a remote offshore location; discharge of treated oily water is a permissible maritime discharge.
N/A	Zero discharge of sewage	Would eliminate treated sewage from being discharged to sea.	Significant health risks from storing sewage onboard. Costs associated with containment and onshore disposal of sewage. Storage of sewage would create an additional hazard for working on deck.	**Rejected** – health and safety considerations outweigh the environmental benefit for a remote offshore location; discharge of treated sewage is a permissible maritime discharge.

CM reference	Control measure	Environmental benefit	Potential cost/issues	Evaluation
N/A	Zero discharge of cooling water	Would eliminate seawater at higher temperature from being discharged to sea.	N/A.	**Rejected** – not technically feasible to operate a MODU or vessel without cooling water; or to install a cooling skid onboard the MODU or vessels.
N/A	Restrict use of desalination plant; or zero discharge of brine water	Would eliminate or reduce brine from being discharged to sea.	Cost associated with transporting potable water offshore. Health risks associated with limited supply of potable water. Costs associated with containment and onshore disposal of brine. Storage of brine would create an additional hazard for working on deck.	**Rejected** – health and safety considerations outweigh the environmental benefit for a remote offshore location; use of 'water making' system and discharge of waste brine is a permissible maritime discharge.
N/A	Zero discharge of putrescible waste	Would eliminate putrescible waste from being discharged to sea.	Significant health risks from storing putrescible (food) waste onboard in a tropical environment. Costs associated with containment (cold storage) and onshore disposal of waste.	**Rejected** – health and safety considerations outweigh the environmental benefit for a remote offshore location; discharge of food waste is a permissible maritime discharge.
N/A	Mandatory closed drain system on vessels	Would eliminate untreated deck drainage from being discharged to sea.	Increased cost due to treatment system and vessel modification requirements.	**Rejected** – costs significantly outweigh the environmental benefit given the minor impacts expected from planned discharges.

6.6.4 Environmental impact assessment

Key receptors	Consequence level
Operational discharges	
Threatened, migratory or local fauna	Sensitive receptors that may be impacted include plankton, fish at sea surface, marine turtles and mammals, and seabirds. Impacts to water quality will be localised and will occur only as long as the discharges occur (i.e., no sustained impacts), therefore recovery will be measured in hours to days. Consequently, only short-term behavioural impacts are expected with no decrease in local population size, area of occupancy of species, loss or disruption of habitat critical or disruption to the breeding cycle. Given the nature of the planned operational discharges, the relatively small volumes that could be released to the marine environment, the high levels of dilution and the nature of the marine environment near the operational area, the consequence level for threatened, migratory or local fauna is considered to be II – Minor.
Physical environment or habitat	Operational discharges are predicted to quickly dilute and disperse in the offshore environment. Water quality changes will be localised and will occur only as long as the discharges occur. Any effects on water quality are expected to be within the surface waters only and have no effect on seabed receptors (including the 'Shelf break and slope of the Arafura Shelf' KEF that overlaps the operational area). Species associated with the continental slope and patch reefs that characterise this KEF (such as demersal fish, whale sharks, sharks and turtles) are unlikely to aggregate within the operational area due to the lack of seafloor features. However, potential impacts to these species are described above. Given the nature of the planned operational discharges, the relatively small volumes that could be released to the marine environment, the high levels of dilution and the nature of the marine environment near the operational area, the consequence level for physical environment or habitat is considered to be II – Minor.
Socio-economic receptors	Not applicable – Given the controls in place to manage the discharges in accordance with regulatory requirements, impacts to commercial fish species are not predicted.
Threatened ecological communities	Not applicable – no threatened ecological communities identified in the area over which operational discharges are expected.
Protected areas	Not applicable – no protected areas identified in the area over which operational discharges are expected.
Overall worst-case consequence	II – Minor

6.6.5 Demonstration of as low as reasonably practicable

A MODU and vessels are required to undertake the activity.

On-board treatment of most wastes and their subsequent discharge to the marine environment is consistent with legislative requirements (such as MARPOL) and considered environmentally acceptable.

All reasonably practicable control measures have been reviewed and those adopted are considered appropriate to manage the impacts such that the residual consequence is assessed to be II – Minor. The proposed control measures are in accordance with the Santos risk management criteria and are considered appropriate to manage impacts to ALARP.

6.6.6 Acceptability evaluation

Is the consequence ranked as I or II?	Yes – maximum planned operational discharge consequence is rated II – Minor.
Is further information required to validate the consequence assessment?	No – potential impacts and risks are well understood through the information available.
Are risks and impacts consistent with the principles of ESD?	Yes – activity evaluated in accordance with Santos' *Environmental Hazard Identification and Assessment Procedure*, which considers principles of ESD.
Have the acceptable levels of impact and risks been informed by relevant species recovery plans, threat abatement plans and conservation advice and Australian marine park zoning objectives)?	Yes – consistent with relevant species recovery plans, conservation management plans and management actions set out in **Table 3-9**, including: + Recovery Plan for Marine Turtles in Australia 2017–2027 (DoEE, 2017) + Wildlife Conservation Plan for Migratory Shorebirds (CoA, 2015c) + Marine Bioregional Plan for the North-West Marine Region (CoA, 2012b).
Are performance outcomes, control measures and associated performance standards consistent with legal and regulatory requirements?	Operational discharges are compliant with the requirements of the *Protection of the Sea (Prevention of Pollution from Ships) Act 1983*, which in Australian waters reflects MARPOL, and is enacted by: + Marine Order 91 (Marine pollution prevention – oil) + Marine Order 95 (Marine pollution prevention – garbage) + Marine Order 96 (Marine pollution prevention – sewage).
Are performance outcomes, control measures and associated performance standards consistent with Santos' Environment, Health and Safety Policy?	Yes – aligns with Santos' Environment, Health and Safety Policy.
Are performance outcomes, control measures and associated performance standards consistent with industry standards?	Yes – the most recent and comparable Drilling and Completions EPs accepted by NOPSEMA have been reviewed for consistency with the performance outcomes, control measures and associated performance standards proposed in this EP.
Have performance outcomes, control measures and associated performance standards taken into consideration stakeholder feedback?	Yes – no objections or claims raised relating to activity operational discharges.
Are performance standards such that the impact or risk is considered to be ALARP?	Yes – see ALARP above.

The consequence of operational discharges on receptors is assessed as II – Minor. Based on an assessment of Santos' acceptability criteria and with the control measures in place, potential impacts are considered acceptable.

Santos

6.7 Drilling and completions discharges

6.7.1 Description of event

Event	Potential impacts may occur in the operational area from the discharge of: + drilled solids (or cuttings) + drilling fluids + lost circulation materials + brines + cement (set or unset) + control fluid from BOP and Christmas Tree valve testing + other miscellaneous chemicals and additives such as tracer dyes and cement spacer + formation water which may be produced from the reservoir during well flowback and would be discharged to sea. During the activity, the estimated discharge volumes that could be expected per well[1] : + 7,700 m^3 of water-based drill fluids and completion fluids + 1,300 m^3 of cuttings + 440 m^3 of NAF-based cuttings discharged at surface (if contingency NAF used; there will be no bulk discharges of NAF) + 200 m^3 of brine + 150 m^3 of cement slurry during cementing of conductors and casings + 130 m^3 of cement (wet) from flushing tanks and lines, cement spacer and/or a cement job not meeting technical and safety standards + 200 m^3 residual drilling fluids + aqueous-based lost circulation material (LCM) may also be pumped downhole at times. Cutting discharge volumes are calculated based on the expected wellbore section sizes and lengths and include some contingency. The total volume of drilling fluid and cement is an estimate based on previous drilling and completion programs. There are many variables during drilling campaigns that could cause the abovementioned volumes to change; for example, re-spud or side-tracking could be required and/or the interval length could change. Some of these variations could cause the estimated discharge volumes to increase or decrease, in particular the need for re-spud or side-track. Any formation water produced during well flowback would be discharged to the marine environment following oil filtration. The volume of formation water is expected to be low, but volumes depend on well performance and reservoir properties. However, the discharge will be limited to the duration of the well flowback. Unused bulk stock on-board the MODU will be managed in according with the decision list in **Table 6-12**, if discharged, approximately 150 m^3 of bulk cement and 80 m^3 of bulk barite/bentonite/brine could be expected.

Extent	Drilling discharges with larger particle sizes such as large drill cuttings are expected to settle directly around the MODU and wells, whereas discharges with finer particles such as drilling muds could be carried with prevailing currents before settling. The seabed area affected by drill cuttings is expected to be localised with the higher concentration of cuttings in the immediate vicinity of the wells. Turbidity from drilling-related discharges is expected to affect water quality near the MODU periodically during drilling. Formation water and control fluids from valve testing are expected to dissipate rapidly and be diluted within the operational area.
Duration	Water quality changes are expected to recover within hours to days following cessation of drilling and completion discharges. Sediment deposition will occur during the activity, with finer particles continuing to settle for approximately two weeks following the drilling activity, with ecological recovery of the benthic habitat expected within months to a year

6.7.1.1 Drilling discharges

The activity will use WBM for all hole sections, however as a contingency, non-aqueous fluids (NAF) may also be used for intermediate and/or production hole sections should technical issues be encountered (**Section 2.3**). These drill fluids will be discharged as follows:

+ The WBM will be discharged at the seabed for the riser-less surface holes. The fluids used for the 20-inch hole section may be partly drilled using a RMR system, in which case some of the WBM will be discharged at the sea surface. WBM used in intermediate and production holes will be discharged at the sea surface.
+ If the intermediate/production holes are drilled with the contingency NAF system, drilled cuttings will be processed through primary and secondary solids control equipment (SCE) to reduce the amount of residual NAF on discharged cuttings to less than 10% (weight per weight (w/w); i.e., mass percentage of NAF on dry cuttings. Remaining volumes of NAF will be transported to the mainland for reconditioning and recycling or disposal onshore.

As detailed in **Section 6.7.1.11**, the fluids and components of the drilling and completion fluids will be selected in accordance with the *Offshore Division Drilling Chemical Selection and Approval Process* (EA-91-II-00007) to ensure that environmentally acceptable products are used or the risks can be demonstrated to be ALARP from the use of other chemicals.

The total estimated volumes of drill cuttings generated per well during the activity is approximately 1, 300 m^3 of water-based cuttings. Drill cuttings associated with the surface hole sections will be discharged at the seabed, unless the RMR system is used for the 20-inch section (as mentioned above), in which case those cuttings will be processed over primary SCE and discharged at the sea surface. Drill cuttings from the deeper well sections will be recirculated to the MODU for processing over primary SCE and discharged at the sea surface. The total estimated volumes of NAF based cuttings generated if the contingency is required for both intermediate and production holes is approximately 440 m^3 per well. NAF based drill cuttings will be recirculated to the MODU for processing over primary and secondary SCE and discharged at the sea surface.

6.7.1.2 Cement discharges

Cement will be used to form permanent barriers and fix casings in place before drilling ahead with subsequent sections in the well. Cement in the annular space between casing and formation will form a seal to ensure the circulation system remains closed. Cement may also be used to seal a lost circulation zone, plug the wells from which a sidetrack may be drilled and when abandoning the wells.

The majority of cement pumped remains downhole, but minor volumes may be discharged at the seabed (when cementing conductor or surface casing) or at surface (when flushing lines or tanks). Some cement may be mixed and discharged as part of cement unit commissioning before the start of a campaign if the cement unit/pump has not been used before or in a considerable period of time.

Once drilling begins, approximately 150 m^3 of cement slurry per well (consisting of wet cement and cementing additives) may be discharged to the seabed during cementing of conductors and casings. Excess cement may also be released to the seabed if contingency activities are required, such as sidetrack drilling (where cement is used for plugs set for side-tracking) or well abandonment (where cement plugs are installed to create permanent barriers).

During drilling, unplanned discharge of cement slurry (consisting of wet cement and cementing additives) at sea surface may be required as a contingency in the event of contamination or if technical issues with the cement system are experienced.

It is intended to transfer any excess dry bulk cement left over at the end of the activity to the next operator using the rig. However, if unable to transfer, the excess cement will be mixed into a slurry and pumped overboard at sea surface at the end of the Barossa Development Drilling Campaign. This slurry will not contain additives. Decisions will be made according to **Table 6-12**.

Additives are required to create a wet cement mixture that meets technical and performance criteria. Cement additives are generally non-toxic or low toxicity, and include products such as extenders, retarders, antifoamers, dispersants and surfactants. Any surplus cementing additives at the end of the activity will not be discharged to the marine environment and will be returned to shore for reuse or disposal.

6.7.1.3 Lost circulation material

Lost circulation can occur in any hole interval and varies in severity. Lost circulation occurs when the drilling fluid flows into natural geological fissures, fractures or caverns. In the surface interval, when drilling riserless, it is often not necessary to take any action to cure the losses as they often self-cure once sufficient cuttings have entered the loss zone.

For losses that have to be cured, there is a choice of options available. Conventional LCM additives such as granular and fibrous material are usually pumped into the loss zone in the first instance. When conventional LCM additives fail to plug the loss zones it may be necessary to pump speciality lost circulation additives, such as cement or cross-linked polymers to heal the loss zones. By design the LCM enters the loss zone thereby plugging it and allowing drilling operations to re-commence. Typically, the LCM additives remain in the subsurface loss zone and do not return to surface. On some occasions the lost circulation is cured before all the material pumped enters the loss zone. When this occurs, the lost circulation material remains in the wellbore until it is usually circulated back to the surface where it is discharged along with the cuttings.

6.7.1.4 Residual drilling fluid discharges

Excess sweeps and mud will be retained in the surface mud pit system, in the event that WBM is required to be pumped while running surface casing. Once the surface casing is run and cemented, surface residual volumes will be discharged to the marine environment, in order to change over to a NAF based system (if required). Non-recyclable water-based fluid would be discharged at the sea surface via the master mud pit dump valve, estimated at up to 200 m3 per well.

6.7.1.5 Blowout preventer and Christmas tree control fluid discharges

A BOP will be installed before drilling the production hole sections, and Christmas trees will be installed on each of the wells once drilling is complete. The BOP and Christmas trees will be routinely checked by completing pressure and function testing. Each function test will release control fluid (approximately 60 to 600 L) to the marine environment. The control fluids are subject to the *Santos Offshore Division Drilling Chemical Selection and Approval Process (EA-91-II-00007)* described in **Section 6.7.1.11**.

6.7.1.6 Miscellaneous chemicals

Tracer dyes may also be used during cementing operations and for equipment leak detection. Other chemicals used during drilling that are planned to be discharged to sea are subject to the *Santos Offshore Division Drilling Chemical Selection and Approval Process (EA-91-II-00007)* described in **Section 6.7.1.11**.

6.7.1.7 Formation water

Formation water which may be produced from the reservoir during well flowback and discharged to sea. This will notionally take 24 to 36 hrs per well pending well and surface process conditions. The non-flammable completion fluids and produced water will be treated via a water treatment package to reduce the oil-in-water content to <30 mg/L before operational discharge. Other chemicals such as methanol and MEG may also be injected into the flow stream and either flared or discharged to sea.

Water that has been condensed from the steam used to heat the fluids via a steam exchanger in the well flowback package will also be discharged to sea. It is estimated that approximately 100 m^3 of heated water at a notional temperature of 60°C could be discharged to sea per well flowback. The discharge rate would be notionally 2 to 3 m^3 per hour.

6.7.1.8 Tank cleaning

At stages during the activity, tanks may need to be cleaned, including mud pits (i.e., tanks used to mix and hold brine, sweeps or WBM), cement mixing/holding tanks and bulk storage tanks. Cleaning may be required to remove or flush 'dead' or residual volumes of WBM, or settled inert solid material and also if switching between WBM and NAF. The cement system will need to be flushed to prevent curing inside the cement unit and pipework after each cement job is completed. In most instances, tanks and pipework would be flushed with seawater or drill water and the diluted fluid discharged to sea surface.

6.7.1.9 Well completion

At the end of drilling and evaluation activities, the wells will be completed in preparation for production as described in **Section 2.3.7**.

6.7.1.10 Residual bulk products

Unmixed bulk drilling fluid solid additives (barite and bentonite), dry cement, brine and drill water will be managed in accordance with the decision list in **Table 6-12**.

Table 6-12: Decision list for managing bulk powders[7] and brines remaining on the mobile offshore drilling unit at the end of drilling campaign

Trigger	Fate of stock	Reasoning
Well is not the last well in the MODU schedule and ongoing use of the product is anticipated.	Retain stock Stock will be retained on-board for use in the next well, or may be sent for temporary storage on a supply vessel. This option eliminates overboard disposal.	These products are expensive. Santos' preferred option is to use all stock in subsequent wells in the MODU schedule to minimise activity costs and reduce discharges.
Well is the last well in the MODU schedule and the next Operator is willing to buy the stock.	Sell stock Stock will be retained on-board or may be sent for temporary storage on a supply vessel for used by the next Operator. This option eliminates overboard disposal.	It may be possible for Santos and the next Operator using the MODU to transfer ownership of the unmixed stock. The implementation of this option is dependent on demand and commercial agreements.
Well is the last well in the MODU schedule and selling the stock to the next Operator is not an option.	Minimise stock Santos will have measures in place to reduce the stock requiring disposal at the end of the activity. This option requires some overboard disposal.	Stock minimisation measures will be put in place without compromising the minimum bulk stock required for well control or dealing with lost circulation.
Well is the last well in the MODU schedule, selling the stock to the next Operator is not an option but another Santos operated MODU is in proximity and can take on stock.	Transfer stock to alternative MODU This option eliminates overboard disposal.	Stock can be transported to an alternate MODU dependent on whether: + Santos has another MODU operating in the region + alternative MODU can use the product + travel distance and cost associated with transporting the stock to the alternative MODU are not prohibiting + alternate MODU has the capacity to take on additional stock.
All other disposal options have been exhausted.	Overboard disposal of stock Stock will be discharged as wet slurry.	Disposal volumes will be minimal due to stock minimisation. Under normal circumstances where the well is the last well in the program and the well drills to plan, the stock cement usually does not exceed 150 m^3. Barite and bentonite stocks are unlikely to exceed 80 m^3 each. A decision log will be prepared demonstrating that this disposal option is ALARP and acceptable.

[7] Bulk powders include any of the following: barite, bentonite and cement.

6.7.1.11 Drilling fluid and chemical selection

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

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

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

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

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

<u>Ecotoxicity assessment</u>

Table 6-13 and **Table 6-14** act as guidance in assessing the ecotoxicity of chemicals during the investigation of potential alternatives. **Table 6-13** is used by the United Kingdom Centre for Environment, Fisheries and Aquaculture (Cefas) to group a chemical based on ecotoxicity results, 'A' representing highest toxicity/risk to environment and 'E' lowest. **Table 6-14** shows classifications/categories of toxicity against aquatic toxicity results.

Table 6-13: Initial Offshore Chemical Notification Scheme grouping

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

Note: Aquatic toxicity refers to the Skeletonema costatum *EC_{50},* Acartia tonsa *LC_{50}, and* Scophthalmus maximus *(juvenile turbot) LC_{50} toxicity tests. Sediment toxicity refers to the* Corophium volutator *LC_{50} test.*
Source: Cefas Standard Procedure 2019, OCNS 011 NL Protocol PART 1: Core Elements

Table 6-14: Aquatic species toxicity grouping

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

Source: United Nations (2019) Globally Harmonized System of classification and labelling of chemicals (GHS), Eighth Revised Edition.

<u>Biodegradation assessment</u>

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

Cefas categorises biodegradation into the groups of:

+ readily biodegradable: results of greater than X% biodegradation in 28 days to an OSPAR harmonised offshore chemical notification format (HOCNF) accepted ready biodegradation protocol
+ moderately biodegradable: results greater than 20% and less than X% to an OSPAR HOCNF accepted ready biodegradation protocol
+ poorly biodegradable: results from OSPAR HOCNF accepted ready biodegradation protocol.

Where X is equal to:

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

<u>Bioaccumulation assessment</u>

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

The following guidance is used by Cefas:

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

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

All drilling and completion chemicals will be selected in accordance with the Santos *Offshore Division Drilling Chemical Selection and Approval Process (EA-91-II-00007).*

6.7.2 Nature and scale of environmental impacts and risks for the activities

Potential receptors: physical environment (water quality, benthic habitat, KEF); threatened, migratory or local fauna; and socio-economic receptors.

6.7.2.1 Dispersion modelling of drilling fluids and cuttings

To understand the fate of the drill cuttings and fluids Asia-Pacific Applied Science Associates (APASA) undertook a dispersion modelling study for the Barossa appraisal drilling campaign undertaken in NT/RL5 under the *Bonaparte Basin Barossa Appraisal Drilling Campaign EP* (ALL/HSE/PLN/020). Modelling was based on a release location at the south-west corner of NT/RL5, as this represents a conservative point to the nearest environmental receptors (i.e., Evans Shoal, Tassie Shoal and Lynedoch Bank) (APASA, 2012).

For the near-seabed discharges of cuttings and fluids, the modelling indicated that the larger particulates (diameter >0.15 mm) would settle within 60 m from the release location. Smaller particulates (diameter <0.15 mm) were expected to be carried further away from the release location (up to 3 km to 4 km), due to slower settling velocities and will settle as a very thin layer of sediment. No contact was predicted with shoals and banks.

For particulates discharged near the water surface, the modelling indicated that material would be transported further from the release location as a result of being exposed to ocean current forces for a longer period. Particulates settled over a larger area (maximum total area of 1.27 km^2 and up to 1.2 km from the release location) as a thinner layer when compared with particulates discharged near-seabed.

Predicted deposition values of drill fluids and cuttings from the combined near-seabed and near-surface discharges were shown to decrease with increasing distance from the well. Particulates settled over a range of distances depending on the season, covering a maximum total area of 1.66 to 19.12 km^2. Within 100 m of the discharge location the average particulate bottom thickness decreased to < 15 mm.

No contact was predicted with shoals and banks from the combined near-seabed and near-surface discharges.

It is expected that the drilling discharges from this activity will behave in a similar way due to the metocean conditions in the region having an influence on the direction and distance of travel, and the similar release rates of drilling and completion fluids. Distribution of the drilling fluids and cuttings will be concentrated around each well, with the smaller particulates carried further from the release location but settling as a very thin layer.

6.7.2.2 Physical environment

Drilling and cement-related discharges will be intermittent during the activity, with volumes dependent on a range of variables. Their discharge to the marine environment will result in a localised reduction in water quality. This would be expected to be temporary (minutes to hours) and localised around the discharge point. The discharges are expected to be dispersed and diluted rapidly, with concentrations significantly dropping with distance from the discharge point. Detectable changes to ambient water quality outside of the operational area are considered unlikely to occur.

Specifics of potential impacts to water quality from the discharge of drilling fluids (WBM and NAF), cement, solid additives (e.g., barite, bentonite), residual hydrocarbons and treated seawater are as follows:

Water quality – turbidity

Drilling solids (i.e., cuttings), formation water, cement and solid additives (e.g., barite, bentonite) will be discharged during the activity.

Discharges at the water surface or close to sea level will result in a reduction in water quality from an increase in turbidity. Once discharged, large particles and flocculated solids form a plume that settles quickly on the seabed. Fine-grained unflocculated clay-size particles and other soluble components form another plume in the water column that drifts with the prevailing currents away from the point source and is diluted rapidly in the receiving waters (Neff, 2005). Modelling of similar discharges in this area (APASA, 2012) indicates that particulates discharged near the sea surface will settle over an area of up to 1.27 km^2 and up to 1.2 km from the discharge location as a thin layer. It is expected that discharges from this activity will behave in a similar way with impacts to water quality within a relatively small radius.

Turbidity increases from discharges at the seabed will have less of an effect than discharges at the sea surface with little change in ambient light levels since light will already be limited at this depth. Modelling of similar discharges in this area (APASA, 2012) indicates that the larger particulates discharged at the seabed would settle within 60m of the release location and smaller particulates within 4 km due to the slower settling velocities.

Cuttings or fluids from development drilling activities will settle rapidly, with only fines discharged at the sea surface being transported further from their release location before they settle.

The radius of impact from this activity will differ from that modelled due to a difference in volume released and seasonal conditions, but it is expected that the larger particulates will still settle close to the well and the impacts are comparable due to the similarity in metocean conditions, rate of discharge and size of particulates.

Water quality – toxicity

Cementing discharges (cement, cement slurry, additives and spacers, etc), control fluids and formation water have the potential to result in toxicity effects. Discharge of cement at the sea surface has not demonstrated significant harm to water column flora and fauna (Neff, 2005).

Components of WBM and NAF with potential toxicity to marine flora and fauna include metals associated with inorganic salt components, organic polymers and additional organic additives as well as barite/bentonite weighting agents. Metals present in drilling fluid generally resemble that of marine sediments, albeit with concentrations of some metals higher than clean marine sediments (Neff, 2005). Metals associated with WBM drill cuttings have been shown to have a low bioavailability as they tend to remain in a non-ionic form, remaining bound to other compounds, presenting a low toxicity risk to marine fauna (Neff, 2005). In general, the acute toxicity of WBM is low (Neff, 2005).

Cuttings generated using NAFs do not disperse as effectively as those generated with WBMs (Neff, 2005) and therefore the extent of impact will be reduced. Toxicity test results from NAFs in one study showed that the olefin and paraffin oil components that made up the synthetic component in the NAF was non-toxic to the water-dwelling organisms studied (Neff *et al*., 2000). However, sediment toxicity results vary depending on the type of olefin or paraffin.

Toxic impacts from the oil content in formation water is expected to be very localised following treatment by filtration to less than 30 ppm. Any toxic effects that might potentially occur would likely be restricted to small organisms such as plankton, larvae and potentially small fish that become entrained in discharged water resulting in relatively high exposure periods. The period of which formation water may be discharged is short; that is, nominally 24 to 36 hours per well flowback target. Monitoring of PFW discharge at the Stag platform (previously operated by Santos) shows that the discharge of PFW does not significantly affect water quality. At a distance of more than 50 m from the Stag discharge point, the PFW could not be differentiated from background conditions in the marine environment. The hydrocarbon and metal concentrations were also below all ANZECC/ARMCANZ 95% species protection guidelines. These results indicate no significant impact from the release of PFW at the Stag facility and can be compared to the potential discharges from the planned well flowback discharge of formation water in terms of the potential for hydrocarbons and chemicals within the discharge. However, it is recognised that the discharge components will be dependent on the reservoir and hydrocarbon type.

Small volumes of control fluids are intermittently discharged subsea during function testing, the volumes are very small (approximately 60 to 600 L) each time and will therefore be rapidly diluted upon discharge within minutes to hours).

Bioaccumulation is the uptake and retention of xenobiotics (substances that are not natural components of the environment) by organisms from their environment. This process can have significant ecological consequences as pollutants move up the food chain to higher order species. Numerous studies have been carried out in the Gulf of Mexico to test and evaluate a range of biological, biochemical and chemical methodologies to detect and assess chronic sub-lethal biological impacts near long-duration activities associated with oil and gas exploration and production. Contaminant concentrations at most locations studied were below levels thought to induce biological responses (Kennicutt *et al*., 1996). Therefore, discharges associated with this activity are not expected to have long-term effects due to bioaccumulation.

Modelling of the drill cuttings and fluids (APASA, 2012) indicates a very thin bottom deposition (0.0026 to 0.026 mm) may occur up to 8 km from the release location however the majority of cuttings or fluids from development drilling activities will settle rapidly, within <100 m of the release location. For this activity, a similar distribution is expected with no contact predicted at shoals or banks from the combined near-seabed and near-surface discharges.

Benthic habitat

The discharge of cuttings coated in WBM, NAF or cement will result in localised burial of benthic organisms and alteration of the benthic substrate. Cementing has the potential to result in toxicity effects; however, given that cement is inert once set (CIN, 2005), chronic toxicity from exposure to set cement will not occur.

A compilation and review of the findings of 75 studies relating to the discharge of synthetic-based muds, which includes NAF, by the International Association of Oil and Gas Producers (OGP, 2003) concluded that benthic community disturbance is in general very localised and temporary. The effects on soft bottom communities from synthetic-based mud cuttings discharges are rarely seen outside of 250 to 500 m (Jensen *et al*., 1999).

Benthic communities (particularly corals and sponges) can be impacted by suspended sediment through three primary cause effect pathways: light reduction, increased suspended sediment concentrations, and sediment deposition (smothering). Studies undertaken as part of the WAMSI Dredging Science Node (WAMSI, 2019) report that both sponges and hard corals are well adapted to sediment and are resilient to increased suspended sediment loads for extended periods of time. However, tolerance mechanisms may result in depletion of energy reserves and reduced sponge health, suggesting that longer term exposure to such extreme sediment disturbance conditions is likely to result in mortality. The benthic biota around the operational area is very similar to that of the wider region, and consists of soft substrates and is devoid of significant bathymetric features (Jacobs, 2016c). No significant seabed features or biota have been found in the immediate region surrounding the operational area. No photosynthetic corals were identified in the area during surveys due to the water depths; however, sponges were sparsely observed throughout the area and also in other surveys of the regions (Jacobs, 2016c).

The depth of accumulated sediments will be greatest close to the well location where the heavier particles are deposited and decrease with increase in distance from the source point.

The effects of drilling discharges on the benthic environment are related to the total mass of drilling solids and drilling fluids discharged; the relative energy of the water column; and benthic habitat at the discharge location (Neff, 2005). The effects of drilling fluids and cuttings piles on seabed communities are caused mainly by burial and low sediment oxygen concentrations caused by organic enrichment (Neff, 2005). With increasing thickness of drill cuttings, the number of taxa, abundance, biomass and diversity of macrofauna has been found to significantly reduce (Trannum *et al*., 2010).

Organic enrichment as a result of WBM drilling cuttings discharge increases bacterial activity. A mild enrichment often sees both an increase in the abundance and diversity of the benthic community in the area of discharge. As more organic enrichment occurs, the seafloor bacteria colonies consume more and more of the oxygen in the sediment, resulting in anoxic conditions. In a highly organic enriched area, the sediment can become anaerobic and both the abundance and diversity of species is much lower than normal (IOGP, 2021).

Recovery of benthic communities from burial and organic enrichment occurs by recruitment of new individuals from planktonic larvae and migration from adjacent undisturbed sediments. Ecological recovery usually begins shortly after completion of drilling and often is well advanced within a year. Hardened cement will provide a surface for colonisation by epifauna. Full recovery may be delayed until concentrations of biodegradable organic matter decrease through microbial biodegradation to the point where surface layers of sediment are oxygenated. Case studies on impacts of WBMs and drilling discharges on soft sediment and benthic fauna are outlined below:

+ For Santos' East Spar development, the area of impact from water-based mud discharges was not more than 100 m from the drill site and short-lived (recovery in less than 18 months) (Sinclair Knight Merz, 1996, 1997; Kinhill, 1998).
+ Benthic monitoring at the Stag production platform (water depth approximately 45 m) indicated that drilling-induced impacts had less of an influence on infaunal assemblages through time than small spatial scale natural variability (Kinhill, 1998).
+ Benthic monitoring at the Santos Van Gogh 3 well location (water depth approximately 350 m) reported sediment deposition one month following drilling extended up to 180 m from the well location along the longest axis and 70 m along the shortest axis (Sea Serpent, 2008). Two months later, monitoring confirmed that the extent of deposition had decreased to a uniform distance of 55 m around the well with a total area reduction of approximately one third (Sea Serpent, 2008). The monitoring revealed that burrow-forming worms and crabs still persisted within the area of sediment deposition (Sea Serpent, 2008).

Other case studies from drilling activities on the NWS regarding impacts of NAF cuttings discharge on the marine environment (APPEA, 1998) have shown:

+ Wannea-3/6 – drilled by Woodside in 1994 and found that 11 months after the cessation of drilling, low residual concentrations of hydrocarbons were detected (<200 ppm), reducing to less than 1 ppm within 200m of the cuttings discharge point.
+ North Rankin-A platform – drilled by Woodside in 1983 and completed in 1991 in water depths of 125 m, with 11 of the 23 wells drilled using low-toxicity oil-based mud. Concentrations of hydrocarbons rapidly decreased from 75,000 ppm beside the platform to 40ppm at 800m and 2ppm at 2 km from the platform in the direction of the prevailing current. Further monitoring conducted in the following years indicated that away from the cuttings pile, the degradation of residual hydrocarbons was occurring successfully with an annual half-life of one year.
+ Mydas-1 and Hawksbill-1 – drilled in 1993 and 1994. Results from studies conducted indicated that impacts to seabed fauna were limited in extent and duration, the extent of contamination was

approximately 100 m from the well head in the direction of the prevailing currents, the biomass and densities of some of the common and numerous taxa had decreased by one to two months after drilling, with effects limited to 100 m from the well; in most cases, biomasses and densities of these taxa had recovered six to eight months after drilling.

+ In Bass Strait, studies conducted by Esso Australia Pty Ltd at the Fortescue platform, in a water depth of 70 m, found that sediment concentrations of synthetic or oil-based fluids were highest (average of 9,600 ppm) at the site closest to the platform, but not detectable (<0.2 ppm) at any site beyond 100 m from the platform. Four months after the end of drilling, concentrations had decreased to an average of 230ppm at the sites closest to the platform, and were not detected at any monitoring station 11 months after drilling. It was concluded that the risks for long-term alteration of benthic infauna from the use of synthetic based fluids were low.
+ In some cases, increased concentrations of NAF-coated cuttings on the seabed have resulted in a decrease in species diversity driven by organic enrichment rather than toxicity, with opportunistic species out-competing other more temperamental species. Microbial degradation of the base fluid in sediments results in oxygen depletion in sediments (Neff *et al*., 2000), leading to impacts on infaunal communities.

The surface hole section of the well is drilled riser-less. Drill cuttings and unrecoverable WBM drilling fluids/ additives from the surface hole sections will be discharged at the seabed at the well location and typically result in a localised area of sediment deposition (cuttings pile) in close proximity to the well site.

A WBM drilling cuttings pile is effectively made up of:

+ a rock fraction (the cuttings)
+ WBM, including:
  - weighting agent (API barite)
  - liquid fraction (the liquid components of the drilling fluids).

Drill cuttings accumulation on seafloor sediments can cause changes in the physical properties and chemical composition of the seabed sediments. These include increased concentrations of organic material, a change in the appearance of the sediment surface, increased sediment grain size and increase in concentrations of metals (relating to weighting agent use).

Barite is one of the main constituents used in WBM, and its use results in elevated levels of barium (Ba) in cuttings. Other chemicals of concern in cuttings, either because of their potential toxicity and/or abundance in WBM are arsenic (As), chromium (Cr), cadmium (Cd), copper (Cu), iron (Fe), lead (Pb), mercury (Hg), nickel (Ni) and zinc (Zn), (Breuer *et al*., 2004).

Dissolved barium and any heavy metal contaminants present in the barite may slowly leach out of an anoxic cuttings pile (Neff. *Et al*, 2005). Breuer *et al*. (2008) has also observed that metals in cuttings, migrate either upward to the overlying water (Ba, Mn, and Fe), or diffuse downward (Cr, Cu and Pb) where they become incorporated into Fe monosulfides. The exposure of these Fe monosulfides to oxygen as a result of transport of oxygen into the cuttings via bioturbation or advection and/or pile resuspension may then lead to the release of the associated metals into the water column (Saulnier and Mucci, 2000; Huerta-Diaz *et al*., 1998).

In a stable cuttings pile with little physical disturbance or bioturbation, it is probable that the fraction of the total cuttings pile metals that is in the dissolved, bioavailable fraction remains low. It is probable that some dissolved metals diffuse into the overlying water column and escape from the pile as identified by Neff *et al*, 2005. However, this efflux is not sufficient to raise the concentration of metals above natural background levels to an ecologically significant extent (Hartley *et al*., 2003). There is no indication that the levels of trace metals in fish and shellfish collected close to offshore installations are significantly above natural background concentrations (Bakke *et al*., 2013).

Marine fauna that are exposed in the laboratory or field to cuttings in sediments do not bioaccumulate significant quantities of metals (Hartley *et al*., 2003). There is some evidence of a limited bioavailability of a few metals, such as Pb and Zn, which are present in cuttings piles; however, doubt remains that metal bioaccumulation in marine fauna from cuttings piles is sufficient to cause harmful effects in marine fauna living on or near cuttings piles (OSPAR, 2019).

Modelling of cuttings pile relocation (disturbance and re-deposition) has confirmed that potential impacts of metals are minimal and disturbance of cuttings drilled with WBM is not expected to result in any significant impact (OSPAR, 2019). Generally, impacts from disturbed cuttings drilled with WBM are expected to be minor and resemble the impacts from currently consented cuttings discharges (OSPAR, 2019).

<u>Key ecological features</u>

The operational area occurs within the 'Shelf break and slope of the Arafura Shelf' KEF, of which one of its defined values is continental slope, patch reefs and hard substrate pinnacles. These values were not observed within the operational area during the Barossa marine studies program, nor are these topographically distinct features evident from the bathymetry data derived from multiple surveys undertaken across the area. The seabed near the drilling locations is mostly bare sand that supports burrowing infauna and sparse scattering of sponges, which is unlikely to be affected by smothering. Habitat supporting significant benthic communities is not expected near the drilling locations and is not likely to be affected by increased sedimentation or from increased turbidity in the water column. Species associated with the continental slope and patch reefs that characterise this KEF (such as demersal fish, whale sharks, sharks and turtles) are unlikely to aggregate within the operational area due to the lack of seafloor features. However, potential impacts to these species are described below.

6.7.2.3 Threatened, migratory or local fauna

Any increases in suspended solids and subsequent decreases in available oxygen surrounding the discharge location may result in a localised impact to organisms present in the water column. Impacts may include obstructions to respiratory processes and other physiological processes as well as behavioural changes due to a reduction in available oxygen or avoidance of the turbidity plume. The increased particle load in the water column could adversely affect respiratory efficiency of small fish species that become entrained in the turbidity plumes. Bioaccumulation of chemicals is not expected to occur due to the limited bioavailability of contaminants and the rapid dispersal of discharge plumes in the deep offshore environment.

6.7.3 Environmental performance outcomes and control measures

The EPOs relating to this event include:

+ No injury or mortality to EPBC Act listed marine fauna. (EPO-05)
+ No significant changes to air, sediment and water quality. (EPO-06)

An assessment of the environmental benefits and the potential costs or issues associated with control measures for this activity are shown in **Table 6-15** to demonstrate the potential impacts from this aspect are ALARP. Control measures that are adopted have associated EPSs and measurement criteria which are presented in **Table 8-2**. Rejected control measures have an ALARP evaluation provided to justify their rejection.

Table 6-15: Control measure evaluation for drilling and completions discharges

CM reference	Control measure	Environmental benefit	Potential cost/issues	Evaluation
Standard control measures				
BAD-CM-007	Chemical selection procedure	Ensures only environmentally acceptable drilling and completions products that could be discharged to sea are used.	Cost associated with implementation of procedure. Range of chemicals reduced with potentially higher costs for alternative products.	**Adopted** – benefit of using environmentally acceptable products outweigh potential costs.
BAD-CM-028	Cuttings management system	Reduces the concentration of drilling mud on cuttings before discharge while drilling with a closed circulating system, thereby reducing the total volume of mud lost to sea. Reduces oil-on-cuttings prior to discharge if using NAF through the use of augers and cuttings dryers.	High cost associated with operating the cuttings management system. Drilling fluids are expensive; hence the intent is to recover and re-use fluids.	**Adopted** – environmental and cost saving benefits of minimising drilling fluid discharges outweigh the cost of operating the cuttings management system.
BAD-CM-029	Inventory control procedure	Restricts the type and volume of drilling discharges and includes a decision-making framework for managing left-over bulk products (refer to **Table 6-12**).	Significant safety risks and/or costs associated with backloading bulk products to vessels for onshore disposal.	**Adopted** – high safety risks and costs associated with onshore disposal of the specified bulk products are grossly disproportionate to the low environmental impacts of disposal in deep, offshore waters.
BAD-CM-030	Oil content measurement procedure	Ensures oil-on-cuttings is accurately measured as specified in BAD-CM-028-EPS-05.	Cost associated with implementing procedure.	**Adopted** – environmental benefits of ensuring procedures are followed outweigh costs.
BD-CM-031	Quality control limits for barite	Contaminant concentration limits in barite meet API specifications to minimise the risk of seabed contamination.	None.	**Adopted** – environmental benefit of using industry acceptable barite outweighs any cost.

CM reference	Control measure	Environmental benefit	Potential cost/issues	Evaluation
BAD-CM-033	Well flowback procedures	Ensures well flowback fluids are appropriately managed and that oil-in-water content in formation water, if produced, is below 30 ppm.	Cost associated with implementation of procedure.	**Adopted** – environmental benefits of ensuring procedures are followed outweigh costs.
Additional control measures				
N/A	Use of RMR for the 30" and entirety of the 20" hole sections	The primary benefit of RMR is the potential reduction of WBM discharged to the environment. RMR returns top-hole cuttings/WBM from the riserless section of the well to the MODU and provides an opportunity to recover and re-use the WBM drilling fluids. RMR does not reduce the volume of cuttings discharged to the sea. Cuttings disposal using RMR occurs from the MODU at (slightly below) sea surface, instead of directly to seabed at the wellhead. Discharging at sea surface rather than at the seabed reduces the accumulation of cuttings around the wellhead, but results in a localised reduction in water quality from increased turbidity and a larger seabed disturbance footprint from sedimentation (albeit at lower sediment concentrations).	Use of RMR in the lower well sections (from the 14 ¾" hole onwards) is not necessary once the BOP is installed as all returns are circulated back to the MODU. Use of RMR in the initial 30" hole (riserless drilling) would require additional time and costs to set the equipment up and with additional running time there is more opportunity for equipment failure which could impede drilling in the lower portion of the 20" hole where RMR is technically necessary. To ensure redundancy of the equipment, a comprehensive inventory of spare parts are on board as well as requirements for preventative maintenance (BAD-CM-040 in **Section 8.6**) and competent personnel to operate and maintain the equipment.	**Rejected –** the use of RMR in other sections of the well or the entirety of the 20" hole is not technically required and could result in potential downtime of the RMR equipment and subsequent delay in operations. Extended use of the RMR will also lengthen the duration of the drilling campaign. The potential impacts from discharges of drill cuttings and fluids when riserless drilling are considered to be negligible; hence, the additional RMR management costs and drilling downtime risks are considered disproportionately high to the low environmental benefits.

CM reference	Control measure	Environmental benefit	Potential cost/issues	Evaluation
N/A	Reinjection of NAF drill cuttings downhole	Eliminates NAF drill cutting discharges to the marine environment.	Not technically feasible to reinject drill cuttings into subsea wellheads, which are being developed as production wells.	**Rejected** – not technically feasible.
N/A	Store and transport NAF drill cuttings to shore for disposal	Eliminates drill cutting discharges to the marine environment.	Skip-and-ship involves the back-loading of some or all drilling fluids and cuttings from the MODU into skips on an activity vessel, which then transfers the fluids/cuttings for discharge at an alternative onshore location. This option introduces safety risks and costs associated with additional lifting operations, vessel movements and onshore landfill disposal.	**Rejected** – high safety risks and costs associated with skip-and-ship are grossly disproportionate to the low environmental impacts of disposal in deep, offshore waters. NAF selected in accordance with control measure BAD-CM-007 so that only environmentally acceptable drilling products are used.
N/A	Recover and store completion fluids on board the MODU for transport and disposal onshore	Eliminates completion fluid discharges to marine environment.	This would involve back-loading the fluids to vessels for onshore disposal. This option introduces safety risks and costs associated with additional bulk product transfer operations and vessel movements.	**Rejected** – high safety risks and costs associated with backloading fluids are grossly disproportionate to the low environmental impacts of disposal in deep, offshore waters. Completion fluids (i.e., brines) selected in accordance with control measure BAD-CM-007 so only environmentally acceptable products are used.

CM reference	Control measure	Environmental benefit	Potential cost/issues	Evaluation
N/A	Eliminate NAF	No NAF cuttings discharged to the marine environment.	While WBM is the base case option, NAF is also maintained as an option in the event it is required for reducing wellbore instability risks. Removing this option may introduce unacceptable safety risks and lead to lower technical performance of the wells.	**Rejected** – the base plan is to drill the wells with a WBM drilling fluid. However, given there have been no directional drilling/ development wells in the Barossa field, the option to use NAF (which has wellbore stability technical benefits that WBM cannot provide) must be retained in case the WBM drilling fluid provides inadequate performance. In addition, base oil (a NAF) is needed for the completion of the wells to enable them to flow back to the well test package on initial clean-up post completion although there would be no NAF contaminated cuttings associated with this. Therefore, this option cannot be rejected.

N/A	Reduce dry oil-on-cuttings to less than 10% average per well	Reduces the amount of residual NAF being discharged to the marine environment.	Santos will have the equipment and has the experience to reduce dry oil-on-cuttings to ~6.9% w/w (which is considered standard industry practice under the IFC HSE Guidelines 2015). However, in the event of frequent or prolonged cuttings management equipment down time and to prevent an exceedance of the oil-on-cuttings target, Santos would need to divert cuttings to skips for onshore disposal (i.e. skip-and-ship) or suspend drilling operations. Due to skip-and-ship limitations and risks (e.g. limited MODU deck space to store skips, high volume of MODU-vessel lifts, etc.) this operation could only be sustained for a short period of time before drilling would need to be suspended. The need to suspend drilling is made even more likely given the large hole sizes planned for these wells and the significant volume of cuttings (440 m^3 NAF-based cuttings per well). Hence, an oil-on-cuttings target of <10% w/w (dry) provides some contingency (~100m^3 of cuttings per well) to manage equipment down time without the need to initiate skip-and-ship operations or to suspend drilling. Suspension of drilling	**Rejected** – NAF is a contingency for these wells. Hence, the potential high costs and drilling risks of ensuring a lower oil-on-cuttings target is achieved (including procurement and management of redundant cuttings equipment, skip-and-ship and drilling suspension) is considered disproportionate to the low environmental consequence of discharging additional oiled cuttings to sea. The potential impacts of oil-on-cuttings are well understood and given the nature of the receiving environment potential impacts are expected to be minor.

CM reference	Control measure	Environmental benefit	Potential cost/issues	Evaluation
			increases the risk of 'stuck pipe' events associated with wellbore destabilisation over time. This could have a significant financial impact, as well as potential environmental consequences if the event resulted in a side-tracked interval. Installing and maintaining additional cuttings dryers and augers would be a way of ensuring equipment redundancy. However, this would introduce additional costs for a contingent drilling fluid and cause operational (e.g. safety) risks given the limited MODU deck space and servicing requirements.	
N/A	Do not discharge cement associated with circulating cement back to the mudline	No or reduced cement discharge to the marine environment.	The discharge associated with circulating cement back to the mudline (i.e., releasing cement to the seabed) cannot be eliminated. The conductor must be cemented in place with cement top at the mudline as this equipment is the structural foundation for the well. All subsequent casing strings will distribute axial loads to the conductor along with the BOP. The conductor must be able to withstand the axial force or it will subside which may render a BOP useless.	**Rejected** – not technically feasible.

CM reference	Control measure	Environmental benefit	Potential cost/issues	Evaluation
N/A	No well clean up or flowback	Reduced quantities of contaminants (i.e., oily-water) entering the marine environment.	Well clean up and testing is required for several reasons, including to prepare the wells for safe production to the FPSO, assess well productivity, understand reservoir characteristics and performance, and plan for the safe management of the reservoir.	**Rejected** – not technically feasible.
N/A	Reduce oil-in-water concentration for formation water discharge during well flowback	Reduced quantities of contaminants (i.e., oil) entering the marine environment. Given the well flowbacks are short in duration (24 to 36 hours), lowering the concentration of oil-in-water is unlikely to result in a significant reduction in total oil released to the marine environment; i.e., reducing the oil-in-water limit from 30 ppm to 15 ppm may prevent approximately 2.5 L of oil being released over a 24- to 36-hour period per well for a typical well flowback program.	To reduce oil-in-water a specialised water treatment tank (to enable re-treatment and storage of the water) would need to be mobilised to the MODU before the well flowback. The tank would consume valuable open deck space desirable for safe working conditions, including crew egress. The tank hire and additional oil filtration cartridges would increase activity costs. MARPOL Annex I (Regulation 56) states for fixed/floating platforms (which includes MODUs) that only the discharge of machinery space drainage and contaminated ballast should be subject to MARPOL, and that discharges including production water discharge, are not subject to these regulations.	**Rejected** – the higher safety risks and costs associated with additional water treatment are considered grossly disproportionate to the negligible environmental benefit of further reducing oil-in-water content to below 30 ppm.

6.7.4 Environmental impact assessment

Key receptors	Consequence level
Drilling and completions discharges	
Threatened, migratory or local fauna	The seabed within the operational area is predominantly bare sediment and contains low abundance and diversity of infauna. Marine invertebrates may inhabit soft sediments and can contribute to the diet of some fauna. The area of soft sediment habitat that is potentially impacted is small compared with the amount of similar habitat available across the bioregion. Therefore, the disturbance is not expected to affect prey availability, and protected fauna species, significantly. Recovery of benthic communities usually begins shortly after the end of drilling and is often well advanced within a year. Full recovery may be delayed until concentrations of biodegradable organic matter and residual hydrocarbons (if NAF is used) decrease through microbial biodegradation to the point where surface layers of sediment are oxygenated. For cement discharges, the impacts to the seabed in the immediate vicinity of the MODU will be longer term as the cement permanently changes the seabed and becomes a different type of substrate for fauna to attach to and it is unlikely to return to its previous state. The impacts are low in magnitude owing to the small area that would be affected and therefore would be an insignificant decrease in available habitat for benthic fauna. Mobile marine species are expected to either avoid turbid stretches of water or pass through with no significant impacts. The toxicity of WBM, NAF, formation water, control fluid and cement is considered low and the potential for bioaccumulation of any toxic compounds is negligible. As with all chemicals selected for use in drilling operations by Santos, the chemicals chosen for the activity will be low aquatic toxicity (for example, EC50/LC50 > 100 mg/L), low bioaccumulation potential (for example, Log Pow <3) and readily biodegradable (for example, more than 60 in 28 days OECD 306), therefore reducing the likelihood of any significant impacts. 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. Impacts will be temporary and the area potentially impacted is small compared with the size of the areas used by these species for foraging. Therefore, no long-term impacts to these species are expected. No decrease in local population size, area of occupancy of species, loss or disruption of critical habitat or disruption to the breeding cycle of any of these protected matters is expected. Fish, sharks and rays may also forage in the soft sediments for marine invertebrates. However, given the small scale of the activity and the regional availability of habitat, seabed and benthic habitat disturbance from drilling and completions discharges is not expected to affect these species. The increased particle load in the water column could adversely affect respiratory efficiency of fish. The operational area is in a high-energy, well mixed deep open water environment and the predicted deposition behaviour of drill fluids and cuttings from the combined near-seabed and near-surface discharges were shown to decrease with increasing distance from the well (APASA, 2012), with particulates settling over a range of distances depending on the season. Disturbance of the seabed is not anticipated to significantly affect mobile marine fauna, such as marine mammals, marine reptiles, fish, sharks and rays, given the sparse benthic and epi-benthic communities expected in the operational area. Impacts to benthic fauna are discussed above. These are localised and while a decrease in local population size may occur, no loss or disruption of habitat critical to the survival of a species or disruption to the breeding cycle of any of these protected matters is expected. Given the low toxicity of the drilling and completions discharges and there are no significant impacts expected to

Key receptors	Consequence level
	threatened and migratory fauna the consequence level for threatened, migratory or local fauna is considered to be II – Minor.
Physical environment or habitat	The seabed within the operational area is largely bare sediment and contains low abundance and diversity of infauna. The operational area occurs within the 'Shelf break and slope of the Arafura Shelf' KEF, of which one of its defined values is continental slope, patch reefs and hard substrate pinnacles. These values were not observed within the operational area during the Barossa marine studies program. The seabed near the drilling locations is mostly bare sand that supports burrowing infauna, which is unlikely to be significantly affected by smothering. The selection criteria for chemical preference through the risk assessment process as outlined in Santos Offshore Division Drilling Chemical Selection and Approval Process (EA-91-II-00007) is low aquatic toxicity (for example, EC50/LC50 > 100 mg/L), low bioaccumulation potential (for example, Log Pow <3) and readily biodegradable (for example, more than 60 in 28 days OECD 306), therefore discharges from this activity are not expected to have significant toxicological impacts on the water or sediment quality for an extended duration. Considering the low sensitivity and widely represented nature of the benthic communities in the drilling locations, potential impacts from discharging cuttings, fluids or cement from the activity is considered highly localised. Any impacts to benthic communities that may occur are expected to be temporary and no substantial change to benthic habitat is considered likely. Based on other modelling studies completed in the region (APASA, 2012), it is unlikely drilling and completions discharges will contact any shoals, banks or protected areas, due to the distance from the operational area. Overall, impacts would likely be temporary, with rapid recolonisation of benthic infauna within the cuttings layer. Epifauna is likely to recolonise within weeks to months. Given the very short duration of each well flowback discharge, the depth of waters and the high degree of dispersal and dilution at the seabed at this depth, seabed loadings of contaminants in formation water are not predicted to reach levels of concern. Given the water depth in the operational area and the total treated water discharge for the short duration of each well flowback (24 to 36 hours), it is reasonable to conclude that discharging water with oil at less than 30 ppm will not have a significant environmental impact and the risk to the environment is negligible. For cement discharges, geomorphology of the habitat would be altered, with cement hardening over time and blanketing the existing habitat. Although impacts on the form of the seabed in the immediate vicinity of the MODU will be longer term, the impacts are low in magnitude owing to the small area that would be affected. The consequence level for physical environment or is considered to be II – Minor.
Socio-economic receptors	Not applicable – drilling and completions discharges are not expected to impact commercial fisheries based on the small size of disturbance compared with the total available fishing area.
Threatened ecological communities	Not applicable – no threatened ecological communities identified in the area over which discharges are expected.
Protected areas	Not applicable – no protected areas identified in the area over which discharges are expected.
Overall worst-case consequence	II – Minor

6.7.5 Demonstration of as low as reasonably practicable

Drilling and cementing is a requirement of the activity, and the resultant fluid and solid by-products cannot be eliminated or avoided.

All reasonably practicable control measures have been reviewed and those adopted are considered appropriate to manage the impacts such that the residual consequence is assessed to be II – Minor. The proposed control measures are in accordance with the Santos risk management criteria and are considered appropriate to manage impacts to ALARP.

6.7.6 Acceptability evaluation

Is the consequence ranked as I or II?	Yes – maximum consequence from drilling and completions discharges is II – Minor.
Is further information required to validate the consequence assessment?	No – potential impacts and risks are well understood through the information available.
Are risks and impacts consistent with the principles of ESD?	Yes – activity evaluated in accordance with Santos' *Environmental Hazard Identification and Assessment Procedure* which considers principles of ecologically sustainable development.
Have the acceptable levels of impact and risks been informed by relevant species recovery plans, threat abatement plans and conservation advice and Australian marine park zoning objectives)?	Yes – no contact with banks and shoals or nearby AMPs are predicted. Consistent with relevant species recovery plans, conservation management plans and management actions set out in **Table 3-9,** including: + Sawfish and River Sharks Multispecies Recovery Plan (CoA, 2015a) + Marine Bioregional Plan for the North-West Marine Region (CoA, 2012b).
Are performance outcomes, control measures and associated performance standards consistent with legal and regulatory requirements?	Through acceptance of this EP, legislative and regulatory requirements will be met as per **Section 1.6.2**.
Are performance outcomes, control measures and associated performance standards consistent with Santos' Environment, Health and Safety Policy?	Yes – aligns with Santos' Environment, Health and Safety Policy.
Are performance outcomes, control measures and associated performance standards consistent with industry standards?	Yes – the most recent and comparable Drilling and Completions EPs accepted by NOPSEMA have been reviewed for consistency with the performance outcomes, control measures and associated performance standards proposed in this EP.
Have performance outcomes, control measures and associated performance standards taken into consideration stakeholder feedback?	Yes – no objections or claims raised relating to activity drilling and completions discharges and potential environmental impacts to marine fauna or commercial fisheries.
Are performance standards such that the impact or risk is considered to be ALARP?	Yes – see ALARP above.

The consequence of drilling and completions discharges on receptors is assessed as II – Minor. Based on an assessment of Santos' acceptability criteria and with the control measures in place, potential impacts are considered acceptable.

6.8 Spill response operations

The spill response strategies that may be adopted in the event of a hydrocarbon spill from this activity have been identified in the Barossa Development OPEP Addendum: Drilling and Completions (BAA-200-0316). An environmental assessment of these spill response strategies has been conducted as presented below.

An overview of the hydrocarbon spill scenarios considered for this activity and relevant to spill response operations is provided in **Section 7.5**, with environmental assessments in **Section 7.6** and **Section 7.7**.

6.8.1 Description of event

Event	In the event of a hydrocarbon spill, response strategies will be implemented to reduce environmental impacts to ALARP. The selection of strategies will be undertaken through a net environmental benefits analysis (NEBA). Spill response will be under the direction of the relevant control agency, as defined in the OPEP, which may be Santos, another agency or both. In all instances, Santos will undertake a 'first-strike' spill response and will act as the Control Agency until the designated Control Agency assumes control. The response strategies considered to be appropriate for the worst-case oil spill scenarios identified for the activity are provided in the *Barossa Development OPEP Addendum – Drilling and Completions* (BAA-200-0316) and comprise: + source control (BOP, subsea first response toolkit (SFRT), relief well, capping stack) + monitor and evaluate + mechanical dispersion + oiled wildlife response + scientific monitoring + waste management. Although a relief well is the primary method to stop a loss of well control (LOWC), secondary source control measures may be employed if the conditions are appropriate. These include a capping stack and/or subsea dispersant injection (SSDI). Deployment of a capping stack would be limited to appropriate conditions (e.g., blowout rates within safe operating limits, safe vertical access) and when operating conditions permit (wind speed, wave height, current and plume radius). SSDI would likely only be used if it could be demonstrated through an operational NEBA that it would provide a net benefit by enabling source control personnel safer access to the site to bring the release under control (e.g., by reducing volatile organic compounds). 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.
Extent	Extent of spill. Spill response could occur anywhere within the EMBA for the worst-case spill scenarios.
Duration	The spill response effort as a whole will exceed the duration of the worst-case spill, due to persistence of the oil in the environment and the requirement to remove this oil and/or monitor impacts and recovery to sensitive receptors. The OPEP provides further detail on the likely duration of specific response strategies.

6.8.2 Nature and scale of environmental impacts

Potential receptors: physical environment (water and sediment quality, shoals and banks, benthic habitats); threatened or migratory fauna (marine mammals, marine reptiles, sharks, fish, rays and birds); protected and significant areas (marine parks, KEFs); and socio-economic receptors (fisheries, tourism, recreation and other third-party operators).

Light emissions	
Spill response activities will involve the use of vessels (and potentially a MODU; herein this section referred to as a 'vessel'), which are required, at a minimum, to display navigational lighting. Vessels may operate near 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 or local fauna Protected areas
Lighting may cause behavioural changes to fish, mammals, birds and marine turtles that can have a heightened consequence during key lifecycle activities, such as turtle nesting and hatching. Turtles and birds, which includes threatened and migratory fauna (**Table 3-7**), have been identified as key fauna susceptible to lighting impacts. **Section 6.2** provides further detail on the nature and scale of light emission impacts. Spill response activities that require lighting may occur anywhere within the moderate exposure value area (MEVA; refer to **Section 7.5.4**), including in protected areas and close to shoals.	
Noise emissions	
Spill response activities will involve the use of aircraft and vessels, which will generate noise both offshore and in nearshore locations within the EMBA.	
Potential receptors	Threatened, migratory or local fauna Protected areas Socio-economic receptors
Underwater noise from the use of vessels may impact marine fauna, such as fish (including commercial species), marine reptiles and marine mammals. **Section 6.1** provides details on potential noise emission impacts. Cetaceans have been identified as the key concern for vessel noise within the MEVA, with the pygmy blue whale distribution BIA intersecting the MEVA. Vessels may also need to enter marine parks and other areas utilised for tourism, commercial and recreational fishing, and traditional purposes.	
Atmospheric emissions	
The use of fuels to power vessel engines, generators and mobile equipment used during spill response activities will result in emissions of greenhouse gases, such as carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O), along with non-GHGs such as sulphur oxides (SO_X) and nitrogen oxides (NO_x). Emissions will result in a localised decrease in air quality.	
Potential receptors	Threatened, migratory or local fauna Physical environment or habitat (air quality) Socio-economic receptors
Atmospheric emissions from spill response equipment will be localised, and the use of mobile equipment, vessels and vehicles is not considered to create emissions on a scale where noticeable impacts would be predicted.. **Section 6.3** provides further details on the nature and scale of air emission impacts.	
Operational discharges and waste	
Operational discharges include those routine discharges from vessels used during spill response, which may include: + deck drainage + putrescible waste and sewage + cooling water from operation of engines	

+ bilge water + ballast water + brine discharge. In addition, there are specific spill response discharges and waste creation that may occur, including: cleaning of oily equipment, vessels and vehicles sewage and putrescible and municipal waste at offshore staging sites creation, storage, transport and disposal of oily waste and contaminated organics.	
Potential receptors	Threatened, migratory or local fauna Physical environment or habitat Protected areas Socio-economic receptors
Operational discharges from vessels may create a localised and temporary reduction in marine water quality. Effects include nutrient enrichment, toxicity, turbidity, and temperature and salinity increases, as detailed in **Section 6.6**. Discharge could potentially occur adjacent to marine habitats, such as corals, seagrass and macroalgae, and in protected areas, which support a more diverse faunal community; however, discharges are still expected to be localised and temporary. Cleaning of oil-contaminated equipment, vehicles and vessels has the potential to spread oil from contaminated areas to areas not impacted by a spill, potentially spreading the impact area and moving oil into a more sensitive environment. Sewage and putrescible and municipal waste will be generated from offshore activities at temporary staging/mooring areas, which may include toilet and washing facilities. These wastes have the potential to impact water quality, impact habitats, and reduce the aesthetic value of the environment, which may be within protected areas.	
Seabed and habitat disturbance, marine fauna interaction	
The movement and operation of vessels during spill response activities have the potential to disturb the physical environment and marine habitats and fauna, which may occur within protected areas. Disturbance may also impact socio-economic values of an area. Spill response operations can impact on wildlife via vessel strikes and behavioural changes due to physical presence of personnel and equipment. Oiled wildlife response activities may also involve deliberate disturbance (hazing), capture, handling, cleaning, rehabilitation, transportation and release of wildlife, which could lead to additional impacts to wildlife.	
Potential receptors	Threatened, migratory and local fauna Physical environment or habitat Protected areas Socio-economic receptors
The use of vessels may disturb benthic habitats, including corals, seagrass and macroalgae. Impacts to habitats from vessels include damage through the deployment of anchors, mooring lines and from grounding. Oiled wildlife response may include the hazing, capture, handling, cleaning, rehabilitation, transportation, cleaning and release of wildlife susceptible to oiling, such as birds and marine turtles. While oiled wildlife response is aimed at having a net benefit, poor responses can potentially create additional stress and exacerbate impacts from oiling, interfere with lifecycle processes, hamper recovery and, in the worst instance, increase levels of mortality. The disturbance to marine habitat, as well as the potential for disruption to culturally sensitive areas, may occur in specially protected areas (e.g., AMP).	
Interactions with other marine users	
Spill response activities may involve the use of vessels and equipment in areas used by the general public or industry in Australia and potentially Indonesia. The mobilisation of spill response personnel into Forward Operating Bases may also place increased demands on local accommodation and other businesses.	

Potential receptors	Socio-economic receptors
The use of vessels in the offshore environment and the undertaking of spill response activities may exclude the general public and industry use of the affected environment. As well as impacting recreational activities (e.g., recreational fishing) of the general public, this may impact on revenue with respect to industries such as commercial fishing. The mobilisation of personnel to regional 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.	
Chemical dispersant application	
Subsea dispersant injection (SSDI) is known to reduce volatile organic compound levels at the sea surface and is shown to be effective at dispersing condensates when applied subsea (RPS, 2019), making conditions safer for responders and source control personnel. **Section 7.6.2.3** outlines the vapour dispersion modelling undertaken to assess the levels of potential airborne concentration of volatiles in the event of a LOWC and for all wind speeds assessed, the modelling indicated that vapour plume concentrations for all zones of concern (human health risk and safety risk) (i.e., ZOC 0 to 3) occurred within approximately 2.5 km from the well (RPS, 2019b), hence the inclusion of SSDI as a potential response strategy. SSDI is shown to reduce surface concentrations of hydrocarbons, thereby reducing the exposure of seabirds and surfacing marine fauna to hydrocarbons. It also disperses hydrocarbons into a larger volume of water, reducing concentrations and enhances biodegradation (French-McCay *et al*., 2018). SSDI is likely to be a secondary response tactic for a well blow out if surface concentrations of hydrocarbons are resulting in an unsafe environment for response personnel. Application of subsea dispersants is likely to result in a safer and more reliable delivery of other source control tactics.	
Potential receptors	Threatened, migratory or local fauna Physical environment and habitat Protected areas Socio-economic receptors
While the aim of chemical dispersants is to provide a net benefit to the environment, the use of dispersants has the potential to increase impact to habitats under the sea surface, including coral, seagrass and macroalgae, and to marine fauna (particularly fish and invertebrates) by increasing entrained oil and dissolved aromatic hydrocarbon concentration and exposure. These sensitive receptors are generally located in shallow coastal areas of the offshore islands and shoals and banks of the region. Increased entrained and dissolved aromatic hydrocarbon concentration may also impact on marine fauna either directly or through impacts to subsea habitats. Direct impacts are most likely to be encountered by plankton, benthic filter feeding invertebrates, fish and sharks. Fish and sharks include threatened/migratory species, which may ingest oil or uptake toxic compounds across gill structures. As a result of increased impact to marine fauna and subtidal habitats, including those that represent values of Protected Areas, socio-economic impacts may be felt through industries such as tourism and commercial fishing. A description of the impacts from entrained oil and aromatic hydrocarbons from a worst-case loss of well control, without a specific consideration of dispersant addition, is provided in **Section 7.5.6**.	

6.8.3 Environmental performance outcomes and control measures

An assessment of the environmental benefits and the potential costs or issues associated with control measures relevant to response vessels and helicopters for this activity are shown in **Table 6-16** to demonstrate the potential impacts from this aspect are ALARP. Additional control measures that are more specific to spill response are presented in the OPEP.

Control measures that are adopted have associated EPSs and measurement criteria which are presented in within the relevant strategy sections of the OPEP. Rejected control measures have an ALARP evaluation provided to justify their rejection.

Table 6-16: Control measure evaluation for spill response operations

CM reference	Control measure	Environmental benefit	Potential cost/issues	Evaluation
BAD-CM-001	Procedure for interacting with marine fauna (complied with by response vessels)	Refer to **Table 7-4**	Refer to **Table 7-4**	**Adopted** – Refer to **Table 7-4**
BAD-CM-034	Minimum lighting for maritime safety (on response vessels)	Refer to **Table 6-6**	Refer to **Table 6-6**	**Adopted** – Refer to **Table 6-6**
BAD-CM-021	Air pollution prevention certification (for response vessels)	Refer to **Table 6-8**	Refer to **Table 6-8**	**Adopted** – Refer to **Table 6-8**
BAD-CM-026	Sewage treatment system (on response vessels)	Refer to **Table 6-11**	Refer to **Table 6-11**	**Adopted** – Refer to **Table 6-11**
BAD-CM-027	Oily water treatment system (on response vessels)	Refer to **Table 6-11**	Refer to **Table 6-11**	**Adopted** – Refer to **Table 6-11**
BAD-CM-022	Santos stakeholder consultation (after an accidental spill event)	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.
NA	Chemical dispersant application - Refer to OPEP for specific controls	Refer to OPEP	Refer to OPEP	Refer to OPEP

6.8.4 Environmental impact assessment

Receptor	Consequence level
Spill response operations – light emissions	
Threatened, migratory or local fauna	The receptors considered most sensitive to lighting from vessel operations are seabirds, shorebirds and marine turtles. Following restrictions on night-time operations by spill response vessels, which will demobilise to mooring areas offshore with safety lighting only, impacts from vessels are considered to be I – Negligible.
Physical environment or habitat	
Threatened ecological communities	
Protected areas	
Socio-economic receptors	
Overall worst-case consequence level	I – Negligible

Receptor	Consequence level
Spill response operations – noise emissions	
Threatened, migratory or local fauna	The receptors considered most sensitive to vessel noise are cetaceans. 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 I – Negligible.
Physical environment or habitat	
Threatened ecological communities	
Protected areas	
Socio-economic receptors	
Overall worst-case consequence level	I – Negligible
Spill response operations – atmospheric emissions	
Threatened, migratory or local fauna	Atmospheric emissions from spill response equipment will be localised, and impacts to even the most sensitive fauna, such as birds, are expected to be Negligible (I).
Physical environment or habitat	
Threatened ecological communities	
Protected areas	
Socio-economic receptors	
Overall worst-case consequence level	I – Negligible
Spill response operations – operational discharges and waste	
Threatened, migratory or local fauna	Operational discharges from vessels may create a localised and temporary reduction in marine water quality, which has the potential to impact shallow marine 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. Washing of vessels and equipment will take place only in defined offshore hot zones preventing impacts to shallow habitats. 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, will be managed by Santos' appointed waste management contractor, and dedicated waste containment areas will prevent the spreading or leaching of hydrocarbon contamination. Operational discharges from spill response operations are expected to be Minor (II).
Physical environment or habitat	
Threatened ecological communities	
Protected areas	
Socio-economic receptors	
Overall worst-case consequence level	II – Minor
Spill response operations – seabed and benthic habitat disturbance; marine fauna interactions	

Receptor	Consequence level
Threatened, migratory or local fauna Physical environment or habitat Threatened ecological communities Protected areas Socio-economic receptors	The use of vessels has the potential to disturb benthic habitats, including sensitive shoal habitats such as corals and macroalgae. A review of shallow water habitats and of bathymetry and the establishment of demarcated areas for access and anchoring will reduce the level of impact to I – Negligible. 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 II – Minor. 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 II – Minor consequence following compliance with the Santos' *Oiled Wildlife Response Framework* and *Northern Territory Oiled Wildlife Response Plan.*
Overall worst-case consequence level	II – Minor
Spill response operations – disruption to other users of marine and coastal areas and townships	
Socio-economic receptors	The use of vessels in the offshore environment and spill response activities may exclude general public and commercial industries (e.g. fishing). Note that this is distinct from the socio-economic impact of a spill itself, as described in **Section 7.6**. With the application of control measures, it is considered that the additional impact of spill response activities on affected industries would be II – Minor.
Overall worst-case consequence level	II – Minor
Spill response operations – chemical dispersant application	
Threatened, migratory or local fauna Physical environment or habitat Threatened ecological communities Protected areas Socio-economic receptors	The use of chemical dispersants has the potential to increase the distribution and concentration of entrained hydrocarbon and dissolved aromatic hydrocarbons within the water column. Entrained hydrocarbon and dissolved aromatic hydrocarbons concentrations are expected to be elevated adjacent to the release site with the potential for increased impacts to nearby benthic and pelagic fishes, sharks and invertebrates. The generic impacts to receptors from entrained hydrocarbon and dissolved aromatic hydrocarbons described in **Section 7.5.6** are considered to apply. The primary controls for reducing impacts to these receptors from dispersant use is in the selection of approved or environmentally risk assessed chemical dispersants and through the careful assessment of application areas such that sensitive receptor impacts are reduced to ALARP. It is important to note that dispersants will only be applied if the response is seen as having a net environmental benefit as per the overarching NEBA analysis of spill response strategies. In the event dispersants are used there is the potential for a Minor (II) additional impact.

6.8.5 Demonstration of as low as reasonably practicable

A NEBA is the primary tool used during spill response to evaluate response strategies and has the goal of selecting strategies that result in the least net impact to key environmental sensitivities. The NEBA process will identify and compare net environmental benefits of alternative spill response options. The NEBA will effectively determine whether an environmental benefit will be achieved through implementing a response strategy or by undertaking no response. The NEBA will be undertaken by the relevant Controlling Agency for the activity. For those activities under the control of Santos, the Incident Management Team (IMT) Environmental Team Leader will be responsible for reviewing the priority receptors and selected response strategies identified in this EP and coordinating the NEBA for each operational period. This will demonstrate that, at the strategy level, the response operations reduce additional environmental impacts to ALARP.

Spill response activities will be conducted in offshore waters using vessels and aircraft, and potentially a MODU should a relief well be required. The greatest potential for additional impacts from implementing spill response is considered to be on wildlife in offshore waters from oiled wildlife response activities.

Santos, together with the Controlling Agency for spill response, will apply appropriate processes and standards to ensure spill response impacts are reduced to a level that is ALARP.

All reasonably practicable control measures have been reviewed and those adopted are considered appropriate to manage the impacts such that the residual consequence is assessed to be II – Minor. The proposed control measures are in accordance with the Santos risk management criteria and are considered appropriate to manage impacts to ALARP.

6.8.6 Acceptability evaluation

Is the consequence ranked as I or II?	Yes – maximum consequence is II – Minor from planned events.
Is further information required to validate the consequence assessment?	No – potential impacts and risks are well understood through the information available.
Are the risks and impacts consistent with the principles of ESD?	Yes – activity evaluated in accordance with Santos' *Environmental Hazard Identification and Assessment Procedure* which considers principles of ecologically sustainable development.
Have the acceptable levels of impact and risks been informed by relevant species recovery plans, threat abatement plans and conservation advice and Australian marine park zoning objectives)?	Yes – Consistent with relevant species recovery plans, conservation management plans and management actions set out in **Table 3-9**, including conservation values of the identified protection priorities (**Section 3**) and relevant species recovery plans, conservation management plans and management actions, including: + Recovery Plan for Marine Turtles in Australia 2017–2027 (DoEE, 2017) + Approved Conservation Advice for *Megaptera novaeangliae* (humpback whale) (TSSC, 2015c) + Approved Conservation Advice for *Rhincodon typus* (whale shark) (TSSC, 2015d) + Conservation Management Plan for the Blue Whale, 2015 to 2025 (CoA, 2015a) + Approved Conservation Advice for *Balaenoptera borealis* (sei whale) (TSSC, 2015a) + Approved Conservation Advice for *Balaenoptera physalus* (fin whale) (TSSC, 2015b) + Recovery Plan for the White Shark (*Carcharodon carcharias*) (DSEWPaC, 2013) + Approved Conservation Advice for *Pristis Clavata* (dwarf sawfish) (DEWHA, 2009) + Approved Conservation Advice for *Pristis pristis* (largetooth sawfish) (DoE, 2014b) + Commonwealth conservation advice on *Pristis zijsron* (green sawfish) (DEWHA, 2008) + Sawfish and River Sharks Multispecies Recovery Plan (DoE, 2015a) + Approved Conservation Advice for *Glyphis garricki* (northern river shark) (DoE, 2014a)

	+ Conservation management plan for the southern right whale 2011 to 2021 (DSEWPaC, 2012) + Approved Conservation Advice for *Aipysurus apraefrontalis* (short-nosed sea snake) (DSEWPaC, 2011) + Approved Conservation Advice for *Calidris ferruginea* (curlew sandpiper) (TSSC, 2015e) + Approved Conservation Advice for *Numenius madagascariensis* (eastern curlew) (TSSC, 2015f) + Approved Conservation Advice for *Calidris canutus* (Red Knot) (TSSC, 2016b) + Approved Conservation Advice for *Anous tenuirostris melanops* (Australian lesser noddy) (TSSC, 2015g) + Approved Conservation Advice for *Limosa lapponica baueri* (bar-tailed godwit (western Alaskan)) (TSSC, 2016f) + Approved conservation advice *Limosa lapponica menzbieri* (bar-tailed godwit (northern Siberian)) (TSSC, 2016a) + Approved Conservation Advice for *Papasula abbotti* (Abbott's booby) (TSSC, 2015h) Management is also consistent with the zoning of the Australian marine parks, in that risks have been reduced to ALARP, such as implementation of spill response activities will limit impacts, thereby conserving the marine park values as required by the North Marine Parks Network Management Plan (Director of National Parks, 2018a) and North-West Marine Parks Network Management Plan (Director of National Parks, 2018b).
Are performance outcomes, control measures and associated performance standards consistent with legal and regulatory requirements?	Yes – Management consistent with *National Plan for Maritime Environmental Emergencies* (AMSA, 2019), amongst other legislation identified in Section 6 and 7. Through acceptance of this EP, legislative and regulatory requirements will be met as per **Section 1.6.2**.
Are performance outcomes, control measures and associated performance standards consistent with Santos' Environment, Health and Safety Policy?	Yes – aligns with Santos' Environment, Health and Safety Policy.
Are performance outcomes, control measures and associated performance standards consistent with industry standards?	Yes – the most recent and comparable Drilling and Completions EPs accepted by NOPSEMA have been reviewed for consistency with the performance outcomes, control measures and associated performance standards proposed in this EP.

Have performance outcomes, control measures and associated performance standards taken into consideration stakeholder feedback?	Yes – requests relating to managing spill response activities have been considered. During any spill response, a close working relationship with relevant regulatory bodies (e.g., AMSA, DEPWS) will occur to ensure there is ongoing, coordinated consultation with relevant stakeholders on the acceptability of response operations. Relevant persons listed in **Table 4-1,** whose functions, interests or activities are considered at risk as a result of the event, will be included in the list of stakeholders who will be notified under Santos' Incident Management Process during the response operations.. Wildlife response will be conducted in accordance with the Northern Territory Oiled Wildlife Response Plan (NTOWRP) and any other NT OWR plans that are published for territory waters (the NT government is currently developing one).
Are performance standards such that the impact or risk is considered to be ALARP?	Yes – see ALARP above.

The consequence of spill response operations on receptors is assessed as II – Minor. Based on an assessment of Santos' acceptability criteria and with the control measures in place, potential impacts are considered acceptable.

7. Unplanned events 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 ALARP 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.

An ENVID workshop (as described in **Section 5**) for unplanned activities was held in June 2021. Santos' environmental assessment identified seven environmental risks associated with unplanned events for this activity. The results of the environmental risk assessment are summarised in **Table 7-1** and described in the following subsections.

Table 7-1: Environmental risk assessment summary

EP Section	Unplanned event	Likelihood	Consequence	Residual risk level
7.1	Release of solid objects	d – Occasional	I – Negligible	Low
7.2	Introduction of invasive marine species	b – Unlikely	III – Moderate	Low
7.3	Marine fauna interaction	b – Unlikely	I – Negligible	Very Low
7.4	Non-hydrocarbon and chemicals release (surface) – liquids	c – Possible	II – Minor	Low
7.6	Hydrocarbon spill – condensate	a – Remote	IV – Major	Low
7.7	Hydrocarbon spill – Marine diesel	c – Possible	II – Minor	Low
7.8	Minor hydrocarbon release (surface and subsea)	c – Possible	II – Minor	Low

7.1 Release of solid objects

7.1.1 Description of event

Event	Solid objects such as those listed below can be accidentally released to the marine environment: non-hazardous solid wastes, such as paper, plastics and packaging hazardous solid wastes, such as batteries, fluorescent tubes, medical wastes and aerosol cans equipment and materials, such as supplies, hard hats, tools or infrastructure parts. Release of these solid objects may occur as a result of: + overfull and/or uncovered bins + incorrectly disposed items + incidents during transfers of waste or supplies + dropped objects/lost equipment.
Extent	The event will only occur within the operational area, and all non-buoyant waste material or dropped objects are expected to sink to the seabed and remain within the operational area. Buoyant objects could potentially move beyond the operational area.
Duration	An unplanned release of solids may occur during operational activities and impacts may occur until the solid degrades.

7.1.2 Nature and scale of environmental impacts

Potential receptors: physical environment (water quality, benthic habitats, KEF); threatened, migratory fauna or local fauna (marine reptiles, whales, sharks, fish and rays).

Solids such as plastics have the potential to affect benthic environments and to harm marine fauna through entanglement or ingestion. Marine turtles and seabirds are particularly at risk from entanglement and ingestion. Marine turtles may mistake plastics for food; once ingested, plastics can damage internal tissues and inhibit physiological processes, which can both potentially result in fauna fatality. Floating, non-biodegradable marine debris has been highlighted as a threat to marine turtles, whales and, whale sharks in the relevant recovery plans and approved conservation advice (refer to **Table 3-9**). The recovery plans and approved conservation advice, as well as the *Threat Abatement Plan for the Impacts of Marine Debris on the Vertebrate Wildlife of Australia's Coasts and Oceans* (DoEE, 2018), have specified several recovery actions to help combat this threat.

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

The area of potential seabed disturbance due to release of a heavier non-hydrocarbon solids would be restricted to the operational area (for example, accidentally dropped equipment). Damage to substrates within the operational area and associated infauna and epifauna may occur, however such impact is expected to be restricted to the size of the dropped object.

The seabed within the operational area consists of soft substrates and is devoid of significant bathymetric features, sediments are predominantly unconsolidated silty sand (Jacobs, 2016a).

The habitat type in the operational area is widely distributed and well represented in northern Australia. While soft sediment benthic habits will not be destroyed, disturbance of the communities on and within them (such as epifauna and infauna) will occur in the event of a dropped object; and depressions may remain on the seabed for some time after removal of the dropped object as they gradually infill over time. The seafloor of this bioregion is strongly affected by cyclonic storms, long-period swells and large internal tides, which can resuspend sediments within the water column and move sediment across the seafloor.

The operational area overlaps the 'Shelf break and slope of the Arafura Shelf' KEF. The seafloor features associated with this KEF (i.e., the shelf break and patch reefs, hard substrate pinnacles and submerged reefs on the shelf slope) were not observed within the operational area during the Barossa marine studies program, nor are these topographically distinct features evident from the bathymetry data derived from multiple surveys undertaken across this area.

7.1.3 Environmental performance outcomes and control measures

The EPO relating to this event is:

+ No unplanned objects, emissions or discharges to sea or air. (EPO-04)

An assessment of the environmental benefits and the potential costs or issues associated with control measures for this activity are shown in **Table 7-2** to demonstrate the potential risks are ALARP. Control measures that are adopted have associated EPSs and measurement criteria which are presented in **Table 8-2**. Rejected control measures have an ALARP evaluation provided to justify their rejection.

Table 7-2: Control measures evaluation for release of solid objects

CM reference	Control measure	Environmental benefit	Potential cost/issues	Evaluation
Standard control measures				
BAD-CM-002	Dropped object prevention procedures	Impacts to environment are reduced by preventing dropped objects and by retrieving dropped objects unless the environmental consequences are negligible or there are risks to safety. Procedure minimises drop risk during lifting operations.	Cost of implementing procedures.	**Adopted** – environmental benefits of preventing dropped objects outweighs procedural compliance costs.
BAD-CM-004	Waste (garbage) management procedures	Reduces probability of garbage being discharged to sea, reducing potential impacts to marine fauna, and ensures compliance with MARPOL Annex V (and Marine Order 95: Marine pollution prevention – garbage).	Cost of implementing procedures. MARPOL requirement to manage waste.	**Adopted** – environmental benefits of ensuring MODU/vessels are compliant outweighs the costs; it is a legislated requirement.
BAD-CM-005	Hazardous chemical management procedures	Reduces the risk of spills and leaks to sea by controlling the storage, handling and clean-up of hazardous chemicals including hydrocarbons.	Cost of implementing procedures.	**Adopted** – environmental benefits of ensuring MODU/ vessels are compliant outweighs the potential costs.

CM reference	Control measure	Environmental benefit	Potential cost/issues	Evaluation
BAD-CM-007	Chemical selection procedure	Only environmentally acceptable drilling products are used reducing potential impacts in the event of an accidental release.	Cost of implementing procedures. Range of chemicals reduced with potentially higher costs for alternative products.	**Adopted** – environmental benefit of storing and handling environmentally acceptable products onboard the MODU/vessels outweigh procedural implementation costs.
BAD-CM-008	General chemical management procedures	Reduces the risk of accidental discharge to sea by controlling the storage, handling and clean-up of chemicals.	Cost of implementing procedures.	**Adopted** – environmental benefits of ensuring procedures are followed outweighs procedural compliance costs.
BAD-CM-009	International Maritime Dangerous Goods Code	Reduces the risk of an environmental incident, such as an accidental release to sea or unintended chemical reaction.	Cost of implementing procedures. Regulatory requirement.	**Adopted** – it is a legislated requirement.
BAD-CM-011	Bulk solid transfer procedure	Reduces likelihood of an unplanned release occurring during bulk transfer through correct equipment maintenance and integrity to prevent accidental loss of solids.	Cost of implementing procedures.	**Adopted** – environmental benefits of ensuring procedures are followed outweighs procedural compliance costs.
Additional control measures				
N/A	Eliminate lifting in field	Reduces the risk of dropped objects.	Eliminating lifting would require MODU/vessels storing more equipment and supplies on-board, and/or additional trips to shore. MODU/vessels will not have enough deck space to store all required equipment, materials, supplies needed for the duration of the activity.	**Rejected** – not feasible to eliminate lifting in the field.

7.1.4 Environmental impact assessment

Receptors	Physical environment (benthic habitats) Threatened, migratory or local fauna (marine mammals, marine reptiles, sharks, fish and rays)
Consequence	I – Negligible

Physical environment (benthic habitats)

In the event of a dropped object, there will be localised and short-term damage to the seabed. The extent of the impact is limited to the size of the dropped object; given the size of the equipment used, any impact is expected to be very small.

Marine invertebrates that may inhabit disturbed soft sediment benthic habitats are expected to occur elsewhere within the operational area and surrounds and therefore the disturbance is not expected to affect prey availability, or protected fauna species.

The operational area overlaps the 'Shelf break and slope of the Arafura Shelf' KEF. The seafloor features associated with this KEF (i.e., the shelf break and patch reefs, hard substrate pinnacles and submerged reefs on the shelf slope) were not observed within the operational area during the Barossa marine studies program, nor are these topographically distinct features evident from the bathymetry data derived from multiple surveys undertaken across this area, It is, therefore, unlikely that the accidental loss of solids overboard would result in any impact to this seabed feature . Furthermore, the seabed footprint that would be impacted by the activity represents a small portion of this KEF and is not expected to impact the values of the KEF.

No significant seabed features or biota have been found in the operational area. Therefore, it is highly unlikely that any objects dropped during the activity would cause a significant impact to the ecological values associated with the seabed or benthic habitats. The consequence level is therefore considered I – Negligible.

Marine fauna – marine mammals, marine reptiles, seabirds, fish and sharks

In the event of loss of a solid object, the quantities would be limited by the type of activities planned. If the solid object can be ingested by marine fauna, impacts would be restricted to a small number of individuals, if any.

Recovery Plan for Marine Turtles in Australia 2017–2027 (**Table 3-9**) has identified marine debris as a potential threat to marine turtles. There is also a *Threat abatement plan for the impacts of marine debris on the vertebrate wildlife of Australia's coasts and oceans* (DoEE, 2018). These plans identify marine debris as potential threats to marine turtles and vertebrate wildlife resulting in potential injury or death and recommend adherence to legislation for the prevention of garbage disposal to prevent impacts.

The limited quantities associated with this event indicate that, even in a worst-case release of solid waste, impacts to fauna would be limited to individuals and are not expected to result in a decrease of the local population size. The consequence level is therefore considered I – Negligible.

Likelihood	D – Occasional

The proposed control measures will ensure the risks of dropped objects, lost equipment or release of hazardous/non-hazardous solid waste to the environment has been reduced. These control measures will also ensure that legislation for the prevention of garbage disposal from vessels is adhered to as recommended by *Threat Abatement Plan for the Impacts of Marine Debris on the Vertebrate Wildlife of Australia's Coasts and Oceans*. The likelihood of dropped objects occurring over the duration of the activity is considered 'Occasional' as it has occurred before in Santos.

Residual Risk	The residual risk is considered Low

7.1.5 Demonstration of as low as reasonably practicable

All reasonably practicable control measures have been reviewed and those adopted are considered appropriate to manage the residual risk to a Low level. The proposed management controls are in accordance with the Santos risk management criteria and are considered appropriate to manage the risk to ALARP.

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7.1.6 Acceptability evaluation

Is the risk ranked between Very Low to Medium?	Yes – residual risk is ranked Low.
Is further information required to validate the consequence assessment?	No – potential impacts and risks well understood through the information available.
Are risks and impacts consistent with the principles of ESD?	Yes – activity evaluated in accordance with Santos' *Environmental Hazard Identification and Assessment Procedure* which considers principles of ESD.
Have the acceptable levels of impact and risks been informed by relevant species recovery plans, threat abatement plans and conservation advice and Australian marine park zoning objectives)?	Yes – control measures implemented will minimise the potential impacts from the activity to species identified in relevant species recovery plans, conservation management plans and management actions set out in **Table 3-9**, including: + North Marine Parks Network Management Plan 2018 (Director of National Parks, 2018a) + Threat Abatement Plan for Impacts of Marine Debris on Vertebrate wildlife of Australia's coasts and oceans (DoEE, 2018) + Recovery Plan for Marine Turtles in Australia (CoA, 2017) + Approved Conservation Advice for *Megaptera novaeangliae* (humpback whale) (TSSC, 2015c) + Approved Conservation Advice for *Rhincodon typus* (whale shark) (TSSC, 2015d) + Approved Conservation Advice for *Balaenoptera physalus* (fin whale) (TSSC, 2015b) + Approved Conservation Advice for *Balaenoptera borealis* (sei whale) (TSSC, 2015a) + Recovery Plan for the Grey Nurse Shark (*Carcharias taurus*) (DoE, 2014a) + Sawfish and River Sharks Multispecies Recovery Plan (CoA, 2015b).
Are performance outcomes, control measures and associated performance standards consistent with legal and regulatory requirements?	Yes – management consistent with MARPOL Annex V and International Maritime Dangerous Goods Code. Through acceptance of this EP, legislative and regulatory requirements will be met as per **Section 1.6.2**.
Are performance outcomes, control measures and associated performance standards consistent with Santos' Environment, Health and Safety Policy?	Yes – aligns with Santos' Environment, Health and Safety Policy.
Are performance outcomes, control measures and associated performance standards consistent with industry standards?	Yes – the most recent and comparable Drilling and Completions EPs accepted by NOPSEMA have been reviewed for consistency with the performance outcomes, control measures and associated performance standards proposed in this EP.
Have performance outcomes, control measures and associated performance standards taken into consideration stakeholder feedback?	Yes – no objections or claims raised relating to unplanned release of solid objects/waste and potential environmental impacts to marine fauna or commercial fisheries.
Are performance standards such that the impact or risk is considered to be ALARP?	Yes – see ALARP above.

The residual risk of an unplanned release of solid objects on receptors is assessed as Low. Based on an assessment of Santos' acceptability criteria and with the control measures in place, potential risks are considered acceptable.

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, MODU and external/internal niches (such as sea chests, seawater systems, etc) + biofouling on equipment that is routinely submerged in water + discharge of high-risk ballast water. 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 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 (benthic habitat); threatened, migratory, or local fauna (marine mammals, marine turtles, sharks, fish and rays); socio-economic (commercial fisheries, other marine users, tourism).

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 northern Australia 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
+ damage to marine and industrial equipment and infrastructure.

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

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

It is recognised that artificial, disturbed and polluted habitats in tropical regions are susceptible to introductions, which is why ports are often areas of higher IMS risk (Neil *et al*., 2005). However, in Australia there are limited records of detrimental impact from IMS compared with 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. However, this depends on the environmental conditions and species. For this reason, increased management requirements have been implemented in recent years by Commonwealth and State regulatory agencies.

If an IMS is introduced, species have been known to colonise areas outside of the areas to which it is introduced but this depends on the diversity and extent of suitable habitat for colonisation.

Potential sources for the introduction of marine species into the operational area include biofouling on the vessels, including external niches (such as propulsion units, steering gear and thruster tunnels) and internal niches (such as sea chests, strainers, seawater pipe work, anchor cable lockers and bilge spaces). Ballast water is responsible for 20 to 30% of all marine pest incursions into Australian waters; however, research indicates biofouling (the accumulation of aquatic micro-organisms, algae, plants and animals on vessel hulls and submerged surfaces) has been responsible for more foreign marine introductions than ballast water (DAFF, 2011).

Equipment that is submerged in water for periods of time (such as ROVs) may acquire marine pest species, which can be spread if the equipment is not cleaned before use in pest-free areas.

IMS are generally unable to successfully establish in deep water ecosystems (Geiling, 2014), most likely due to a lack of light and suitable habitat to sustain the growth and survival of IMS. Therefore, most IMS are found in tidal and subtidal zones with only a few species known to extend into deeper waters of the continental shelf (Bax *et al*., 2003). The majority of species introduced to an area outside of their natural range (e.g., via ballast water) will not survive to establish or subsequently become invasive or a pest (Wells *et al*., 2009).

IMS risks are relevant to all maritime activities, including commercial shipping, fishing, military, petroleum, as well as recreational boating.

7.2.3 Environmental performance outcomes and control measures

The EPO relating to this event is:

+ No introduction of marine pest species. (EPO-02)

An assessment of the environmental benefits and the potential costs or issues associated with control measures for this activity are shown in **Table 7-3** to demonstrate that potential risks are ALARP. Control measures that are adopted have associated EPSs and measurement criteria which are presented in **Table 8-2**. Rejected control measures have an ALARP evaluation provided to justify their rejection.

Table 7-3: Control measures evaluation for introduction of invasive marine species

CM reference	Control measure	Environmental benefit	Potential cost/issues	Evaluation
Standard control measures				
BAD-CM-023	Compliance with the *Biosecurity Act 2015*	The likelihood of introducing IMS is reduced due to assessment procedure, DAWE clearance and management of ballast water.	Cost associated with implementing procedures. Costs associating with reducing the vessel/MODU risk to 'low' (for example, dry docking, hull cleaning or additional costs due to inspections).	**Adopted** – it is a legislated requirement.

CM reference	Control measure	Environmental benefit	Potential cost/issues	Evaluation
BAD-CM-025	Anti-foulant system	The likelihood of introducing IMS is reduced due to anti-foulant systems being compliant with legislation.	Cost associated with contracting assurance checks of anti-fouling systems. Regulatory requirement.	**Adopted** – it is a legislated requirement.
Additional control measures				
N/A	Heat treatment of ballast water to eliminate IMS	Would reduce potential for IMS to establish by reducing the potential for IMS present in ballast water.	High cost to implement. High heat required to be effective, could result in injury or mortality of native species if temperature exceeds tolerance thresholds.	**Rejected** – based on increased risk to marine environment compared with base case risk.
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 from overseas.	Vessels and equipment suitable for the activity may not be available in state or national waters causing activity delays and cost increases. An IMS risk assessment is still required for all contracted vessels.	**Rejected** – potential for significant schedule delays and activity costs if suitable vessels are not 'locally' available. All contracted vessels must be 'low' risk of introducing IMS regardless of their origin.
N/A	Mandatory dry docking of vessels/MODU before entering field to clean vessel and/or equipment and remove biofouling	Ensures that the risk of IMS being present on vessel/ MODU or associated equipment is low.	Significant cost and could lead to scheduling delays. May be unjustified depending on MODU/vessel history and condition, and IMS risk management practices.	**Rejected** – costs disproportionately high compared with environmental benefit given the proposed risk-based management framework, which includes potential dry docking and cleaning if justified.
N/A	Use an alternative ballast system to avoid uptake or discharge of water	Eliminate need for ballast water exchange, therefore decreasing risk of introducing IMS through ballast water.	Vessels/MODU suitable for the activity may not have options for alternative ballast system, therefore would require modification at significant cost.	**Rejected** – costs disproportionately high compared with environment benefit given other controls in place already reduce the risk.

CM reference	Control measure	Environmental benefit	Potential cost/issues	Evaluation
N/A	Zero discharge of ballast water	Would reduce the potential for introducing IMS by implementing a no ballast water exchange policy on vessels.	Ballast water exchange required on the vessels for stability.	**Rejected** – on the basis that ballast water exchange is a safety-critical activity for marine operations.

7.2.4 Environmental impact assessment

Receptors	Physical environment (benthic habitats and primary producers) Threatened, migratory, or local fauna (marine mammals, marine turtles, sharks, fish and rays) Socio-economic (commercial fisheries)
Consequence	III – Moderate
Physical environment (benthic habitats and primary producers) The seabed in the operational area is largely bare sediment and is devoid of filter feeders (which includes sponges and soft corals) and epifauna (Jacobs, 2016a). A low abundance and diversity of infauna has been sampled in the operational area and no features associated with the 'Shelf Break and slope of the Arafura Shelf KEF' were identified. However, if IMS are established, the consequence level is considered III – Moderate.	
Threatened, migratory, or local fauna (marine mammals, marine turtles, sharks, fish and rays) IMS, if successfully established, can outcompete native species for food or space, prey on native species or change the nature of the environment and can subsequently impact on fisheries or aquaculture. Therefore, if established, the consequence level is considered III – Moderate.	
Socio-economic (commercial fisheries) The introduction of IMS could have a detrimental effect on commercial fisheries in the area due to the IMS outcompeting native species for food or space, prey on native species or change the nature of the environment. Therefore, if established, the consequence level is considered III – Moderate.	
Likelihood	B – Unlikely
The pathways for IMS introduction are well known; consequently, standard preventive measures are proposed. The ability for invasive marine species to colonise a habitat depends on several environmental conditions. It has been found that highly disturbed environments (such as marinas) are more susceptible to colonisation than are open water environments where the number of dilutions and the degree of dispersal are high (Paulay *et al*., 2002). IMS are more likely to populate shallower areas with favourable substrates. Given water depths across the operational area are greater than 200 m, this creates an unfavourable habitat for colonisation (light limiting and low habitat biodiversity with sparse epibiota) and it is distant from shallow coastal habitats, there is a very low likelihood that IMS would be able to survive translocation and subsequently establish and colonise. With control measures in place to reduce the risk of introduction of IMS, the likelihood of introducing an IMS is considered unlikely.	
Residual Risk	The residual risk is considered Low.

7.2.5 Demonstration of as low as reasonably practicable

The MODU, vessels and submersible equipment are required for the activity and no alternatives are feasible.

All reasonably practicable control measures have been reviewed and those adopted are considered appropriate to manage the residual risk to a 'Low' level. The proposed management controls are in accordance with the Santos risk management criteria and are considered appropriate to manage the risk to ALARP.

7.2.6 Acceptability evaluation

Is the risk ranked between Very Low to Medium?	Yes – introduction of IMS residual risk ranking is Low.
Is further information required to validate the consequence assessment?	No – potential impacts and risks well understood through the information available.
Are risks and impacts consistent with the principles of ESD?	Yes – activity evaluated in accordance with Santos' *Environmental Hazard Identification and Assessment Procedure* which considers principles of ESD.
Have the acceptable levels of impact and risks been informed by relevant species recovery plans, threat abatement plans and conservation advice and Australian marine park zoning objectives)?	Yes – while several plans identify habitat modification (which could occur as a result of IMS establishing) as a threat to marine fauna, significant impacts are not predicted for this activity and IMS is not identified as a specific threat.
Are performance outcomes, control measures and associated performance standards consistent with legal and regulatory requirements?	Yes – management consistent with the *Biosecurity Act 2015* and National Biofouling Management Guidance for The Petroleum Production and Exploration Industry (Marine Pest Sectoral Committee, 2018). Through acceptance of this EP, legislative and regulatory requirements will be met as per **Section 1.6.2**.
Are performance outcomes, control measures and associated performance standards consistent with Santos' Environment, Health and Safety Policy?	Yes – aligns with Santos' Environment, Health and Safety Policy.
Are performance outcomes, control measures and associated performance standards consistent with industry standards?	Yes – the most recent and comparable Drilling and Completions EPs accepted by NOPSEMA have been reviewed for consistency with the performance outcomes, control measures and associated performance standards proposed in this EP.
Have performance outcomes, control measures and associated performance standards taken into consideration stakeholder feedback?	Yes – requests relating to IMS management and potential environmental impacts to marine fauna or commercial fisheries have been considered.
Are performance standards such that the impact or risk is considered to be ALARP?	Yes – see ALARP above.

The residual risk of an unplanned introduction of IMS is assessed as Low. Based on an assessment of Santos' acceptability criteria and with the control measures in place, potential risks are considered acceptable.

7.3 Marine fauna interaction

7.3.1 Description of event

Event	There is the potential for the MODU, equipment (for example ROV), vessels or helicopters involved in the Barossa Development Drilling Campaign to interact with marine fauna, including potential strike or collision that could result in severe injury or mortality.
Extent	Within the operational area.
Duration	During the activity.

7.3.2 Nature and scale of environmental impacts

Potential receptors: threatened, migratory fauna or local fauna (marine mammals, marine turtles, whale sharks, seabirds).

Marine fauna in surface waters that are most at risk from vessel collision include marine mammals, marine turtles and whale sharks. The operational area does not contain any significant feeding, breeding or aggregation areas for marine fauna.

7.3.2.1 Marine mammals

Cetaceans are naturally inquisitive marine mammals that are often attracted to vessels underway; for example, dolphins commonly 'bow ride' with vessels. There are no BIAs for cetaceans within the operational area and therefore it is unlikely that peaks of presence will be observed, but individuals of various species may be encountered at any time of year, including Omura's whales (not EPBC listed) which were frequently present in the area between April and September inclusive, with a peak in June and July (JASCO, 2016).

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 (for example, a Bryde's whale in Bass Strait in 1992) (Simmonds *et al*., 2004), though the data indicates this is likely to be associated with container ships and fast ferries. Some cetacean species, such as humpback whales, can detect and change course to avoid a vessel (Simmonds *et al*., 2004).

As presented in Department of the Environment and Energy's National Strategy for Mitigating Vessel Strike of Marine Megafauna (DoEE, 2016), the majority of the reported vessel collisions for whales in Australian waters between 1990 and 2015 have occurred along eastern or south-eastern Australia, with no reported incidences in NT waters (DoEE, 2016).

The International Whaling Commission has compiled a database of the worldwide occurrence of vessel strikes to cetaceans, within which Australia constitutes approximately 7% (35 reports) of the reported worldwide (approximately 471 reports) vessel strike records involving large whales (Peel *et al*., 2018).

The reaction of whales to the approach of a ship is quite variable. Some species remain motionless when close to 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).

Dugongs are not expected to occur in the operational area and, therefore, are not considered credible receptors for marine fauna interaction and excluded from further discussion.

7.3.2.2 Marine reptiles

Turtle/vessel interactions arising from increased vessel traffic is also recognised as one of several key impacts to marine turtles in the *Recovery Plan for Marine Turtles in Australia 2017–2027* (CoA, 2017). In the recovery plan, vessel disturbance is identified as a risk to flatback turtles. Marine turtles are highly mobile and, given the low speeds of vessels typically used for operations, are likely to be able to move from an area where there is vessel activity. Marine turtles make extensive migrations through the region; and it is possible individual turtles of any of the species known from the region may be encountered in the operational area, however the operational area does not contain any significant feeding, breeding or aggregation areas for marine turtles.

Marine turtle mortality due to boat strike has been identified as an issue in Queensland waters in the Recovery Plan for Marine Turtles in Australia 2017–2027 (DoEE, 2017). However, turtles appear to be more vulnerable to boat strike in areas of high urban population where incidents of pleasure crafts are higher.

7.3.2.3 Sharks, fish and rays

Large sharks which frequent the upper portions of the water column, such as whale sharks, are most vulnerable to collision with vessels. Whale sharks which have been shown to spend approximately 25% of their time less than 2 m from the surface and greater than 40% in the upper 15 m of the water column (Wilson *et al*., 2006; Gleiss *et al*., 2013). Whale sharks, other pelagic fish and demersal fish are likely to exhibit a short-term avoidance to vessels or ROVs. This is likely to be initiated through the vibrations and underwater noise emitted from these activities (**Section 6.1**) rather than the physical presence. Such avoidance is likely to be temporary. The whale shark BIA does not overlap the operational area and therefore significant numbers are not expected to be encountered.

7.3.2.4 Seabirds

A number of protected species of marine birds may occur at times within the operational area (**Table 3-7**). Seabirds may be attracted to the drilling operations due to lighting and operational discharges such as macerated food waste.

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

7.3.3 Environmental performance outcomes and control measures

The EPO relating to this event is:

+ No injury or mortality to EPBC Act listed marine fauna. (EPO-05)

An assessment of the environmental benefits and the potential costs or issues associated with control measures for this activity are shown in **Table 7-4** to demonstrate that potential risks are ALARP. Control measures that are adopted have associated EPSs and measurement criteria which are presented in **Table 8-2**. Rejected control measures have an ALARP evaluation provided to justify their rejection.

Table 7-4: Control measures evaluation for marine fauna interaction

CM reference	Control measure	Environmental benefit	Potential cost/issues	Evaluation
Standard Control measures				
BAD-CM-001	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, and helicopters can increase distances from sighted fauna if required.	Potential delay in vessel and helicopter movement, increasing activity duration and costs to Santos. Cost associated with implementing procedures. Regulatory requirements under EPBC Regulations 2000.	**Adopted** – marine fauna interaction restrictions, such as vessel and helicopter speed and direction, are based on legislated requirements and must be adopted.
Additional control measures				
N/A	Adopt further measures to those outlined in 'EPBC Regulations 2000 — Part 8 Division 8.1 during peak periods of ecological sensitivity, for example, additional management considerations for vessels outlined in the *Australian national guidelines for whale and dolphin watching* (2017)	Negligible due to the absence of BIAs or seasonal aggregations and/or migration of fauna in the operational area.	Administrative costs to update existing Santos procedure and induction materials and train personnel. Operational costs through interruption to activities through implementation of controls developed for an industry trying to get close to marine fauna, when Santos' activities aim to avoid fauna.	**Rejected** – the existing control ensures compliance with legislation. No additional relevant controls have been identified in government or industry guidelines.
N/A	Manage the timing of the activity to avoid sensitive periods	Negligible due to the absence of BIAs or seasonal aggregations and/or migration of fauna in the operational area.	As the activity will be greater than 12 months in duration there would be a high cost to demobilise and remobilise the MODU and vessels. Protected marine fauna species are present year-round, albeit in low numbers, therefore avoidance is not feasible.	**Rejected** – the high financial cost would be grossly disproportionate to negligible environmental benefits

CM reference	Control measure	Environmental benefit	Potential cost/issues	Evaluation
N/A	Restrict vessel operating speeds in the operational area	Reduce consequence of collisions (causing harm) and likelihood as fauna have longer to detect and avoid the vessel.	Administrative costs to update existing Santos procedure and induction materials and train personnel.	**Rejected** – not considered necessary given that there are no marine fauna aggregation areas, migration pathways or BIAs near the operational area, noting that vessels will comply with EPBC Regulations – Part 8 Division 8.1 Interacting with cetaceans (and applied for marine turtles), through implementation of the Procedure for interacting with marine fauna (BAD-CM-001).
N/A	Dedicated MMO on vessels (EPBC Policy Statement 2.1 Part B)	Improved ability to spot and identify marine fauna at risk of collision (that may cause harm).	Additional cost of contracting MMO.	**Rejected** – likelihood of animals being encountered is too low to justify additional cost of MMO, personnel can observe for marine fauna when piloting vessels; cost would be grossly disproportionate to negligible environmental benefits.
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.	Vessels are required to support 24-hour MODU operations. Would increase the duration of the activity resulting in significant financial costs. No other maritime industry has such a restriction.	**Rejected** – the high financial cost would be grossly disproportionate to negligible environmental benefits.

7.3.4 Environmental impact assessment

Key receptors	Threatened, migratory or local fauna (marine mammals, marine reptiles, sharks and seabirds).
Consequence	I – Negligible
In the event of a collision with marine fauna including seabirds, there is the potential for individual animal injury or death. The number of receptors present at the operational area is expected to be limited to a small number of transient individuals. No known BIAs intersect with the operational area for marine mammals, whale sharks, reptiles or seabirds. The closest protected area is the Oceanic Shoals AMP, being approximately 33 km away. Vessel movements will be of relatively low frequency; albeit, for an extended duration. While injury or death to individual animals would highly undesirable, this would represent a small proportion of any local population and not beyond any natural variation in population size. According to the Santos consequence descriptor definitions, this would be of Negligible (I) environmental consequence.	
Likelihood	B – Unlikely
The likelihood of marine fauna interaction resulting in injury or death is considered unlikely given the implementation of the Santos procedure for interacting with marine fauna; lack of BIAs or significant breeding, nesting and aggregation areas of marine fauna within the operational area; and the tendency for marine fauna to move away from vessels and helicopters.	
Residual risk	The residual risk is considered Very Low

7.3.5 Demonstration of as low as reasonably practicable

No alternative options to the use of the MODU, vessels and helicopters are possible in order to undertake the activity.

All reasonably practicable control measures have been reviewed and those adopted are considered appropriate to manage the residual risk to a Low level. The proposed management controls are in accordance with the Santos risk management criteria and are considered appropriate to manage the risk to ALARP.

7.3.6 Acceptability evaluation

Is the risk ranked between Very Low to Medium?	Yes – maximum marine fauna interaction residual risk ranking is Very Low.
Is further information required to validate the consequence assessment?	No – potential impacts and risks well understood through the information available.
Are risks and impacts consistent with the principles of ESD?	Yes – activity evaluated in accordance with Santos' *Environmental Hazard Identification and Assessment Procedure* which considers principles of ESD.
Have the acceptable levels of impact and risks been informed by relevant species recovery plans, threat abatement plans and conservation advice and Australian marine park zoning objectives)?	Yes – control measures implemented will minimise the potential risks and impacts from vessel strike from the activity. Consistent with relevant species recovery plans, conservation management plans and management actions set out in **Table 3-9**, including: + Recovery Plan for Marine Turtles in Australia (CoA, 2017) + Approved Conservation Advice for *Megaptera novaeangliae* (humpback whale) (TSSC, 2015c) + Approved Conservation Advice for *Rhincodon typus* (whale shark) (TSSC, 2015d) + Conservation Management Plan for the Blue Whale, 2015–2025 (CoA, 2015a) + Approved Conservation Advice for *Balaenoptera borealis* (sei whale) (TSSC, 2015a) + Approved Conservation Advice for *Balaenoptera physalus* (fin whale) (TSSC, 2015b) + Recovery Plan for the Grey Nurse Shark (*Carcharias taurus*) (DoE, 2014a).
Are performance outcomes, control measures and associated performance standards consistent with legal and regulatory requirements?	Yes – management consistent with EPBC Regulations Part 8. Through acceptance of this EP, legislative and regulatory requirements will be met as per **Section 1.6.2**.
Are performance outcomes, control measures and associated performance standards consistent with Santos' Environment, Health and Safety Policy?	Yes – aligns with Santos' Environment, Health and Safety Policy.
Are performance outcomes, control measures and associated performance standards consistent with industry standards?	Yes – the most recent and comparable Drilling and Completions EPs accepted by NOPSEMA have been reviewed for consistency with the performance outcomes, control measures and associated performance standards proposed in this EP.
Have performance outcomes, control measures and associated performance standards taken into consideration stakeholder feedback?	Yes – requests relating to management of vessel movement and potential environmental impacts to marine fauna or commercial fisheries have been considered.
Are performance standards such that the impact or risk is considered to be ALARP?	Yes – see ALARP above.

The residual risk of unplanned marine fauna interaction is assessed as Very Low. Based on an assessment of Santos' acceptability criteria and with the control measures in place, potential risks are considered acceptable.

7.4 Non-hydrocarbon and chemicals release (surface) – liquids

7.4.1 Description of event

Event	Non-hydrocarbon liquids including miscellaneous chemicals and waste streams (brine, mixed cement, cleaning and cooling agents, stored or spent chemicals and leftover paint materials) are used or stored on-board the MODU/vessels during the activity. An accidental release of chemicals and other non-hydrocarbon liquids into the marine environment has the potential to occur from: + transferring, storing or using bulk products (e.g., mixed cement) + mechanical failure of equipment, such as tank or pipework failure + handling and storage spills and leaks due to insufficient fastening or inadequate bunding + hose or hose connection failure or leak + lifting – dropped objects damaging liquid vessels (containers) + inadequate bunding. A release of non-hydrocarbon liquids or chemicals may result in impacts to water quality and hence sensitive environmental receptors.
Extent	The maximum volume of non-hydrocarbon liquids or chemicals that could be released during routine operations is likely to be small and limited to the volume of individual containers (e.g., drums) stored on deck of vessels or the MODU. The worst-case credible scenario of an unplanned release would be the disposal of an unsuitable WBM system which cannot be re-used (approximately 100 m^3 in any one pit for a nominal rig), which does not include NAF. Although the release would be intentional, the disposal of a whole mud pit is not planned. These types of releases would occur at the sea surface only. Dilution from discharges in open waters is rapid, with 1 in 1,000 dilution usually occurring within 30 minutes (Costello & Read, 1994). If the spill is not contained on deck, a release to the marine environment would be likely to rapidly disperse within the operational area. The environment that may be affected for non-hydrocarbon liquids or chemical release resulting in a decrease in water quality is likely to be restricted to around the MODU and vessels but contained within the operational area.
Duration	The duration of the impact is limited to the time the released chemical/liquid takes to disperse to below harmful concentrations. In the ocean, this is expected to be in the order of minutes to hours.

7.4.2 Nature and scale of environmental impacts

Potential receptors: physical environment (water and sediment quality, benthic habitats); threatened, migratory or local fauna (marine mammals, marine reptiles, sharks and rays, fish and birds).

7.4.2.1 Physical environment

Non-hydrocarbon liquids or chemicals accidentally released to the marine environment may lead to contamination of the water column near the MODU and vessels. The potential impacts would most likely be highly localised and restricted to the immediate area surrounding the spill, with rapid dispersal to concentrations below impact thresholds likely to occur in the open ocean.

Due to the small volumes and expected rapid dispersal to concentrations below impact thresholds, impacts to water quality are not expected to cause flow-on effects to sediment quality or benthic habitats, including the 'Shelf Break and Slope of the Arafura Shelf' KEF on the seafloor (greater than 200 m below the surface) and shoals. There is no emergent or intertidal habitat that could be impacted by a surface spill. Owing to the water depth, any spilled material is unlikely to reach land or affect any of benthic habitats including shallow water shoals given the distance to the nearest shoal is 38 km.

7.4.2.2 Threatened, migratory or local fauna

Changes to water quality could potentially lead to short-term impacts on marine fauna (e.g., pelagic fish and sharks, marine mammals, marine reptiles and seabirds). As summarised in **Table 3-8**, the operational area does not overlap any BIAs and therefore only low numbers of animals are expected to be encountered in the operational area.

Recovery plans and conservation advice for numerous protected species identify marine pollution and contamination impacts as a threat to the species.

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

7.4.3 Environmental performance outcomes and control measures

The EPO relating to this event is:

+ No unplanned objects, emissions or discharges to sea or air. [EPO-04]

An assessment of the environmental benefits and the potential costs or issues associated with control measures for this activity are shown in **Table 7-5** to demonstrate that potential risks are ALARP. Control measures that are adopted have associated EPSs and measurement criteria which are presented in **Table 8-2**. Rejected control measures have an ALARP evaluation provided to justify their rejection.

Table 7-5: Control measure evaluation for non-hydrocarbon and chemicals release (surface) – liquids

CM reference	Control measure	Environmental benefit	Potential cost/issues	Evaluation
Standard control measures				
BAD-CM-002	Dropped object prevention procedures	Impacts to environment are reduced by preventing dropped objects and by retrieving dropped objects unless the environmental consequences are negligible or there are risks to safety. Minimises dropped object risk during lifting operations that may cause secondary spill resulting in reduction in water quality.	Cost of implementing procedure.	**Adopted** – environmental benefits of ensuring procedures are followed outweighs the costs.
BAD-CM-004	Waste (garbage) management procedures	Reduces probability of waste being discharged to sea, reducing potential impacts to marine fauna.	Cost of implementing procedure.	**Adopted** – environmental benefits of ensuring procedures are followed outweighs the costs.

CM reference	Control measure	Environmental benefit	Potential cost/issues	Evaluation
BAD-CM-005	Hazardous chemical management procedures	Reduces the risk of spills and leaks (discharges) to the sea by controlling the storage, handling and clean-up of hazardous chemicals.	Cost of implementing procedure. Regulatory requirement to manage hazardous chemicals.	**Adopted** – environmental benefits of ensuring procedures are followed outweighs the costs; plus it is a legislated requirement.
BAD-CM-007	Chemical selection procedure	Selection of environmentally acceptable chemicals reduces the consequence of an unplanned chemical release to sea.	Cost of implementing procedure. Range of chemicals reduced and potential higher chemical costs.	**Adopted** – environmental benefits of ensuring procedures are followed outweighs the costs and potential reduction of available chemicals.
BAD-CM-008	General chemical management procedures	Potential impacts to the environment are reduced through following correct procedures for the safe handling and storage of chemicals.	Cost of implementing procedure. Appropriate chemical management is also necessary for safety reasons.	**Adopted** – environmental benefits of ensuring procedures are followed outweighs the costs.
BAD-CM-009	International Maritime Dangerous Goods Code	Dangerous goods managed in accordance with International Maritime Dangerous Goods Code to reduce the risk of an environmental incident, such as an accidental release to sea or unintended chemical reaction.	Cost of implementing procedure. Regulatory requirement to manage dangerous goods.	**Adopted** – environmental benefits of ensuring procedures are followed outweighs the costs; plus it is a legislated requirement.
BAD-CM-010	Bulk liquid transfer procedure	Bulk liquid transferred in accordance with bulk transfer procedures to reduce the risk of an unintentional release to the sea.	Cost of implementing procedure. Cost of purchasing and maintaining equipment (e.g., bulk hoses and connections).	**Adopted** – environmental benefits of ensuring procedures are followed outweighs the costs.
BAD-CM-012	MODU and vessel spill response plans	Ensures appropriate spill prevention and clean equipment is available, and crew are competent in its use.	Cost of implementing procedure.	**Adopted** – environmental benefits of ensuring procedures are followed outweighs the costs

CM reference	Control measure	Environmental benefit	Potential cost/issues	Evaluation
Additional control measures				
N/A	Eliminate lifting in field	Reduces the risk of non-hydrocarbons or chemicals (within containers) being accidentally dropped and/or discharged to the marine environment during lifting.	Eliminating lifting would require MODU/ vessels storing more equipment and supplies on-board, and/or additional trips to shore. MODU/ vessels will not have enough deck space to store all required equipment, materials, supplies needed for the duration of the activity.	**Rejected** – not feasible to eliminate lifting in the field.

7.4.4 Environmental impact assessment

Receptors	Physical environment (water quality, benthic habitat) Threatened, migratory or local fauna (marine mammals, marine reptiles, sharks, fish, rays and birds)
Consequence	II – Minor

In the event of a non-hydrocarbon liquid or chemical spill, the most likely largest spills would be between 250 litres to 1 m^3 (the size of the largest, most common storage container); but could possibly be up to 100 m^3 (from a loss of a mud pit).

Impacts to water quality would be expected but due to the dispersive nature of the ocean environment and water depths, impacts to benthic habitats (including those of the 'Shelf Break and Slope of the Arafura Shelf 'KEF) are not predicted. Species associated with the continental slope and patch reefs that characterise this KEF (such as demersal fish, whale sharks, sharks and turtles) are unlikely to aggregate within the operational area due to the lack of seafloor features. However, potential impacts to these species are described above.

Water quality changes are expected to be short-term and localised due to the selection of environmentally acceptable chemicals and relatively small size of an unplanned spill.

Habitat degradation, deteriorating water quality and marine pollution are identified as potential threats to several marine fauna species (that may be present in the operational area) in relevant recovery plans and Conservation Advice (**Table 3-9**) and to matters of national environmental significance (MNES) (DoEE, 2013).

A small non-hydrocarbon liquid release is unlikely to have widespread ecological effects, given the nature of the chemicals on board, the small volume that could be released, the operational area water depth and transient nature of marine fauna in this area.

Potential impacts to the physical environment (water quality) are considered to be Minor (II).

Likelihood	C – Possible

Santos reviewed non-hydrocarbon liquid spills and leaks from equipment and machinery in recent history (due to split hoses, small leaks, or handling errors). Most of the spills and leaks reported occurred within bunded areas, were less than 100 L, did not reach the marine environment and were cleaned up immediately.

The likelihood of a small (less than 100 L) hazardous liquids release occurring with the control measures in place is considered to be Possible (c).

Residual Risk	The residual risk is considered **Low**.

7.4.5 Demonstration of as low as reasonably practicable

A thorough set of controls has been proposed to minimise the risks of minor hazardous liquid spills and leaks occurring and subsequent environmental consequences should they occur.

All reasonably practicable control measures have been reviewed and those adopted are considered appropriate to manage the residual risk to a Low level. The proposed management controls are in accordance with the Santos risk management criteria and are considered appropriate to manage the risk to ALARP.

7.4.6 Acceptability evaluation

Is the risk ranked between Very Low to Medium?	Yes – residual risk is ranked Low.
Is further information required to validate the consequence assessment?	No – potential impacts and risks are well understood through the information available.
Are risks and impacts consistent with the principles of ESD?	Yes – activity evaluated in accordance with Santos' *Environmental Hazard Identification and Assessment Procedure*, which considers principles of ESD.
Have the acceptable levels of impact and risks been informed by relevant species recovery plans, threat abatement plans and conservation advice and Australian marine park zoning objectives)?	Yes – consistent with relevant species recovery plans, conservation management plans and management actions set out in **Table 3-9**, including: + Recovery Plan for Marine Turtles in Australia 2017–2027 (DoEE, 2017) + Approved Conservation Advice for *Megaptera novaeangliae* (humpback whale) (TSSC, 2015c) + Approved Conservation Advice for *Rhincodon typus* (whale shark) (TSSC, 2015d) + Conservation management plan for the blue whale, 2015–2025 (CoA, 2015a) + Approved Conservation Advice for *Balaenoptera borealis* (sei whale) (TSSC, 2015a) + Approved Conservation Advice for *Balaenoptera physalus* (fin whale) (TSSC, 2015b) + Sawfish and River Sharks Multispecies Recovery Plan (DoE, 2015a) + Wildlife Conservation Plan for Migratory Shorebirds (CoA, 2015c) + Approved Conservation Advice for *Calidris ferruginea* (curlew Sandpiper) (TSSC, 2015e) + Approved Conservation Advice for *Calidris canutus* (red knot) (TSSC, 2016b) + Approved Conservation Advice for *Numenius madagascariensis* (eastern curlew) (TSSC, 2015f) + Marine Bioregional Plan for the North Marine Region (CoA, 2012a).
Are performance outcomes, control measures and associated performance standards consistent with legal and regulatory requirements?	Yes – management consistent with MARPOL Annex V, Marine Order 97; MARPOL Annex III and Marine Order 94 (Marine pollution prevention – packaged harmful substances). Through acceptance of this EP, legislative and regulatory requirements will be met as per **Section 1.6.2**.
Are performance outcomes, control measures and associated performance standards consistent with Santos' Environment, Health and Safety Policy?	Yes – aligns with Santos' Environment, Health and Safety Policy.
Are performance outcomes, control measures and associated performance standards consistent with industry standards?	Yes – the most recent and comparable Drilling and Completions EPs accepted by NOPSEMA have been reviewed for consistency with the performance outcomes, control measures and associated performance standards proposed in this EP.

Have performance outcomes, control measures and associated performance standards taken into consideration stakeholder feedback?	Yes – requests relating to activity unplanned events and potential environmental impacts to marine fauna or commercial fisheries have been considered.
Are performance standards such that the impact or risk is considered to be ALARP?	Yes – see ALARP above.

The residual risk of an unplanned non-hydrocarbon and chemicals release (surface) is assessed as Low. Based on an assessment of Santos' acceptability criteria and with the control measures in place, potential risks are considered acceptable.

7.5 Overview of unplanned release of hydrocarbons

The potential sources of an unplanned release of hydrocarbons are:

- loss of well control (LOWC) resulting in a loss of natural gas and liquid condensate (assessed in detail, in **Section 7.6**)
- loss of containment of MDO (due to a vessel collision event or refuelling incident within the operational area (assessed in detail, in **Section 7.7**). All vessels used to undertake activities within the scope of this EP will be fuelled using MDO or lighter (e.g., marine gas oil, automotive diesel). Heavier fuel types, such as intermediate or heavy fuel oil will not be used.
- minor spills of control fluids, lubricant oils, waste oils and formation fluids (assessed in detail, in **Section 7.8**)

A minor spill (approximately 10 m^3) of MDO could occur during vessel to MODU refuelling resulting in a discharge of hydrocarbons to the marine environment at the sea surface. Spills during refuelling can occur through several pathways, including fuel hose breaks, coupling failure or tank overfilling.

Spills resulting from overfilling will be contained within the MODU bunds and closed drains. If the refuelling hose is ruptured, the fuel bunkering activity will cease by turning off the pump, the fuel remaining in the transfer line will escape to the environment as well as fuel released before the transfer operation being stopped. Spill volumes were determined from transfer hose inventory and spill prevention measures including ‘dry break’ or ‘break away’ couplings, rapid shutdown of fuel pumps and spill response preparedness, with 10 m^3 considered to be the maximum volume that could escape from the hose before shutdown.

Given this volume is far less than that associated with a vessel collision, it is not assessed further in this EP.

7.5.1 Spill scenarios assessed using oil spill dispersion modelling

Spill trajectory modelling was used to predict the potential extent (and area) of a worst-case spill event for both the LOWC and vessel collision within the operational area (RPS, 2019).

7.5.1.1 Loss of well control

Santos has identified a subsea LOWC as the credible worst-case type of oil release scenario that could potentially occur during the activity and could occur at any time of year. The LOWC scenario that was assessed is:

- a LOWC of 129 000 m^3 subsea release of Barossa condensate over 90 days.

7.5.1.2 Vessel collision

It is considered credible that a release of MDO to the marine environment could occur as a result of a collision between the support vessels, between a support vessel and the MODU, or between a passing third-party vessel and the MODU or a support vessel. Such events could have sufficient impact to result in the rupture of the hull and MDO tank leading to a release to sea. This is considered credible given the MDO tanks may not be protected or double-hulled, and fuel tank ruptures resulting in a hydrocarbon release have occurred before within the maritime industry.

The AMSA (2015) *Technical guidelines for preparing contingency plans for marine and coastal facilities* recommend that the spill scenario for modelling and impact assessment should be based on the largest single fuel tank volume. The specific vessels to undertake the activity are yet to be confirmed; however, a review of available vessels indicated the largest single fuel tank is likely to be up to 120 m^3 in capacity. Although the likely vessel’s largest fuel tank will be smaller, a conservative modelled spill volume of 250 m^3 has been used for this EP. The release is assumed to take place over six hours at any time of year.

7.5.2 Spill modelling overview

To determine the spatial extent from potential hydrocarbon spills, modelling was completed for the vessel collision and LOWC scenarios (RPS 2016; 2019).

The spill modelling was performed using an advanced three-dimensional trajectory and fates model using Spill Impact Mapping Analysis Program. This model calculates the transport, spreading, entrainment and evaporation of spilled hydrocarbons over time, based on the prevailing wind and current conditions and the physical and chemical properties. Stochastic modelling was performed, which involved running 100 single spill simulations per season, with a total of 300 simulations for each spill scenario. Each simulation had the same spill information (i.e., release location, volume, duration and hydrocarbon properties) but the start time(s) were randomly varied based on the period of each season between 2010 and 2014. This ensured each spill simulation was exposed to different sets of wind and current conditions.

A five-year (2010 to 2014), previously-verified dataset of currents and winds and detailed hydrocarbon properties were used as inputs (RPS, 2019a). The results from the Barossa marine studies program observed that surface current directions in the area were predominantly toward the south to south-east in summer conditions and to the west to north-west during the winter months (Fugro, 2015). These results aligned well with the modelling inputs used by RPS. Given the lack of shallow or emergent features that may locally affect currents to a significant degree, the current conditions are unlikely to vary significantly at any of the spill locations. The winds influencing the area are driven by broadscale processes and are not expected to vary significantly between spill locations. Therefore, any variations in metocean conditions between spill locations are of a scale that would not significantly influence modelling outcomes.

Deterministic modelling was also performed for the LOWC scenario to understand the potential area of influence that could be expected from the largest single spill event. The worst-case deterministic scenarios selected were:

+ largest swept area of condensate on the sea surface above 10 g/m^2 (moderate exposure value)
+ greatest dissolved hydrocarbon time-averaged exposure concentration at the Evans and Tassie Shoals (being the nearest known sensitive seabed features).

7.5.2.1 Loss of well control spill modelling

<u>Volume and type of release</u>

Hydrocarbons that could be released to the environment are natural gas and hydrocarbon liquid (condensate) from a subsea blowout. Key parameters for the scenario modelled are given in **Table 7-7** on the basis of reservoir properties identified during appraisal drilling and on analysis of the time taken to drill a relief well (90 days) (**Table 7-6**).

Table 7-6: Estimated timeframe for the implementation of a relief well

Task	Duration (in days)
Total days before arrival, ready to spud/begin relief well operations	41
Drilling relief well	49
Total days from LOWC to 'well kill'	**90**

Table 7-7: Summary of spill scenario modelled for subsea loss of well control scenario

Parameter	Scenario
Scenario description	Long-term subsea well blowout

Parameter	Scenario
Number of seasons assessed	Three seasons: + Summer (December to February) + Transitional (March, September to November) + Winter (April to August)
Number of randomly selected spill start times per season	100
Hydrocarbon type	Barossa condensate
Spill volume (stb/day)	Condensate – 9,190 (day 1) depleting to 8,619 (day 90) Water – 3,434 (day 1) depleting to 3,429 (day 90)
Gas rate (scf/day)	919,000,000 (day 1) depleting to 862,000,000 (day 90)
Condensate to gas ratio (scf/MMscf)	10
Release duration	90 days
Simulation length	110 days

7.5.3 Hydrocarbon characteristics

7.5.3.1 Barossa condensate

Analysis of an assay obtained during the 2013–14 Barossa Appraisal Drilling Campaign was used to determine the weathering characteristics of the Barossa condensate. Barossa condensate is a low viscosity, Group 1 (non-persistent) hydrocarbon. The condensate would rapidly spread and thin out on the sea surface, with a large proportion of the hydrocarbon evaporating (up to 57% over the first few hours/days and up to 79% after a few days, depending on weather conditions, sea state and time of year) (RPS, 2019a). Only 7% of the condensate is considered persistent, which would eventually breakdown due to decay (RPS, 2019a). Key physical/chemical properties of the Barossa condensate are shown in **Table 7-8**.

Table 7-8: Properties of Barossa condensate

Parameter		Barossa condensate
Density (kg/m^3)		782 (at 16 °C)
API		50.6
Dynamic viscosity (cP)		1.35 (at 10 °C)
Pour point (°C)		-6
Hydrocarbon property category		Group I
Hydrocarbon property classification		Non-persistent
Boiling point °C		
Non-persistent	<180	57
	180–265	22
	265–380	14
Persistent	>380	7

7.5.3.2 Barossa condensate weathering

An example of the predicted weathering of Barossa condensate is shown in **Figure 7-1**, which shows the fate and weathering graph for the deterministic trajectory (single spill) that resulted in the largest sea surface exposure above 10 g/m^2. At the conclusion of the simulation approximately 80% of the spilled oil had evaporated, 16% had decayed and 3.8% was predicted to remain within the water (assuming no oil spill response was undertaken).

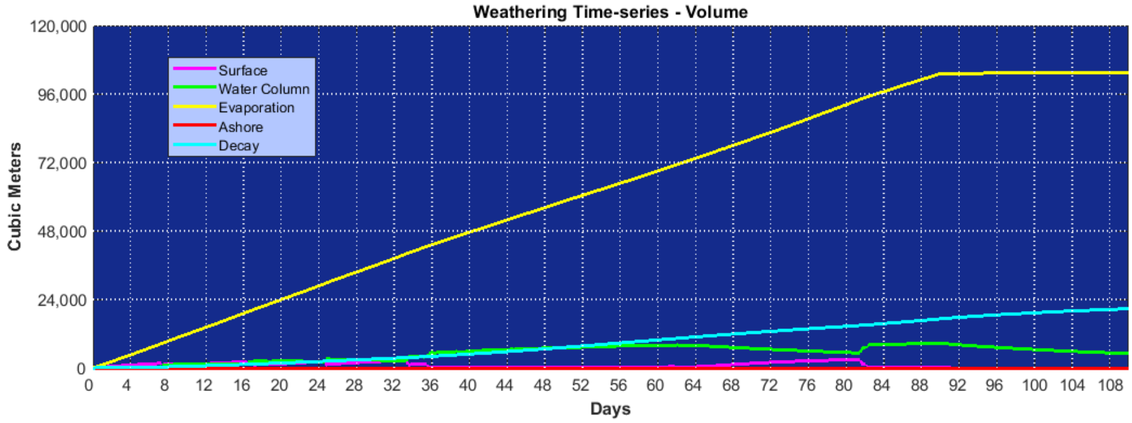

Figure 7-1: Predicted weathering and fates graph for the trajectory with the largest sea surface swept area at the 10 g/m^2 exposure value. Results are based on a 129,000 m^3 subsea release of Barossa condensate over 90 days, tracked for 110 days, 6 am 1st December 2012 (RPS, 2019a)

7.5.3.3 Vessel collision spill modelling

Modelling was undertaken at a single location at the south-west corner of the permit area (operational area). This location is considered to provide a representative and conservative estimate of the potential environmental impacts and risks to the marine environment based on the geographical location of the nearest sensitive receptors to the east and west of the operational area (i.e., Lynedoch Bank, Evans Shoal and Tassie Shoal). The release location is broadly equidistant between these sensitive receptors.

Volume and type of release

A surface release of 250 m^3 of MDO was modelled from the vessel. A summary of the representative characteristics of MDO, as assessed in this EP, is provided in **Table 7-9**.

Table 7-9: Summary of MDO characteristics (RPS, 2016)

Density at 25 °C (kg/^{3})	Viscosity at 25 °C (cP)	Component boiling point (°C) % of total			
		Volatile (%) <180	Semi-volatile (%) 180-265	Low volatility (%) 265-380	Residual (%) >380
829	4.0	6	35	54	5

7.5.3.4 Marine diesel oil weathering

MDO is a mixture of volatile, semi-volatile and low volatility hydrocarbons and approximately 60 to 80% of the MDO is predicted to evaporate within 24 to 48 hours, depending upon the prevailing conditions.

The heavier components of MDO tend to become entrained into the upper water column as oil droplets in the presence of waves but can re-float to the surface if wave energies abate. Entrained MDO is largely concentrated in surface waters (0 to 10 m).

The results of the weathering analyses are presented in **Figure 7-2**.

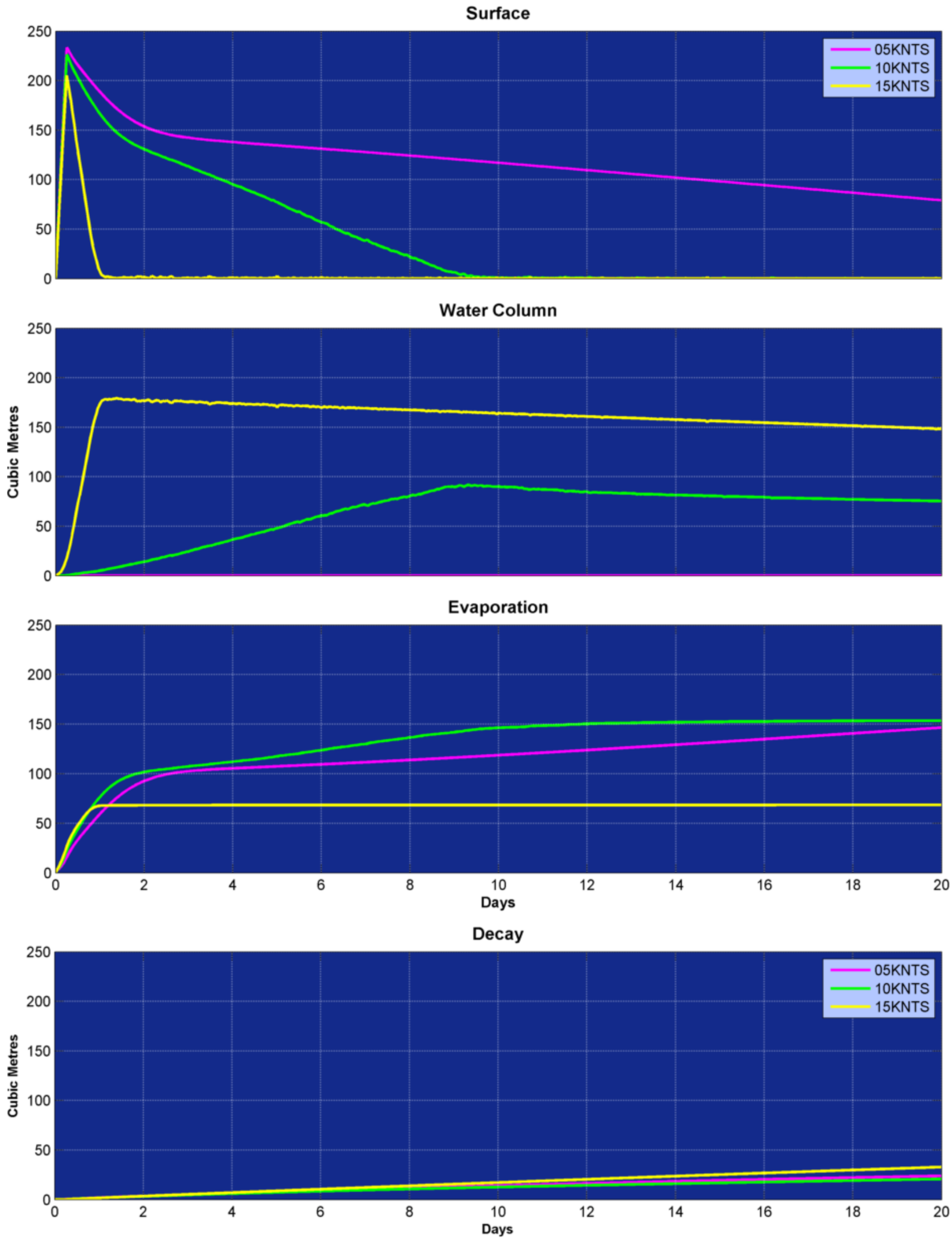

Figure 7-2: Predicted weathering and fates for a 250 m^3 release of marine diesel oil (RPS, 2016)

International Tanker Owners Pollution Federation (2011) and AMOSC (2011) categorise MDO as a light 'group II' hydrocarbon. In the marine environment, a 5% residual of the total quantity of MDO spilt will remain after the volatilisation and solubilisation processes associated with weathering. In the marine environment, MDO is expected to behave as follows:

+ MDO will spread rapidly in the direction of the prevailing wind and waves.
+ Evaporation will be the dominant process contributing to the fate of spilled MDO from the sea surface and will account for 60 to 80% reduction of the net hydrocarbon balance.

- The evaporation rate of MDO will increase in warmer air and sea temperatures.
- MDO residues usually consist of heavy compounds that may persist longer and will tend to disperse as oil droplets into the upper layers of the water column.

7.5.4 Hydrocarbon exposure values

To inform the environmental assessment it is important to understand the profile of the concentrations of hydrocarbons after a spill. To do this NOPSEMA recommends identifying hydrocarbon exposure values that broadly reflect the range of consequences that could occur at certain concentrations (NOPSEMA, 2019). The exposure values that have been applied to this EP are provided in **Table 7-10**.

To identify appropriate exposure values Santos has considered the advice provided by NOPSEMA in *Bulletin #1 Oil Spill Modelling* (2019) and scientific literature. The selected hydrocarbon exposure values are discussed in **Table 7-11** to **Table 7-14**. These tables explain how the exposure value is relevant to the risk evaluation and provides context on how that exposure value is used to inform response planning (which is addressed further in the OPEP).

Table 7-10: Hydrocarbon exposure values for the environment that may be affected

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

The low exposure values, which approximate a range of potential socio-economic effects, are used as a predictive tool to set the outer boundaries of the EMBA shown in **Figure 7-3**. A 'best fit' line is drawn around the outermost limits of the low exposure value contours for all three phases of hydrocarbons (floating, dissolved and entrained) in all seasons.

These low exposure values are not considered to be representative of a biological impact, but they are adequate for identifying the full range of environmental receptors that might be contacted by surface and/or subsurface hydrocarbons (NOPSEMA, 2019) and a visible sheen.

Determining exposure values that may be representative of biological impact is complex since the degree of impact will depend on the sensitivity of the receptors contacted, the duration of the exposure and the toxicity of the hydrocarbon type making the contact. The toxicity of a hydrocarbon will also change over time, due to weathering processes altering the composition of the hydrocarbon.

To inform the environmental assessment, exposure values that may be representative of biological impact have also been identified. These are called 'moderate exposure values' (defined by the MEVA) and 'high exposure values' (defined by the high exposure value area) and are shown in **Figure 7-5**. Moderate and high exposure values are modelled for each fate of hydrocarbon to identify what contact is predicted for surface (floating oil), subsurface (entrained oil and dissolved aromatic hydrocarbons), and shoreline accumulation of hydrocarbon at sensitivities.

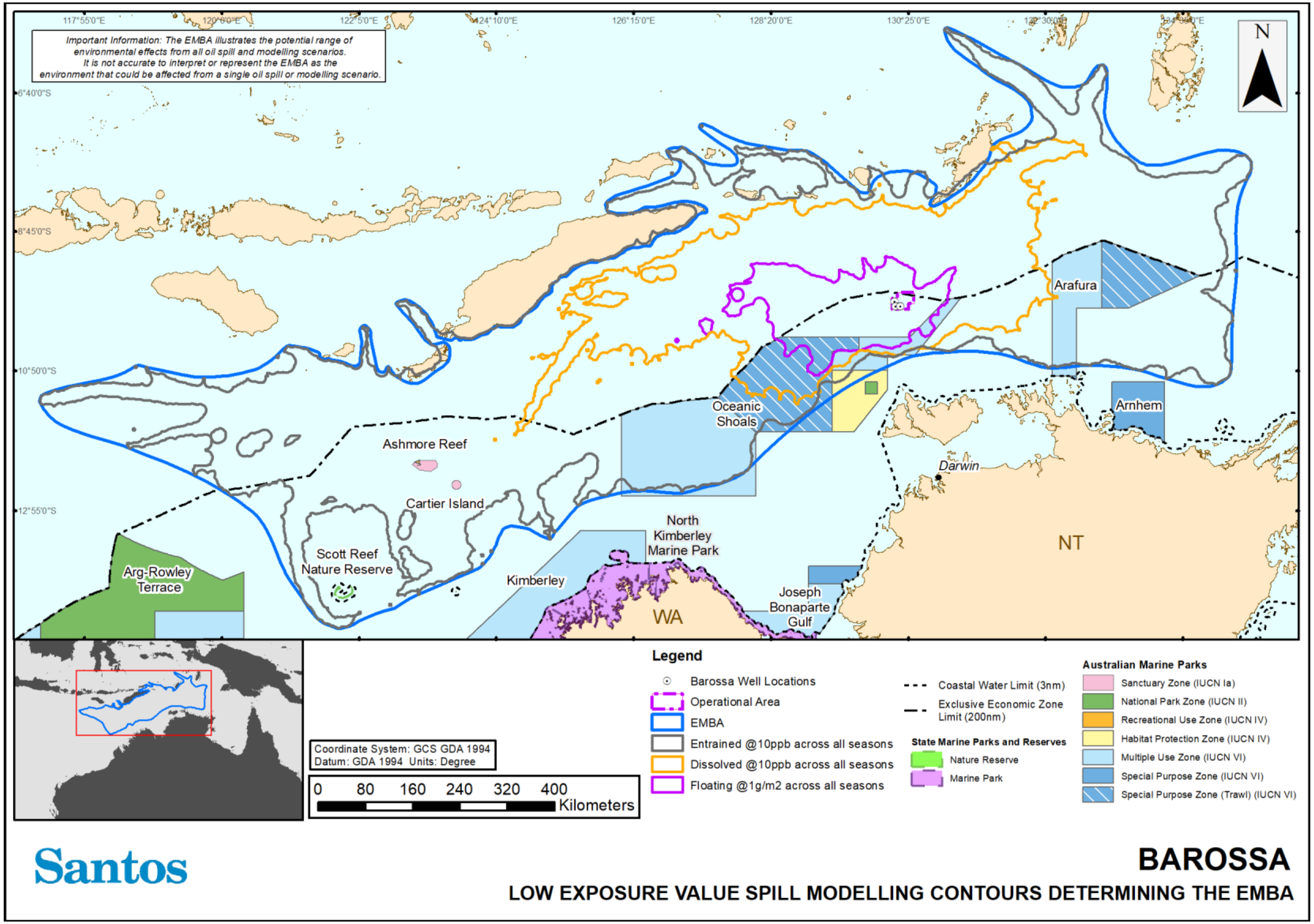

Figure 7-3: Low exposure value contours of floating, dissolved and entrained hydrocarbons used to define the EMBA

Table 7-11: Floating hydrocarbons exposure values

Surface oil concentration (g/m²)	Exposure value	Description
1	Low	**Risk evaluation** It is recognised that a lower floating oil concentration of 1 g/m² (equivalent to a thickness of 0.001 mm or 1 ml of oil per m²) is visible as a rainbow sheen on the sea surface. Although this is lower than the exposure value for ecological impacts, it may be relevant to socio-economic receptors and has been used as the exposure value to define the spatial extent of the environment that might be contacted (EMBA) from floating oil. **Response planning** Contact at 1 g/m² (as predicted by oil spill trajectory modelling) is used as a conservative trigger for activating scientific monitoring plans as detailed in the OPEP.
10	Moderate	**Risk evaluation** There is a paucity of data on floating oil concentrations with respect to impacts to marine organisms. Hydrocarbon concentrations for registering biological impacts resulting from contact of surface slicks have been estimated by different researchers at about 10 to 25 g/m² (French *et al*., 1999; Koops *et al*., 2004; NOAA, 2002). The impact of floating oil on birds is better understood than on other receptors. A conservative exposure value of 10 g/m² has been applied to impacts from surface hydrocarbons (floating oil) in this EP. Although based on birds, this hydrocarbon exposure value is also considered appropriate for turtles, sea snakes and marine mammals (NRDAMCME, 1997). This value has been used to define the MEVA. **Response planning** Contact at 10 g/m² is not specifically used for spill response planning.
50	High	**Risk evaluation** At greater thicknesses the potential for impact of surface oil to wildlife increases. All other things being equal, contact to wildlife by surface oil at 50 g/m² is expected to result in a greater impact. **Response planning** Containment and recovery effectiveness drops significantly with reduced oil thickness (McKinney *et al*., 2017; NOAA, 2014). McKinney *et al*. (2017) tested the effectiveness of various oil skimmers at various oil thicknesses. Their results showed that the oil recovery rate of skimmers dropped significantly when oil thickness was less than 50 g/m² (less than Bonn Agreement Code 4). Hence, 50 g/m² has been set as a guide for planning effective containment and recovery operations. Similarly, surface oil greater than 50 g/m² (Bonn Agreement Code 4/5 and equivalent to oil observed as discontinuous or continuous true colour) is considered to be a lower limit for effective dispersant operations and is therefore considered for planning.

Table 7-12: Shoreline hydrocarbon accumulation exposure values

Shoreline Accumulation (g/m^2)	Exposure Value	Description
10	Low	**Risk evaluation** An accumulated concentration of oil above 10 g/m^2 on shorelines is considered to represent a level of socio-economic effect (NOPSEMA, 2019). For example, reduction in visual amenity of shorelines. This value has been used in previous studies to represent a low contact value for interpreting shoreline accumulation modelling results (French-McCay, 2005a, 2005b) and is used to define the EMBA. **Response planning** Not specifically used for response planning because below the limit that can be effectively cleaned.
100	Moderate	**Risk evaluation** The impact exposure value for exposure to hydrocarbons stranded on shorelines is derived from levels likely to cause adverse impacts to marine or coastal fauna and habitats. These habitats and marine fauna known to use shorelines are most at risk of exposure to shoreline accumulations of oil, due to smothering of intertidal habitats (such as mangroves and emergent coral reefs) and coating of marine fauna. Environmental risk assessment studies (French-McCay, 2009) report that an oil thickness of 0.1 mm (100 g/m^2) on shorelines is assumed as the lethal exposure value for invertebrates on hard substrates (rocky, artificial or human-made) and sediments (mud, silt, sand or gravel) in intertidal habitats. Therefore, a conservative exposure value for impacts of 100 g/m^2 has been applied to impacts from shoreline accumulation of hydrocarbons. This value has been used to define the MEVA. **Response planning** A shoreline concentration of 100 g/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 exposure value equates to approximately ½ a cup of oil per square metre of shoreline contacted.
1,000	High	**Risk evaluation** At greater thicknesses, the potential for impact of accumulated oil to shoreline receptors increases. All other things being equal, accumulation of oil above 1000 g/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.

Table 7-13: Dissolved aromatic hydrocarbon exposure values

Dissolved hydrocarbons (ppb)	Exposure value	Description
10	Low	**Risk evaluation** Dissolved aromatic hydrocarbons (DAH) include the monoaromatic hydrocarbons (compounds with a single benzene ring such as benzene, toluene, ethyl benzene, and xylenes) and polycyclic aromatic hydrocarbons [PAHs] (compounds with multiple benzene rings such as naphthalenes and phenanthrenes). These compounds have a greater bioavailability than other components of oil and are the main contributors to oil toxicity. The toxicity of DAHs is a function of the concentration and duration of exposure by sensitive receptors with greater concentration and exposure time causing more severe impacts. Typically tests of toxicity done under laboratory conditions measure toxicity as proportion of test organisms affected (e.g., 50% mortality or LC50) at the end of a set time, often 48 or 96 hours. French-McCay (2002) found LC50 for dissolved PAHs with a 96-hour 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). More recently, French-McKay (2018) described in-water thresholds as 10 TO 100 µg/L (equivalent to ppb). For the effect of UV on PAH toxicity, French-McKay *et al.* (2018) use the findings of DWH NRDA Trustees (2016) to adjust for this by reducing the water column exposure thresholds by 10 x in the top 20 m of the water column. The dissolved hydrocarbon 10 ppb exposure value has been used to inform the EMBA. An exposure value of 10 ppb is appropriate as it is concentration that could have some potential negative effect. **Response planning** Contact at 10 ppb (as predicted by oil spill trajectory modelling) is used as a trigger for activating scientific monitoring plans as detailed in the OPEP. Establishes planning area for scientific monitoring based on potential for exceedance of water quality triggers (NOPSEMA, 2019).
50	Moderate	**Risk evaluation** Approximates potential toxic effects, particularly sublethal effects to sensitive species (see the above text). Consistent with NOPSEMA (2019). This value has been used to define the MEVA. Ecotoxicology tests on a broad range of representative taxa of ecological relevance for mainly tropical Australia were conducted in order to inform the assessment of the potential for toxicity impacts from unweathered (i.e., fresh) and weathered Barossa condensate to sensitive marine biota. The ecotoxicity testing focused on the dissolved aromatic hydrocarbon concentration of the water accommodated fraction (WAF) as these hydrocarbons are more biologically available to organisms through absorption into their tissues when compared with entrained hydrocarbons (Jacobs, 2016b). Based on the ecotoxicology tests, the dissolved aromatic exposure values applied in this EP are considered highly conservative for the Barossa condensate. Specifically, the moderate exposure values of 50 ppb for 95% species protection for dissolved aromatic hydrocarbons is approximately 23 times more conservative than that

		for the Barossa condensate (1,146 ppb for the 95% species protection threshold). **Response planning** Encompassed by response to 10 ppb. There is nothing different for higher exposure values.
400	High	**Risk evaluation** Approximates toxic effects including lethal effects to sensitive species (NOPSEMA, 2019). **Response planning** Encompassed by response to 10 ppb. There is nothing different for higher exposure values.

Table 7-14: Entrained hydrocarbon exposure values

Entrained hydrocarbons (ppb)	Exposure value	Description
10	Low	**Risk evaluation** Entrained hydrocarbons, as opposed to DAHs, are oil droplets suspended in the water column and insoluble. Entrained hydrocarbons are not as bioavailable to marine organisms compared with DAHs and on that basis are considered to be a less toxic, especially over shorter exposure time frames. Entrained hydrocarbons still have potential effects on marine organisms through direct contact with exposed tissues and ingestion (NRC, 2005). However, the level of exposure causing effects is considered to be considerably higher than for DAHs. Much of the published scientific literature does not provide sufficient information to determine if toxicity is caused by entrained hydrocarbons, but rather the toxicity of total oils which includes both dissolved and entrained components. Variations in the methodology of the total water accommodated fraction (entrained and dissolved) may account for much of the observed wide variation in reported exposure values, which also depend on the test organism types, duration of exposure, oil type and the initial oil concentration. Total oil toxicity acute effects of total oil as LC50 for molluscs range from 500 to 2000 ppb (Clark *et al*., 2001; Long & 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 & Holdway, 2000; Clark *et al*. ,2001) and 45 to 465,000,000 ppb (Gulec & Holdway, 2000; Barron *et al*., 2004), respectively. The 10 ppb exposure value represents the very lowest concentration and corresponds generally with the lowest trigger levels for chronic exposure for entrained hydrocarbons in the ANZECC & ARMCANZ (2000) water quality guidelines. This is consistent with NOPSEMA (2019) guidance. **Response planning** Contact at 10 ppb (as predicted by oil spill trajectory modelling) is used as a trigger for activating scientific monitoring plans as detailed in the OPEP. Establishes planning area for scientific monitoring based on potential for exceedance of water quality triggers (NOPSEMA, 2019).
100	Moderate	**Risk evaluation** The 100 ppb exposure value is considered to be more representative of sub-lethal impacts to most species and lethal impacts to sensitive species based on toxicity testing as described above. This is considered conservative as toxicity to marine organisms from oil is likely to be driven by the more bioavailable dissolved aromatic fraction, which is typically not differentiated from entrained oil in toxicity tests using water accommodated fractions (WAFs). Given entrained oil is expected to have lower

Entrained hydrocarbons (ppb)	Exposure value	Description
		toxicity than dissolved aromatics, especially over time periods where these soluble fractions have dissolved from entrained oil, the higher Moderate exposure value for entrained oil over DAH (100 versus 50 ppb) is considered appropriate. This value has been used to define the MEVA. Note that NOPSEMA does not define a moderate exposure value for entrained oil, and 100 ppb is defined as the high exposure value. However, Santos has adopted 100 ppb as the moderate exposure level for impact assessment purposes in the absence of a NOPSEMA defined moderate value and based on existing literature (Bridges *et al.*, 2018; French-McCay, 2016; French-McCay, 2018). **Response planning** Encompassed by response to 10 ppb. There is nothing different for higher exposure values.

7.5.5 Spill risk assessment approach

The spill risk assessment approach adopted is outlined below:

- Identify the spatial extent of the EMBA. This has been completed for this EP as part of the assessment of the existing environment and receptors that are known to occur or may occur within the EMBA are described in **Section 3** and **Appendix C**.
- Identify the MEVA where there is the potential for impact to receptors at moderate exposure levels or above.
- Identify areas of high environmental value within the EMBA.
- Identify and then risk assess (as described in **Section 5**) hot spots. Hot spots are effectively a subset of these high environmental value areas, and their determination is described in **Section 7.5.5.3**.
- Identify priorities for protection (for consideration of spill response strategies in the OPEP).

7.5.5.1 Spill environment that may be affected

Defining the EMBA by an oil spill is the first step in oil spill risk and impact assessment. For activities where there is the potential for multiple spill scenarios, the spill scenario, or combination of spill scenarios, resulting in the greatest spatial extent is used to define the overall EMBA for the activity. The MEVA is defined as the area within the EMBA where potential impact to receptors may occur.

7.5.5.2 Areas of high environmental value

Within the MEVA are areas that are considered to have high environmental value, which include receptors with one or more:

- protected area status – this is used as an indicator of the biodiversity values contained within that area, such as a world heritage area, Ramsar wetland and marine protected area
- BIA of listed threatened species – these are spatially defined areas where aggregations of individuals of a species are known to display biologically important behaviour, such as breeding, feeding, resting or migration
- sensitivity of habitats to impact from hydrocarbons in accordance with the guidance document *Sensitivity mapping for oil spill response* produced by IPIECA (2012), the International Maritime Organisation and International Association of Oil and Gas Producers
- sensitivities of receptors with respect to hydrocarbon-impact pathways

- status of zones within protected areas (IUCN (1A) and sanctuary zones compared with IUCN (VI) and multiple use zones)
- listed species status and predominant habitat (surface versus subsurface)
- social values, socio-economic and heritage features (such as commercial fishing, recreational fishing, amenities, aquaculture).

7.5.5.3 Hot spots

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

- greatest intrinsic environmental value
- highest probability of contact by oil (either floating, entrained or dissolved aromatic)
- greatest potential concentration or volume of oil arriving at the area.

These areas are termed 'hot spots'. Defining hot spots is typically the first step in undertaking detailed spill risk assessment and spill response planning. Hot spots are a subset of the high environmental value areas that:

- have the highest probability of contact (at least higher than 5%) at or above the moderate exposure value for surface hydrocarbons based on modelling results
- receive the greatest concentration or volume of oil, either floating or stranded oil, entrained oil or DAH above contact exposure values described in **Section 7.5.4**.

7.5.5.4 Priorities for protection

For the purposes of a spill response preparedness strategy, it is not necessary for all hot spots to have detailed planning. For example, wholly submerged hot spots may only be contacted by entrained oil, and the response would be largely to implement scientific monitoring to determine impact and recovery. Hot spots with features that are not wholly submerged (emergent features) should have specific spill response planning conducted. This final determination of 'Priority for Protection' sites, for the oil spill response strategy, is based on the worst-case estimate of floating oil concentration, shoreline loading and minimum contact time at exposure value concentrations. Further detail on the process for selection of Priority for Protection sites is detailed in the Oil Spill Risk Assessment and Response Planning Procedure (QE-91-II-20003). The oil spill response strategies for Priority for Protection sites are undertaken within the activity OPEP. An assessment of each Priority for Protection will be undertaken to determine the most appropriate spill response strategies based on the type of oil and the values of the protection sites. This can be done through a strategic Net Environmental Benefit Analysis (NEBA) approach. Identified protection sites, associated key sensitivities and the applicable response strategies can be found in the OPEP.

7.5.5.5 Net environmental benefit analysis

NEBA is a structured approach used by the response community and stakeholders to select spill response strategies that will effectively remove oil, are feasible to use safely in particular conditions, and will reduce the impact of an oil spill on the environment.

The NEBA process is used during pre-spill planning (strategic NEBA) and during a response (operational NEBA). A strategic NEBA is an integral part of the contingency planning process and is used to ensure that response strategies for scenarios are well informed. An operational NEBA is used to ensure that evolving conditions are understood, so that response strategies can be adjusted as necessary to manage individual response actions and end points.

Balancing trade-offs may involve differing and conflicting priorities, values and perceptions of the importance of sensitive receptors. There is no universally accepted way to assign perceived value or importance, and it is not a quantitative process. Overall, the NEBA process provides an estimate of potential environmental effects that are sufficient to allow the parties to compare and select preferred combinations of response strategies to reduce environmental impacts to ALARP.

A strategic NEBA has been developed for all response strategies identified as applicable to credible spills identified in the OPEP related to an unplanned release of condensate, with the potential environmental benefit or potential impact to each protection priority area. This will provide information that will help to select response strategies tailored to the key environmental values within the areas of highest priority. A summary of spill response strategies is available for each of the Priority for Protection sites and the potential impact that a response strategy has on the area’s environmental values.

This information is to be considered in the NEBA process that takes place during a spill response (i.e., an operational NEBA). An operational NEBA will also consider real-time monitoring of the effectiveness and potential impacts of a response and will also consider accessibility, feasibility and safety of responders (refer to the *Barossa Development OPEP* (BAA-200-0314)).

7.5.6 Potential hydrocarbon impact pathways and nature and scale of impact

To help inform the hydrocarbon spill risk assessment receptors within the EMBA and potential impact pathways have been defined (**Table 7-15**). The potential impact pathways consider physical and chemical pathways. Physical pathways include contact from floating oil, accumulated shoreline oil, or entrained oil droplets. Chemical pathways include ingestion, inhalation or contact from any hydrocarbon phase. These are summarised in **Table 7-15** and the information is drawn upon within the hydrocarbon risk assessment for the spill scenario. Table 7-16 further describes the nature and scale of the hydrocarbon spills for this activity on marine fauna and socio-economic receptors found within the MEVA.

There was no shoreline oil accumulation predicted for any receptors in any season at any exposure value and therefore accumulated shoreline oil and potential impact pathways are not discussed further.

Table 7-15: Physical and chemical pathways for hydrocarbon exposure and potential impacts to receptors

Receptor	Physical pathway	Potential impacts	Chemical pathway	Potential impacts
Seagrasses and macroalgae	Coating of leaves/thalli reducing light availability and gas exchange. Degree of coating depends upon the energy and tidal reach of the shoreline, the type of the receptor and continual weathering of the oil.	Bleaching or blackening of leaves. Defoliation. Reduced growth.	External contact by oil and adsorption across cellular membranes.	Mortality. Bleaching or blackening of leaves. Defoliation. Disease. Reduced growth. Reduced reproductive output. Reduced seed/propagule viability.
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 DAH across cellular membranes. Reduced mobility and capacity for oxygen exchange.	Mortality. Cell damage. Reduced metabolic capacity. Reduced immune response. Disease. Reduced growth. Reduced reproductive output. Reduced egg/larval success. Growth abnormalities. Behavioural disruption.
Sharks, rays and fish	Coating of adults but primarily eggs and larvae – reduced mobility and capacity for oxygen exchange.	Mortality. Oxygen debt. Starvation. Dehydration. Increased predation. Behavioural disruption.	Ingestion. External contact and adsorption across exposed skin and cellular membranes. Uptake of DAH across cellular membranes (for example, gills).	Mortality. Cell damage. Flesh taint. Reduced metabolic capacity. Reduced immune response. Disease. Reduced growth. Reduced reproductive output. Reduced egg/larval success. Growth abnormalities. Behavioural disruption.

Receptor	Physical pathway	Potential impacts	Chemical pathway	Potential impacts
Birds (seabirds and shorebirds)	Degree of coating is dependent upon the energy and tidal reach of the shoreline, the type of the receptor and continual weathering of the oil.	Feather and skin irritation and damage, with the potential to cause secondary impacts such as: + physical restriction of flight and swimming movement + mortality + hypothermia/impairing the waterproofing of feathers + disruption to feeding/ starvation + disruption to breeding + disruption to migration.	Ingestion (during feeding or preening). External contact and adsorption across exposed skin and membranes.	Mortality. Cell damage, lesions. Secondary infections. Reduced metabolic capacity. Reduced immune response. Disease. Reduced growth. Reduced reproductive output. Growth abnormalities. Behavioural disruption.
Marine reptiles	Degree of coating is dependent upon the energy and tidal reach of the shoreline, the type of the receptor and continual weathering of the oil.	Irritation of eyes/mouth and potential illness, which may cause secondary impacts such as: + mortality + disruption to feeding/ starvation + physical restriction + behavioural disruption.	Inhalation. Ingestion. External contact and adsorption across exposed skin and membranes.	Mortality. Cell damage, lesions. Secondary infections. Reduced metabolic capacity. Reduced immune response. Disease. Reduced growth. Reduced hatchling success. Reduced reproductive output. Growth abnormalities. Behavioural disruption.

Receptor	Physical pathway	Potential impacts	Chemical pathway	Potential impacts
Marine mammals	Fur damage and matting, reduced mobility and buoyancy (for applicable species). Coating of feeding apparatus in some species (baleen whales).	Irritation of eyes/mouth, damage to fur and potential illness, which may cause secondary impacts such as: + mortality. + disruption to feeding/ starvation. + physical restriction. + behavioural disruption.	Inhalation. Ingestion. External contact and adsorption across exposed skin and membranes.	Mortality. Cell damage, lesions. Secondary infections. Reduced metabolic capacity. Reduced immune response. Disease. Reduced growth. Reduced reproductive output. Growth abnormalities. Behavioural disruption.
Plankton	Coating of feeding apparatus. Reduced mobility and capacity for oxygen exchange.	Mortality. Behavioural disruption (for example, reduced mobility).	Inhalation. Ingestion. External contact.	Mortality. Impairment of biological activities (for example, feeding, respiration). Reduced mobility.
Water quality and sediment quality	Presence of hydrocarbon residue in the water, which may filter down to sediments or continue to biodegrade on the surface. Degree of loading in the water column is dependent upon the influence of wave energy and tidal range.	Impacts to flora and fauna, as discussed in rows above.	Adsorption via cellular membranes and soft tissue, ingestion, irritation/burning on contact and inhalation. Impacts to flora and fauna, as discussed in rows above.	Impacts to flora and fauna, as discussed in rows above.

Receptor	Physical pathway	Potential impacts	Chemical pathway	Potential impacts
Protected areas	Coating of benthic 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.	Degradation of cultural or maritime heritage sites. Disruption to tourism, recreation or shipping activities. Displacement of fishing; reduction in natural resources.	Similar to those discussed above, including ‘fish’.	Similar to those discussed above resulting in socio-economic impacts.

Table 7-16: Nature and scale of hydrocarbon spills on environment and socio-economic receptors within the moderate exposure value area (Figure 7-5)

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. 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. The EMBA has the potential to overlap with spawning of some fish species given the year round spawning of some species, including those of commercial fish species (refer socio-economic receptors below). 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.	
Marine mammals	Lethal or sub-lethal physical and toxic effects such as irritation of eyes/mouth and potential illness.	At risk of direct contact with surface hydrocarbons due to chance of surfacing within slick. Effects include irritation of eyes/mouth and potential illness. Surface respiration could lead to accidental ingestion of hydrocarbons or result in the coating of sensitive epidermal surfaces. Potential impact to feeding apparatus of some species (baleen whales).

<table>
<tr><th rowspan="2">Receptor</th><th colspan="2">Impacts of hydrocarbon spills</th></tr>
<tr><th>Entrained and dissolved aromatic hydrocarbons in the water column</th><th>Surface hydrocarbons</th></tr>
<tr><td></td><td colspan="2">Ten migratory marine mammal species were identified by the PMST as occurring within the MEVA. Omura's whales are also known to occur in the vicinity. Of these, one is listed as endangered (blue whale) and three as vulnerable (humpback whale, fin whale and sei whale). In the unlikely event of a loss of well control, stochastic modelling indicates that the MEVA may extend up to 162 km on the sea surface, 484 km for entrained hydrocarbons and up to 200 km for dissolved aromatic hydrocarbons from the release location. Therefore, there is the potential that entrained and dissolved aromatics hydrocarbons may intersect the BIA for the pygmy blue whale (Figure 3-6). Pygmy blue whale migration extends over several months in May-August (Northern migration) and November-December (Southern migration) and encompasses a large geographical area. Impacts to pygmy blue whale may include behavioural impacts (e.g., avoidance of impacted areas), sub-lethal biological effects (e.g., skin irritation, irritation from ingestion or inhalation) and, in rare circumstances, death. Other marine mammal species may also be transient in the MEVA.</td></tr>
<tr><td>Marine reptiles</td><td>Lethal or sub-lethal physical and toxic effects such as irritation of eyes/mouth and potential illness.

The Recovery Plan for Marine Turtles in Australia 2017–2027 (CoA, 2017) highlights acute chemical discharge as one of several threats to marine turtles.

Marine turtles are susceptible to the effects of hydrocarbon spills during all life stages (National Oceanic and Atmospheric Administration, 2010). Adult sea turtles exhibit no avoidance behaviour when they encounter hydrocarbon spills (National Oceanic and Atmospheric Administration, 2010).</td><td>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. Breathing and inhalation of toxic vapours may occur from exposure to hydrocarbons in surface waters.</td></tr>
</table>

Receptor	Impacts of hydrocarbon spills	
	Entrained and dissolved aromatic hydrocarbons in the water column	Surface hydrocarbons
	Eight species of threatened marine reptile were identified within the MEVA. Loggerhead, green, leatherback, hawksbill, flatback and Olive Ridley turtles are widely dispersed across northern Australia 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 MEVA overlaps with the outer edge of flatback turtle BIAs for foraging and internesting. The critically endangered short-nosed and leaf-scaled seasnakes may also occur in small numbers in the MEVA, potential impacts to seasnakes are similar to those of turtles. In the unlikely event of a loss of well control, stochastic modelling indicates that the MEVA may extend up to 162 km on the sea surface, 484 km for entrained hydrocarbons and up to 200 km for dissolved aromatic hydrocarbons from the release location. A number of species of marine turtles may be transient in the MEVA, whilst seasnakes may be found at nearby shoals and banks, as well as at location close to Ashmore Reef and Cartier Island. The *Recovery Plan for Marine Turtles in Australia 2017–2027* defines an internesting buffer around mainland NT islands as 60 km (DoEE, 2017) and therefore foraging turtles may be encountered in the MEVA. It has, however, been demonstrated via a study tracking 47 internesting flatback turtles from five different mainland and island rookeries over 1,289 tracking days that flatback turtles remained in water depths of <44 m, favouring a mean depth of <10 m (Whittock *et al*., 2016). Whittock *et al*. (2016) defined suitable internesting habitat as water 0 to 16 m deep and within 5 to 10 km of the coastline. There is no evidence to date to indicate flatback turtles swim out into deep offshore waters during the internesting period (Pendoley, 2019). Water depths in the MEVA are generally outside this water depth and are beyond this distance from coastlines. Therefore, while the MEVA overlaps a small area of a flatback turtle internesting BIA, the number of individuals likely to be present in this area is expected to be limited. Any impacts from hydrocarbon spills are therefore expected to be limited to impacts on individuals, and are unlikely to result in impacts to the overall population of any turtle species. Shoreline accumulation of hydrocarbons is not predicted to occur and therefore will not impact nesting beaches, but may impact individuals in the surrounding waters.	

<table>
<tr><th rowspan="2">Receptor</th><th colspan="2">Impacts of hydrocarbon spills</th></tr>
<tr><th>Entrained and dissolved aromatic hydrocarbons in the water column</th><th>Surface hydrocarbons</th></tr>
<tr><td rowspan="2">Birds (seabirds and shorebirds)</td><td>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.</td><td>Particularly vulnerable to surface slicks. As most fish survive beneath floating slicks, they will continue to attract foraging seabirds, which typically do not exhibit avoidance behaviour. Smothering can lead to reduced water proofing of feathers and ingestion while preening. In addition, direct contact with hydrocarbons can erode feathers causing chemical damage to the feather structure that subsequently affects ability to thermoregulate and maintain buoyancy on water.
Shorebirds may be impacted by the presence of hydrocarbons accumulated on shorelines which may result in exposure to eggs and ingestion by foraging individuals. Shoreline hydrocarbons are expected to be less toxic than fresh oils due to weathering processes such as photo oxidation and biodegradation reducing the levels of lighter chain hydrocarbons which are generally more toxic.</td></tr>
<tr><td colspan="2">Six threatened species of seabirds and shorebirds were identified within the MEVA by the PMST (Appendix D).
Stochastic modelling predicts that the MEVA will not contact shorelines nor intersect any known BIAs or aggregation areas for seabirds or migratory shorebirds. However, seabirds may contact surface slicks at or above moderate exposure value whilst foraging in offshore, open water locations. While impacts on individual birds may occur in the event of a loss of well control, given that no hydrocarbon contact with shorelines or BIAs is predicted, it is expected that there will be no impacts to bird populations breeding, feeding and roosting in these areas. Therefore, impacts at a population level are considered unlikely.
Impacts to birds may include coating by oil when floating in open water, diving into open and coastal waters to feed on fish. Other impacts could include behavioural impacts whereby birds avoid important nesting and migratory stop-over areas including Ramsar wetlands or reduced food availability if important foraging areas are impacted.</td></tr>
</table>

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. For further information about environmental impacts to fish/sharks/rays from hydrocarbon exposure and toxicity effects, refer to **Table 7-15.**.	While fish, sharks and rays do not generally break the sea surface, individuals may feed at the surface. For condensate/MDO spills where a slick is expected to quickly disperse and evaporate, prolonged exposure to surface hydrocarbons by fish, shark and ray species is unlikely. Due to the filter-feeding nature of whale sharks they may be susceptible to ingesting surface hydrocarbons, both fresh and weathered (tar balls) if feeding at the sea surface particularly from MDO spills.
	Northern Australian waters support a diverse assemblage of fish, particularly in shallower water near banks and shoals. Site attached fish associated with shoals and banks in the MEVA may be exposed to hydrocarbons at harmful levels. Seven threatened species of fish and sharks were identified by the PMST including the white shark, whale shark, speartooth shark, sawfishes (dwarf, freshwater, green) and northern river shark which may be present in the MEVA. These threatened and migratory fish and sharks could be present at low densities all year round within the operational area and MEVA; 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. No BIAs for fish, sharks and rays overlap the MEVA.	
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. Impacts on spawning fish can also result in impacts to commercial fisheries.	In addition to the effects of entrained and DAHs, exclusion zones surrounding a spill can directly impact fisheries by restricting access for fishermen. Weathered slicks may form tar balls which may result in oiling of nets and fishing infrastructure.

Santos

<table>
<tr><th rowspan="2">Receptor</th><th colspan="2">Impacts of hydrocarbon spills</th></tr>
<tr><th>Entrained and dissolved aromatic hydrocarbons in the water column</th><th>Surface hydrocarbons</th></tr>
<tr><td></td><td colspan="2">A number of commercial fisheries operate within the MEVA (Section 3.2.6.1). Impacts to these fisheries from a spill include, but are not limited to, a disruption/displacement of fishing activities caused by the physical presence of the slick, loss of catch, decline in commercially important fish stocks and/or suspension of fishing operations.
Southern bluefin tuna are known to spawn within the MEVA, therefore a hydrocarbon spill occurring during spawning or movement from spawning grounds to the southern coast could have effects on the commercial fishery stock. It is likely that other commercial fish that are targeted in the region (refer to Section 3.2.6.1) could also be affected if spawning occurs during a hydrocarbon spill event.
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 to 300 ppm (4,000 to 300,000 ppb) of hydrocarbons in the water, for durations of 24 hours or more, with response to phenols and naphthenic acids being the strongest. Given that entrained hydrocarbons are predicted to exceed the moderate exposure value at some locations in the MEVA, hydrocarbon taint is possible in fish flesh although it is difficult to assess how long fish might be exposed for, small, less mobile fishes would be more susceptible. It is possible 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 banks and shoals and could occur through direct impacts to fish or to fish habitats (for example, seagrass, coral reef, mangrove habitats).
The same negative impacts could also occur to important traditional Indonesian and recreational fish target species (particularly around the banks and shoals of the region, and Ashmore Reef).</td></tr>
<tr><td>Recreation and tourism</td><td colspan="2">There is limited tourism and recreation in remote, offshore waters, however some shoals and banks in the MEVA may be frequented. A hydrocarbon spill may temporarily displace these users from the EMBA, and impact upon natural resources (e.g. fish) targeted and seascapes valued by these users. It is considered highly unlikely that there will be long-term impacts to tourism and recreation activities.</td></tr>
<tr><td>Shipping</td><td>Two shipping fairways intersect the MEVA. Hydrocarbons in the water column will have no effect on shipping.</td><td>Exclusion zones surrounding a spill will reduce access for shipping vessels for the duration of the response undertaken for spill clean-up (if applicable), ships may have to chart alternative routes leading to potential delays and increased costs.</td></tr>
<tr><td>Defence</td><td colspan="2">The level of defence activities performed near the operational area is low, though the MEVA does overlap some of the Northwest Exercise Area. Interference of defence activities due to a hydrocarbon spill is expected to be minimal.</td></tr>
</table>

Receptor	Impacts of hydrocarbon spills	
	Entrained and dissolved aromatic hydrocarbons in the water column	**Surface hydrocarbons**
Shipwrecks	Surface hydrocarbons will have no impact on shipwrecks as all shipwrecks within the MEVA are submerged and therefore will not be contacted by surface hydrocarbons. Hydrocarbons in the water column may extend 484 km for entrained hydrocarbons and up to 200 km for dissolved aromatic hydrocarbons from the release location. The potential for in-water hydrocarbons to impact on shipwrecks is poorly documented. However, it has been proposed that exposure to oil may alter bacterial community composition (biofilms) inhabiting shipwrecks possibly altering corrosion potential (Salerno *et al*., 2016). The biofilms promote the recruitment of macro-organisms and can form protective surfaces which may decrease access for abiotic corrosion and may assist with the historic preservation of metal shipwrecks (dependent on the environmental conditions). Further studies have provided evidence that exposure of shipwreck surfaces to residual spill contaminants has the potential to alter biofilm taxonomy and functional potential, which may place the biodiversity and the preservation of historic metal structures in the deep sea at risk (Mugge *et al.*, 2019).	
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. While the MEVA is largely offshore, the potential visible presence of surface oil within the EMBA would be of concern to Indigenous people.	
Existing oil and gas activity	A number of oil and gas operators have existing infrastructure within, and would transit through, the MEVA (e.g. Santos Bayu-Undan and Inpex Ichthys's gas export pipelines). An exclusion zone surrounding a spill has the potential to adversely affect such operators.	
Protected areas		
Marine parks and Commonwealth heritage areas	Protected areas are described in **Section 3.2.4**. Stochastic modelling results indicate that the open water environment within the Oceanic Shoals Marine Park may be affected (probability 4% to 33%) by surface and entrained hydrocarbons. There is also a low probability (4% to 12%) of the waters of the Arafura Marine Park being contacted by entrained hydrocarbons at or above moderate exposure values in summer and transitional seasons. These protected areas support sensitive habitats and faunal groups described above.	
KEFs	KEFs are described in **Section 3.2.4.2**. While some features associated with the KEFs are subtidal or submerged and would not be directly contacted by a surface slick, they all may support increased productivity or abundance of marine fauna that use surface waters above the features (including plankton, pelagic invertebrates and fish, marine mammals, marine reptiles and seabirds) which may be impacted by floating oil. Impacts to marine fauna are described above. Stochastic modelling predicts that sea surface, entrained and dissolved hydrocarbons at high exposure values could occur in waters above the KEF of the' Shelf break and slope of the Arafura Shelf'. Surface and/or entrained hydrocarbons at moderate exposure values may also occur in waters above the 'Carbonate bank and terrace system of the Van Diemen Rise' KEF and of the 'Pinnacles of the Bonaparte Basin' KEF. Hydrocarbons are expected to remain in the upper water column with probability of contact decreasing with water depth.	

<table>
<tr><th rowspan="2">Receptor</th><th colspan="2">Impacts of hydrocarbon spills</th></tr>
<tr><th>Entrained and dissolved aromatic hydrocarbons in the water column</th><th>Surface hydrocarbons</th></tr>
<tr><td>Offshore banks and shoals</td><td colspan="2">Shallow banks/shoals within the top 20 m of the water column may be impacted by entrained hydrocarbons. Modelling results show entrained hydrocarbons at or above moderate exposure values may contact Margaret Harris Bank, Lynedoch Bank, Evans Shoal, Franklin Shoal, Flinders Shoal, Blackwood Shoal and Tassie Shoal, all of which rise to water depths shallower than 20 m.
Whilst the modelling also showed surface hydrocarbons at or above moderate exposure values may contact Tassie Shoal and an unnamed shoal, both these shoals are submerged (i.e., do not break the sea surface) therefore impacts from surface exposure is improbable.
Banks and shoals support a diverse and varied range of benthic communities, reef-building soft corals, hard corals and filter-feeders (Heyward et al., 2012, 1997b). Surveys of Tassie, Evans and Blackwood Shoals and Lynedoch Bank recorded coral and algae species, filter-feeder communities, sponges, demersal fish and pelagic fish. It is expected that Margaret Harris Bank, Franklin Shoal and Flinders Shoal would be characterised by similar communities.
Benthic communities are vulnerable to hydrocarbons. Filter feeders are particularly susceptible as they are likely to directly ingest hydrocarbons while feeding. This may cause mortality or sublethal impacts such as alteration in respiration rates, decreases in filter feeding activity and reduced growth rates, biochemical effects.
Entrained hydrocarbons may impact on subtidal macroalgae of banks and shoals in the top 20 m of the water column. Given the hydrocarbon characteristics (i.e., very low levels of aromatics in the three ring PAHs and above) and weathering/decay of the entrained and dissolved hydrocarbons of the released condensate, the potential impacts associated with these hydrocarbons are expected to be minimal. Studies have shown that impacts on algae and seagrasses are variable, and generally recover quickly (Runcie et al., 2010; Taylor & Rasheed, 2011).
Impacts to shallow water corals from entrained hydrocarbons may include increased mortality and sub-lethal effects such changes in feeding, bleaching (loss of zooxanthellae), increased mucous production resulting in reduced growth rates and impaired reproduction (Negri & Heyward, 2000). Given the patchy distribution of shallow water corals, the potential impacts on coral reefs are expected to be restricted to sub-lethal impacts.</td></tr>
<tr><td>Wetlands</td><td colspan="2">Ramsar wetlands are present at Ashmore Reef and provide key habitats that support a high diversity and abundance of migratory birds and various wetland habitats. The MEVA does not contact Ashmore Reef Ramsar wetland, with low maximum entrained hydrocarbon exposure values predicted. Hence, potential impacts are expected to be minimal.</td></tr>
<tr><td>Threatened ecological communities</td><td colspan="2">There are no threatened ecological communities within the MEVA.</td></tr>
</table>

7.5.7 Spill response strategies

Numerous oil spill response strategies are available to be implemented in the event of a spill. These are generally strategies that have been implemented in the past or are considered good industry practice. Section 4 of the *Barossa Development OPEP Addendum – Drilling and Completions* (BAA-200-0316) provides a detailed description of the applicable response strategies for this activity, which include, depending on the type and size of the spill:

- source control (BOP, subsea first response toolkit (SFRT), relief well, capping stack)
- monitoring and evaluation
- mechanical dispersion
- oiled wildlife response
- scientific monitoring
- waste management.

7.6 Hydrocarbon spill – condensate

7.6.1 Description of event

Event	A loss of well control (LOWC) during drilling may occur due to a number of reasons, including: + shallow gas + well kick + tripping/swabbing + loss of primary and secondary well control + failure to keep the correct mud density. In the event of a LOWC, condensate and associated gas may be released to the marine environment. Worst-case credible spill scenarios were estimated to cover the possibility of a blowout from any well drilled under this EP. The worst-case credible spill scenarios were predicted by selecting the most likely hydrocarbon flow parameters from the wells to yield the credible maximum blowout volumes and rates (i.e., environmentally credible worst-case volume and rate) from both subsurface (seabed) and surface (MODU drill floor) releases. Key parameters for input to the worst-case scenarios were taken from well design documents, suitable analogues, latest reservoir models, or best estimates where information was unavailable. The worst-case scenario was the subsea LOWC. Quantitative hydrocarbon spill modelling was undertaken for the worst-case subsea LOWC scenario. Outputs from the modelling were used to inform the environmental assessment and to assist with emergency planning. The environmental consequences of a LOWC are highly variable, dependent on the characteristics of the hydrocarbon released, the dynamics of the receiving environment and the proximity of the release point to sensitive environmental receptors.
Extent	The EMBA for modelled LOWC scenarios are defined in **Section 7.5.4** and **Figure 7-5**. For information on the extent of potential impact associated with a LOWC, refer to **Section 7.6.2**.
Duration	The duration of a LOWC is predicted to be 90 days (refer to **Table 7-6**). This is the estimated time required to drill a relief well and gain control of the primary well. Hydrocarbons would persist within the environment for a longer period of time, although the condensate released is expected to weather quickly through evaporation and dispersion (**Section 7.5.3.2**).

7.6.2 Nature and scale of environmental impacts

Potential receptors: physical environment (water and sediment quality, shoals and banks, benthic habitats), threatened or migratory fauna (marine mammals, marine reptiles, sharks, fish, rays and birds), protected and significant areas (marine parks, KEFs), socio-economic receptors (fisheries, tourism, recreation and other third-party operators).

Hydrocarbon spills will cause a decline in water quality and may cause chemical (e.g., toxic) and physical (e.g., coating of emergent habitats, oiling of wildlife at sea surface) impacts to marine species. The severity of the impact of a hydrocarbon spill depends on the magnitude of the spill (i.e., extent, duration) and sensitivity of the receptor.

The magnitude of potential environmental impact from a condensate release (which behaves in a similar manner in the marine environment to MDO) is dependent on multiple factors including hydrocarbon type, release volume and rate, and ocean and weather conditions.

An assessment of the sensitive environmental receptors at risk from a condensate release has been determined based on a literature review and trajectory and fate modelling described below.

The potential impact pathways (physical and chemical) of hydrocarbon exposure to relevant habitat and marine fauna receptors are summarised in **Table 7-15** and an impact assessment is completed for receptors within the MEVA in **Table 7-16**.

7.6.2.1 Stochastic spill dispersion modelling – summary of results for moderate exposure values

The spill modelling results at or above moderate exposure values (as used to define the MEVA) are summarised below for a subsea LOWC, more detailed results are provided in **Appendix G**.

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

The currents in the region are dominated by tidal and wind driven currents which are dependent on the season. These will influence the direction that the hydrocarbons (entrained and floating) travel in a particular season.

Accumulated shoreline oil

No shoreline accumulation of oil was identified at any exposure value in any season.

Surface oil greater than 10 g/m²

Modelling results indicate that sea surface hydrocarbons above 10 g/m^2 may extend up to 162 km west during transitional seasons, up to 122 km west-south-west in summer months and up to 126 km west-south-west during winter. Locations potentially contacted at the moderate exposure value for surface oil include:

+ A high contact probability of 100% was predicted at 'Shelf Break and slope of the Arafura Shelf' KEF, with a minimum arrival time of 0.04 days. Contact probability of 39% at the 'Carbonate bank and terrace system of the Van Diemen Rise' KEF was also predicted with a minimum arrival time of 10.2 days. Noting that these receptors are submerged; hence, less susceptible to surface oil impacts.
+ The Oceanic Shoals was the only AMP predicted to be contacted, with a 12% probability of exposure in the transitional seasons.
+ Two shoals were predicted to be contacted at a low probability (17%) within 12.3 days (Unnamed shoal and Tassie shoal).
+ The probability for condensate to cross the Australian Exclusive Economic Zone at the moderate exposure value was 24% in summer and 10% in transitional seasons, with corresponding minimum times of arrival of 18 days and two days respectively.

Entrained oil greater than 100 ppb

Modelling results predict that entrained hydrocarbons at 100 ppb would occur within 0 to 10 m water depth, with a maximum distance from the release location of 484 km to the west (transitional and winter seasons). Sensitive locations potentially contacted at or above the moderate exposure value:

+ No entrained oil was predicted below the 10 to 20 m water depth.
+ High probability of entrained oil crossing the Australian Exclusive Economic Zone (98%).
+ The Arafura and Oceanic Shoals AMPs were the only AMPs predicted to be contacted, at 12% and 33% probability respectively, with maximum exposure values of 143 ppb and 215 ppb respectively.
+ The 'Shelf break and slope of the Arafura Shelf', 'Carbonate bank and terrace system of the Van Diemen Rise' and 'Pinnacles of the Bonaparte Basin' were the only KEFs predicted to be contacted, at 100%, 42% and 6% probability respectively, with maximum exposure values of 1,843 ppb, 289 ppb and 126 ppb respectively.
+ A number of shoals and banks were predicted to be contacted by entrained oil at 9% to 46% probability, with maximum exposure values ranging from 113 to 246 ppb.

Dissolved oil greater than 50 ppb

Modelling results for dissolved aromatic hydrocarbons predict that hydrocarbons above 50 ppb may extend 39 km east-northeast in summer, 43 km east-northeast in transitional seasons and 39 km west south-west in winter.

The 'Shelf break and slope of the Arafura Shelf' KEF was the only receptor contacted at the moderate exposure value with a contact probability of 100%, a maximum exposure value of 575 ppb and a minimum arrival time of 0.1 days.

7.6.2.2 Deterministic spill dispersion modelling

The stochastic simulation output provides a probabilistic temporal and spatial representation of an oil spill incident. Individual stochastic realisations were selected to run in deterministic mode. The deterministic simulations were selected by identifying the stochastic realisation from each scenario that resulted in:

- largest swept area of condensate on the sea surface above 10 g/m^2
- greatest dissolved hydrocarbon time-averaged exposure concentration at the Evans Shoal and Tassie Shoals (being the nearest known physical sensitive receptors).

Largest swept area of condensate on the sea surface above 10 g/m^2

The deterministic trajectory that resulted in the largest swept area of condensate on the sea surface above 10 g/m^2 had begun at 6 am, 1st of December 2012, during summer conditions.

Zones of exposure on the sea surface (swept area) over the entire 110-day simulation occurred west-southwest from the release location.

Figure 7-4 displays the time series for the zone of exposure at the low exposure value (1 g/m^2) and moderate exposure value (10 g/m^2) over the 110-day simulation. The maximum area of coverage at the low exposure value on the sea surface was approximately 380 km^2 at 80 days. Between day 32 and 60, the wind speeds increased to above 12 knots and peaked at 27 knots causing the condensate to entrain. This resulted in a reduction of condensate on the sea surface.

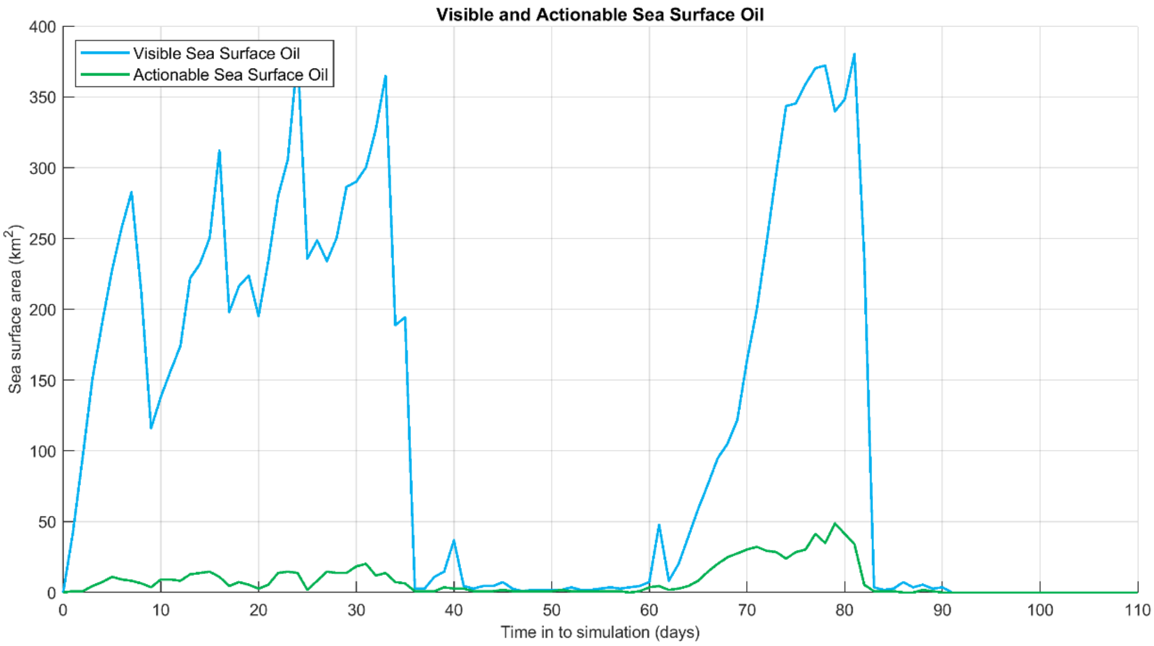

Figure 7-4: Time series of the area of visible oil (1 g/m^2) and oil at moderate exposure value (10 g/m^2) on the sea surface for the trajectory with the largest sea surface swept area at 10 g/m^2. Results are based on a 129,000 m^3 subsea release of Barossa condensate over 90 days, tracked for 110 days, 6 am 1st December 2012

At the conclusion of the simulation, approximately 103,258 m^3 (80%) spilled oil was lost to the atmosphere through evaporation. Approximately 20,707 m^3 (16%) of the condensate was predicted to have decayed by the end of the simulation, while approximately 5,024 m^3 (3.8%) was predicted to remain within the water.

Greatest dissolved hydrocarbon time-averaged exposure concentration at the Evans and Tassie Shoals

The simulations that resulted in the greatest exposure of dissolved hydrocarbons at the Evans Shoal and Tassie Shoal receptors were identified for runs commencing in winter (run 83) and transitional season (run 30) conditions.

Run 83, starting at 8 pm 25 June 2014 during winter conditions, produced a maximum dissolved hydrocarbon exposure of 19.2 ppb (over a 96-hour window) at Evans Shoals. While run 30, starting at 7 pm on 16 October 2011 during transitional season conditions, resulted in a maximum dissolved hydrocarbon exposure at Tassie Shoal of 12.3 ppb (over a 96-hour window).

7.6.2.3 Vapour dispersion modelling

A vapour dispersion modelling study was undertaken to assess levels of potential airborne concentrations of volatiles from a LOWC (RPS, 2019b).

Vapour dispersion modelling methodology

The gas and vapor modelling (RPS, 2019b) was performed using an advanced three-dimensional trajectory and fates blowout model OILMAPDeep, coupled with a three-dimensional gas and vapor plume atmospheric model AIRMAP. The OILMAPDeep model calculates the blowout dynamics at the seabed and the rise of the resultant gas, oil and water plume through the water column. Once on the water surface OILMAPDeep calculates the transport, spreading, entrainment and evaporation of spilled hydrocarbons over time, based on the prevailing wind and current conditions and the physical and chemical properties. The atmospheric plume model (AIRMAP) is coupled to the OILMAPDeep model and is used to calculate the atmospheric concentrations of the blowout gas and the elevated hydrocarbons (benzene) from the spilled hydrocarbon liquids. **Table 7-17** provides the settings and thresholds used for the vapour dispersion modelling.

Table 7-17: Settings and thresholds used for vapour dispersion modelling

<table>
<tr><th colspan="2">Input variable</th><th colspan="2">Value</th></tr>
<tr><td colspan="2">Scenario</td><td colspan="2">LOWC</td></tr>
<tr><td colspan="2">Water depth (m)</td><td colspan="2">250</td></tr>
<tr><td colspan="2">Tubing diameter (inch)</td><td colspan="2">10.71</td></tr>
<tr><td colspan="2">Condensate rate (stb/day)</td><td colspan="2">9,190 (day 1)</td></tr>
<tr><td colspan="2">Gas rate (MMscf/day)</td><td colspan="2">919 (day 1)</td></tr>
<tr><td colspan="2">Reservoir temperature (°C)</td><td colspan="2">170</td></tr>
<tr><td colspan="2">Release pressure (bar)</td><td colspan="2">5,982</td></tr>
<tr><td colspan="2">Release duration (hours)</td><td colspan="2">24</td></tr>
<tr><td colspan="2">Simulation length (hours)</td><td colspan="2">24</td></tr>
<tr><th colspan="4">Wind conditions</th></tr>
<tr><td colspan="2">Minimum</td><td colspan="2">1 knot</td></tr>
<tr><td colspan="2">Average</td><td colspan="2">10 knots</td></tr>
<tr><td colspan="2">Maximum</td><td colspan="2">37 knots</td></tr>
<tr><th colspan="4">Atmospheric reporting thresholds</th></tr>
<tr><th rowspan="2">Zone of concern (ZOC)</th><th rowspan="2">Criteria for ZOC (benzene)</th><th colspan="2">Atmospheric concentration</th></tr>
<tr><th>mg/m³</th><th>ppm</th></tr>
<tr><td>ZOC 0</td><td>Trigger for immediate removal of personnel from workspace</td><td>1</td><td>0.25</td></tr>
<tr><td>ZOC 1</td><td>Exceeds trigger for long-term adverse health effects</td><td>2</td><td>0.5</td></tr>
<tr><td>ZOC 2</td><td>Danger of exceeding flammable range</td><td>19,168</td><td>6,000</td></tr>
<tr><td>ZOC 3</td><td>Exceeded flammable limit, explosion possible if ignition source present</td><td>38,336</td><td>12,000</td></tr>
</table>

<u>Vapour dispersion modelling results</u>

For all wind speeds assessed, the modelling indicated that vapour plume concentrations for all zones of concern (human health risk and safety risk; and also a proxy for potential environmental harm to marine fauna at or above sea surface) (i.e., ZOC 0 to 3) occurred within approximately 2.5 km from the well (RPS, 2019b).

7.6.3 Environmental performance outcomes and control measures

The EPOs relating to this event include:

+ No loss of containment of hydrocarbon to the marine environment. [EPO-03]
+ No unplanned objects, emissions or discharges to sea or air. [EPO-04]
+ No injury or mortality to EPBC Act listed fauna during activities. [DC-EPO-05]

An assessment of the environmental benefits and the potential costs or issues associated with control measures for this activity are shown in **Table 7-18** to demonstrate that potential risks are ALARP. Control measures that are adopted have associated EPSs and measurement criteria which are presented in **Table 8-2**. Rejected control measures have an ALARP evaluation provided to justify their rejection.

The OPEP contains oil spill response strategies and associated performance outcomes, control measures and performance standards; and an ALARP evaluation.

Table 7-18: Control measure evaluation for a loss of well control hydrocarbon spill

CM reference	Control measure	Environmental benefit	Potential cost/issues	Evaluation
Standard control measures				
BAD-CM-013	Source control plan	Ensures source control arrangements are effectively and efficiently implemented in order to reduce the volume of oil released to the environment.	Costs associated with preparing documents, assurance (audits) and maintaining response capability (spill response exercises, service provider contract administration).	**Adopted** – environmental benefits of ensuring source control arrangements in place outweighs the financial costs.
BAD-CM-017	Accepted OPEP	Implements response plans to deal with an unplanned hydrocarbon release quickly and efficiently to reduce impacts to the marine environment.	Administrative costs of preparing documents and large costs of preparing for and implementing response strategies.	**Adopted** – regulatory requirement, must be adopted.
BAD-CM-018	Drilling and completions management process	Includes control measures for well integrity and well control in an accepted WOMP, MODU Safety Case. Defines critical acceptance criteria for well operations that reduce the risk of a LOWC. Accounts for emergency situations such as cyclone response plans.	Costs associated with preparing and implementing the WOMP, Safety Case and D&C programs.	**Adopted** – regulatory requirement, must be adopted.
BAD-CM-034	Minimum lighting for maritime safety	Ensures the MODU is seen by other marine users, thereby reducing the potential for collision during drilling operations.	Standard maritime safety and navigational equipment; regulatory requirement and therefore the cost is not identified as an issue.	**Adopted** – regulatory requirement, must be adopted.
BAD-CM-038	Petroleum Safety Zone (500 m) established	PSZ alerts other marine users to the presence of the MODU and wellheads, thereby reducing the likelihood of vessel collision and fishing gear snagging on the wellheads.	Negligible costs.	**Adopted** – regulatory requirement, must be adopted.

CM reference	Control measure	Environmental benefit	Potential cost/issues	Evaluation
BAD-CM-040	MODU planned maintenance system	Requires that equipment is maintained and certified including BOP, reducing probability of a loss of well control.	High cost of maintaining MODU equipment and managing the maintenance system.	**Adopted** – benefits of ensuring MODU is maintained and equipment is operating as intended outweighs the potential high costs.
BAD-CM-042	Relief well MODU identification	Ensures relief well MODU availability is confirmed to be able to meet the timeframes defined in Table 9-4 of the OPEP prior to spud.	Potential delay to drilling schedule in the event that a suitable MODU for relief well drilling is not available within required timeframes.	**Adopted** – ensuring there is a suitable MODU for relief well drilling is considered best practice.
Additional control measures				
N/A	Manage the timing of the activity to avoid sensitive biological periods (e.g., fish spawning, whale foraging)	Reduce potential environmental consequences by avoiding sensitive biological periods for conservation significant marine fauna in the MEVA.	Drilling campaign is longer than 12 months. High cost in suspending activities and demobilising/ remobilising the MODU and vessels. Impracticable to avoid all biological sensitive periods in the MEVA due to the variability between species (e.g. spawning fish species) and extended length.	**Rejected** – high cost is grossly disproportionate to the environmental benefits given remote likelihood of a LOWC, and the nature and scale of potential impacts within the MEVA.
N/A	Manage the timing to avoid drilling during cyclone season	In the event of a LOWC, cyclonic conditions may spread oil further than predicted and/or hindering oil spill response activities.	Drilling campaign is longer than 12 months. The official Northern Territory cyclone season runs from 1 November to 30 April; hence, drilling would be precluded for up to 6 months per year. High cost in suspending activities and demobilising/ remobilising the MODU and vessels. Cyclones are a known risk and drilling within cyclone season is appropriately managed under current industry standards and regulatory regime (e.g. Safety Case). Weather conditions are monitored, and drilling operations respond in accordingly.	**Rejected** – the financial cost of mobilising a MODU and vessels either side of cyclone season adds significant costs to the development. Such costs are unwarranted given the risks are well understood and standard industry practices will be used to manage the risk.

CM reference	Control measure	Environmental benefit	Potential cost/issues	Evaluation
N/A	Dedicated spill response resources/ facilities in close proximity to the operational area	Would enable a faster spill response as resources will be in close proximity.	Significant additional costs associated with securing dedicated resources. Modelling shows no shoreline loading of hydrocarbons.	**Rejected** – significant costs grossly disproportionate to environmental benefits given remote likelihood of a LOWC, lack of shoreline oil and low persistence of condensate in a tropical climate.
N/A	A dedicated second MODU on standby for the purpose of relief well drilling	Could reduce the length of time taken to drill a relief well and may reduce the time frame for stopping a blowout by around 20 to 30 days.	For the dedicated second MODU to be ready for relief well drilling, it would need to be contracted, crewed and hold a valid NOPSEMA Safety Case. This could cost around \$250,000 to \$600,000 USD per day for a minimum negotiated contract term, plus a cost associated for MODU mobilisation and demobilisation (depending on MODU type). After reviewing availability, it is anticipated a MODU would need to be brought in from overseas to guarantee availability of this rig. It is conceivable that to cover the full duration of the drilling campaign (up to eight 90-day wells) with a relief MODU on standby, the additional cost would be in the order of \$160 million to \$380 million USD, depending on where the MODU was mobilised from/to and the market at the time. Introducing another MODU and support equipment/personnel on standby would result in additional environmental and safety risks.	**Rejected** – significant costs considered grossly disproportionate to the environmental benefit considering the remote likelihood of a LOWC. In addition, it is envisaged that a MODU would be made available through the APPEA-administered MoU (MODU and Well Services). The MOU agreement documents the commitment to share rigs, equipment, and service personnel in the event of a major loss of containment incident, significantly increasing the resources available to a titleholder company.

CM reference	Control measure	Environmental benefit	Potential cost/issues	Evaluation
N/A	Amend the well design to reduce the volume of hydrocarbons released in the event of a LOWC	By reducing the diameter of the wellbore through the reservoir and back to surface increases the backpressure on the well and hence the flowrates through well redesign. This would result in a reduction in overall volume of hydrocarbons released to the environment in the event of a LOWC.	The wellbore size for each of the wells is driven by the deliverability requirements of the wells. Reducing the size of the wellbore would require additional wells to be constructed. This would result in a significant increase in costs and longer activity duration, as well as an increase in discharges to sea and air, greater area of seabed disturbance and a longer period of potential interaction with other marine users. Adding one additional well would cost in the order of $50 million to $60 million USD.	**Rejected** – modelling conducted for the Barossa OPP used a smaller wellbore (8.5-inch) compared to that used for spill modelling for this EP (10.5-inch). The EMBAs for these two scenarios are similar in size due to the increased exit velocity from the smaller wellbore diameter (8.5-inch) reducing the droplet size and resulting in >80% of the condensate remaining in the water column. Whereas the larger droplets encountered from the larger wellbore design (10.5-inch) would rise to the surface where they may be subject to evaporation and re-entrainment. Therefore, reducing the wellbore size will not result in a significant reduction in the EMBA size, and the environmental and economic costs of increasing the number of wells and duration of the campaign are considered grossly disproportionate to the potential reduction in environmental impact.

7.6.4 Environmental impact assessment

The below environmental impact assessment follows the approach detailed in **Section 7.5.5**.

7.6.4.1 Identification of hot spots for consequence assessment

Hot spots that are predicted to be contacted by hydrocarbons in any phase within the MEVA and EMBA for a LOWC are listed in **Table 7-19**. The values and sensitivities associated with these areas are described in **Appendix C**. These hot spots meet the criteria (as described in **Section 7.5.5**) which includes a probability of contact greater than 5%, or high volumes of entrained and dissolved hydrocarbons.

Note that the worst-case values were taken from the modelling scenarios to identify the hot spots and therefore is taken from any season and any hydrocarbon phase at any water depth.

Table 7-19: Identified high environmental value and hot spot receptors

Receptor	Exposure values			Hot Spot
	Low (EMBA)	Moderate (MEVA)	High (HEVA)	
Arafura AMP	✓	✓		
Ashmore Reef AMP	✓			
Cartier Island AMP	✓			
Oceanic Shoals AMP	✓	✓		Y
Carbonate bank and terrace system of the Sahul Shelf KEF	✓			
Pinnacles of the Bonaparte Basin KEF	✓	✓		
Shelf break and slope of the Arafura Shelf KEF	✓	✓	✓	Y
Carbonate bank and terrace system of the Van Diemen Rise KEF	✓	✓		Y
Tributary canyons of the Arafura Depression KEF	✓			
Continental slope demersal fish communities KEF	✓			
Ashmore Reef and Cartier Island and surrounding Commonwealth waters KEF	✓			
Barton Shoal	✓			
Dillon Shoal	✓			
Cootamundra Shoal	✓			
Calder Shoal	✓			
Margaret Harries Banks	✓			
Money Shoal	✓			
Lynedoch Bank	✓	✓		Y
Evans Shoal	✓	✓		Y
Franklin Shoal	✓			
Flinders Shoal	✓			
Blackwood Shoal	✓	✓		Y

Receptor	Exposure values			Hot Spot
	Low (EMBA)	Moderate (MEVA)	High (HEVA)	
Martin Shoal	✓			
Loxton Shoal	✓			
Sunset Shoal	✓			
Troubadour Shoals	✓			
Sunrise Bank	✓			
Bellona Bank	✓			
Echo Shoals	✓			
Big Bank Shoals	✓			
Karmt Shoal	✓			
Jabiru Shoals	✓			
Pee Shoal	✓			
Mangola Shoal	✓			
Vee Shoal	✓			
Fantome Shoal	✓			
Johnson Bank	✓			
Woodbine Bank	✓			
Barracouta Shoal	✓			
Tassie Shoal	✓	✓		Y
Unnamed shoal	✓	✓		Y

This process identified the following hot spots:

- Arafura and Oceanic Shoals AMPs
- Shelf break and slope of the Arafura Shelf KEF
- Carbonate bank and terrace system of the Van Diemen Rise KEF
- Pinnacles of the Bonaparte Basin KEF
- Lynedoch Bank
- Evans Shoal
- Blackwood Shoal
- Tassie Shoal
- Unnamed Shoal[8].

[8] 'Unnamed shoal' is assumed to have similar values to those at other banks and shoals in the region as described in **Appendix C**.

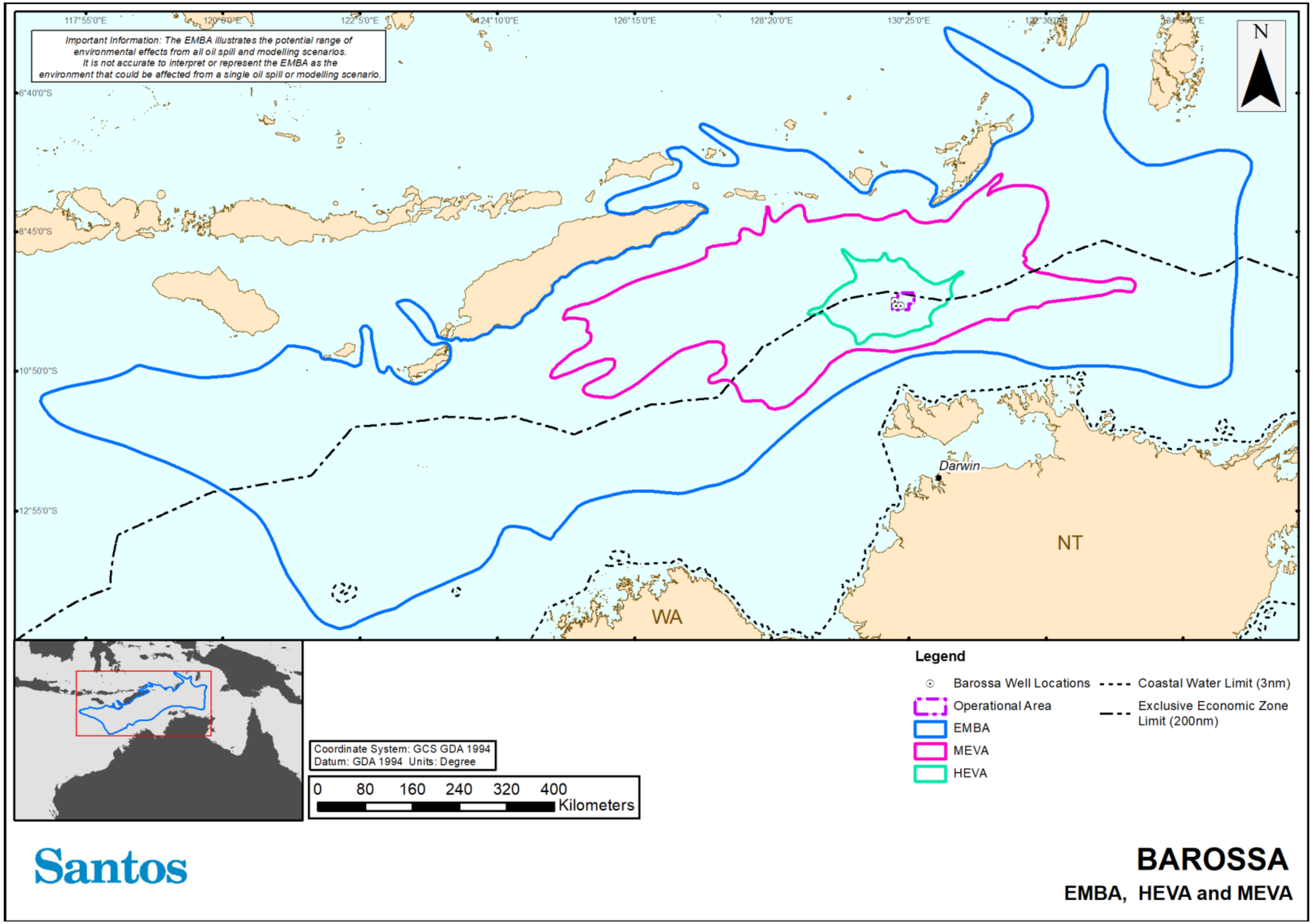

Figure 7-5: Environment that may be affected, moderate exposure value area and high exposure value area from a loss of well control

Table 7-20: Impact, likelihoods and consequence ranking – loss of well control

Receptors	Physical environment (water and sediment quality, benthic habitats, KEFs) Threatened, migratory or local fauna (marine mammals, marine reptiles, sharks, rays, fish, and birds) Protected and significant areas (marine parks) Socio-economic receptors (fisheries, tourism and recreation)
Consequence	IV – Major

A summary of the consequence assessment for each receptor category is presented below. Potential impact pathways (physical and chemical) of hydrocarbon exposure for receptors are summarised in **Table 7-15**, and potential impacts to receptors that may be found within the area of moderate exposure are further described in **Table 7-16**.

Physical environment or habitat

There are no emergent or shoreline habitats within the MEVA.

Stochastic modelling indicates surface, entrained and dissolved aromatic hydrocarbons at or above moderate exposure values may affect water quality in the Arafura and Oceanic Shoals AMPs, KEFs and at various banks and shoals.

Banks and shoals support a diverse and varied range of benthic communities, reef-building soft corals, hard corals and filter-feeders (Heyward *et al*., 2012, 1997b). Some of the shoals/banks close to the operational area have the potential to be contacted in this spill scenario by entrained hydrocarbons at the moderate exposure level at relatively low probabilities (9% to 46%), as predicted by stochastic modelling.

Potential impacts that may occur as a result of hydrocarbon exposure could include sub-lethal stress and, in some cases, total or partial mortality of sensitive benthic organisms (e.g., corals) and the early life stages of resident fish and invertebrate species. Exposure to entrained hydrocarbons may also increase mortality in the early life stages of benthic species affected and could cause localised and long-term effects to the shallow hard coral communities at these shoals/banks.

A hydrocarbon release during a loss of well control has the potential to result in a localised, temporary reduction in air quality near the release site. Based on the Barossa condensate assay, up to 57% of the hydrocarbons would evaporate within the first few hours, with almost 80% evaporated after two days when on the sea surface (RPS APASA, 2017). Additionally, as demonstrated by the vapour dispersion modelling, hydrocarbon vapor concentrations above human health risk and safety risk levels (also considered a proxy for environmental risk) would extend to approximately 2.5 km (RPS, 2019b).

Hydrocarbon vapor in this open water offshore environment would rapidly disperse with the prevailing wind. Potential impacts to air quality are expected to be temporary however may be significant for short periods of time in relatively close proximity to the release location.

Water quality and sediment quality will be affected by the release of hydrocarbons with the potential for Major (IV) consequences due to the long-term nature of hydrocarbon contamination.

Threatened or migratory fauna

In the event of a LOWC, a reduction in water quality has the potential to impact marine fauna. Marine fauna present in the area may be exposure to floating oil, entrained oil, or dissolved aromatic hydrocarbons. A description of impacts to marine fauna from exposure to condensate is provided in **Table 7-16**.

Impacts would be greatest within several kilometres of the spill where the toxic aromatic components of the condensate will be at their highest concentration, and when oil is at its thickest on the sea surface. Upon release to the marine environment, the condensate will rapidly lose toxicity with time and will spread thinner at the surface as evaporation continues or due to entrainment within the water column.

Breeding/foraging BIAs for seabirds or migratory shorebirds are not predicted to be contacted by hydrocarbons at or above moderate exposure values. Seabirds may contact surface slicks at or above moderate exposure values whilst foraging in offshore, open water locations and could cause slight secondary effects through ingestion after preening or ingestion of oiled fish (as described in **Table 7-15** and **Table 7-16**).

The pygmy blue whale BIA may be contacted by hydrocarbons at or above moderate exposure values for surface and entrained hydrocarbons. Potential impacts are likely to be limited to individuals that may be transiting through

the area with potential for coating of baleen (in whales) and ingestion of oiled prey (plankton/fish) as described in **Table 7-15** and **Table 7-16**. Based on the stochastic modelling outputs, the spill may contact various BIAs for marine turtles, but given the distance from key areas for breeding and nesting, any potential impacts are likely to be limited to individuals that may be transiting through the area or feeding at nearby submerged shoals and banks. The potential sensitive receptors in the surrounding areas of the spill will include fish, marine mammals, marine reptiles and seabirds, as discussed in **Table 7-16**. There is considered to be the potential for Major (IV) consequences to marine fauna, defined as 'Major long-term effect on local population, industry or ecosystem factors'. *Protected areas* The MEVA intersects two AMPs (Section **3.2.4**) at 12% and 33% probability of exposure. Although hydrocarbons are only predicted to occur within the 0 to 10-m layer of the water column, long-term effects on one or more of the protected area's values could occur (e.g. sediment contamination). Hence, potential consequences are considered to be Major (IV). *Socio-economic receptors* There is potential for temporary disrupt to fishing activities (traditional, recreational and commercial) due to surface, dissolved or entrained oil. Although only expected in the medium term, the consequence is considered to be Moderate (III) due to the potential significant loss of value to local fishing industries. A LOWC and associated oil spill could also disrupt other oil and gas operations in the region (e.g. Santos Bayu Undan operations), military exercises and commercial shipping. Potential consequences are considered to be Moderate (III) for these socio-economic receptors. On the basis of the above assessment, a LOWC has the potential to impact an array of environmental and socio-economic receptors, with the highest consequence considered to be Major (IV).	
Likelihood	A – Remote
The likelihood of a LOWC event occurring during the activity with the proposed control measures in place is extremely low when considering industry and Santos' statistics. Wells are designed with essential engineering and safety control measures to prevent a loss of containment occurring. Blowout events during oil well development drilling has been reported at a frequency of 3.4 × 10-5 per drilled well (IOGP, 2019; development drilling operations at normal wells, North Sea Standard). Control measures in place to control the flow of hydrocarbons include construction design, safety shutdown systems, regular inspection and maintenance, and competent personnel. Industry-standard and activity-specific control measures to reduce the chance of a loss of containment event resulting in a release have been implemented, including procedures such as the NOPSEMA-accepted WOMP and safety case, and a spill response plan (OPEP). These control measures are considered to reduce the risk of a loss of containment occurring to a level that is acceptable and ALARP. Santos considers there to be less technical uncertainty and risk when drilling production wells compared to exploration wells. The likelihood of a LOWC occurring with the control measures in place and then resulting in a Major (IV) consequence is considered to be Remote (a).	
Residual Risk	The residual risk is considered **Low**.

7.6.5 Demonstration of as low as reasonably practicable

The industry standard safe drilling methodologies, including the inherently safe well design and its operations with primary (i.e., maintaining the appropriate hydrostatic pressure) and secondary well control features (i.e., BOP) will be implemented to reduce the probability of a loss of containment. All safety options have been considered in well design and equipment choice for the activity.

The combination of the standard prevention control measures (**Section 7.6.3**), and the spill response strategies, as presented in the OPEP, together reduce the hydrocarbon spill risk and impact.

Santos has determined applicable source control response measures to limit the spill volume from a LOWC event to ALARP.

Source control

A number of source control options have been evaluated for the activity (refer to the OPEP). Of these source control options, the drilling of a relief well is considered the primary means of controlling the source in the event of an unplanned well release. Spill response and impact assessment for this activity has been based on the relief well taking 90 days to execute. A breakdown of the key tasks and their timeframe to drill a relief well in 90 days have been included in the *Barossa Development OPEP* (BAA-200-0314).

Spill mitigation controls

Santos considers that through the selection of appropriate spill response strategies, development of spill response controls and maintenance of preparedness arrangements and resources to implement these controls, spill risk is mitigated to ALARP. Preparedness spill response controls are outlined in **Table 7-18** while those that would be implemented in the event of a spill are outlined within the OPEP.

All reasonably practicable control measures have been reviewed (refer OPEP for further evaluation) and those adopted are considered appropriate to reduce the residual risk to a 'Low' level. The proposed control measures are in accordance with the Santos risk management criteria and are considered appropriate to manage the risk to ALARP.

7.6.6 Acceptability evaluation

Is the risk ranked between Very Low and Medium?	Yes – maximum credible hydrocarbon spill (condensate from a LOWC) residual risk is ranked as Low.
Is further information required to validate the consequence assessment?	No – hydrocarbon spill modelling results were used to determine consequence and risk.
Are risks and impacts consistent with the principles of ESD?	Yes – activity evaluated in accordance with Santos' *Environmental Hazard Identification and Assessment Procedure,* which considers principles of ESD.
Have the acceptable levels of impact and risks been informed by relevant species recovery plans, threat abatement plans and conservation advice and Australian marine park zoning objectives)?	Yes – consistent with relevant species recovery plans, conservation management plans and management actions set out in **Table 3-9**, including: + Recovery Plan for Marine Turtles in Australia 2017–2027 (DoEE, 2017) + Approved Conservation Advice for *Megaptera novaeangliae* (humpback whale) (TSSC, 2015c) + Approved Conservation Advice for *Rhincodon typus* (whale shark) (TSSC, 2015d) + Conservation management plan for the blue whale, 2015 to 2025 (CoA, 2015a) + Approved Conservation Advice for *Balaenoptera borealis* (sei whale) (TSSC, 2015a) + Approved Conservation Advice for *Balaenoptera physalus* (fin whale) (TSSC, 2015b) + Recovery plan for the white shark (*Carcharodon carcharias*) (DSEWPaC, 2013) + Approved Conservation Advice for *Pristis clavate (Dwarf Sawfish)* (DEWHA, 2009) + Approved Conservation Advice for *Pristis pristis* (largetooth sawfish) (DoE, 2014b)

	+ Commonwealth Conservation Advice on *Pristis zijsron* (green sawfish) (DEWHA, 2008) + Sawfish and River Sharks Multispecies Recovery Plan (DoE, 2015a) + Recovery plan for the grey nurse shark (*Carcharias taurus*) (DoE, 2014a) + Approved Conservation Advice for *Glyphis garricki* (northern river shark) (DoE, 2014c) + National recovery plan for threatened albatrosses and giant petrels 2011 to 2016 (DSEWPaC, 2011b) + Approved Conservation Advice for *Calidris ferruginea* (curlew sandpiper) (TSSC, 2015e) + Approved Conservation Advice for *Numenius madagascariensis* (Eastern Curlew) (TSSC, 2015f) + Approved conservation advice *Calidris canutus* (red knot) (TSSC, 2016b) + Approved Conservation Advice for *Limosa lapponica baueri* (bar-tailed godwit (western Alaskan)) (TSSC, 2016f) + Approved conservation advice *Limosa lapponica menzbieri* (bar-tailed godwit (northern Siberian)) (TSSC, 2016a) + Approved Conservation Advice for *Papasula abbotti* (Abbott's booby) (TSSC, 2015h) + Marine Bioregional Plan for the North-West Marine Region (CoA, 2012b). Management is also consistent with the zoning of the Australian marine parks, and their management plans (i.e., North Marine Parks Network Management Plan 2018 (Director of National Parks, 2018a) and North-West Marine Parks Network Management Plan 2018 (Director of National Parks, 2018b) in that risks have been reduced to ALARP, such as implementation of spill response activities will limit impacts, thereby conserving the marine park values which includes habitats critical to the diversity and value of the protected areas.
Are performance outcomes, control measures and associated performance standards consistent with legal and regulatory requirements?	Yes – management consistent with OPGGS Act and Regulations, including Safety Case and WOMP. Through acceptance of this EP, legislative and regulatory requirements will be met as per **Section 1.6.2**.
Are performance outcomes, control measures and associated performance standards consistent with Santos' Environment, Health and Safety Policy?	Yes – aligns with Santos' Environment, Health and Safety Policy.
Are performance outcomes, control measures and associated performance standards consistent with industry standards?	Yes – the most recent and comparable Drilling and Completions EPs accepted by NOPSEMA have been reviewed for consistency with the performance outcomes, control measures and associated performance standards proposed in this EP.
Have performance outcomes, control measures and associated performance	Yes – requests relating to managing oil spill response activities and potential environmental impacts to marine fauna or commercial fisheries have been considered.

standards taken into consideration stakeholder feedback?	Oil spill matters raised by ECNT are addressed in **Section 4**.
Are performance standards such that the impact or risk is considered to be ALARP?	Yes – see ALARP above.

The residual risk of an unplanned hydrocarbon spill (condensate) is assessed as Low. Based on an assessment of Santos' acceptability criteria and with the control measures in place, potential risks are considered acceptable.

7.7 Hydrocarbon spill – marine diesel oil

7.7.1 Description of event

Event	*Worst-credible MDO spill* It is considered credible that a release of MDO to the marine environment could occur as a result of a collision between the support vessels, between a support vessel and the MODU, or between a passing third party vessel and the MODU or a support vessel. Such a collision could rupture a fuel tank resulting in the release of MDO to sea. Vessel collision could occur due to factors such as human error, poor navigation, vessel equipment failure or poor weather. As described in Section **7.5.1.2**, a spill scenario of 250 m^3 of MDO has been assumed for this EP. *Refuelling incident* The second most significant MDO spill scenario identified is a refuelling incident (fuel hose failure or rupture, coupling failure or tank overfilling) where fuel bunkering would need to be stopped manually. Fuel released before the cessation of pumping as well as fuel remaining in the transfer line may be released to the environment. Spill volumes were determined from transfer hose inventory and spill prevention measures including 'dry break' or 'break away' couplings, rapid shutdown of fuel pumps and spill response preparedness, with 10 m^3 considered to be the maximum volume that could be released from the hose before shutdown.
Extent	Spill trajectory modelling (RPS, 2016) indicated that there was some probability of a 250 m^3 MDO spill extending as follows (using the moderate exposure value): + Shoreline loading was not predicted to occur. + Surface oil was predicted to occur within approximately 132 km. + Entrained oil was predicted to occur within approximately 240 km. + Dissolved hydrocarbons were not predicted to occur.
Duration	A 250 m^3 release of MDO was modelled for a release over 6 hours, replicating the potential duration of a spill arising from a significant collision. Hydrocarbons would persist within the environment for a longer period of time, although MDO is expected to weather quickly through evaporation and dispersion.

7.7.2 Nature and scale of environmental impacts

Potential receptors: physical environment (water and sediment quality, shoals and banks, benthic habitats), threatened or migratory fauna (marine mammals, marine reptiles, sharks, fish, rays and birds), protected and significant areas (marine parks, KEFs), socio-economic receptors (fisheries, tourism, recreation and other third-party operators).

Hydrocarbon spills will cause a decline in water quality and may cause chemical (e.g., toxic) and physical (e.g., coating of emergent habitats, oiling of wildlife at sea surface) impacts to marine species. The severity of the impact of a hydrocarbon spill depends on the magnitude of the spill (i.e., extent, duration) and sensitivity of the receptor. The nature and scale of a hydrocarbon spill is described throughout this chapter for a vessel collision scenario, given smaller hydrocarbon spills (from refuelling) will impact a smaller area than a vessel collision.

Potential impact pathways (physical and chemical) of hydrocarbon exposure for receptors are summarised in and potential impacts to receptors found within the EMBA are further described in **Table 7-20**.

Table 7-18 summarises the potential impacts of hydrocarbon spills to sensitive receptors and values within the EMBA.

7.7.2.1 Stochastic spill dispersion modelling

The modelling results (RPS, 2016) are presented for the fate of hydrocarbon from a vessel collision at the exposure values defined in **Section 7.5.4**.

A surface release of MDO to the marine environment would result in a localised reduction in water quality in the upper surface waters of the water column near the location of the spill. Modelling was undertaken at a single location at the south-west corner of the permit area (operational area). This location is considered to provide a representative and conservative estimate of the potential environmental impacts and risks based on the geographical location of the nearest sensitive receptors to the east and west of the operational area (i.e., Lynedoch Bank, Evans Shoal and Tassie Shoal). The release location is broadly equidistant between these sensitive receptors.

The spill modelling results at or above moderate exposure values are summarised below for a surface vessel collision, more detailed results are provided in **Appendix G** for the purposes of risk evaluation.

Further parameters required to inform spill response strategies are described in the OPEP. The currents in the region are dominated by tidal and wind driven currents which are dependent on the season. These will influence the direction that the hydrocarbons (entrained and floating) travel in a particular season.

Accumulated shoreline oil

No shoreline accumulation of oil was identified at any exposure value in any season.

Floating oil

The maximum distance sea surface oil at the moderate exposure value (> 10 g/m^2) is predicted to travel from the release location varied greatly between seasons. Based on the stochastic modelling outputs, hydrocarbon was predicted to travel approximately 28.1 km (east-northeast), 132 km (west) and 71 km (west) during summer, transitional and winter conditions, respectively (RPS APASA, 2015).

The only receptors predicted to be contacted at a moderate exposure value are the surface waters of the ‘Shelf break and slope of the Arafura Shelf’ KEF with the highest probability (100%) in summer, and ‘Carbonate bank and terrace system of Van Diemen Rise’ KEF at 1% probability in transitional seasons.

Entrained oil

The stochastic modelling outputs show that the moderate exposure value for entrained hydrocarbons extended up to approximately 240 km from the release location, depending on the prevailing oceanic conditions (i.e., winds and currents) influencing the released hydrocarbon.

The sensitive receptors which have very low probability (1%-11%) of being contacted at the moderate entrained exposure value during various seasons include:

+ Shoals and banks.
+ ‘Shelf break and slope of the Arafura Shelf’, ‘Carbonate bank and terrace system of the Van Diemen Rise’ and ‘Pinnacles of the Bonaparte Basin’ KEFs.
+ Open waters of the Oceanic Shoals and Arafura AMPs.

Dissolved oil

No receptors were predicted to be exposed to moderate or high dissolved aromatic concentrations under any season assessed.

7.7.3 Environmental performance outcomes and control measures

The EPOs relating to this event include:

- No loss of containment of hydrocarbon to the marine environment. [EPO-03]
- No unplanned objects, emissions or discharges to sea or air. [EPO-04]

An assessment of the environmental benefits and the potential costs or issues associated with control measures for this activity are shown in **Table 7-21** to demonstrate that potential risks are ALARP. Control measures that are adopted have associated EPSs and measurement criteria which are presented in **Table 8-2**. Rejected control measures have an ALARP evaluation provided to justify their rejection.

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 7-21: Control measure evaluation for the surface release of marine diesel oil (vessel collision/bunkering)

CM reference	Control measure	Environmental benefit	Potential cost/issues	Evaluation
Standard control measures				
BAD-CM-012	MODU and vessel spill response plans	Implements response plans (SOPEP/SMPEP) on board vessels and MODU to deal with unplanned hydrocarbon releases and spills quickly and efficiently in order to reduce impacts to the marine environment.	Cost of implementing the procedures.	**Adopted** – environmental benefits of ensuring response plans in place, are followed and measures implemented outweighs the costs.
BAD-CM-015	Maritime Notices	Maritime notifications ensure marine users are informed of the proposed activities, reducing the likelihood of unplanned interactions.	Negligible costs.	**Adopted** – it is a regulatory requirement.
BAD-CM-016	Support vessel	Minimises the risk of a third-party vessel colliding with the MODU and vessels through visual identification and communication with approaching vessels.	Significant cost to charter support vessels; however, the MODU safety case requires a standby vessel during drilling for emergency response purposes.	**Adopted** – environmental and safety benefits considered to outweigh costs.

CM reference	Control measure	Environmental benefit	Potential cost/issues	Evaluation
BAD-CM-017	Accepted OPEP	Implements response plans to deal with an unplanned hydrocarbon release quickly and efficiently in order to reduce impacts to the marine environment.	High cost associated with preparing documents, ongoing management (spill response exercises) and implementation of OPEP.	**Adopted** – regulatory requirement, must be adopted.
BAD-CM-020	Fuel oil quality	Use of MDO rather than a 'heavier' fuel type reduces potential spill impacts as MDO is less persistent in the marine environment.	Potential fuel 'change over' costs prior to vessel commencement.	**Adopted** – environmental benefits of ensuring vessels use MDO are considered to outweigh the costs.
BAD-CM-010	Bulk liquid (hydrocarbon) transfer procedure	Bulk liquid transferred in accordance with bulk transfer procedures to reduce the risk of an unintentional release of MDO to the sea.	Cost of implementing procedure. Cost of purchasing and maintaining equipment (e.g., bulk hoses and connections).	**Adopted** – environmental benefits of ensuring procedures are followed outweighs the costs.
BAD-CM-022	Santos stakeholder consultation	Stakeholder consultation ensures marine users are aware of the proposed activities, reducing the likelihood of unplanned interactions.	Cost to prepare and distribute information, and to address any feedback provided.	**Adopted** – benefits considered to outweigh costs.
BAD-CM-034	Minimum lighting for maritime safety	Ensures the MODU and vessels are seen by other marine users, thereby reducing the potential for interaction and collision.	Standard maritime safety and navigational equipment; regulatory requirement.	**Adopted** – it is a regulatory requirement.
BAD-CM-036	Seafarer certification	Demonstrates appropriately trained and competent personnel, to navigate vessels and reduce interaction with other marine users.	Costs associated with personnel time in obtaining qualifications; regulatory requirement.	**Adopted** – it is a regulatory requirement.

CM reference	Control measure	Environmental benefit	Potential cost/issues	Evaluation
BAD-CM-037	Marine assurance standard	Ensures contracted vessels are operated, maintained and manned in accordance with industry standards and regulatory requirements.	Cost associated with implementing procedures.	**Adopted** – benefit of assuring vessels outweighs procedure compliance costs.
BAD-CM-038	Petroleum Safety Zone (500 m) established	PSZ alerts other marine users to the presence of the MODU, thereby reducing the likelihood of vessel collision.	Negligible costs; it is a regulatory requirement.	**Adopted** – it is a regulatory requirement.
BAD-CM-040	MODU planned maintenance system	Requires that equipment is maintained and certified, reducing probability of an unplanned MDO spill.	High cost of maintaining MODU equipment and managing the maintenance system.	**Adopted** – benefits of ensuring MODU is maintained outweighs the costs.
BAD-CM-041	Vessel planned maintenance system	Requires that equipment is maintained and certified, reducing the probability of an unplanned MDO spill.	High cost of maintaining vessel equipment and managing the maintenance system.	**Adopted** – benefits of ensuring vessels are maintained outweighs the costs.
Additional control measures				
N/A	Manage the timing of the activity to avoid sensitive biological periods (e.g., fish spawning, whale foraging)	Reduce potential environmental consequences by avoiding sensitive biological periods for conservation significant marine fauna in the MEVA.	Drilling campaign is longer than 12 months, requiring ongoing vessel support. High cost in suspending activities and demobilising/ remobilising the MODU and vessels. Impracticable to avoid all biological sensitive periods in the MEVA due to the variability between species (e.g. spawning fish species) and extended length.	**Rejected** – high cost is grossly disproportionate to the environmental benefits given remote likelihood of a vessel collision and fuel oil spill, and the nature and scale of potential impacts within the MEVA.

CM reference	Control measure	Environmental benefit	Potential cost/issues	Evaluation
N/A	Zero fuel bunkering via hose	Removes spill risk from fuel bunkering activities via hose.	Cost associated with transfer of MDO via drums or containers which then needs to be transferred to fuel storage tanks on board. Not possible to modify MODU to allow additional fuel storage to facilitate this.	**Rejected** – not feasible to modify MODU fuel storage facilities. Would result in significant lifting operations. Does not eliminate the risk of an MDO refuelling spill to sea. MDO bunkering operations are standard industry practice.
N/A	Require all vessels involved in the activity to be double hulled	Reduces the likelihood of a loss of hydrocarbon inventory in the highly unlikely event of a vessel collision, minimising potential environmental impact.	Vessels are subject to availability and are required to meet Santos' standards during activities, requirement of a double hull on vessels would limit the number available to Santos. It is Santos' preference that vessels are doubled hulled.	**Rejected** – potential high costs associated with only contracting double hulled support vessels is considered to be grossly disproportionate compared with the low risk of a vessel collision and MDO spill.

7.7.4 Environmental impact assessment

Receptors	Physical environment and habitats – water quality, KEFs Threatened, migratory or local fauna – plankton, invertebrates, marine mammals, marine reptiles, sharks, rays and fish, seabirds Protected areas – marine parks Socio-economic – commercial, recreational and traditional fisheries; recreation and tourism, oil and gas industry
Consequence	II – Minor

A summary of the consequence assessment for each receptor category is presented below. Potential impact pathways (physical and chemical) of hydrocarbon exposure for receptors are summarised in **Table 7-15**, and potential impacts to receptors that may be found within the area of moderate exposure are further described in **Table 7-16**, as they fall within the MEVA for a LOWC.

Physical environment and habitats

It is likely that water quality will be reduced due to hydrocarbon contamination (both at the sea surface and in the upper water column as a result of entrained and dissolved hydrocarbons) at the location of the spill, as well as within surrounding marine waters over shoals and banks, open waters of the Oceanic Shoals and Arafura AMPs and the KEFs of the 'Shelf break and slope of the Arafura Shelf', 'Carbonate bank and terrace system of the Van Diemen Rise' and 'Pinnacles of the Bonaparte Basin'. However, water quality changes are expected to be temporary in nature due to rapid evaporation, natural degradation and dispersion of MDO in the open ocean (Neff *et al.*, 2000b) and restricted to within 240 km from the release location.

The open waters above the seabed KEFs of the 'Shelf break and slope of the Arafura Shelf', 'Carbonate bank and terrace system of the Van Diemen Rise' and 'Pinnacles of the Bonaparte Basin' may be contacted by hydrocarbons at or above moderate exposure values. The maximum depth that hydrocarbons associated with a surface release of 250 m^3 of MDO may entrain is 20 to 30 m; being a water depth above the KEFs.

Some of the shoals/banks close to the operational area have the potential to be contacted in this spill scenario by entrained hydrocarbons at a moderate exposure level at relatively low probabilities (1% to 11%), as predicted by stochastic modelling. Given the surface nature of the release the maximum depth that hydrocarbons associated with a 250 m^3 spill of MDO may entrain is 20 to 30 m. Considering this, and the broad depth range of the shoals/banks, any potential impacts will be limited to the upper water column layers which these features extend into. Potential impacts that may occur as a result of hydrocarbon exposure could include sub-lethal stress and, in some cases, total or partial mortality of sensitive benthic organisms (e.g., corals) and the early life stages of resident fish and invertebrate species.

The stochastic modelling outputs show that the moderate exposure value did not contact any receptors in any season.

Potential impacts to shoals and banks are expected to be Minor (II) – Detectable but insignificant change to local population, industry or ecosystem factors.

Threatened/migratory fauna

A surface release of MDO to the marine environment would result in a localised reduction in water quality in the upper surface waters of the water column. As a light hydrocarbon, MDO undergoes rapid spreading and evaporative loss in warm waters, indicating that a surface slick will be temporary. The high rate of evaporation means that little MDO will become entrained and few aromatic hydrocarbons are predicted to become dissolved reducing impact to marine fauna. Surface oil, and entrained hydrocarbon in the sea surface layer, could have the physical effect of coating fauna interacting within and under the surface, including plankton, pelagic invertebrates and fishes, marine reptiles, marine mammals and seabirds, and may also affect some species through ingestion of oiled fish (as described in **Table 7-15**Table 7-15).

Seabirds may contact surface slicks at or above the moderate exposure value whilst foraging in offshore, open water locations and could cause slight secondary effects through ingestion after preening or ingestion of oiled fish (as described in **Table 7-15** and **Table 7-16**). Breeding/foraging BIAs for seabirds or migratory shorebirds are not predicted to be contacted by hydrocarbons above the moderate exposure value.

The pygmy blue whale BIA may be contacted by hydrocarbons at or above moderate exposure values for surface and entrained hydrocarbons and therefore impacts to their migratory behaviour could be expected. Potential impacts are likely to be limited to individuals that may be transiting through the area with potential for coating of baleen (in whales) and ingestion of oiled prey (plankton/fish) as described in **Table 7-15** and **Table 7-16**.

There is the potential for turtles to be foraging at submerged shoals and banks or transiting through open waters within the region, therefore turtle behaviour could be disrupted (as described in **Table 7-16**). Based on the stochastic modelling outputs, the spill may contact various BIAs for marine turtles, but given the rapid dispersion of MDO, any potential impacts are likely to be limited to individuals that may be transiting through the area.

Potential impacts to marine fauna are expected to be Minor (II) – Detectable but insignificant change to local population, industry or ecosystem factors.

Protected areas

The stochastic modelling results predict that the open water environment within the Oceanic Shoals and Arafura AMP may be affected by a 250 m^3 release of MDO at or above moderate exposure values.

Impacts to the values of these marine parks are anticipated to be temporary and localised due to the rapid evaporation rates of the volatile components of MDO and its rapid natural degradation and dispersion in the open ocean.

Potential impacts to protected areas are expected to be Minor (II) – Detectable but insignificant change to local population, industry or ecosystem factors.

Socio-economic receptors

There is the potential for hydrocarbons to temporarily disrupt fishing activities if the surface or entrained hydrocarbon moves through fishing areas. However, the high rate of evaporation means that little MDO will become entrained and few aromatic hydrocarbons are predicted to become dissolved.

Given the volume of oil that could potentially be released, it is unlikely 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.

A MDO spill could also disrupt other oil and gas operations in the region (e.g. support vessels transiting to/from Darwin), military exercises and commercial shipping. Potential consequences are considered to be Minor (II) for these socio-economic receptors. On the basis of the above assessment, a MDO spill has the potential to impact an array of environmental and socio-economic receptors, with the highest consequence considered to be Minor (II).	
Likelihood	C – Possible
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 minor consequence is considered to be possible.	
Residual Risk	The residual risk is considered **Low**.

7.7.5 Demonstration of as low as reasonably practicable

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

All reasonably practicable control measures have been reviewed and those adopted are considered appropriate to manage the residual risk to a Low level. The proposed management controls are in accordance with the Santos risk management criteria and are considered appropriate to manage the risk to ALARP.

In terms of spill response activities, Santos will implement oil spill response as specified within the OPEP. A detailed ALARP assessment on the adequacy of arrangements available to support spill response strategies and control measures is presented in the *Barossa Development OPEP Addendum – Drilling and Completions* (BAA-200-0316).

7.7.6 Acceptability evaluation

Is the risk ranked between Very Low to Medium?	Yes – residual risk is ranked as Low.
Is further information required to validate the consequence assessment?	No – potential impacts and risks are well understood through the information available.
Are risks and impacts consistent with the principles of ESD?	Yes – activity evaluated in accordance with Santos' *Environmental Hazard Identification and Assessment Procedure*, which considers principles of ESD.
Have the acceptable levels of impact and risks been informed by relevant species recovery plans, threat abatement plans and conservation advice and Australian marine park zoning objectives)?	Yes – consistent with relevant species recovery plans, conservation management plans and management actions set out in **Table 3-9**, including: + Approved Conservation Advice for *Megaptera novaeangliae* (humpback whale) (TSSC, 2015c) + Recovery Plan for Marine Turtles in Australia 2017–2027 (DoEE, 2017) + Approved Conservation Advice for *Rhincodon typus* (whale shark) (TSSC, 2015d) + Conservation management plan for the blue whale, 2015 to 2025 (CoA, 2015a) + Approved Conservation Advice for *Balaenoptera borealis* (sei whale) (TSSC, 2015a) + Approved Conservation Advice for *Balaenoptera physalus* (fin whale) (TSSC, 2015b) + Recovery plan for the grey nurse shark (*Carcharias taurus*) (DoE, 2014a) + Recovery plan for the white shark (*Carcharodon carcharias*) (DSEWPaC, 2013) + Sawfish and River Sharks Multispecies Recovery Plan (DoE, 2015a). + Marine Bioregional Plan for the North-West Marine Region (CoA, 2012b).
Are performance outcomes, control measures and associated performance standards consistent with legal and regulatory requirements?	Yes – management consistent with *Marine Safety (Domestic Commercial Vessel) National Law Act* 2012, Marine Order Part 30: Prevention of Collisions, Marine Order Part 21: Safety of Navigation and Emergency Procedures, and *Navigation Act 2012*. Through acceptance of this EP, legislative and regulatory requirements will be met as per **Section 1.6.2**.
Are performance outcomes, control measures and associated performance standards consistent with Santos' Environment, Health and Safety Policy?	Yes – aligns with Santos' Environment, Health and Safety Policy.
Are performance outcomes, control measures and associated performance standards consistent with industry standards?	Yes – the most recent and comparable Drilling and Completions EPs accepted by NOPSEMA have been reviewed for consistency with the performance outcomes, control measures and associated performance standards proposed in this EP.

Have performance outcomes, control measures and associated performance standards taken into consideration stakeholder feedback?	Yes – requests relating to managing oil spill response activities and potential environmental impacts to marine fauna or commercial fisheries have been considered.
Are performance standards such that the impact or risk is considered to be ALARP?	Yes – see ALARP above.

The residual risk of an unplanned hydrocarbon spill (MDO) is assessed as Low. Based on an assessment of Santos' acceptability criteria and with the control measures in place, potential risks are considered acceptable.

7.8 Minor hydrocarbon release (surface and subsea)

7.8.1 Description of event

Event	Causes for accidental hydrocarbon releases (other than MDO release from a vessel collision or bunkering, and LOWC) include: + ROV failure (including oil seal, hydraulic system hose and quick disconnect system failures) + loss of primary containment (drums, tanks, intermediate bulk containers [IBCs], etc) due to handling, storage and dropped objects (e.g., swinging load during lifting activities) + vessel or MODU pipework failure or rupture, hydraulic hose failure, inadequate bunding + dropped objects damaging MDO infrastructure (hoses, pipes, tanks, etc) + helicopter refuelling loss of containment of aviation fuel + drop-out of formation fluids from flaring during well flowback. Hydrocarbons could include formation fluids, hydraulic fluids, lubricant oils and waste oils. The MODU/vessels main engines and equipment such as pumps, cranes, winches, power packs and generators require MDO for fuel and a variety of hydraulic fluids and lubricating oils for efficient operation and maintenance of moving parts. These products are present within the equipment and also held in storage containers and tanks on the MODU and vessels. Small hydrocarbon leaks could occur from loss of primary containment due to handling, storage and dropped objects (during lifting activities or in-board refuelling such as for equipment or helicopters on deck). Volumes are likely to be small and limited to the volume of individual containers (e.g., IBC, 44-gallon drums) stored on the deck of vessels or the MODU. The credible spill for this scenario is considered to be the loss of an IBC (1 m^3) during transfer from a vessel to the MODU. Equipment deployed overboard during drilling (e.g., ROV operations) can result in unplanned discharges (of hydraulic fluids) directly to the marine environment due to equipment failure, equipment interactions with the vessel thrusters and/or accidental contact with subsea infrastructure. The largest credible hydrocarbon spill from ROV operations would be an accidental release of approximately 0.05 m^3 (50 L) of hydraulic fluid from the deployed ROV. Well flowback is a planned activity as part of the well completion program. Hydrocarbon flaring may be interrupted by pressure drops, incomplete combustion, or higher than anticipated drilling fluid content in the flaring system during well flowback. As a result of flaring drop out, formation fluids may subsequently be discharged into the marine environment. Similarly, some flowback cushioning fluids (i.e. base oil) may accidentally be released during well flowback. Hydrocarbon spilt volumes due to drop out from flaring and well flowback are difficult to estimate. Given the automatic and manual systems in place during flaring, the accidental release of hydrocarbon is expected to be low (less than 1.6 m^3). Minor accidental loss of other hydrocarbon-based liquids (e.g., used lubricating oils, cooking oil, and hydraulic oil) to the marine environment could also occur via tank pipework failure or rupture, hydraulic hose failure, inadequate bunding and/or storage, insufficient fastening or inadequate handling.
Extent	The relative low volumes of spilt hydrocarbons are expected to rapidly disperse into the marine environment. Below harmful concentrations are expected to occur at short distances from the hydrocarbon release point. Potential impacts beyond the operational area are not expected.
Duration	Potentially harmful concentrations limited to a very short period (hours to days) immediately following release.

7.8.2 Nature and scale of environmental impacts

Potential receptors: physical environment (water quality); threatened, migratory or local fauna (marine mammals, marine reptiles, sharks and rays, fish and birds.

Hydraulic fluids and lubricating fluids behave similarly to MDO when spilt in the marine environment (for information on MDO behaviour in the marine environment refer to **Section 7.7**). Hydraulic fluids are medium oils of light to moderate viscosity and have a relatively rapid spreading rate and, like MDO, will dissipate quickly, particularly in high sea states, although lubricating oils are more viscous and so the spreading rate of a spill of these oils would be slightly slower.

7.8.2.1 Physical environment

Minor volumes of hydrocarbons released to the marine environment would lead to contamination of the water column near the MODU and vessels. The potential impacts would most likely be highly localised and restricted to the immediate area surrounding the spill, with rapid dispersal to concentrations below impact thresholds likely to occur in the open ocean.

Due to the small volumes and expected rapid dispersal to concentrations below impact thresholds, detectable impacts to sediment quality or benthic habitats are not expected.

There is no emergent or intertidal habitat that could be impacted by a surface spill.

7.8.2.2 Threatened migratory or local fauna

The minor and short-term changes to water quality that may result are not predicted to impact on marine fauna (e.g., pelagic fish and sharks, marine mammals, marine reptiles and seabirds). No BIAs overlap the operational area and it is unlikely these types of spills will extend beyond the operational area.

Small hydrocarbon spills are unlikely to have an ecological effect on threatened or migratory fauna, given the volumes that could be released, and the dispersive nature of the open ocean environment. Physical coating of marine fauna or lethal/sub-lethal toxicity effects from any accidentally released hydrocarbons is considered unlikely, given the expected low volumes/concentrations and short exposure times.

7.8.3 Environmental performance outcomes and control measures

The EPOs relating to this event include:

- No loss of containment of hydrocarbon to the marine environment. [EPO-03]
- No unplanned objects, emissions or discharges to sea or air. [EPO-04]

An assessment of the environmental benefits and the potential costs or issues associated with control measures for this activity are shown in **Table 7-22** to demonstrate that potential risks are ALARP. Control measures that are adopted have associated EPSs and measurement criteria which are presented in **Table 8-2**. Rejected control measures have an ALARP evaluation provided to justify their rejection.

Table 7-22: Control measure evaluation for minor release of hydrocarbons

CM reference	Control measure	Environmental benefit	Potential cost/issues	Evaluation
Standard control measures				
BAD-CM-002	Dropped object prevention procedures	Impacts to environment are reduced by preventing dropped objects and by retrieving dropped objects unless the environmental consequences are negligible or there are risks to safety. Procedure minimises drop risk during lifting operations.	Cost of procedure implementation.	**Adopted** – environmental benefits of preventing dropped objects and resultant hydrocarbon spill outweighs the costs.
BAD-CM-005	Hazardous chemical management procedures	Reduces the risk of spills and leaks to sea by controlling the storage, handling and clean-up of hydrocarbons.	Cost of procedure implementation.	**Adopted** – environmental benefits of implementing the procedures outweighs the costs.
BAD-CM-007	Chemical selection procedure	Only environmentally acceptable drilling chemicals (including base oils) are used reducing potential impacts in the event of an accidental release.	Cost of procedure implementation. Range of chemicals reduced with potentially higher costs for alternative products.	**Adopted** – benefit of only using environmentally acceptable chemicals outweighs the costs.
BAD-CM-008	General chemical management procedures	Reduces the risk of accidental discharge to sea by controlling the storage, handling and clean-up of hydrocarbons.	Cost of procedure implementation.	**Adopted –** environmental benefits of ensuring procedures are followed outweighs the costs.

CM reference	Control measure	Environmental benefit	Potential cost/issues	Evaluation
BAD-CM-009	International Maritime Dangerous Goods Code	Reduces the risk of an environmental incident, such as an accidental release to sea or unintended chemical reaction.	Cost of procedure implementation; it is a legislated requirement.	**Adopted** – it is a legislated requirement.
BAD-CM-012	MODU and vessel spill response plans	Implements response plans (SOPEP/SMPEP) on board vessels and MODU to deal with unplanned hydrocarbon releases and spills quickly and efficiently in order to reduce impacts to the marine environment.	Cost of plan development and implementation.	**Adopted** – environmental benefits of ensuring response plans are in place in the event of a spill outweighs the costs.
BAD-CM-014	ROV inspection and maintenance procedures	Maintenance and pre-deployment inspection on ROV completed as scheduled to reduce the risk of unplanned hydraulic fluid releases to the marine environment.	Cost of procedure implementation.	**Adopted –** environmental benefits of ensuring procedures are followed outweigh costs.
BAD-CM-033	Well flowback procedures	Includes control measures that reduce the risk of hydrocarbons from entering the marine environment during well flowback.	Cost of procedure implementation.	**Adopted** – environmental benefits of ensuring procedures are followed outweighs costs.
BAD-CM-040	MODU planned maintenance system	Requires that equipment is maintained and certified, reducing probability of leaks of hydrocarbons from the equipment.	Cost of managing the system.	**Adopted** – environmental benefits of ensuring MODU is maintained outweighs the costs.
BAD-CM-041	Vessel planned maintenance system	Requires that equipment is maintained and certified, reducing probability of leaks of hydrocarbons from the equipment.	Cost of managing the system.	**Adopted** – environmental benefits of ensuring vessels are maintained outweigh the costs.

CM reference	Control measure	Environmental benefit	Potential cost/issues	Evaluation
Additional control measures				
N/A	Do not undertake flaring during well flowback	Reduces risk of accidental hydrocarbon discharge due to flare dropout.	Flaring is a requirement for safe well flowback. Eliminating flaring may lead to flammable gases building up to unsafe levels onboard the MODU.	**Rejected** – safety issues outweigh the environmental benefit for short-term well flowback.
N/A	Eliminate lifting in field	Reduces the risk release of hydrocarbon to the marine environment from hydrocarbon containers or secondary impact with hydrocarbon containing equipment due to dropped objects.	Eliminating lifting would require MODU/vessels storing more equipment and supplies on-board, and/or additional trips to shore. MODU/vessels will not have enough deck space to store all required equipment, materials, supplies needed for the duration of the activity.	**Rejected** – not feasible to eliminate lifting in the field.

7.8.4 Environmental impact assessment

Receptors	Physical environment (water quality) Threatened, migratory or local fauna (marine mammals, marine reptiles, sharks, fish, rays and birds)
Consequence	I – Negligible
In the event of a minor hydrocarbon spill, the quantities would be limited to approximately 1 m^3 for the loss of the contents of an IBC, 1.6 m^3 during flaring drop out or 50 L for ROV hydraulic fluid. The small volumes, dilution and dispersion from natural weathering processes such as ocean currents are such that spills will be limited in area and duration. The susceptibility of marine fauna to hydrocarbons is dependent on hydrocarbon type and exposure duration; however, given that exposures would be limited in extent and duration, exposure to marine fauna from this hazard is considered to be low. The small volumes of worst-case discharges are such that, the impacts to receptors will decline rapidly with time and distance at the sea surface. Harmful effects are not expected to the benthic community due to the water depths. Near the sea surface, fish are able to detect and avoid contact with surface slicks and as a result, fish mortalities rarely occur in open waters from surface spills (Kennish, 1997; Scholz *et al*., 1992). Pelagic fish species are therefore generally not highly susceptible to impacts from hydrocarbon spills. In offshore waters near to the release point, pelagic fish are at risk of exposure to the more toxic aromatic components of the hydrocarbons. Pelagic fish in offshore waters are highly mobile and comprise species such as tunas, sharks and mackerel. Due to their mobility, it is unlikely that pelagic fish would be exposed to toxic components for long periods in this spill scenario. The more toxic components would also rapidly evaporate and concentrations would significantly diminish with distance from the spill site, limiting the potential area of impact. Given that a small hydrocarbon spill would not result in a decreased population size at a local or regional scale or long-term reduction to water and sediment quality, but would be detectable, it is expected that a spill of this nature would result in a I – Negligible consequence.	
Likelihood	C – Possible
The likelihood of releasing minor volumes of hydrocarbons to the environment during routine operations is considered Possible (c). The likelihood is considered less for well flowback operations given the very short duration of these activities (days) and given the activity is intensely managed and monitored.	
Residual Risk	The residual risk is considered **Low**.

7.8.5 Demonstration of as low as reasonably practicable

Storage and use of hydraulic and lubricating oils/fluids for equipment and machinery, including for ROV operations, are required to undertake the activity, so their removal from the activity is not viable. Well flowback is also required to complete the wells, and flaring is a safety critical activity.

All reasonably practicable control measures have been reviewed and those adopted are considered appropriate to manage the residual risk to a Low level. The proposed management controls are in accordance with the Santos risk management criteria and are considered appropriate to manage the risk to ALARP**.**

7.8.6 Acceptability evaluation

Is the risk ranked between Very Low and Medium?	Yes – maximum minor hydrocarbon spill residual risk is ranked as Low.
Is further information required to validate the consequence assessment?	No – potential impacts and risks are well understood through the information available.
Are risks and impacts consistent with the principles of ESD?	Yes – activity evaluated in accordance with Santos' *Environmental Hazard Identification and Assessment Procedure* which considers principles of ESD.
Have the acceptable levels of impact and risks been informed by relevant species recovery plans, threat abatement plans and conservation advice and Australian marine park zoning objectives)?	Yes – consistent with relevant species recovery plans, conservation management plans and management actions set out in **Table 3-9**, including: + Recovery Plan for Marine Turtles in Australia 2017–2027 (DoEE, 2017) + Approved Conservation Advice for *Megaptera novaeangliae* (humpback whale) (TSSC, 2015c) + Approved Conservation Advice for *Rhincodon typus* (whale shark) (TSSC, 2015d) + Conservation Management Plan for the Blue Whale 2015–2025 (CoA, 2015a) + Approved Conservation Advice for *Balaenoptera borealis* (sei whale) (TSSC, 2015a) + Approved Conservation Advice for *Balaenoptera physalus* (fin whale) (TSSC, 2015b) + Recovery plan for the grey nurse shark (*Carcharias taurus*) (DoE, 2014a) + Recovery plan for the white shark (*Carcharodon carcharias*) (DSEWPaC, 2013) + Sawfish and River Sharks Multispecies Recovery Plan (DoE, 2015a) + Marine Bioregional Plan for the North-West Marine Region (CoA, 2012b).
Are performance outcomes, control measures and associated performance standards consistent with legal and regulatory requirements?	Yes – management consistent with Marine Order 91 (Marine pollution prevention – oil). Through acceptance of this EP, legislative and regulatory requirements will be met as per **Section 1.6.2**.
Are performance outcomes, control measures and associated performance standards consistent with Santos' Environment, Health and Safety Policy?	Yes – aligns with Santos' Environment, Health and Safety Policy.
Are performance outcomes, control measures and associated performance standards consistent with industry standards?	Yes – the most recent and comparable Drilling and Completions EPs accepted by NOPSEMA have been reviewed for consistency with the performance outcomes, control measures and associated performance standards proposed in this EP.
Have performance outcomes, control measures and associated performance standards taken into consideration stakeholder feedback?	Yes – requests relating to managing spill response activities and potential environmental impacts to marine fauna or commercial fisheries have been considered.

Are performance standards such that the impact or risk is considered to be ALARP?	Yes – see ALARP above.

The residual risk of an unplanned minor hydrocarbon release (surface and subsea) is assessed as Low. Based on an assessment of Santos' acceptability criteria and with the control measures in place, potential risks are considered acceptable.

8. Implementation strategy

OPGGS(E)R 2009 Requirements
Regulation 14(1)
The environment plan must contain an implementation strategy for the activity in accordance with this regulation.
Regulation 14(10)
The implementation strategy must comply with the Act, the regulations and any other environmental legislation applying to the activity.

This section describes the implementation strategy for this EP as required by the regulations.

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

Ongoing stakeholder management is discussed in **Section 4.5**.

8.1 Environmental management system

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

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

+ a common approach is followed across the organisation
+ proactive management
+ mandatory requirements are implemented and are auditable
+ management performance is measured and corrective actions are taken
+ opportunities for improvement are recognised and implemented
+ workforce commitments are understood and demonstrated.

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

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

8.2 Environment, Health and Safety Policy

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

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 in accordance with Santos' *Offshore Division environmental hazard identification and assessment guideline* (EA-91-IG-00004_5). The control measures and environmental performance standards that will be implemented to manage the identified risks and impacts, and the environmental performance outcomes that will be achieved, are detailed below.

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

Any new, or proposed amendment to a control measure, EPS or EPO will be managed in accordance with the *Environment Management of Change Procedure* (EA-91-IQ-10001) (**Section 8.10.2**).

Oil spill response control measures and environmental performance standards and outcomes are listed in the OPEP.

8.4 Environmental performance outcomes

To ensure environmental risks and impacts will be of an acceptable level, environmental performance outcomes have been defined and are listed in **Table 8-1**, with the exception of those relating to oil spill response, which are listed in the OPEP. These outcomes will be achieved by implementing the identified control measures to the defined environmental performance standards.

Table 8-1: Environmental performance outcomes

Reference	Environmental performance outcomes
EPO-01	No significant impacts to other marine users
EPO-02	No introduction of marine pest species
EPO-03	No loss of containment of hydrocarbon to the marine environment
EPO-04	No unplanned objects, emissions or discharges to sea or air
EPO-05	No injury or mortality to EPBC Act listed marine fauna
EPO-06	No significant changes to air, sediment and water quality
EPO-07	Seabed disturbance limited to planned activities and defined locations within the operational area
EPO-08	No significant impacts to marine fauna from lighting emissions

8.4.1 Control measures and performance standards

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

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 oil spill preparedness and response operations are contained within the OPEP.

Table 8-2: Control measures and environmental performance standards for the proposed activity (Environment Plan)

Control Measure	Control measure reference no.	Environmental Performance Standard	EPS reference no.	Measurement Criteria	EPO reference no. (Table 8-1)
Procedure for interacting with marine fauna	BAD-CM-001	Vessel(s) comply with Santos' *Protected Marine Fauna Interaction and Sighting Procedure* (EA-91-11-00003) which ensures compliance with Part 8 of *Environment Protection and Biodiversity Regulations 2000* which includes controls for minimising the risk of collision with marine fauna.	BAD-CM-001-EPS-01	Conformance checked on receipt of marine fauna sighting datasheets. Completed vessel statement of conformance.	EPO-05
		Any vessel strikes with cetaceans will be reported in the National Ship Strike Database.	BAD-CM-001-EPS-02	Conformance checked on Santos' receipt of incident report.	
		Helicopter contractor procedures comply with Santos' *Protected Marine Fauna Interaction and Sighting Procedure* (EA-91-11-00003), which ensures compliance with Part 8 of the Environment Protection and Biodiversity Conservation Regulations 2000, which includes controls for minimising interaction with marine fauna.	BAD-CM-001-EPS-03	Helicopter contractor procedures align with Santos' *Protected Marine Fauna Interaction and Sighting Procedure* (EA-91-11-00003).	
Dropped object prevention procedures	BAD-CM-002	Safety Case includes the following control measures for dropped objects that reduce the risk of objects entering the marine environment: + lifting equipment certification and inspection + lifting crew competencies + heavy-lift procedures + preventative maintenance on cranes.	BAD-CM-002-EPS-01	NOPSEMA-accepted Safety Case. Completed inspection checklist. Details contained in incident documents.	EPO-04
		Lifting operations managed in accordance with work instructions or procedures.	BAD-CM-002-EPS-02	MODU work instructions or procedures.	
		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.	BAD-CM-002-EPS-03	Fate of dropped objects detailed in incident documents.	
MODU station-keeping system	BAD-CM-003	MODU station keeping system maintains the MODU at the desired location.	BAD-CM-003-EPS-01	Loss of tension on two or more anchors.	EPO-04 EPO-07
		Anchors positioned and maintained at locations defined in the rig mooring analysis to reduce risks to seabed habitat and petroleum infrastructure.	BAD-CM-003-EPS-02	Completed Mooring Report demonstrates that intended positions were maintained.	
		All parts of the MODU mooring system deployed to sea are recovered within three months of MODU departure to mitigate consequences from objects remaining in the marine environment.	BAD-CM-003-EPS-03	Mooring recovery recorded in daily vessel report.	
		Positioning of the MODU will be undertaken in accordance with the mooring design and analysis and the drilling contractors' rig move procedure, which includes procedures for the deployment and retrieval of anchors using support vessels to minimise seabed disturbance.	BAD-CM-003-EPS-04	Procedures for the deployment and retrieval of anchors are implemented	
Waste (garbage) management procedure	BAD-CM-004	Waste management procedure implemented to reduce the risk of unplanned release of waste to sea. The procedure includes standards for: + bin types + lids and covers + waste segregation + bin storage.	BAD-CM-004-EPS-01	Completed inspection checklist.	EPO-04
		No waste (garbage[9]) discharged to sea, unless the waste is food waste disposed in accordance with MARPOL Annex V.	BAD-CM-004-EPS-02	Completed garbage disposal record book or recording system.	

[9] Garbage as defined by MARPOL Annex V and excludes waste generated as part of the 'drilling' process as described in these standards.

Control Measure	Control measure reference no.	Environmental Performance Standard	EPS reference no.	Measurement Criteria	EPO reference no. (Table 8-1)
		Pursuant to MARPOL Annex V, placards displayed to notify personnel of waste disposal restrictions.	BAD-CM-004-EPS-03	Completed inspection checklist.	
Hazardous chemical[10] management procedures	BAD-CM-005	For hazardous chemicals including hydrocarbons, the following standards apply to reduce the risk of an accidental release to sea: + Storage containers closed when the product is not being used. + Storage containers managed in a manner that provides for secondary containment in the event of a spill or leak. + Storage containers labelled with the technical product name as per the SDS. + Spills and leaks to deck, excluding storage bunds and drip trays, immediately cleaned up. + Storage bunds and drip trays do not contain free flowing volumes of liquid. + Spill response equipment readily available.	BAD-CM-005-EPS-01	Completed inspection checklist.	EPO-04
Deck cleaning product selection	BAD-CM-006	Deck cleaning products planned to be released to sea meet the criteria for not being harmful to the marine environment according to MARPOL Annex V.	BAD-CM-006-EPS-01	SDS and product supplier supplementary data as required. Completed inspection checklist.	EPO-06
Chemical selection procedure	BAD-CM-007	Firefighting foam on board the MODU and vessels will not be discharged to sea during testing of the firefighting system.	BAD-CM-007-EPS-01	Completed ISPP certificate.	EPO-04 EPO-06
		Drilling, completions and cement chemicals potentially discharged to sea are Gold/Silver/D or E rated through OCNS, or PLONOR substances listed by OSPAR, or have a complete risk assessment as per Santos' *Santos Offshore Division Drilling Chemical Selection and Approval Process* (EA-91-II-00007) so that only environmentally acceptable products are used.	BAD-CM-007-EPS-02	Completed Santos risk assessment. Completed operational reports demonstrating that only approved drilling chemicals have been used.	
General chemical management procedures	BAD-CM-008	SDS[11] available for all chemicals to aid in the process of hazard identification and chemical management.	BAD-CM-008-EPS-01	Completed operational reports.	EPO-04
		Chemicals managed in accordance with SDS in relation to safe handling and storage, spill response and emergency procedures, and disposal considerations.	BAD-CM-008-EPS-02	Completed inspection checklist.	
International Maritime Dangerous Goods Code	BAD-CM-009	Dangerous goods managed in accordance with International Maritime Dangerous Goods Code to reduce the risk of an environmental incident, such as an accidental release to sea or unintended chemical reaction.	BAD-CM-009-EPS-01	Completed Multimodal Dangerous Goods Form for OSV transfers demonstrates compliance. Completed inspection checklist.	EPO-04
Bulk liquid transfer procedure	BAD-CM-010	Bulk liquids transferred in accordance with bulk transfer procedure to reduce the risk of a release to sea. The procedures will require: + hose integrity: certified hoses will be used + hose flotation: bulk hoses in the water fitted with floatation collars + hose connections: hoses used for hydrocarbons fitted with hammer union connections at the MODU's manifold, self-sealing (dry-break) connections at the vessel end and self-sealing break-away connections when two or more hoses are joined together + valve alignment: a MODU supervisor checks that all valves are lined up correctly + tank venting: air vents for hydrocarbon storage tanks bunded if there is a risk of spill to deck + supervision: dedicated hose watch person while pumping bulk product + communications: constant radio communications between MODU control room and vessel + inventory control: MODU control room monitors tank fill levels + emergency shutdown available and tested before each transfer operation.	BAD-CM-010-EPS-01	Completed procedural documents, for example work permits, job safety analysis forms, checklists, etc. Spill details contained in incident documentation.	EPO-04 EPO-06

[10] Chemical in both liquid and solid form
[11] Safety data sheet or material safety data sheet.

Control Measure	Control measure reference no.	Environmental Performance Standard	EPS reference no.	Measurement Criteria	EPO reference no. (Table 8-1)
Bulk solid transfer procedure	BAD-CM-011	Bulk solids transferred in accordance with bulk transfer procedures to reduce the risk of an unintentional[12] release to sea. The procedures include standards for: + hose integrity: certified hoses will be used + hose flotation: bulk hoses in the water fitted with floatation collars + valve alignment: a MODU supervisor checks that all valves are lined up correctly + communications: constant radio communications between MODU control room and vessel + inventory control: MODU control room monitors tank fill levels or air vents watched to detect tank overfill + emergency shutdown available and tested before each transfer operation.	BAD-CM-011-EPS-01	Completed procedural documents, for example work permits, job safety analysis forms, checklists, etc. Spill details contained in incident documentation.	EPO-04
MODU and vessel spill response plans	BAD-CM-012	MODU and vessels have and implement a SOPEP, or SMPEP, pursuant to MARPOL Annex I.	BAD-CM-012-EPS-01	Approved SOPEP or SMPEP.	EPO-03 EPO-04 EPO-06
		SOPEP or SMPEP spill response exercises conducted at least every three months to ensure personnel are prepared.	BAD-CM-012-EPS-02	Spill exercise records or evidence of a spill exercise in an operational report.	
Source control plan	BAD-CM-013	Prior to drilling there will be a source control plan in place.	BAD-CM-013-EPS-01	Source control plan.	EPO-03 EPO-04 EPO-06
ROV inspection and maintenance procedures	BAD-CM-014	Preventative maintenance on ROV completed as scheduled to reduce the risk of hydraulic fluid releases to sea.	BAD-CM-014-EPS-01	Maintenance records or evidence of maintenance in operational reports.	EPO-04
		ROV pre-deployment inspection completed to reduce the risk of hydraulic fluid releases to sea.	BAD-CM-014-EPS-02	Completed pre-deployment inspection checklist.	
Maritime notices	BAD-CM-015	Information provided to either AMSA, Department of Defence (DoD), AHO and/or nearest port authority on MODU arrival and departure so that the maritime industry is aware of petroleum activities.	BAD-CM-015-EPS-01	Transmittal records demonstrate notification of activity before the activity commencing.	EPO-01
Support vessel	BAD-CM-016	At least one support vessel available at all times to monitor the MODU 500 m PSZ to identify and communicate with any approaching third-party vessels.	BAD-CM-016-EPS-01	Daily Vessel Report.	EPO-01 EPO-03
		Support vessels will be equipped with an AIS and radar.	BAD-CM-016-EPS-02	Completed inspection report or statement of conformance from vessel contractor.	
		Monitoring of surrounding marine environment is undertaken from vessel bridge.	BAD-CM-016-EPS-03	Bridge log (or equivalent).	
Accepted OPEP	BAD-CM-017	In the event of an oil spill to sea, the Santos OPEP requirements are implemented to mitigate environmental impacts.	BAD-CM-017-EPS-01	Completed incident documentation.	EPO-03 EPO-06
Drilling and completions management process (DCMP)	BAD-CM-018	NOPSEMA-accepted WOMP provides control measures for well integrity including: + measures for suspension in the event of a cyclone that reduce the risk of an unplanned release of hydrocarbons + completion and ongoing management of wells will be in accordance with the requirements of the accepted WOMP.	BAD-CM-018-EPS-01	NOPSEMA-accepted WOMP.	EPO-03 EPO-04 EPO-06
		NOPSEMA accepted Safety Case includes control measures for well control that reduce the risk of an unplanned release of hydrocarbons.	BAD-CM-018-EPS-02	NOPSEMA-accepted Safety Case.	

[12] Tank venting and associated product loss is an intentional release to sea for safety reasons.

Control Measure	Control measure reference no.	Environmental Performance Standard	EPS reference no.	Measurement Criteria	EPO reference no. (Table 8-1)
		Santos Critical Acceptance Criteria (CAC) for critical well operations and integrity aspects are achieved. CAC will be selected based on the well objectives and Santos' Drilling and Completions Management Process technical standards, being: + location, rig moves and support + well control equipment + well barriers + drilling and completions fluids + surveying and trajectory control + casing, liner and tubing + cement + wellhead and production trees + completion components.	BAD-CM-018-EPS-03	Completed CAC in well program.	
Waste incineration procedures	BAD-CM-019	Waste incineration managed in accordance with MARPOL Annex VI, except incineration on vessels within the 500 m PSZ shall not occur.	BAD-CM-019-EPS-01	Completed waste record book or recording system.	EPO-04 EPO-06
Fuel oil quality	BAD-CM-020	MARPOL-compliant (Marine Order 97) fuel oil (MDO) will be used during the activity.	BAD-CM-020-EPS-01	Fuel bunkering records and/or relevant purchase records.	EPO-04 EPO-06
		Intermediate fuel oil or heavy fuel oil will not be used during the activity.	BAD-CM-020-EPS-02		
Air pollution prevention certification	BAD-CM-021	Pursuant to MARPOL Annex VI, MODU and vessels will maintain a current International Air Pollution Prevention Certificate, as relevant to vessel class, which certifies that measures to prevent ODS emissions, and reduce Nox, Sox, and incineration emissions during the activity are in place.	BAD-CM-021-EPS-01	Current international air pollution prevention certificate.	EPO-04 EPO-06
Santos stakeholder consultation	BAD-CM-022	Santos will notify all relevant stakeholders listed, or as revised, in **Table 8-4** of relevant activity details before they begin, including activity timing, vessel movements, proposed cessation date and vessel details.	BAD-CM-022-EPS-01	Santos correspondence to relevant stakeholders.	EPO-01
		If the MODU departs and returns from the operational area, relevant maritime notices will be updated.	BAD-CM-022-EPS-02	Santos correspondence to relevant stakeholders.	
		All correspondence with external stakeholders is recorded.	BAD-CM-022-EPS-03	Saved consultation records.	
		Santos' Consultation Coordinator is contactable before, during and after completion of the planned activity to ensure stakeholder feedback is evaluated and considered during the operational activity phases.	BAD-CM-022-EPS-04	Consultation Coordinator contact details provided to relevant persons in all correspondence.	
Compliance with the Biosecurity Act 2015	BAD-CM-023	Vessels and MODU on contract to Santos are managed to low risk in accordance with the Santos IMSMP (EA-00-RI-10172) before movement or transit into or within the invasive marine species management zone, which requires: + assessment of applicable vessels using the IMSMP risk assessment + the management of immersible equipment to low risk.	BAD-CM-023-EPS-01	Completed risk assessment demonstrating MODU, equipment and vessels are 'low risk'.	EPO-02
		Pursuant to the *Biosecurity Act 2015* and Australian Ballast Water Management Requirements 2017, vessels carrying ballast water and engaged in international voyages shall manage ballast water so that marine pest species are not introduced.	BAD-CM-023-EPS-02	Records show Ballast Water Management is implemented. Completed ballast water record book or log is maintained.	
		Vessels receive entry clearance from DAWE (Seaports) as necessary (or as applicable to their location and movements).	BAD-CM-023-EPS-03	Records show a complete Questionnaire for Biosecurity Exemptions for Biosecurity Control Determination issued to Seaports at least one month in advance where practicable.	

Control Measure	Control measure reference no.	Environmental Performance Standard	EPS reference no.	Measurement Criteria	EPO reference no. (Table 8-1)
MODU identification system	BAD-CM-024	MODU has an AIS to aid in its detection at sea.	BAD-CM-024-EPS-01	Noted in inspection report or statement of conformance supplied by MODU/vessel contractor.	EPO-01 EPO-03
Anti-foulant system	BAD-CM-025	Vessel anti-foulant system maintained in compliance with International Convention on the Control of Harmful Anti-fouling Systems on Ships where applicable.	BAD-CM-025-EPS-01	Current International Anti-Fouling System Certificate.	EPO-02 EPO-06
Sewage treatment system	BAD-CM-026	Pursuant to MARPOL Annex VI, MODU and vessel(s) have a current International Sewage Pollution Prevention Certificate which certifies that required measures to reduce impacts from sewage disposal are in place (as applicable to vessel class).	BAD-CM-026-EPS-01	Current International Sewage Pollution Prevention Certificate.	EPO-04 EPO-06
		Sewage discharged in accordance with MARPOL Annex IV.	BAD-CM-026-EPS-02	Completed inspection checklist.	EPO-04 EPO-06
		Preventive maintenance on sewage treatment equipment is completed as scheduled.	BAD-CM-026-EPS-03	Maintenance records.	EPO-04 EPO-06
Oily water treatment system	BAD-CM-027	Oily mixtures (bilge water) only discharged to sea in accordance with MARPOL Annex I.	BAD-CM-027-EPS-01	Completed inspection checklist. Oil record book or log.	EPO-04 EPO-06
		Preventative maintenance on oil filtering equipment completed as scheduled.	BAD-CM-027-EPS-02	Maintenance records or evidence of maintenance in operational reports.	EPO-04 EPO-06
		Pursuant to MARPOL Annex I, a MODU and vessel(s) will have an International Oil Pollution Prevention Certificate which certifies that required measures to reduce impacts of planned oil discharges are in place (as applicable to vessel class).	BAD-CM-027-EPS-03	Current International Oil Pollution Prevention Certificate.	EPO-04 EPO-06
Cuttings management system	BAD-CM-028	All well returns to the MODU are diverted to shale shakers, except if drilling with seawater. The recovered drilling fluid is recycled to the mud pits and separated drilled cuttings/solids diverted overboard. If drilling with seawater, cuttings/solids returned to the MODU are diverted overboard.	BAD-CM-028-EPS-01	Daily Mud Report.	EPO-04 EPO-06
		The shale shakers are fitted with screens that meet API standards for solids removal particle size cut points.	BAD-CM-028-EPS-02	Inspection records.	
		Centrifuges are used as required to remove additional finer drilled cuttings/solids that are too small for the shale shakers to remove.	BAD-CM-028-EPS-03	Daily Mud Report.	
		Shale shakers are inspected by a dedicated shale shaker hand whilst drilling to ensure: + shakers are running and screens vibrating + shaker screens are not damaged or blinding.	BAD-CM-028-EPS-04	Daily Mud Report.	
		IF NAF is used, a compliance engineer tracks oil on cuttings daily to ensure the average oil-on-cuttings does not exceed 10% w/w dry average per well.	BAD-CM-028-EPS-05	Daily mud compliance report	
		Amount of residual NAF on discharged cuttings is less than 10% (w/w) dry per well.	BAD-CM-028-EPS-06	Completed operational reports.	
		If the average oil-on-cuttings for a well cannot be achieved, cuttings will be retained in enclosed containers and shipped ashore in accordance with jurisdictional requirements.	BAD-CM-028-EPS-07	Completed operational reports.	

Control Measure	Control measure reference no.	Environmental Performance Standard	EPS reference no.	Measurement Criteria	EPO reference no. (Table 8-1)
Inventory control procedure	BAD-CM-029	Only residual water-based fluid systems, brine, completion chemicals, cement and cement spacer within MODU mud pits and surface tanks that is no longer required will diverted overboard.	BAD-CM-029-EPS-01	End of Well Report.	EPO-04 EPO-06
		Non-aqueous fluid (NAF) and base oil operational readiness checklist completed before taking product onto the MODU, or before mixing or circulating if the product is already on the MODU. The aspects that will be checked are: + systems of work + equipment + maintenance + deck drainage + spill containment + valves and lines + hoses.	BAD-CM-029-EPS-02	Completed operational checklist.	
		Non-aqueous fluid (NAF) within MODU mud pits that is no longer required will not be released to sea[13].	BAD-CM-029-EPS-03	Completed operational reports.	
		If non-aqueous fluid (NAF) has been displaced out of the well bore, only interface fluids with residual synthetic base oil content of <1% will be discharged overboard if no longer required.	BAD-CM-029-EPS-04	Completed operational reports.	
		Unusable inventories of bulk cement, drilling fluid solid additives, brine and drill water on-board the MODU managed according to the decision list in **Table 6-12**.	BAD-CM-029-EPS-05	End of Well Report. Completed decision log.	
Oil content measurement procedure	BAD-CM-030	All drilling-related synthetic base oil content measurements and calculations will be made in accordance with the methods detailed *Operational Guidelines for the use of Non-Aqueous Drilling Fluids (DR-91-ID-016).*	BAD-CM-030-EPS-01	Completed operational reports.	EPO-06
Quality control limits for Barite	BAD-CM-031	The contaminant limit concentrations in barite used for the drilling meets the standards of: + mercury (Hg) – 1 mg/kg dry weight in stock barite + cadmium (Cd) – 3 mg/kg dry weight in stock barite.	BAD-CM-031-EPS-01	Records show barite used for the drilling meets the required standards.	EPO-06
		All barite is selected in accordance with API specifications which has limitations on all contaminant concentrations.	BAD-CM-031-EPS-02	Mud reports show all mud is API standard.	EPO-06
Ozone-depleting substance handling procedures	BAD-CM-032	ODSs managed in accordance with MARPOL Annex VI to reduce the risk of an accidental release of ODS to air.	BAD-CM-032-EPS-01	Completed ODS record book or recording system.	EPO-04
Well flowback procedures	BAD-CM-033	NOPSEMA-accepted MODU Safety Case Revision for well flowback includes control measures that reduce the risk of hydrocarbons from entering the marine environment (where applicable).	BAD-CM-033-EPS-01	NOPSEMA-accepted safety case revision for well flowback.	EPO-03 EPO-04 EPO-06
		Santos Well Flowback Program checklists completed to ensure safety and environmental control measures are implemented.	BAD-CM-033-EPS-02	Completed well flowback program checklist.	
		High efficiency burner heads and a specialist noise silenced flare will be utilised during well flowback to ensure effective flaring of hydrocarbons.	BAD-CM-033-EPS-03	Well test design report	
		Oil burner pilots to remain ignited during a well flowback to reduce the risk of hydrocarbons being released to sea and air.	BAD-CM-033-EPS-04	Incident report of flare drop-out.	
		Gas line pilots will be used and will remain ignited during a well flowback to reduce the risk of hydrocarbons being released to air	BAD-CM-033-EPS-05	Completed well flowback program checklist	

[13] Note that the product will be back loaded to a support vessel and/or left on the MODU for future use.

Control Measure	Control measure reference no.	Environmental Performance Standard	EPS reference no.	Measurement Criteria	EPO reference no. (Table 8-1)
		Burner monitored by a dedicated flare watcher during a well flowback to identify and communicate an unplanned flare drop-out.	BAD-CM-033-EPS-06	Incident report of flare drop-out.	
		In the event of a flare drop-out or hydrocarbon being observed on the sea surface then liquid flaring, and if applicable the well flowback, shall cease and the event investigated and corrected before proceeding.	BAD-CM-033-EPS-07	Incident report of flare drop-out or unplanned hydrocarbon release.	
		Two burner booms provided on the MODU to allow for redundancy and operation in all weather conditions.	BAD-CM-033-EPS-08	Well test design report	
		During a well flowback, formation water and completion fluids containing hydrocarbons must be: + flared with hydrocarbons, or + treated through an oil-water filtration system before discharge to sea at an oil in water concentration of <30 ppm, or + stored in tanks on-board and shipped ashore for disposal.	BAD-CM-033-EPS-09	Completed operational reports.	
		Oil-water filtration equipment will be: + designed to reduce oil-in-water to less than 30 ppm + calibrated before use + monitored for oil-in-water content to assess the performance of the filtration equipment.	BAD-CM-033-EPS-10	Completed operational reports.	
		No extended production tests for assessing reservoir depletion, and maximum rate will only be used to remove solids from the well.	BAD-CM-033-EPS-11	Completed operational reports.	
Minimum lighting for maritime safety	BAD-CM-034	Vessel/MODU navigation lighting and equipment is compliant with International Rules for Preventing Collisions at Sea/Marine Order 30: Prevention of Collisions, and with Marine Order 21: Safety of Navigation and Emergency Procedures.	BAD-CM-034-EPS-01	Vessel certification confirms compliance with applicable regulations.	EPO-01 EPO-03 EPO-08
No fishing from MODU or vessels	BAD-CM-035	Personnel are prohibited from recreational fishing activities on MODU or vessels.	BAD-CM-035-EPS-01	Induction records confirm no fishing prohibition is communicated to all personnel.	EPO-01
Seafarer certification	BAD-CM-036	Vessel crew are trained and competent, in accordance with Flag State regulations, to navigate vessels.	BAD-CM-036-EPS-01	Training records.	EPO-01 EPO-03
Marine assurance standard	BAD-CM-037	Vessels selected and on-boarded in accordance with the *Offshore Marine Assurance Procedure* (SO-91-ZH-10001) to ensure contracted vessels are operated, maintained and manned in accordance with industry standards (for example, Marine Orders) and regulatory requirements (this EP) and the relevant Santos procedures mentioned in this EP.	BAD-CM-037-EPS-01	Completed documentation demonstrates procedure requirements.	EPO-01 EPO-02 EPO-03 EPO-04 EPO-05 EPO-06 EPO-08
Petroleum Safety Zone (500 m) established	BAD-CM-038	A 500 m PSZ is defined around the MODU during the activity.	BAD-CM-038-EPS-01	Notice to Mariners placed with AHO outlining PSZ and time frames of the activity.	EPO-03
		A 500m PSZ is defined around each wellhead once installed and well completed.	BAD-CM-038-EPS-02		
Recovery of deployed equipment	BAD-CM-039	All equipment deployed during any activity will be recovered at the end of each drilling campaign.	BAD-CM-039-EPS-01	Survey records.	EPO-04 EPO-07
MODU planned maintenance system	BAD-CM-040	Documented maintenance program is in place for equipment on MODU that provides a status on the maintenance of equipment.	BAD-CM-040-EPS-01	Vessel daily/weekly records. CMMS records.	EPO-04 EPO-06

Control Measure	Control measure reference no.	Environmental Performance Standard	EPS reference no.	Measurement Criteria	EPO reference no. (Table 8-1)
				Vessel contractor written verification demonstrates compliance with Planned Maintenance System.	
Vessel planned maintenance system	BAD-CM-041	Documented maintenance program is in place for equipment on vessels that provides a status on the maintenance of equipment.	BAD-CM-040-EPS-01	Vessel daily/weekly records. International Maritime Contractors Association Common Marine Inspection Document. Vessel contractor written verification demonstrates compliance with Planned Maintenance System. CMMS records.	EPO-04 EPO-06
Relief well MODU identification	BAD-CM-042	Prior to drilling commencement, as detailed in Assurance Review 4 of the DCMP, a suitable relief well MODU will be confirmed to be available. Drilling will not proceed if there is not a least one relief well MODU option that could execute a relief well within the time frames committed to in Table 9-4 of the OPEP. If the preferred MODU becomes unavailable during the activity, Santos will update the SCP to identify a suitable alternative MODU.	BAD-CM-042-EPS-01	Relief well capability register confirms MODU availability for the duration of each campaign. Source Control Plan updated if MODU availability changes	EPO-03

8.5 Leadership, accountability and responsibility

OPGGS(E)R 2009 Requirements
Regulation 14(4)
The implementation strategy must establish a clear chain of command, setting out the roles and responsibilities of personnel in relation to the implementation, management and review of the environment plan, including during emergencies or potential emergencies.

Santos' Offshore Manager – Drilling and Completions, is accountable for ensuring implementation, management and review of this EP.

The effective implementation of this EP requires collaboration and cooperation among Santos 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
Santos Offshore Manager – Drilling and Completions	+ 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 Santos personnel, government agencies and the media + Approves MoC documents, if acceptable and ALARP + Ensures annual HSE improvement plan is completed
Santos Drilling Superintendent	+ Ensures conformance with environmental performance outcomes and standards in the EP + Delegates HSE responsibility and informs these personnel of their responsibilities under the EP + Empowers personnel to `stop-the-job' due to HSE concerns + Ensures HSE incidents are reported, investigated, corrected and communicated + Ensures MODU meets quarantine requirements to operate in Australian waters + Ensures HSE inspections and audits are completed and corrective actions implemented + Reviews MoC documents + Ensures personnel on the MODU have the necessary qualifications, training and/or supervision

Role	Responsibilities
Santos Marine Superintendent	+ Ensures conformance with environmental performance outcomes and standards in the EP + Delegates HSE responsibility and informs these personnel of their responsibilities under the EP + Empowers personnel to `stop-the-job' due to HSE concerns + Ensures HSE incidents are reported, investigated, corrected and communicated + Ensure vessels meet quarantine requirements to operate in Australian waters + Ensures HSE inspections and audits are completed and corrective actions implemented + Reviews MoC documents + Ensures personnel on the vessels have the necessary qualifications, training and/or supervision
Santos Offshore Supervisors/ MODU Offshore Installation Manager/Vessel Masters	+ Ensures compliance with all HSE laws, conventions and approvals (e.g., safety case) + Ensures conformance with delegated environmental performance outcomes and standards in the EP + Reports any new, or increase in, HSE risk or impact + Ensures MoC procedures are followed + Ensures crew adhered to operational work systems and procedures + Ensures plant and equipment is being operated as intended and is maintained + Empowers personnel to 'stop-the-job' due to HSE concerns + Ensures all HSE incidents, hazards or non-conformances are reported + Facilitates HSE investigations and ensures corrective actions are implemented + Ensures crew are competent and prepared to respond to HSE incidents
Santos Drilling HSE Advisor	+ Ensures the EP is managed and reviewed: monitors conformance with EPOs and environmental performance standards, 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 + Ensure subcontractors are communicated the EP requirements

Role	Responsibilities
Santos Stakeholder Coordinator	+ Ensures relevant stakeholders are identified throughout the life of the EP + Maintains a stakeholder contact and information database + Maintains a Stakeholder Notification Log specific to the EP + Maintains records of all stakeholder correspondence specific to the EP + Before the activity begins and on advice of Santos Drilling HSE Adviser, notifies all relevant stakeholders listed, or as revised, in **Table 8-4**. The notification will include information on activity timing, vessel MODU movements and vessel/MODU details + On advice of Santos Drilling HSE Adviser, provide cessation notifications to relevant stakeholders identified in **Table 8-4** + Is available before, during and after the activity to ensure opportunities for stakeholders to provide feedback are available + Prepares and distributes quarterly consultation updates to relevant stakeholders
Santos Emergency Response Advisor	+ Is responsible for overarching incident and crisis management responsibility + Manages the Crisis Management Team and IMT personnel training program + Reviews and assesses competencies for Crisis Management Team, IMT, and field-based Incident Response Team members + Manages the Duty roster system for Crisis Management Team and IMT personnel + Manages the maintenance and readiness of incident response resources and equipment
Santos Oil Spill Response Advisor	+ Provides upfront and ongoing guidance, framework, and direction on preparation of the OPEP and Addendum relevant to this activity + Develops and maintains arrangements and contracts for incident response support from third parties + Develops and defines objectives, strategies and tactical plans for response preparedness defined in this OPEP and IRP + Undertakes assurance activities on arrangements outlined within the OPEP

8.6 Workforce training and competency

OPGGS(E)R 2009 Requirements
Regulation 14(5)
The implementation strategy must include measures to ensure that each employee or contractor working on, or in connection with, the activity is aware of his or her responsibilities in relation to the environment plan, including during emergencies or potential emergencies, and has the appropriate competencies and training.

This section describes the mechanisms that will be in place so that each employee and contractor is aware of his or her responsibilities in relation to the EP and has appropriate training and competencies.

8.6.1 Activity inductions

Santos will ensure inductions addressing environmental management requirements are implemented. Inductions will include information about:

+ Santos' Environment, Health and Safety Policy
+ regulatory regime (NOPSEMA regulations)
+ operating environment (e.g., nearby protected marine areas, sensitive environmental periods)
+ interaction with other marine users (i.e., topic to reinforce the importance of marine communications about any potential interactions with active commercial fishing)
+ activities with highest risk (e.g., invasive marine species and hydrocarbon releases)
+ relevant EP commitments (e.g., **Table 8-1** and **Table 8-2**)
+ incident reporting and notifications
+ regulatory compliance reporting
+ management of change process
+ oil pollution emergency response (e.g., OPEP requirements).

8.6.2 Training and competency

All members of the workforce on the MODU and vessels will complete relevant training and hold qualifications and certificates for their role. Santos 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, etc.

Personnel qualification and training records will be sampled before and/or during an activity. Such checks will be performed during the procurement process, facility acceptance testing, inductions, crew change, and operational inspections and audits.

Additional training and competency requirements for relevant personnel specific to spill response are provided in the OPEP.

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 (for example, oil on water, dropped objects).

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 updating the plan.

MODU and vessels are required to have and implement incident response plans, such as an emergency response plan and SMPEP or SOPEP. Regular incident response drills and exercises (for example, as defined in an emergency response plan, SMPEP or SOPEP) are performed to refresh the crew in using equipment and implementing incident response procedures.

Santos will implement the OPEP in the event of a hydrocarbon spill. The OPEP details how Santos will prepare and respond to a spill event and meets the requirement of the OPGGS(E)R 2009.

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.

All personnel will be informed through inductions and daily operational meetings of their duty to report HSE incidents and hazards. Reported HSE incidents and hazards will be shared during daily operational meetings and will be documented in the incident management systems as appropriate. HSE incidents will be investigated using root cause analysis.

Environmental recordable and reportable incidents will be reported to NOPSEMA as required, in accordance with **Table 8-4**. The incident reporting requirements will be provided to all crew on board the facilities and 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) Regulations:

- a recordable incident, for an activity, means a breach of an EPO or EPS, in the EP that applies to the activity, that is not a reportable incident
- a reportable incident, for an activity, means an incident relating to the activity that has caused, or has the potential to cause, moderate to significant environmental damage.

For the purposes of this EP, a reportable incident is an incident that is assessed to have an environmental consequence of moderate or higher in accordance with the Santos environmental impact and risk assessment process outlined in **Section 5**. Of the planned and unplanned events assessed within this EP, the items identified to have a potential consequence level of moderate or higher if the event were to occur and would therefore be a reportable incident were:

- introduction of invasive marine species (III – Moderate)
- hydrocarbon release (subsurface) from LOWC (IV – Major).

In addition to the above, an incident relating to the activity that has caused death or injury to threatened, migratory or local fauna will also be treated as a reportable incident.

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.
Regulation 14(7)
The implementation strategy must provide for sufficient monitoring of, and maintaining a quantitative record of, emissions and discharges (whether occurring during normal operations or otherwise), such that the record can be used to assess whether the environmental performance outcomes and standards in the environment plan are being met.

8.9.1 Notifications and compliance reporting

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

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 Notice to Mariners to be issued. AMSA's JRCC requires the: + vessel and MODU details (including name, callsign and Maritime Mobile Service Identity) + satellite communications details (including INMARSAT-C and satellite telephone numbers) + area of operation + requested clearance from other vessels + any other information that may contribute to safety at sea + when operations start and end.	At least 24 to 48 hours before operations begin.	Written	AMSA's JRCC rccaus@amsa.gov.au
		No less than four weeks before operations.	Written	AHO datacentre@hydro.gov.au
Consultation	The activity will be included in the Quarterly Consultation Update until the activity has ended. In the event that distribution of this update does not correlate with the schedule for an activity, notifications will be provided to identified relevant commercial fishers within the operational area prior to and following the activity.	Quarterly	Written	The Quarterly Consultation Update is circulated to a broad group of Santos' stakeholders, including many of the stakeholders identified in **Section 4**

Initiation	Required Information	Timing	Type	Recipient
Department of Agriculture, Water and the Environment – Biosecurity (vessels, aircraft and personnel) (refer **Table 4-2**)	In accordance with control measure BAD-CM-023, Santos will: + pursuant to the *Biosecurity Act 2015* and the *Biosecurity (Exposed Conveyances – Exceptions from Biosecurity Control) Determination 2016*, undertake a vessel biosecurity risk and be assessed as 'low' by the Commonwealth Department of Agriculture before interacting with domestic vessels and aircraft + undertake pre-arrival approval for the vessels (where applicable) using the Maritime Arrivals Reporting System (MARS) to meet the DAWE biosecurity reporting obligations.	At least one month before activity begins. MARS reporting at least 12 hours before arrival.	Written	DAWE Biosecurity (vessels, aircraft and personnel)
OPGGS(E) Regulation 29 & 30 – Notifications NOPSEMA must be notified that the activity is to begin	Complete NOPSEMA's Regulation 29 Start or End of Activity Notification form before the activity.	At least ten days before the activity begins.	Written	NOPSEMA
During the activity				
OPGGS(E) Regulation 26B – Recordable Incidents NOPSEMA must be notified of a breach of an EPO or EPS, in the environment plan that applies to the activity that is not a reportable incident	Complete NOPSEMA's Recordable Environmental Incident Monthly Report form.	The report must be submitted as soon as practicable after the end of the calendar month, and in any case, not later than 15 days after the end of the calendar month.	Written	NOPSEMA

Initiation	Required Information	Timing	Type	Recipient
OPGGS(E) Regulation 16(E), 26 & 26A – Reportable Incident NOPSEMA must be notified of any reportable incidents For the purposes of Regulation 16(E), a reportable incident is defined as: an incident relating to the activity that has caused, or has the potential to cause, moderate to significant environmental damage an incident relating to the activity that has caused death or injury to threatened, migratory or local fauna	The oral notification must contain: + all material facts and circumstances concerning the reportable incident known or by reasonable search or enquiry could be found out + any action taken to avoid or mitigate any adverse environmental impacts of the reportable incident + the corrective action that has been taken, or is proposed to be taken, to stop, control or remedy the reportable incident.	As soon as practicable, and in any case not later than two hours after the first occurrence of a reportable incident, or if the incident was not detected at the time of the first occurrence, at the time of becoming aware of the reportable incident.	Oral	NOPSEMA
	A written record of the oral notification must be submitted. The written record is not required to include anything that was not included in the oral notification.	As soon as practicable after the oral notification.	Written	NOPSEMA NOPTA
	A written report must contain: + all material facts and circumstances concerning the reportable incident known or by reasonable search or enquiry could be found out + any action taken to avoid or mitigate any adverse environmental impacts of the reportable incident + the corrective action that has been taken, or is proposed to be taken, to stop, control or remedy the reportable incident + the action that has been taken, or is proposed to be taken, to prevent a similar incident occurring in the future + reporting using NOPSEMA's Report of an Accident, Dangerous Occurrence or Environmental Incident form.	Must be submitted as soon as practicable, and in any case not later than three days after the first occurrence of the reportable incident unless NOPSEMA specifies otherwise. Same report to be submitted to National Offshore Petroleum Titles Administrator (NOPTA) within seven days after giving the written report to NOPSEMA.	Written	NOPSEMA NOPTA

Santos

Initiation	Required Information	Timing	Type	Recipient
AMSA Reporting	Titleholder agrees to notify AMSA of any marine pollution incident[14].	Notification within two hours of incident.	Oral	AMSA JRCC
	Harmful Substances Report and SITREP available online (refer OPEP).	Harmful Substances Report as requested by AMSA following verbal notification.	Written	AMSA JRCC
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 (requested through consultation)	The DNP should be made aware of oil/gas pollution incidences which occur within a marine park or are likely to impact on a marine park as soon as possible. Notification should be provided to the 24-hour Marine Compliance Duty Officer on 0419 293 465. The notification should include: + titleholder details + time and location of the incident (including name of marine park likely to be affected) + proposed response arrangements as per the OPEP (such as dispersant, containment, etc.) + confirmation of providing access to relevant monitoring and evaluation reports when available + contact details for the response coordinator. + Note that the DNP may request daily or weekly Situation Reports, depending on the scale and severity of the pollution incident.	Verbal notification as soon as reasonably practicable.	Oral	Director of National Parks

[14] For clarity and consistency across Santos regulatory reporting requirements Santos will meet the requirement of reporting marine oil pollution by reporting oil spills assessed to have an environmental consequence of moderate or higher in accordance with Santos' environmental impact and risk assessment process outlined in **Section 5**.

Initiation	Required Information	Timing	Type	Recipient
DAWE Reporting Any harm or mortality to EPBC Act- listed threatened marine fauna Marine Fauna Sighting Data Discovery of underwater cultural heritage	Notification of any harm or mortality to an EPBC listed species of marine fauna whether attributable to the activity or not.	Within seven days to EPBC.permits@environment.gov.au.	Written	DAWE
	If MNES are considered at risk from a spill or response strategy, or where there is death or injury to a protected species.	Email notification as soon as practicable.	Written	DAWE (Director of monitoring and audit section)
	Marine fauna sighting data recorded in the marine fauna sighting database.	As soon as practicable, in any case no later than three months after the end of the activity.	Written	DAWE
	Underwater cultural heritage details recorded in online database if discovered during activity.	As soon as practicable, in any case no later than three months after the end of the activity.	Written	DAWE
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
NT Department of Environment, Parks and Water Security (DEPWS) Marine Pollution incidents	Verbal reporting will consist of transfer of information to conduct a coordinated emergency response. All reporting will be performed by the vessel master as per the vessel-specific SOPEP.	As soon as practicable.	Oral	DEPWS (Pollution Response Hotline; Environmental Operations)
	Written reports will contain all material facts and circumstances concerning the reportable incident, actions taken to avoid or mitigate any adverse impacts, and corrective action taken.	Written report as soon as practicable.	Written	DEPWS (Pollution Response Hotline; Environmental Operations)
AFMA	Verbal notification if any spill may affect Commonwealth fisheries within the EMBA.	Verbal notification within eight hours.	Verbal	AFMA

Initiation	Required Information	Timing	Type	Recipient
DFAT	Any oil spill that has entered or is likely to enter international waters.	Verbal phone call notification within 8 hours, if the spill is likely to extend into international waters.	Verbal	DFAT (24-hour consular emergency centre)
		Follow up with email outlining details of incident.	Written	DFAT (24-hour consular emergency centre)
Consultation with AMSA (refer **Table 4-2**)	Notification of updates to both AHO and JRCC on progress and, importantly, any changes to the intended operations.	As soon as possible.	Written	AMSA's JRCC AHO
End of the activity				
OPGGS(E) Regulation 26C – Environmental Performance NOPSEMA must be notified of the environmental performance at the intervals provided for in the EP	Report must contain sufficient information to determine whether or not EPO and EPS in the EP have been met.	An environmental performance report will be submitted to NOPSEMA annually from the date of acceptance of this EP.	Written	NOPSEMA
OPGGS(E) Regulation 29 – Notifications NOPSEMA must be notified that the activity is completed	Complete NOPSEMA's Regulation 29 Start or End of Activity Notification form.	Within ten days after finishing the activity.	Written	NOPSEMA

Initiation	Required Information	Timing	Type	Recipient
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 six months of the final Regulation 29 (2) notification.	Written	NOPSEMA
AMSA (JRCC) Consultation	Notification that activity has completed.	Within ten days of completion.	Written	JRCC
AHO	Notification that activity has completed.	Within ten days of completion.	Written	AHO

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.

Discharges to the marine environment associated with this activity will be recorded and controlled in accordance with requirements under relevant marine orders and/or MARPOL requirements.

Santos and MODU/vessel contractors will maintain records so that emissions and discharges can be determined or estimated. Such records will be maintained for a period of five years. Contractors are required to make these records available upon request.

In addition, Santos will maintain records of discharges or emissions (where practicable), to the environment as described in **Table 8-5**.

Table 8-5: Monitoring of emissions and discharges

Discharge/emission	Parameter	Quantitative Record
Drilling chemicals (discharged to marine environment as per **Section 6.7**)	Volumes consumed Average oil on cuttings (NAF)	Volumes used will be estimated based on known inventories
Air emissions	Fuel volume Flared hydrocarbons	GHG calculations based on measured fuel use and flared hydrocarbons in accordance with NGERs reporting requirements
Oily water during well flowback	Volume and location	Measured volume included in a well flowback report
Oily water	Volume and location	Oil Record Book* or equivalent report
Garbage (including food scraps)	Volume and location	Volumes recorded in Garbage Record Book*
Sewage	Volume and location	Estimated based on POB and days on location
Unplanned discharge of solid objects	Volume	NOPSEMA recordable or reportable incident reports as per **Table 8-4**
Unplanned discharge of hazardous liquids	Volume	NOPSEMA recordable or reportable incident reports as per **Table 8-4**
Unplanned hydrocarbon release	Volume	NOPSEMA recordable or reportable incident reports as per **Table 8-4**

**Maintained as per vessel class in accordance with relevant Marine Orders.*

8.10 Document management

8.10.1 Information management and document control

This EP and OPEP, as well as approved management of change documents, are controlled documents and current versions will be available on Santos' intranet. Santos contractors are also required to maintain current versions of these documents.

Environmental performance outcomes and standards will be measured based on the measurement criteria listed in **Table 8-2**. Such records will be maintained for a period of five years. Contractors are required to make these records available upon request.

8.10.2 Management of change

The MoC process provides a systematic approach to initiate, assess, document, approve, communicate and implement changes to EPs and OPEPs.

The MoC process considers Regulations 7, 8 and 17 of the OPGGS(E)R 2009 and determines if a proposed change can proceed and the manner in which it can proceed. The MoC procedure will determine whether a revision of the EP is required and whether that revision is to be submitted to NOPSEMA. For a change to proceed, the associated environmental impacts and risks must be demonstrated to be acceptable and ALARP. Additional stakeholder consultation may be required, depending on the nature and scale of the change.

The MoC procedure also allows for the assessment of new information that may become available after EP acceptance, such as new management plans for AMPs, new recovery plans or conservation advice for species, and changes to the EPBC Protected Matters Search results. If a review identifies new information, this is treated as a 'Change that has an impact on EP', and the MoC process is followed accordingly.

Accepted MoCs become part of the in-force EP or OPEP, are tracked on a register and are made available on Santos' intranet. Where appropriate, the EP compliance register will be updated so that CM or EPS changes are communicated to the workforce and implemented. Any MoC will be distributed to the relevant 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.

8.10.3 Reviews

This EP has assessed impacts and risk across the entire operational area, during any time of the year, for planned and unplanned events given the nature of the 24/7 operations.

It is recognised that the over the validity of this EP things may change, such as:

+ legislation
+ businesses conditions, activities, systems, processes and people
+ industry practices
+ science and technology
+ societal and stakeholder expectations.

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

+ Maintain membership of APPEA (Australian Petroleum Production & Exploration Association), which provides a mechanism for communicating potential changes in legislation, industry practice and other issues that may affect EP implementation to relevant personnel in Santos.
+ Undertake annual spill response exercises to check spill response arrangements and capability are adequate.

- Identify stakeholders before the activity commencing under this EP via the mechanisms outlined in **Section 4**.
- Review the Values and Sensitivities within the EMBA which includes completing a new EPBC Protected Matters Search, reviewing **Appendix B** against relevant legislation to capture and review any relevant updates and incorporate as required, and reviewing any recently known published relevant scientific papers.
- Subscribe to various regulator updates.
- Have regular liaison meetings with Regulators.

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

8.11 Audits and inspections

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

8.11.1 Audits

Santos maintains activity audit plans and schedules which are frequently reviewed and updated.

Audits will be undertaken in a manner consistent with Santos' Assurance Operating Standard SMS-LRG-OS03.

During the activity, an audit against the EP and/or OPEP will be performed at least annually, and may be desktop only or include a field-based component.

Audit findings may include opportunities for improvement and non-conformances. Audit non-conformances are managed as described in **Section 8.11.3**.

8.11.2 Inspections

HSE inspections will be conducted at least monthly during the activity to identify hazards, incidents and EP non-conformances. These inspections will also check compliance against a selection of the EPOs and EPSs of this EP (**Table 8-2**) and inform end of activity reporting (**Table 8-4**).

8.11.3 Non-conformance management

EP non-conformances will be addressed and resolved by a systematic corrective action process as outlined in Santos' Assurance Operating Standard (SMS-LRG-OS03) and the Assurance Procedure (SMS-LRG-OS03-PD01). Non-conformances arising from audits and inspections will be entered into Santos' incident and action tracking management system (i.e., HSE Toolbox). Once entered, corrective actions, time frames and responsible persons (including action owners and event validators) will be assigned. Corrective action 'close out' will be monitored using a management escalation process.

8.11.4 Continuous improvement

For this EP, continuous improvement will be driven by:

- improvements identified from the review of business-level HSE key performance indicators
- actions arising from Santos and departmental HSE improvement plans

- corrective actions and feedback from HSE audits and inspections, incident investigations and after-action reviews
- opportunities for improvement and changes identified during pre-activity reviews and MoC documents
- actions taken to address objections or claims, and issues raised during the ongoing stakeholder management process (**Section 4.5**).

This may result in a review of the EP, with changes applied in accordance with **Section 8.10.2**.

Identified continuous improvement opportunities will be assessed in accordance with the MoC process to ensure any potential changes to this EP, or OPEP, are managed in accordance with the OPGGS(E)R 2009 and in a controlled manner.

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[TSSC] Threatened Species Scientific Committee (2015c). Conservation Advice *Megaptera novaeangliae* humpback whale. Department of the Environment, Canberra.

[TSSC] Threatened Species Scientific Committee (2015d). Conservation Advice *Rhincodon typus* whale shark. Department of the Environment, Canberra.

[TSSC] Threatened Species Scientific Committee (2015e). Conservation Advice *Calidris ferruginea* curlew sandpiper. Threatened Species Scientific Committee, Canberra.

[TSSC] Threatened Species Scientific Committee (2015f). Conservation Advice *Numenius madagascariensis* eastern curlew. Threatened Species Scientific Committee, Canberra.

[TSSC] Threatened Species Scientific Committee (2015g). Conservation Advice *Anous tenuirostris melanops* Australian lesser noddy. Canberra: Department of the Environment.

[TSSC] Threatened Species Scientific Committee (2020). Conservation Advice *Papasula abbotti* Abbott's booby. Canberra: Department of the Environment.

[TSSC] Threatened Species Scientific Committee (2016a). Conservation Advice *Limosa lapponica menzbieri* Bar-tailed godwit (northern Siberian). Canberra: Department of the Environment.

[TSSC] Threatened Species Scientific Committee (2016b). Conservation advice *Calidris canutus* red knot. Threatened Species Scientific Committee, Canberra.

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APPENDIX A – SANTOS' ENVIRONMENT, HEALTH AND SAFETY POLICY

Environmental Management

Santos

Policy

Our commitment

We share the community's concern for the proper care and custody of our environment for present and future generations. At Santos protecting the environment and valuing cultural heritage are an integral part of the way we do business.

Our objective is to implement best environmental practices wherever practical to do so. We are committed to demonstrating leadership in environmental management and ensuring that our actions are performed in a manner which has acceptable impact on the land, sea and air.

We will comply with all applicable environmental legislation and regulations relevant to our business.

We will promote continuous improvement in energy efficiency, greenhouse gas emission reduction and innovation to reduce our carbon footprint and energy use.

Our actions

Wherever we operate we will:

+ Maintain open community and government consultation regarding our activities and our environmental performance
+ Educate, train and encourage our workforce to conduct activities in an environmentally responsible manner
+ Identify, assess and control risks to the environment and the surrounding community in order to manage the potential for unacceptable pollution and impacts
+ Develop and implement systems to manage all activities which have the potential to affect the surrounding natural environment
+ Measure our environmental performance and set targets for continual improvement; and
+ Conduct monitoring of the surrounding natural environment thereby contributing to knowledge of natural systems and enabling any impacts to be detected.

Governance

This policy has been reviewed and endorsed by the Santos WA Energy Holdings Board of Directors and management who foresee benefits in, and take responsibility for, its successful implementation.

By accepting employment with Santos, each employee and contractor acknowledges that they are responsible for the application of this policy.

K. T. Gallagher

Kevin Gallagher
Managing Director & CEO

APPROVED 28 November 2018

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APPENDIX B– LEGISLATIVE REQUIREMENTS RELEVANT TO THE ACTIVITY

Table B-1: Assessment of Relevant Commonwealth Legislation

Requirement Legislation	Summary	Relevant to activity?	Administering authority	Assessment of relevance to the activity	EP section
Aboriginal and Torres Strait Islander Heritage Protection Act 1984	This Act provides for the preservation and protection from injury or desecration areas and objects that are of significance to Aboriginal people, under which the Minister may make a declaration to protect such areas and objects. The Act also requires the discovery of Aboriginal remains to be reported to the Minister.	Yes	Commonwealth – Department of Agriculture, Water and the Environment	No activity being undertaken on land or near shore. No known sites of Aboriginal Heritage Significance within the operational area. May be relevant in the event of a hydrocarbon spill requiring shoreline access	**Section 3.2.6.8** – Heritage
Australian Ballast Water Management 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 IMS and potential ballast water exchange.	**Section 7.2** – Introduction of invasive marine species
Australian Heritage Council Act 2003	This Act identifies areas of heritage value listed on the Register of the National Estate and sets up the Australian Heritage Council and its functions.	No	Australian Heritage Council	There are no world heritage properties, national heritage places or Commonwealth heritage places within the operational area, however the EMBA intersects the 'Scott Reef and surrounds – Commonwealth area' and the Ashmore Reef AMP that could potentially be impacted by a loss of well control.	**Section 3.2.6.8** – Heritage **Section 7.6** – Hydrocarbon spill – condensate

Requirement Legislation	Summary	Relevant to activity?	Administering authority	Assessment of relevance to the activity	EP section
Australian Maritime Safety Authority Act 1990 (AMSA Act)	This Act specifies that the Australian Maritime Safety Authority's (AMSA) role includes protection of the marine environment from pollution from ships and other environmental damage caused by shipping. AMSA is responsible for administering the Marine Order in Commonwealth waters. This Act facilitates international cooperation and mutual assistance in preparing and responding to a major oil spill incident and encourages countries to develop and maintain an adequate capability to deal with oil pollution emergencies. Requirements are given effect through AMSA. AMSA is the lead agency for responding to oil spills in the marine environment and is responsible for the Australian National Plan for Maritime Environmental Emergencies.	Yes	AMSA	This Act applies to the use of any vessel associated with operations and is relevant to the activity in regard to the unplanned pollution from ships.	**Section 7.4** – Non-hydrocarbon and chemicals release (surface) – liquids **Section 7.7** – Hydrocarbon spill – marine diesel oil **Section 7.8** – Minor hydrocarbon release (surface and subsea)
Aquatic Resources Management Act 2016	This Act will be the primary legislation used to manage fishing, aquaculture, pearling and aquatic resources in Western Australia. The Act was scheduled for commencement on 1 January 2019; however, this has been deferred while an amendment to the Act is progressed.	Yes	Department of Primary Industries and Regional Development	Vessel movements have the potential to introduce IMS. This Act was considered during development of the Santos IMS Management Zone (IMSMZ) and IMS Management Plan (EA-00-RI-10172).	**Section 7.2** – Introduction of invasive marine species
Marine Orders	Marine Orders (MO) are subordinate rules made pursuant to the *Navigation Act 2012* and *Protection of the Sea (Prevention of Pollution from Ships) Act 1983* affecting the maritime industry. They are a means of implementing Australia's international maritime obligations by giving effect to international conventions in Australian law.	Yes	AMSA	Vessel movements, safety, discharges and emissions.	**Section 6** and **7** – Planned and unplanned events

Requirement Legislation	Summary	Relevant to activity?	Administering authority	Assessment of relevance to the activity	EP section
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	This Act applies to all internationally source vessels operating in Australian Waters which could have the potential for the introduction of IMS and potential ballast water exchange.	**Section 7.2** – Introduction of invasive marine species
Corporations Act 2001	This Act is the principal legislation regulating matters of Australian companies, such as the formation and operation of companies, duties of officers, takeovers and fundraising.	Yes	Commonwealth – Australian Securities and Investments Commission	The titleholder has provided Australian Company Number details within the meaning of the Act.	**Section 1.5** – Operator and titleholder details

Requirement Legislation	Summary	Relevant to activity?	Administering authority	Assessment of relevance to the activity	EP section
Environment Protection and Biodiversity Conservation Act 1999 Environment Protection and Biodiversity Conservation Amendment Regulations 2006	The National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) is the sole assessor for offshore petroleum activities in Commonwealth water (as of 28 February 2014). Under these arrangements, environmental protection will be met through NOPSEMA's decision-making processes. This Act is the Australian Government's key piece of environmental legislation. The Act focuses on the protection of MNES. Australian Marine Park Management Plans were also developed under this Act.	Yes	Commonwealth – Department of Agriculture, Water and the Environment	This Act applies to all aspects of the activity that have the potential to impact MNES. Appropriate environmental approvals will be sought from NOPSEMA for all operations (this EP) which outlines compliance with the relevant regulations and plans under the Act. Where activities have existing approvals under the Act, these will continue to apply. Consideration has also been afforded to Section 527E of the Act. See the note below this table (**Appendix B2**) containing Santos' approach to addressing the requirements of Section 527E.	**Section 6** and **7** – Planned and unplanned events s
Underwater Cultural Heritage Act 2018 *Underwater Cultural Heritage (Consequential and Transitional Provisions) Act 2018*	This Act replaces the *Historic Shipwrecks Act 1976* and extends protection from the shipwreck to other wrecks such as submerged aircraft and human remains. It also increases penalties applicable to damaged sites. The Act came into effect on 1 July 2019. 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.	Yes	Commonwealth – Department of Agriculture, Water and the Environment	Anyone who finds the remains of a vessel or aircraft, or an article associated with a vessel or aircraft, needs to notify the relevant authorities, via online form.	**Section 3.2.6.8** – Heritage **Table 8-4** – Notification requirements

Requirement Legislation	Summary	Relevant to activity?	Administering authority	Assessment of relevance to the activity	EP section
National Biofouling Management Guidance for the Petroleum Production and Exploration Industry 2009	The guidance document provides recommendations for the management of biofouling hazards by the petroleum industry.	Yes	Commonwealth – Department of Agriculture, Water and the Environment	Applying the recommendations within this document and implementing effective biofouling controls can reduce the risk of the introduction of an introduced marine species.	**Section 7.2** – Introduction of invasive marine species
National Environment Protection Measures (Implementation) Act 1998 (and associated regulations)	The Act provides for the implementation of national environment protection measures (NEPMs) in respect of certain activities carried on by or on behalf of the Commonwealth and Commonwealth authorities, and for related purposes. Specific objects of the Act are to: make provision for the implementation of national environment protection measures in respect of certain activities carried on, by or on behalf of the Commonwealth and Commonwealth authorities protect, restore and enhance the quality of the environment in Australia, having regard to the need to maintain ecologically sustainable development ensure the community has access to relevant and meaningful information about pollution.	Yes	Commonwealth – Department of Agriculture, Water and the Environment	The Act enables implementation of National Environment Protection Measures (NEPMs), which are a set of national objectives designed to assist in protecting or managing aspects of the environment. National objectives are concerned with; air toxics, ambient air quality, assessment of site contamination, MDO vehicle emissions, movement of controlled waste, national pollutant inventory and used packaging. Demonstration that the activity will be undertaken in line with the principles of ecologically sustainable development, and that impacts and risks resulting from these activities relevant to NEPM national objectives are ALARP and acceptable.	**Section 6.3** – Atmospheric emissions

Requirement Legislation	Summary	Relevant to activity?	Administering authority	Assessment of relevance to the activity	EP section
National Greenhouse and Energy Reporting Act 2007	Introduces a single national reporting framework for the reporting and dissemination of information about greenhouse gas emissions, greenhouse gas projects and energy use and production of corporations.	Yes	Commonwealth – Department of Agriculture, Water and the Environment Climate Change Authority	This Act applies to the atmospheric emissions through combustion engine use to operate the vessels associated with the activity.	**Section 6.3** – Atmospheric emissions
Maritime Legislation Amendment (Prevention of Air Pollution from Ships) Act 2007	This Act implements the requirements of MARPOL 73/78 Annex VI for shipping in Commonwealth waters.	Yes	Commonwealth, Department of Infrastructure and Regional Development.	Implementation of this Act reduces the impact of GHG emissions associated with vessel use for drilling 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
Marine Safety (Domestic Commercial Vessel) National Law Act 2012	This Act is a single regulatory framework for the certification, construction, equipment, design and operation of domestic commercial vessels inside Australia's exclusive economic zone.	Yes	Commonwealth – Australian Maritime Safety Authority (AMSA)	All vessel movements associated with the activity will be governed by AMSA marine safety regulations under the Act.	**Section 6.5** – Interactions with other marine users **Section 6.8** – Spill response operations **Section 7.7** – Hydrocarbon spill – marine diesel oil

Requirement Legislation	Summary	Relevant to activity?	Administering authority	Assessment of relevance to the activity	EP section
Navigation Act 2012	An Act regulating navigation and shipping, including SOLAS. A number of Marine Orders enacted under this Act apply directly to offshore petroleum exploration and production activities: Marine Order 21: Safety and emergency arrangements Marine Order 27: Safety of navigation and radio equipment Marine Order 30: Prevention of collisions Marine Order 58: Safe management of vessels Marine Order 70: Seafarer certification.	Yes	AMSA (operational) Department of Infrastructure and Regional Development Minister for Infrastructure and Regional Development	All vessel movements associated with the activity will be governed by marine safety regulations and Marine Orders under the Act.	**Section 6.5** – Interactions with other marine users **Section 6.8** – Spill response operations **Section 7.7** – Hydrocarbon spill – marine diesel oil
Offshore Petroleum and Greenhouse Gas Storage Act 2006 Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009	Petroleum exploration and development activities in Australia's offshore areas are subject to the environmental requirements specified in the OPGGS Act and associated Regulations. The OPGGS Act contains a broad requirement for titleholders to operate in accordance with 'good oil-field practice'. Specific environmental provisions relating to work practices essentially require operators to control and prevent the escape of wastes and petroleum. The Act also requires that activities are carried out in a manner that does not unduly interfere with other rights or interests, including the conservation of the resources of the sea and sea-bed, such as fishing or shipping. In some cases, where there are particular environmental sensitivities or multiple use issues it may be necessary to apply special conditions to an exploration permit area. The holder of a petroleum	Yes	NOPSEMA	Drilling activities in Commonwealth waters are to be performed: consistent with the principles of ecologically sustainable development as set out in section 3A of the EPBC Act so environmental impacts and risks of the activity are reduced to ALARP and are of an acceptable level. Demonstrate that the activity will be undertaken in line with the principles of ecologically sustainable development, and that impacts and risks resulting from these activities are ALARP and acceptable.	**Section 6** – Planned activities risk and impact assessment **Section 7** – Unplanned events risk and impact assessment

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Requirement Legislation	Summary	Relevant to activity?	Administering authority	Assessment of relevance to the activity	EP section
	title must maintain adequate insurance against expenses or liabilities arising from activities in the title, including expenses relating to clean-up or other remedying of the effects of the escape of petroleum. The OPGGS Environment Regulations provide an objective based regime for the management of environmental performance for Australian offshore petroleum exploration and production activities in areas of Commonwealth jurisdiction. Key objectives of the Environment Regulations include to: ensure operations are performed in a way that is consistent with the principles of ecologically sustainable development adopt best practice to achieve agreed environment protection standards in industry operations encourage industry to continuously improve its environmental performance.				
Ozone Protection and Synthetic Greenhouse Gas Management Act 1989 (and associated regulations)	Regulates the manufacture, importation and use of ODSs (typically used in fire-fighting equipment and refrigerants). Applicable to the handling of any ODS.	Yes	Commonwealth – Department of Agriculture, Water and the Environment	The activity does not include import, export or manufacture activities of ODS. This Act applies where ODS is found on vessel refrigeration systems, however, this is a rare occurrence.	**Section 6.3** – Atmospheric emissions

Requirement Legislation	Summary	Relevant to activity?	Administering authority	Assessment of relevance to the activity	EP section
Protection of the Sea (Powers of Intervention) Act 1981 Protection of the Sea (Powers of Intervention) Regulations 1983	The Act authorises the Commonwealth to take measures for the purpose of protecting the sea from pollution by oil and other noxious substances discharged from ships and provides legal immunity for persons acting under an AMSA direction.	Yes	Commonwealth – Department of Infrastructure and Regional Development	This Act applies to vessel discharges and movements associated with the activity. The Act is relevant to the extent that Santos will comply with MARPOL through the following relevant Marine Orders relating to marine pollution prevention have been put in place to give effect to relevant regulations of Annexes I, II, III, IV, V and VI of MARPOL 73/78: Marine Order 91: Marine pollution prevention – oil Marine Order 93: Marine pollution prevention – noxious liquid substances Marine Order 94: Marine pollution prevention – packaged harmful substances Marine Order 95: Marine pollution prevention – garbage Marine Order 96: Marine pollution prevention – sewage.	**Section 6.5** – Interactions with other marine users **Section 6.6** – Operational discharges **Section 6.8** – Spill response operations **Section 7** – Unplanned hydrocarbon and non-hydrocarbon/ chemical spills Introduction of IMS

Requirement Legislation	Summary	Relevant to activity?	Administering authority	Assessment of relevance to the activity	EP section
Protection of the Sea (Prevention of Pollution from Ships) Act 1983 Protection of the Sea (Prevention of Pollution from Ships) (Orders) Regulations 1994	This Act relates to the protection of the sea from pollution by oil and other harmful substances discharged from ships. This Act disallows any harmful discharge of sewage, oil and noxious substances into the sea and sets the requirements for a shipboard waste management plan. The following Marine Orders relating to marine pollution prevention have been put in place to give effect to relevant regulations of Annexes I, II, III, IV, V and VI of MARPOL 73/78: Marine Order 91: Marine pollution prevention – oil Marine Order 93: Marine pollution prevention – noxious liquid substances Marine Order 94: Marine pollution prevention – packaged harmful substances Marine Order 95: Marine pollution prevention – garbage Marine Order 96: Marine pollution prevention – sewage Marine Order 97: Marine pollution prevention – air pollution.	Yes	Commonwealth – Department of Infrastructure and Regional Development	This Act applies to vessel discharges and movements associated with the activity. The Act is relevant to the extent that Santos will comply with MARPOL through the following relevant Marine Orders relating to marine pollution prevention have been put in place to give effect to relevant regulations of Annexes I, II, III, IV, V and VI of MARPOL 73/78: Marine Order 91: Marine pollution prevention – oil Marine Order 93: Marine pollution prevention – noxious liquid substances Marine Order 94: Marine pollution prevention – packaged harmful substances Marine Order 95: Marine pollution prevention – garbage Marine Order 96: Marine pollution prevention – sewage.	**Section 6.6** – Operational discharges **Section 6.8** – Spill response operations **Section 7** – for unplanned hydrocarbon and non-hydrocarbon/ chemical spills Introduction of IMS
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.	No	AMSA	This Act applies to MDO refuelling which may occur within the operational area.	**Section 7.7** – Hydrocarbon spill – marine diesel oil

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Requirement Legislation	Summary	Relevant to activity?	Administering authority	Assessment of relevance to the activity	EP section
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. This is enacted by Marine Order 98 (Marine pollution – anti-fouling systems) 2013.	Yes	Commonwealth, Department of Infrastructure and Regional Development and AMSA	This Act applies to vessel movements in Australian Waters associated with the activity. Vessels are required to have biofouling systems in place to prevent introduction of IMS/harmful impact on Australian biodiversity. This is enacted by Marine Order 98 (Marine Pollution – Anti-fouling Systems) 2013.	**Section 7.2** – Introduction of invasive marine species

Table B2: Northern Territory Legislation

State Legislation	**Summary**	**Relevant to activity?**	**Administering Authority**	**Relevant aspects of the activity**	**EP Section**
Dangerous Goods Act 1998 (NT) and Dangerous Goods Regulations 1985 (NT)	This Act relates to the handling of certain dangerous goods within the NT. Regulations stipulate requirements for the safe handling, storage and transportation of dangerous goods, including provision of adequate training for personnel, suitable labelling, storage facilities and on-site emergency response capability.	Yes	Department of the Attorney-General and Justice	Relates to the handling of dangerous goods in NT waters.	**Section 6** – Planned releases
Waste Management and Pollution Control Act 1998	This Act provides for the protection of the NT environment though encouragement of effective waste management and pollution prevention and control practices.	Yes	NT EPA Department of Environment, Parks and Water Security	Unplanned events may impact on NT waters.	**Section 7** – Unplanned releases

State Legislation	Summary	Relevant to activity?	Administering Authority	Relevant aspects of the activity	EP Section
Heritage Act 2011	This Act establishes the NT Heritage Council and governs protection of both natural and cultural heritage places within the NT jurisdiction by setting out the process for obtaining permission to do work within these places.	Yes	Department of Territory Families, Housing and Communities	Unplanned LOWC may result in impact to natural and cultural places.	**Section 7.6** – Hydrocarbon spill – condensate
Marine Pollution Act 1999 and Marine Pollution Regulations	This Act protects the NT marine and coastal environment from ship sourced pollution including litter/rubbish, hydrocarbons and substances than may be hazardous to the marine environment (including substances that may be in ballast and grey water). This Act also gives effect to MARPOL in NT waters. Operation of vessels and Emergency Response plans to be compliant with requirements of this Act.	Yes	NT Department of Environment, Parks and Water Security	Unplanned events may impact on NT waters.	**Section 7** – Unplanned releases

Table B3: Western Australia Legislation

State Legislation	Summary	Relevant to activity?	Administering Authority	Relevant aspects of the activity	EP Section
Biodiversity Conservation Act 2016	The *Biodiversity Conservation Act 2016* came into effect on 3 December 2016 and replaced the Wildlife Conservation Act 1950. Relating to potential impacts to listed species: this Act provides for the conservation and protection of Western Australian wildlife.	Yes	Department of Biodiversity, Conservation and Attractions	Yes, planned and unplanned releases that could potentially impact listed species.	**Section 6** – Planned activities risk and impact assessment **Section 7** – Unplanned events risk and impact 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 during response actions in WA waters.	**Section 6.8** – Spill Response Operations
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)	Transportation of controlled waste during response actions in WA waters.	**Section 6.8** – Spill Response Operations
Fish Resources Management Act 1994 Fish Resources Management Regulations 1995	This Act establishes a framework for management of fishery resources and is the nominated lead agency responsible for implementing Western Australian marine biosecurity management requirements through implementation of the *Fish Resources Management Act 1994* (FRMA 1994) and associated regulations.	Yes	Department of Primary Industries and Regional Development	Introduction of IMS during response actions in WA waters.	**Section 6.8** – Spill Response Operations

Table B4: International Agreements and Conventions

International agreements and conventions	Summary	Relevant to activity?	Relevant aspects	EP section
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)	This agreement recognises the special international concern for the protection of migratory birds and birds in danger of extinction that migrate between Australia and Japan. Implemented in *EPBC Act 1999.*	Yes	Only relevant in so far as the credible spill scenario may result in impact to migratory seabirds foraging in area.	**Section 7.6 and 7.7** – unplanned hydrocarbon releases
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)	This agreement recognises the special international concern for the protection of migratory birds and birds in danger of extinction that migrate between Australia and China. Implemented in *EPBC Act 1999.*	Yes	Only relevant in so far as the credible spill scenario may result in impact to migratory seabirds foraging in area.	**Section 7.6** and **7.7** – unplanned hydrocarbon releases
Convention for the Control of Transboundary Movements of Hazardous Wastes and Their Disposal 1989 (Basel Convention)	This convention deals with the transboundary movement of hazardous wastes, particularly by sea. Implemented in *Hazardous Waste (Regulation of Exports and Imports) Act 1989.*	No	Activity does not involve transboundary movement of hazardous wastes.	N/A
United Nations Convention on Biological Diversity 1992	An international treaty to sustain life on earth.	Yes	Relevant only insofar as the activity may interact with MNES (threatened and migratory species) protected under the EPBC Act.	**Section 6** – Planned activities risk and impact assessment **Section 7** – Unplanned events risk and impact assessment

International agreements and conventions	Summary	Relevant to activity?	Relevant aspects	EP section
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 6.8** – Spill response operations **Section 7.6** and **7.7** – unplanned hydrocarbon releases
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 6.8** – Spill response operations **Section 7.6 and 7.7** – Unplanned hydrocarbon releases
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 vessels.	N/A

International agreements and conventions	Summary	Relevant to activity?	Relevant aspects	EP section
International Convention for the Prevention of Pollution from Ships 1973/1978 (MARPOL 73/78)	This Convention and Protocol (together known as MARPOL 73/78) build on earlier conventions in the same area. MARPOL is concerned with operational discharges of pollutants from ships. It contains six Annexes, dealing respectively with oil, noxious liquid substances, harmful packaged substances, sewage, garbage and air pollution. Detailed rules are laid out as to the extent to which (if at all) such substances can be released in different sea areas. The legislation giving effect to MARPOL in Australia is the Protection of the Sea (Prevention of Pollution from Ships) Act 1983, the *Navigation Act 2012* and several Parts of Marine Orders made under this legislation.	Yes	Already dealt with through the *Protection of the Sea (Prevention of Pollution from Ships) Act 1983* – refer to legislation table above.	N/A
International Convention for the Safety of Life at Sea 1974	This convention is generally regarded as the most important of all international treaties concerning the safety of merchant ships Implemented in the *Air Navigation Act 1920.*	Yes	Only relevant in so far as SOLAS relates to safety aspects of the activity, such as navigation aids which reduce potential for vessel collision and hydrocarbon release to the environment.	**Section 6.5** – Interactions with other marine users
International Convention on Civil Liability for oil pollution damage (1969)	This convention provides a mechanism for ensuring the payment of compensation for oil pollution damage.	No	Relevant to oil tankers.	N/A

International agreements and conventions	Summary	Relevant to activity?	Relevant aspects	EP section
International Convention for the Control and Management of Ships' Ballast Water and Sediments (Ballast Water Convention) 2004	The International Maritime Organization has been addressing the problem of invasive marine species in ship's ballast water since the 1980s. Ballast water and sediments guidelines were adopted in 1991 and the ballast water convention was adopted in 2004. Recent accession by Finland has triggered the final entry into force of these international requirements. As a result, the International Convention for the Control and Management of Ships Ballast Water and Sediment will enter into force on 8th September 2017 (International Maritime Organization Briefing 22 2016). It aims to prevent the spread of harmful aquatic organisms from one region to another, by establishing standards and procedures for the management and control of ships' ballast water and sediments. Ballast water management systems must be approved by the Administration in accordance with this International Maritime Organization Guideline.	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 7.2** – Introduction of invasive marine species

International agreements and conventions	Summary	Relevant to activity?	Relevant aspects	EP section
United Nations Convention on the Law of the Sea (UNCLOS) (1982)	Part XII of the convention sets up a general legal framework for marine environment protection. The convention imposes obligations on State Parties to prevent, reduce and control marine pollution from the various major pollution sources, including pollution from land, from the atmosphere, from vessels and from dumping (Articles 207 to 212). Subsequent articles provide a regime for the enforcement of national marine pollution laws in the many different situations that can arise. Australia signed the agreement relating to the implementation of Part XI of the Convention in 1982, and UNCLOS in 1994.	Yes	Only relevant to the extent that Santos will comply with MARPOL through the following relevant Marine Orders relating to marine pollution prevention have been put in place to give effect to relevant regulations of Annexes I, II, III, IV, V and VI of MARPOL 73/78: Marine Order 91: Marine pollution prevention – oil Marine Order 93: Marine pollution prevention – noxious liquid substances Marine Order 94: Marine pollution prevention – packaged harmful substances Marine Order 95: Marine pollution prevention – garbage Marine Order 96: Marine pollution prevention – sewage Marine Order 97: Marine pollution prevention – air pollution.	**Section 6.6** – Operational discharges **Section 6.8** – Spill response operations **Section 7** – for unplanned hydrocarbon and non-hydrocarbon/ chemical spills, Introduction of IMS
United Nations Framework Convention on Climate Change (1992)	The objective of the convention is to stabilise greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous interference with the climate system. Australia ratified the convention in December 1992 and it came into force on 21 December 1993.	Yes	Only relevant to the extent that to reduce impact of GHG emissions associated with vessel use, Santos will comply with MARPOL Annex VI (Marine Order 97: Marine pollution prevention – air pollution) and require the use of low sulphur fuel. The MODU and vessels will use MDO, which is a low sulphur fuel.	**Section 6.3** – Atmospheric emissions

Appendix B2: Consideration of the Indirect Consequences under Section 527E of the EPBC Act

Sub-section 75(2) of the EPBC Act requires that the Minister responsible for administering the EPBC Act, or their delegate when deciding whether an action is a controlled action, consider 'all adverse impacts (if any)' the action has, will have, or is likely to have, on protected matters.

For the purposes of the Act, under section 527E(1) an event or circumstance is an 'impact' of an action taken by a person if: (a) the event or circumstance is a direct consequence of the action; or (b) for an event or circumstance that is an indirect consequence of the action—subject to subsection 527E(2), the action is a substantial cause of that event or circumstance.

In respect to section 527E(1)(b), events/circumstances that are a result of actions taken by a third party (called a 'secondary action'), such as those arising in the context of scope 3 greenhouse gas emissions, will only be an indirect consequence of the action (called the 'primary action') where:

- The action is a substantial cause of the event or circumstance; and
- The primary action facilitates the secondary action to a major extent; and
- Both the secondary action and event/circumstance is either within the contemplation of the proponent of the primary action or is a reasonably foreseeable consequence of the primary action.

Santos has considered the potential for 'indirect consequences' to arise in relation to the Barossa development and specifically the petroleum activity that is the subject of this Environment Plan. In this context, for the purposes of applying section 527E(1)(b) and (2) of the EPBC Act to the OPGGS(E)R regulatory regime:

- The 'event or circumstances' is consumption or combustion of gas by a third party.
- The 'impact' is emission of greenhouse gases.
- The 'action' is:
  - The whole Barossa development in the context of an OPP assessment.
  - The particular petroleum activity (or activities) in the context of an Environment Plan assessment.

The OPP for the Barossa development was submitted by Santos in October 2016 and accepted by NOPSEMA in March 2018. A comprehensive environmental impact assessment was completed in accordance with established practice and policies at that time.

In the context of an Environment Plan, the nature of the 'petroleum activity' will determine the scope of relevant 'indirect consequences'. This may be a subset of the consequences that are relevant when undertaking an OPP assessment, as the activities are a component of the project as a whole.

For an event or circumstance to be an indirect consequence of a petroleum activity, the petroleum activity must be demonstrated as:

- A substantial cause of that event or circumstance (s. 527E(1)(b); and
- Facilitating, to a major extent, the action taken by the third party (as further explained in s. 527E(2)).

Neither the term 'substantial' or 'major' is defined in the EPBC Act. In accordance with typically usage and dictionary definitions:

- 'Substantial' means weighty or big, in a relative sense to be considerable and with reference to degrees of relevance, something more than significant.
- 'Major' means greater in size, amount, importance etc and constituting the majority or larger part.

In the context of this Environment Plan, the scope of relevant petroleum activity is limited to the drilling and completion of Barossa development wells. The Environment Plan does not permit the construction and operation of other facilities required to produce and transport the reservoir hydrocarbons (i.e. natural gas). Notably in relation to s.527E(1)(b) and (2):

+ No natural gas is recovered as a result of the drilling and completions activities. There are a number of subsequent, interposed petroleum activities that must be authorised under the OPGGS(E)R and then undertaken before any gas is capable of being recovered.
+ Gas consumption/combustion cannot reasonably be said to have been facilitated by a petroleum activity which has no resource extraction component. Even if it some kind of facilitation could be observed, drilling and completions activities cannot reasonably be characterised as an important or majority facilitator of that action. These activities are multiple steps removed from such a characterisation. Drilling and completions activities are therefore not a primary action to a secondary action involving gas consumption/combustion.
+ There are a chain of events prior to resource (i.e. natural gas) recovery, and then a chain of events afterwards and ahead of any resource being consumed by a third party. From a causal perspective, the link between drilling and completions activities and a third party greenhouse gas emission is weak. This petroleum activity cannot reasonably be characterised as having a weighty/big, considerable or significant causal relationship to third party gas consumption/combustion.
+ In this context, Santos has concluded that drilling and completions activities do not facilitate to a major extent natural gas consumption/combustion and this petroleum activity is not a substantial cause of any associated scope 3 greenhouse gas emissions.

At a later stage, Santos will be submitting Barossa development Environment Plans to extract, produce and transport the natural gas. Santos will have no ability to extract the natural gas from the development wells until such time as these petroleum activities have been assessed, meet the criteria in regulation 10A of the OPGGS(E)R and the Environment Plans have been accepted by NOPSEMA.

The causal relationship between production operations petroleum activities and consumption or combustion of gas by a third party is different in those circumstances. Santos will consider such indirect consequences in its future production operations Environment Plan.

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APPENDIX C – BAROSSA DEVELOPMENT VALUES AND SENSITIVITIES OF THE MARINE AND COASTAL ENVIRONMENT

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APPENDIX D– EPBC ACT PROTECTED MATTERS SEARCHES

Appendix D1 – Operational area PMST Report

Appendix D2 – EMBA PMST Report

Appendix D3 – MEVA PMST Report

APPENDIX E – STAKEHOLDER CONSULTATION RECORDS

APPENDIX F – SANTOS' ENVIRONMENT CONSEQUENCE DESCRIPTORS

Excerpt from *Offshore Division environmental hazard identification and assessment guideline* (EA-91-IG-00004), Revision 5 (issued October 2020).

Consequence level		I	II	III	IV	V	VI
Acceptability		Acceptable	Acceptable	Unacceptable	Unacceptable	Unacceptable	Unacceptable
Severity description		**Negligible** **No impact or negligible impact**	**Minor** **Detectable but insignificant change to local population, industry or ecosystem factors. Localised effect**	**Moderate** **Significant impact to local population, industry or ecosystem factors**	**Major** **Major long-term effect on local population, industry or ecosystem factors**	**Severe** **Complete loss of local population, industry or ecosystem factors AND/OR extensive regional impacts with slow recovery**	**Critical** **Irreversible impact to regional population, industry or ecosystem factors**
Environmental Receptors	Fauna In particular, EPBC Act listed threatened/migratory fauna or *WA Biodiversity Conservation Act 2016* specially protected fauna	Short-term behavioural impacts only to small proportion of local population and not during critical lifecycle activity. No decrease in local population size. No reduction in area of occupancy of species. No loss/disruption of habitat critical to survival of a species. No disruption to the breeding cycle of any individual. No introduction of disease likely to cause a detectable population decline.	Detectable but insignificant decrease in local population size. Insignificant reduction in area of occupancy of species. Insignificant loss/disruption of habitat critical to survival of a species. Insignificant disruption to the breeding cycle of local population.	Significant decrease in local population size but no threat to overall population viability. Significant behavioural disruption to local population. Significant disruption to the breeding cycle of a local population. Significant reduction in area of occupancy of species. Significant loss of habitat critical to survival of a species. Modify, destroy, remove, isolate or decrease availability of quality of habitat to the extent that a significant decline in local population is likely. Introduce disease likely to cause a significant population decline.	Long-term decrease in local population size and threat to local population viability. Major disruption to the breeding cycle of local population. Major reduction in area of occupancy of species. Fragmentation of existing population. Major loss of habitat critical to survival of a species. Modify, destroy, remove, isolate or decrease availability of quality of habitat to the extent that a long-term decline in local population is likely. Introduce disease likely to cause a long-term population decline.	Complete loss of local population. Complete loss of habitat critical to survival of local population. Widespread (regional) decline in population size or habitat critical to regional population.	Complete loss of regional population. Complete loss of habitat critical to survival of regional population.
	Physical Environment/Habitat Includes: air quality; water quality; benthic habitat (biotic/abiotic), particularly habitats that are rare or unique; habitat that represents a Key Ecological Feature[15]; habitat within a protected area; habitats that include benthic primary producers[16] and/or epi-fauna[17]	No or negligible reduction in physical environment/habitat area/function.	Detectable but localised and insignificant loss of area/function of physical environment/habitat. Rapid recovery evident within approximately two years (two season recovery).	Significant loss of area and/or function of local physical environment/habitat. Recovery over medium term (2–10 years).	Major, large-scale loss of area and/or function of physical environment/local habitat. Slow recovery over decades.	Extensive destruction of local physical environment/habitat with no recovery. Long-term (decades) and widespread loss of area or function of primary producers on a regional scale.	Complete destruction of regional physical environment/habitat with no recovery. Complete loss of area or function of primary producers on a regional scale.
	Threatened ecological communities (EPBC Act listed ecological communities)	No decline in threatened ecological community population size, diversity or function. No reduction in area of threatened ecological community. No introduction of disease likely to cause decline in threatened ecological community population size, diversity or function.	Detectable but insignificant decline in threatened ecological community population size, diversity or function; Insignificant reduction in area of threatened ecological community.	Significant decline in threatened ecological community population size, diversity or function. Significant reduction in area of threatened ecological community. Introduction of disease likely to cause significant decline in threatened ecological community population size, diversity or function.	Major, long-term decline in threatened ecological community population size, diversity or function. Major reduction in area of threatened ecological community. Fragmentation of threatened ecological community. Introduce disease likely to cause long-term decline in threatened ecological community population size, diversity or function.	Extensive, long-term decline in threatened ecological community population size, diversity or function. Complete loss of threatened ecological community.	Complete loss of threatened ecological community with no recovery.

[15] As defined by the Department of Agriculture, Water and Environment
[16] Benthic photosynthetic organisms such as seagrass, algae, hard corals and mangroves
[17] Fauna attached to the substrate including sponges, soft corals and crinoids.

Consequence level	I	II	III	IV	V	VI
Acceptability	Acceptable	Acceptable	Unacceptable	Unacceptable	Unacceptable	Unacceptable
Severity description	**Negligible** **No impact or negligible impact**	**Minor** **Detectable but insignificant change to local population, industry or ecosystem factors. Localised effect**	**Moderate** **Significant impact to local population, industry or ecosystem factors**	**Major** **Major long-term effect on local population, industry or ecosystem factors**	**Severe** **Complete loss of local population, industry or ecosystem factors AND/OR extensive regional impacts with slow recovery**	**Critical** **Irreversible impact to regional population, industry or ecosystem factors**
Protected Areas Includes: World Heritage Properties; Ramsar wetlands; Commonwealth/National Heritage Areas; Land/Marine Conservation Reserves.	No or negligible impact on protected area values. No decline in species population within protected area. No or negligible alteration, modification, obscuring or diminishing of protected area values.*	Detectable but insignificant impact on one of more of protected area's values. Detectable but insignificant decline in species population within protected area. Detectable but insignificant alteration, modification, obscuring or diminishing of protected area values.*	Significant impact on one of more of protected area's values. Significant decrease in population within protected area. Significant alteration, modification, obscuring or diminishing of protected area values.	Major long-term effect on one of more of protected area's values; Long-term decrease in species population contained within protected area and threat to that population's viability. Major alteration, modification, obscuring or diminishing of protected area values.	Extensive loss of one or more of protected area's values. Extensive loss of species population contained within protected area.	Complete loss of one or more of protected area's values with no recovery. Complete loss of species population contained within protected area with no recovery.
Socio-economic receptors Includes: fisheries (commercial and recreational); tourism; oil and gas; defence; commercial shipping.	No or negligible loss of value of the local industry. No or negligible reduction in key natural features or populations supporting the activity.	Detectable but insignificant short-term loss of value of the local industry. Detectable but insignificant reduction in key natural features or population supporting the local activity.	Significant loss of value of the local industry. Significant medium-term reduction of key natural features or populations supporting the local activity.	Major long-term loss of value of the local industry and threat to viability. Major reduction of key natural features or populations supporting the local activity.	Shutdown of local industry or widespread major damage to regional industry. Extensive loss of key natural features or populations supporting the local industry.	Permanent shutdown of local or regional industry. Permanent loss of key natural features or populations supporting the local or regional industry.

APPENDIX G – SPILL MODELLING RESULTS SUMMARY (MAXIMUM VALUES ACROSS ALL SEASONS AND WATER DEPTHS)

Appendix G1: Loss of well control spill modelling results (maximum values across all seasons and water depths)

Receptor	Receptor type	Probability of exposure (percent)					Minimum time before exposure on the sea surface (days)						
		Moderate exposure values			High exposure values		Moderate exposure values			High exposure values		Maximum dissolved hydrocarbon exposure (ppb) for a 96-hour window	Maximum entrained hydrocarbon exposure (ppb) for a 96-hour window
		Surface hydrocarbons (10 g/m²)	Dissolved hydrocarbons (50 ppb)	Entrained hydrocarbons (100 ppb)	Surface hydrocarbons (50 g/m²)	Dissolved hydrocarbons (400 ppb)	Surface hydrocarbons (10 g/m²)	Dissolved hydrocarbons (50 ppb)	Entrained hydrocarbons (100 ppb)	Surface hydrocarbons (50 g/m²)	Dissolved hydrocarbons (400 ppb)	0–10 m layer	0–10 m layer
Arafura	AMP	-	-	12	-	-	-	-	23.4	-	-	-	143
Ashmore Reef		-	-	-	-	-	-	-	-	-	-	-	13
Cartier Island		-	-	-	-	-	-	-	-	-	-	-	22
Oceanic Shoals		12	-	33	-	-	19.5		3.8	-		28	215
Carbonate bank and terrace system of the Sahul Shelf	KEF	-	-	-	-	-	-	-	-	-	-	-	45
Pinnacles of the Bonaparte Basin		-	-	6	-	-	-	-	12.3	-	-	-	126
Shelf break and slope of the Arafura Shelf		100	100	100	100	32	0.04	0.1	0.1	0.17	0.1	575	1843
Carbonate bank and terrace system of the Van Diemen Rise		39	-	42	-	-	10.2		2.7	-		23	289
Tributary canyons of the Arafura Depression		-	-	-	-	-	-	-		-	-	-	93
Continental slope demersal fish communities		-	-	-	-	-	-	-	-	-	-	-	22
Ashmore Reef and Cartier Island and surrounding Commonwealth waters		-	-	-	-	-	-	-	-	-	-	-	22
Barton Shoal	Shoals	-	-	-	-	-	-	-	-	-	-	-	21
Dillon Shoal		-	-	-	-	-	-	-	-	-	-	-	31
The Boxers		-	-	-	-	-	-	-	-	-	-	-	41
Cootamundra Shoal		-	-	-	-	-	-	-	-	-	-	-	29
Calder Shoal		-	-	-	-	-	-	-		-	-	-	45
Margaret Harries Banks		-	-	17	-	-	-	-	12.8	-	-	-	113
Lynedoch Bank		-	-	9	-	-	-	-	6.0	-	-	-	123
Evans Shoal		-	-	46		-	-		3.2	-		22	246

Receptor	Receptor type	Probability of exposure (percent)					Minimum time before exposure on the sea surface (days)						
		Moderate exposure values			High exposure values		Moderate exposure values			High exposure values		Maximum dissolved hydrocarbon exposure (ppb) for a 96-hour window	Maximum entrained hydrocarbon exposure (ppb) for a 96-hour window
		Surface hydrocarbons (10 g/m²)	Dissolved hydrocarbons (50 ppb)	Entrained hydrocarbons (100 ppb)	Surface hydrocarbons (50 g/m²)	Dissolved hydrocarbons (400 ppb)	Surface hydrocarbons (10 g/m²)	Dissolved hydrocarbons (50 ppb)	Entrained hydrocarbons (100 ppb)	Surface hydrocarbons (50 g/m²)	Dissolved hydrocarbons (400 ppb)	0–10 m layer	0–10 m layer
Franklin Shoal		-	-	17	-	-	-		5.6	-	-	11	149
Flinders Shoal		-	-	16	-	-	-		5.7	-	-	14	168
Blackwood Shoal		-	-	17	-	-	-		4.9		-	12	196
Martin Shoal		-	-	-	-	-	-	-	-	-	-	-	74
Loxton Shoal		-	-	-	-	-	-	-	-	-	-	-	74
Sunset Shoal		-	-	-	-	-	-	-	-	-	-	-	73
Troubadour Shoals		-	-	-	-	-	-	-	-	-	-	-	105
Sunrise Bank		-	-	-	-	-	-	-	-	-	-	-	59
Bellona Bank		-	-	-	-	-	-	-	-	-	-	-	81
Echo Shoals		-	-	-	-	-	-	-	-	-	-	-	72
Big Bank Shoals		-	-	-	-	-	-	-	-	-	-	-	52
Karmt Shoal		-	-	-	-	-	-	-	-	-	-	-	53
Jabiru Shoals		-	-	-	-	-	-	-	-	-	-	-	22
Pee Shoal		-	-	-	-	-	-	-	-	-	-	-	17
Mangola Shoal		-	-	-	-	-	-	-	-	-	-	-	16
Fantome Shoal		-	-	-	-	-	-	-	-	-	-	-	17
Johnson Bank		-	-	-	-	-	-	-	-	-	-	-	11
Woodbine Bank		-	-	-	-	-	-	-	-	-	-	-	18
Deep Shoal 1		-	-	-	-	-	-	-	-	-	-	-	19
Unnamed Shoal		17	-	-	-	-	12.3	-	-	-	-	-	-
Tassie Shoal		17	-	23	-	-	12.3	-	5.3	-	-	10	179

Appendix G2: Vessel collision spill modelling results (maximum values across all seasons and water depths)

Receptor	Receptor type	Probability of exposure					Minimum time before exposure on the sea surface (days)				
		Moderate exposure values			High exposure values		Moderate exposure values			High exposure values	
		Surface hydrocarbons (10-25 g/m²)	Dissolved hydrocarbons (50 ppb)	Entrained hydrocarbons (100 ppb	Surface hydrocarbons (>25 g/m²)	Dissolved hydrocarbons (400 ppb)	Surface hydrocarbons (10-25 g/m²)	Dissolved hydrocarbons (50 ppb)	Entrained hydrocarbons (100 ppb)	Surface hydrocarbons (>25 g/m²)	Dissolved hydrocarbons (400 ppb)
Oceanic shoals	AMP	-	-	6	-	-	-	-	5.0	-	-
Arafura		-	-	1	-	-	-	-	15.2	-	-
Shelf break and slope of the Arafura Shelf	KEF	100	-	3	100	-	0.04	-	0.04	0.04	-
Pinnacles of the Bonaparte Basin		-	-	1	-	-	-	-	13.5	-	-
Carbonate bank and terrace system of the Van Diemen Rise		1	-	4	-	-	3.3	-	2.0-	-	-
Margaret Harries Banks	Shoals	-	-	2	-	-	-	-	7.9	-	-
Evans Shoal		-	-	6	-	-	-	-	1.6	-	-
Echo shoals		-	-	1	-	-	-	-	18.8	-	--
Franklin Shoal		-	-	2	-	-	-	-	3.2	-	-
Flinders Shoal		-	-	11	-	-	-	-	3.4	-	-
Lynedoch Bank		-	-	1	-	-	-	-	6.0	-	-
Blackwood Shoal		-	-	4	-	-	-	-	2.9	-	-
Martin Shoal		-	-	1	-	-	-	-	4.2	-	-
Sunset shoal		-	-	1	-	-	-	-	19.3	-	-
Troubadour Shoals		-	-	1	-	-	-	-	6.9	-	-
Tassie Shoal		-	-	5	-	-	-	-	3.8	-	-