

# Barossa Development

## Production Operations Environment Plan

# Santos

### Overview

The Barossa Development is an offshore natural gas development located approximately 300 kilometres north-west of Darwin. The development will backfill gas supply to the existing Darwin LNG (DLNG) facility at Wickham Point.

Santos NA Barossa Pty Ltd (Santos), as Operator, on behalf of co-venturers SK E&S Australia and JERA, is executing the Barossa Development with first gas production targeted for the first half of 2025.

The development is located in Commonwealth waters within petroleum production licence NT/L1, known as the Barossa Field (**Figure 1**). The development involves producing natural gas and condensate from the Barossa Field through subsea wells and a network of subsea flowlines and marine risers to a Floating, Production, Storage and Offloading (FPSO) vessel.

Processing will occur on the FPSO to separate the natural gas and condensate. The condensate will be transferred from the FPSO to specialised offtake tankers for export.

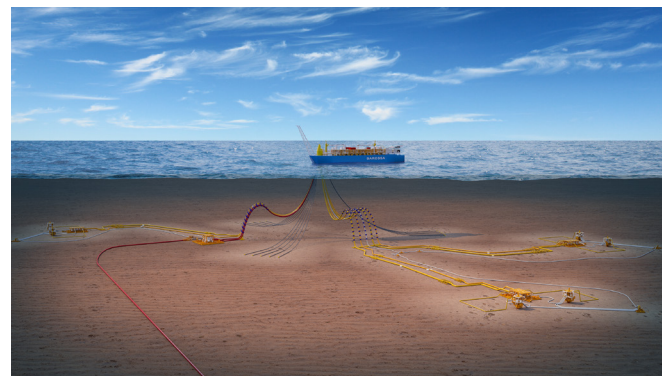
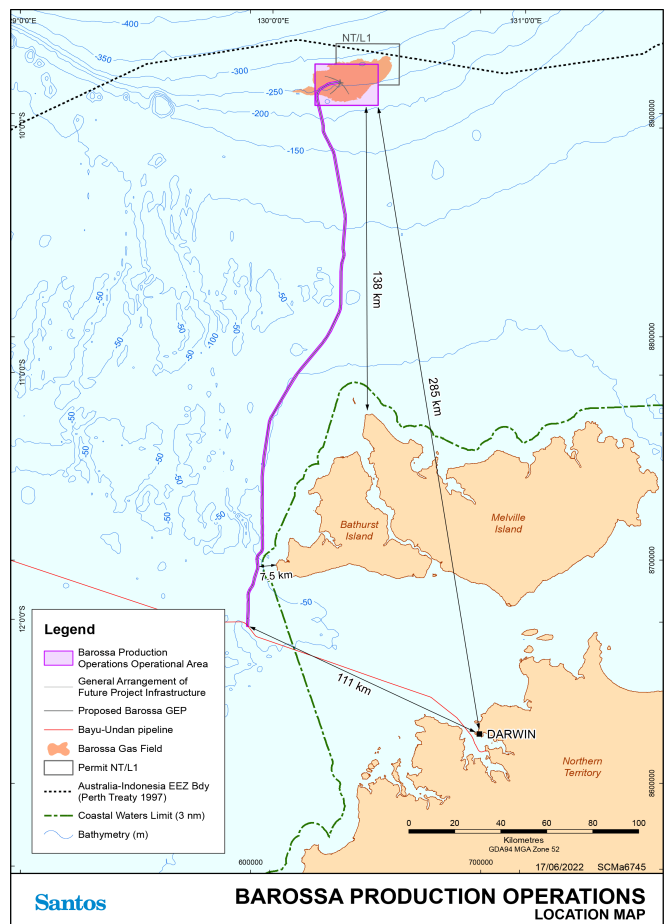
Gas will be transported from the FPSO to DLNG via a new 262 km Barossa Gas Export Pipeline (Barossa GEP) connected to the existing Bayu-Undan to Darwin pipeline. This continues to be the 'base case' for delivery of Barossa gas to the DLNG facility and Santos continues to progress regulatory approvals for this case.

Santos is also investigating the potential extension of the Barossa GEP all the way to Darwin in support of any future opportunity to deliver gas to DLNG while preserving the Bayu-Undan to Darwin pipeline for life extension and/or re-purposing opportunities, including potential Carbon Capture and Storage at Bayu-Undan. Regulatory approvals for this alternative case are also being progressed with the relevant authorities.

The Commonwealth Government's independent expert regulator for offshore oil and gas development, NOPSEMA, has accepted Santos' Offshore Project Proposal (OPP) and subsequent Environment Plans to drill the production wells in the Barossa Field and install the Barossa GEP.

During 2022 Santos will submit two further Environment Plans to NOPSEMA for assessment – one for the installation and pre-commissioning of Subsea Infrastructure and FPSO Moorings in the Barossa Field and the other for Production Operations covering the sustained operations of the FPSO and the Barossa GEP. This consultation package relates to Barossa Production Operations.

**Figure 1: Barossa Development Location**



## Production Operations - Key Facilities

The key facilities during production operations are:

- Floating Production, Storage and Offloading (FPSO) facility
- Gas Export Pipeline
- Subsea production system tied back to FPSO (including moorings)

### Floating Production, Storage & Offloading

The FPSO enables in-field hydrocarbon processing and condensate storage and export. Reservoir fluids will be separated on the FPSO into separate gas and condensate streams.

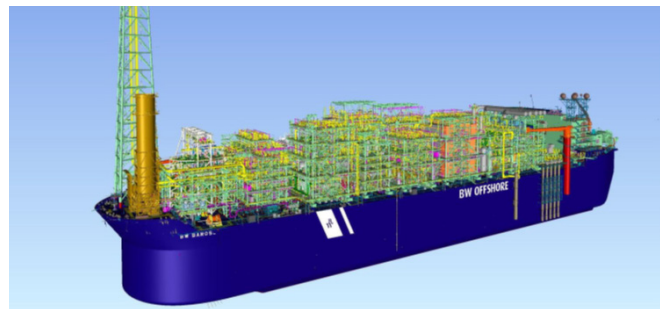
Condensate that is recovered from the gas is stabilised, cooled and stored in tanks in the hull of the FPSO (noting that the FPSO will be double hulled). The condensate is then periodically offloaded to export tankers using a tandem offloading system.

The gas stream is dehydrated, stripped of condensate, treated for partial CO<sub>2</sub> removal and compressed for export via the Barossa GEP.

The FPSO will be 355 m in length and 64 m wide with capacity for 140 personnel. It will be permanently moored using a turret mooring system to enable positioning in all met-ocean conditions.

The main design elements, facilities and services of the FPSO are:

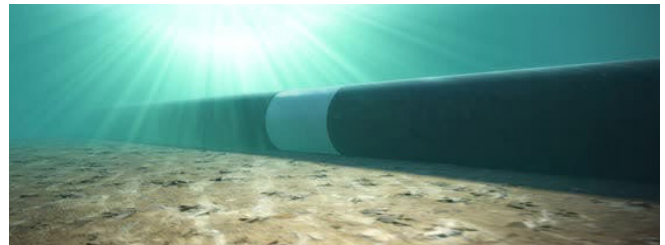
- Subsea control system to manage operation of the in-field subsea infrastructure
- Gas-liquid separation facilities
- Gas processing system, including thermal oxidiser
- Mercury removal and disposal to shore
- Facilities for stabilisation, storage and offloading of condensates
- Compression facilities
- Flaring and venting systems
- Gas turbine generators for supply of electric power
- Accommodation facilities for 140 personnel
- Reverse osmosis plant to provide potable water
- Cooling water systems
- Produced water treatment facilities
- Sewage and greywater treatment systems
- Open and closed drainage systems
- Ballast water system



### Gas Export Pipeline

The Barossa GEP will transport the processed dry gas from the Barossa Field to a tie-in point on the existing Bayu-Undan to Darwin Pipeline. The carbon steel and concrete-coated rigid pipeline will be 262 km in length. The Barossa GEP route is shown in **Figure 2**.

An indicative layout of the subsea infrastructure in the Barossa Field during Production Operations is shown in **Figure 2** while the Operational Area is shown in **Figure 3**.



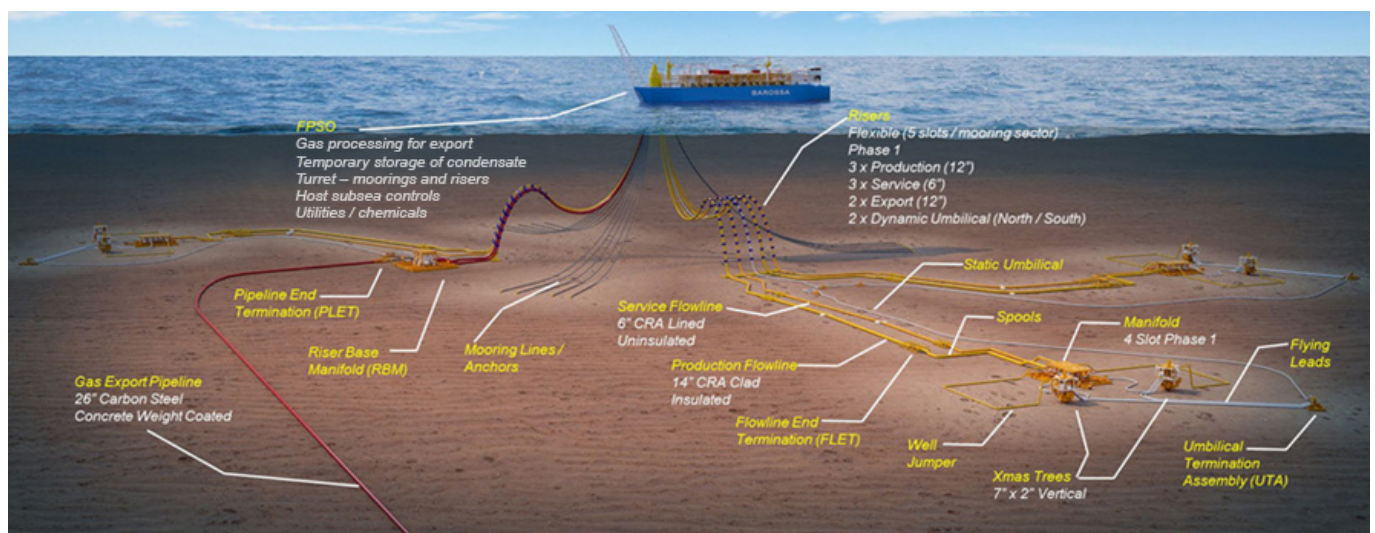
### Subsea Wells and Infrastructure

In-field subsea infrastructure includes the following:

- Subsea production wells
- Manifolds and rigid jumper connecting spools
- Rigid flowlines, flexible risers, umbilicals and flying leads
- Submerged Turret Production (STP) buoy and FPSO mooring system
- Gas export system

Additional information on the subsea infrastructure is available in the separate Subsea Infrastructure and FPSO Moorings Installation EP fact sheet.

**Figure 2: Barossa Field layout during Production Operations**



## Table 1: Production Operations Activity Information

ACTIVITY INFORMATION		
<b>Location</b>	Production operations will occur within Commonwealth waters in petroleum production licence NT/L1 and pipeline licence NT/PL5.	
<b>Schedule</b>	Activities as early as H2, 2024 with planned production operations in H1, 2025.	
<b>Duration</b>	~25 years of operations.	
<b>Water depth</b>	FPSO: permanently moored in ~255 m within the Barossa Field. Pipeline: ranging from 33 m (southern end) to 254 m (northern end in Barossa Field).	
<b>Equipment/vessels</b>	<ul style="list-style-type: none"> <li>• Permanently moored FPSO with regular condensate offtakes</li> <li>• Offshore vessels and helicopters</li> <li>• Subsea production system and infrastructure</li> <li>• 26-inch carbon steel, concrete coated gas pipeline 262 km in length</li> </ul>	
<b>Key activities</b>	<ul style="list-style-type: none"> <li>• Integrity testing of the subsea production system and supporting infrastructure including the testing of wells and valves</li> <li>• Introduction of well fluids and hydrocarbons</li> <li>• Hook-up of the FPSO, final commissioning and operation of the subsea production system, FPSO and GEP</li> <li>• Temporary condensate storage and offloading to third party tankers</li> <li>• Inspection, maintenance and repair (IMR) and survey activities</li> <li>• Support activities (general vessel and helicopter activities, crew and equipment transfer, refuelling, transfer of waste and supplies).</li> </ul>	
<b>Exclusion zone</b>	Petroleum Safety Zones (approx. 500 m radius) around installed relevant subsea equipment (wells, manifolds/ terminations, risers and moorings) (subject to NOPSEMA acceptance and gazettal). A Precautionary Safety Zone within the Operational Area will also be requested (via AMSA process).	
<b>Operational area</b>	See Figure 1 comprising the Barossa Field and GEP route.	
<b>Natural environment (within the Operational Area)</b>	<p>FPSO location: seabed is generally flat and devoid of significant bathymetric features. Marine sediments predominantly silty sand and lack hard substrate.</p> <p>Pipeline and subsea infrastructure: seabed varies from relatively smooth and gentle slopes (northern end) to being irregular with channels, ridges and mounds with steep gradients (southern end). Gradual transition in marine sediments from fine to medium sands/silt and clay (northern end) to coarse, gravelly sands (southern end).</p> <p>The Operational Area is located within Commonwealth waters in the Timor Sea within the North Marine Region (NMR).</p>	
<b>Proximity to key regional features</b>	<b>Regional Feature</b>	<b>Distance</b>
	Darwin NT	~300 km from FPSO. ~123 km from pipeline
	Tiwi Islands, NT	~140 km from FPSO. ~7 km from pipeline at closest point adjacent to the south west of Bathurst Island
	Oceanic Shoals Marine Park	~50 km from FPSO. Pipeline traverses a section of the Marine Park
	Key Ecological Feature - Shelf Break and Slope of Arafura Shelf	Partial overlap with the Operational Area
	Commercial Fisheries - Supplementary information provided to commercial fishers	Partial overlap of the Operational Area with Timor Reef Fishery, Northern Prawn Fishery and Spanish Mackerel Fishery
<b>Worst case hydrocarbon spill scenario</b>	Potential hydrocarbon spill risks will be described in the EP including vessel collision and accidental damage to subsea infrastructure. Those deemed as credible spill risks will be modelled and assessed in detail.	
<b>Response tier required</b>	A Level 3 response would be implemented as per the activity-specific Oil Pollution Emergency Plan (OPEP).	

## Environmental Impacts and Risks

Relevant environmental aspects associated with planned and unplanned production operations activities are described in **Table 2**.

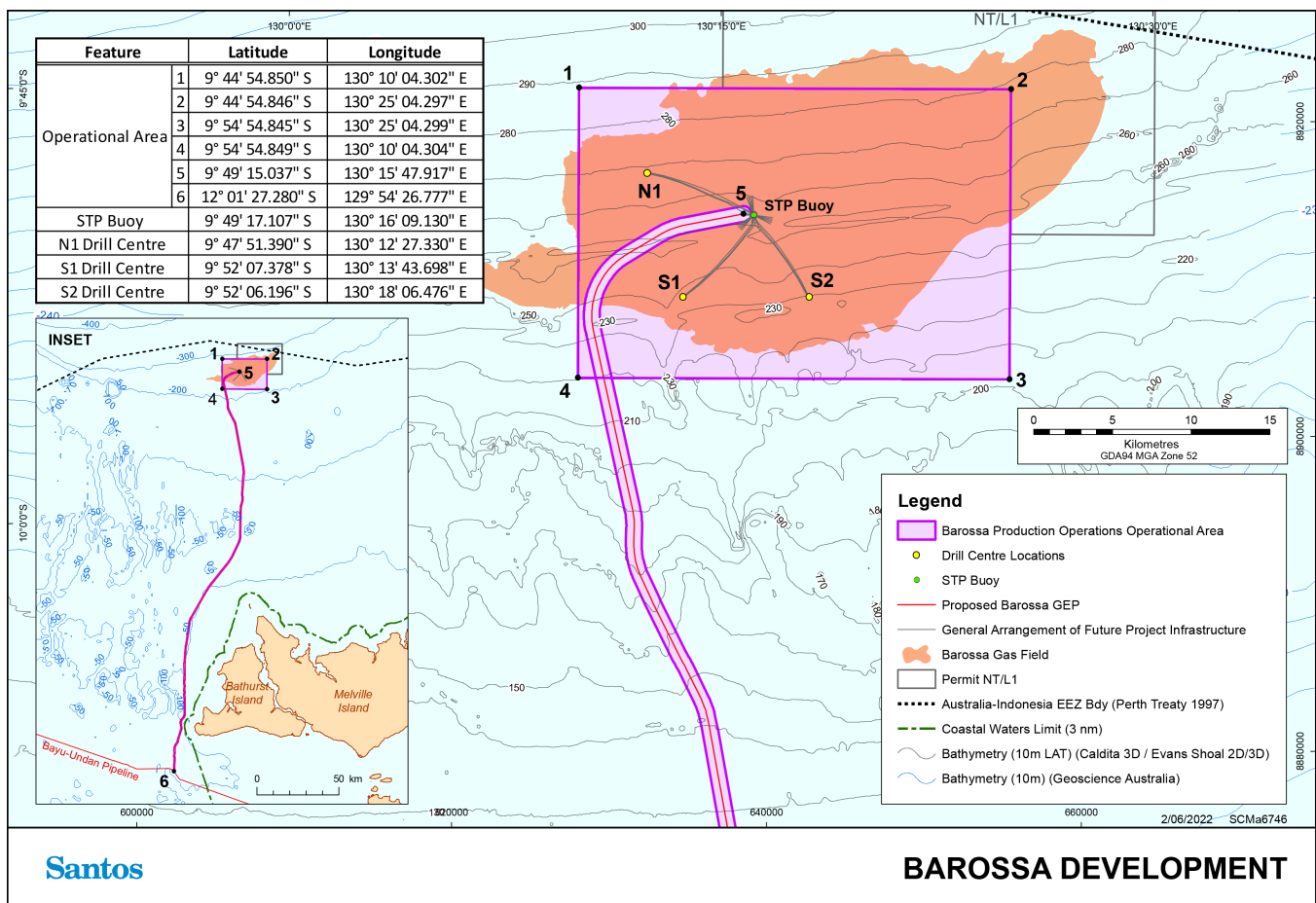
The environmental assessments for the proposed production operation activities have considered the following information:

- The activities involve standard offshore industry practices.
- The identified environmental aspects, receiving environment and potential impacts and risks are well understood.
- The FPSO is in a remote offshore location that does not coincide with any marine reserves or biological important areas (BIAs).
- Activities will occur in an open-ocean environment with highly dispersive metocean processes.
- The benthic habitats in the area are widely represented at a regional scale.

- Impact on the activities of other marine users, mainly commercial fishers, will be offset by the availability of extensive actively fished areas outside the Operational Area.
- The Gas Export Pipeline which intersects the Marine Park and is closest to shorelines will transport dry natural gas only.
- Greenhouse gas emissions will be managed over the life of the development in accordance with Australian regulations and Santos' climate transition strategy and action plan outlined in our Climate Change Report.

Development has been ongoing since 2016, with feedback incorporated into accepted and proposed environment plans. Santos draws stakeholders' attention to the significant amount of publicly available information on the existing environment, impacts and risks and management approach for the project. This information is contained within the Barossa Development Area OPP, Development Drilling EP and GEP Installation EP available on the NOPSEMA website.

**Figure 3: Production Operations - Operational Area**





**Table 2: Environmental Assessment**

ENVIRONMENTAL ASSESSMENT	
ASPECT	ASSESSMENT
<b>Noise emissions (planned)</b>	<p>FPSO: Ongoing noise will be generated by the FPSO and visits of other vessels and helicopters. FPSO is in a remote location with transient marine life. Regular maintenance of equipment will occur. Vessel and helicopter visits will be regular but of limited duration.</p> <p>Pipeline and subsea infrastructure: Noise from vessels during IMR activities will be of low impact and limited duration.</p>
<b>Atmospheric emissions (planned)</b>	<p>Santos has industry-leading emissions reduction targets, including a net-zero Scope 1 and 2 2040 target. All emissions associated with the project have been reduced to ALARP, and continuous improvement processes will be implemented to enable Santos to reach its net zero targets.</p> <p>FPSO: Emissions will occur throughout operations with the primary sources being venting of reservoir CO<sub>2</sub> and fuel combustion on the FPSO and visiting vessels. All visiting vessels use marine diesel. The FPSO primarily uses fuel gas with emergency diesel as a back-up. Emissions will also occur during flaring.</p> <p>Reservoir CO<sub>2</sub> is premised to be removed offshore prior to delivery into the gas export pipeline to a level that is compatible with existing DLNG facilities. GHG emissions will be reported to the Clean Energy Regulator using the <i>National Greenhouse and Energy Reporting Act 2007</i> (NGER) methodology.</p> <p>Emissions associated with venting of the reservoir CO<sub>2</sub> varies with production rates and reservoir properties, although they are expected to average ~1.8 mt CO<sub>2</sub>e/ year on plateau production. Whilst venting of reservoir CO<sub>2</sub> is common industry practice, as part of continuous improvement Santos is progressing the design of the Bayu-Undan Carbon Capture and Storage Project. This project has the potential to prevent these reservoir CO<sub>2</sub> emissions through capture and permanently storage in a depleted reservoir.</p> <p>Emissions associated with fuel combustion and flaring have previously been estimated at between 0.7 and 1.7 mt CO<sub>2</sub>e/yr. Energy efficient design measures and operating practices have since been developed to reduce these emissions to ALARP, resulting in emissions at the lower end of the previous range. These design measures include a fully electrified operation powered by a highly efficient combined cycle power generation system as well as LP flare recovery systems.</p> <p>Pipeline and subsea infrastructure: Emissions from the subsea and pipeline infrastructure will be limited to vessels during IMR and survey activities.</p>
<b>Light emissions (planned)</b>	<p>FPSO: The FPSO and visiting vessels will be constantly lit to meet operational safety and navigational requirements. Under normal operations, the pilot flare for the FPSO is not expected to be brighter than normal operational lighting. Light emissions from non-routine/upset flare events will be intermittent and varied in duration.</p> <p>Pipeline and subsea infrastructure: Light from vessels during IMR activities along the pipeline will be minimal, in order to meet operational safety and navigational requirements.</p>
<b>Seabed and benthic habitat disturbance (planned)</b>	<p>FPSO: The FPSO will attach to a mooring buoy, held in place by a subsea mooring system. All visiting vessels will operate on Dynamic Positioning (DP) negating any requirement to anchor.</p> <p>Pipeline and subsea infrastructure: Minor seabed disturbance associated with lateral movement of installed infrastructure is expected to only occur in cyclonic and storm events. It is anticipated, as seen with other pipelines in the region, that the pipeline will become partially buried which provides further stabilisation.</p>
<b>Operational discharges (planned)</b>	<p>FPSO: A number of planned discharges will be released to the marine environment during operations. These include production water (produced formation water), cooling water and treated sewage and greywater. Produced water will have a hydrocarbon content that is no greater than an average of 30 mg/L, being a standard industry threshold for oil-in-water concentration. Discharges to the marine environment will be recorded and controlled in accordance with requirements under relevant maritime requirements.</p> <p>Chemicals associated with production and marine operations will be routinely discharged to the marine environment or could be released due to an unplanned event. Therefore chemical selection and management protocols will be implemented. Assessment and approval of chemical products is based on potential environmental hazards, intended use and justification, quantity required and management controls proposed. Hazardous and non-hazardous wastes will be removed from the FPSO and vessels and returned to shore for recycling and/or disposal.</p> <p>Pipeline and subsea infrastructure: The GEP will be nitrogen filled and ready for hook-up to the FPSO. No discharges are anticipated during the hook-up phase.</p>
<b>Introduction of Invasive Marine Species (unplanned)</b>	<p>Operations will be managed in accordance with a Quarantine Management Plan and all relevant Australian and international regulations. As part of ongoing maintenance and to facilitate inspections, the removal of marine growth may be required.</p>
<b>Collision with other vessels (unplanned)</b>	<p>FPSO: The FPSO is permanently moored (weathervaning). The FPSO will be located away from key commercial shipping channels. The location will be communicated to others ships with Notice to Mariners from the Australian Hydrographic Office AHO. All visiting vessels use dynamic positioning. Maritime standards and international regulations apply to all vessels. Santos will be seeking the implementation of a cautionary safety zone around the FPSO.</p> <p>GEP: During IMR campaigns, the location of vessels will be communicated to other ships with Notice to Mariners from the AHO.</p>

ENVIRONMENTAL ASSESSMENT (CONTINUED)	
ASPECT	ASSESSMENT
<b>Collision with marine fauna (unplanned)</b>	<p>FPSO: The FPSO is permanently moored and located in a remote area where marine life is predominantly transient. Speed restrictions will apply to vessel movements.</p> <p>Pipeline and subsea infrastructure: IMR vessels will have speed restrictions.</p>
<b>Loss of hazardous and non-hazardous materials (unplanned)</b>	<p>Large unplanned hydrocarbon and chemical releases represent low probability events that are generally associated with accidental or unanticipated events, such as equipment failure, vessel collisions or emergency conditions.</p> <p>A comprehensive suite of control measures will be implemented to reduce the risks and potential impacts in the unlikely event of an unplanned discharge to the marine environment, including elimination controls (wherever possible), engineering controls, planned maintenance, operational procedures and spill response measures.</p> <p>Note: the pipeline will contain dry gas (no liquid hydrocarbon). The GEP and subsea infrastructure will be clearly marked on Australian nautical charts.</p>
<b>Implementation of spill response (unplanned)</b>	A Level 3 response would be implemented as per the activity-specific Oil Pollution Emergency Plan (OPEP).

## General Commitments

Santos will implement control measures to ensure environmental impacts and risks are acceptable and 'as low as reasonably practicable' (ALARP). These measures will be detailed in the EP submitted to NOPSEMA for assessment. The EP will be available on the NOPSEMA website.

Included are commitments to the following control measures to minimise interactions with other marine users. In addition to control measures for managing specific environmental impacts and risks, the EP will include control measures to minimise interactions with other marine users. Control measures identified by stakeholders to address any objections or claims will be considered by Santos and documented in the EP.

AREA OF INTEREST	SANTOS COMMITMENTS
<b>Maritime notices</b> <ul style="list-style-type: none"> <li>• <b>Notice to Mariners (NTM)</b></li> <li>• <b>AUSCOAST warnings</b></li> </ul>	During Operations vessel movements are notified via the Australian Maritime Safety Authority Joint Rescue Coordination Centre, Australian Hydrographic Office and designated port authorities.
<b>Stakeholder notifications</b>	Prior to Operations commencing, other relevant marine users identified during stakeholder consultation will be provided a commencement notification prior to the activity commencing. Santos will ensure all stakeholder feedback is recorded, evaluated and responded to.
<b>Monitoring during activity to reduce potential for collision or interference with other marine users</b>	During Operations the FPSO facility will monitor approaching third-party vessels and communicate with the vessels.

## Feedback

In accordance with Division 2.2A – Consultation in Preparing an Environment Plan - of the Commonwealth *Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009*, Santos is consulting with 'relevant persons' whose functions, interests or activities may be affected by the activities to be carried out under this EP. The consultation process will help inform the preparation of the plan that, once completed, will be submitted to NOPSEMA for formal assessment and made publicly available.

**If you have any objections, claims or information requests please contact us by 15 July 2022 via phone or email.**

Santos will endeavour to address all stakeholder feedback prior to the EP being submitted to NOPSEMA.

Consultation for this activity will be ongoing post regulatory acceptance and throughout the period of operations.

### Contact

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